

A Report on The Sixteenth International TOVS Study Conference

Angra dos Reis, Brazil

7-13 May 2008

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FOREWORD

The International TOVS Working Group (ITWG) is convened as a sub-group of the International Radiation Commission (IRC) of the International Association of Meteorology and Atmospheric Physics (IAMAP). The ITWG continues to organise International TOVS Study Conferences (ITSCs) which have met approximately every 18 months since 1983. Through this forum, operational and research users of TIROS Operational Vertical Sounder (TOVS), Advanced TOVS (ATOVS) and other atmospheric sounding data have exchanged information on data processing methods, derived products, and the impacts of radiances and inferred atmospheric temperature, moisture, and cloud fields on numerical weather prediction (NWP) and climate studies.

The Sixteenth International TOVS Study Conference (ITSC-XVI) was held at the Hotel do Frade near Angra dos Reis from 7-13 May 2008. With about 130 participants representing 18 countries and 3 international organizations, this conference report summarises the scientific exchanges and outcomes of the meeting. A companion document, *The Technical Proceedings of The Sixteenth International TOVS Study Conference*, contains the complete text of ITSC-XVI scientific presentations. The ITWG Web site (<http://cimss.ssec.wisc.edu/itwg/>) contains electronic versions of the conference presentations and publications. Together, these documents and Web pages reflect the conduct of a highly successful meeting in Angra. An active and mature community of TOVS and ATOVS data users exists, and considerable progress and positive results were reported at ITSC-XVI in a number of areas, including many related to the ATOVS system, use of IASI measurements, and to the other current and impending advanced sounders.

ITSC-XVI was sponsored by industry, government agencies and a university, including, VCS Engineering, CNES, Kongsberg Spacotec AS, ABB, ITT Industries, Ball Aerospace, the Met Office, the University of Wisconsin-Madison Space Science and Engineering Center, EUMETSAT, NOAA/NESDIS, CPTEC, SeaSpace, NASA, NPOESS and the NSMC. The support of these groups is gratefully acknowledged. We wish to thank the local organising committee from the Centro de Previsão de Tempo e Estudos Climáticos, National Institute of Space Research (INPE/CPTEC), located in Cachoeira Paulista, SP, Brazil, especially to Dr. Dirceu Herdies, Dr. Rodrigo Souza and Dr. Simone da Costa for their exceptional effort and talent in leading the local organization, and to Carine Previatti and Marcelo Acquaviva of Acquaviva Produções e Promoções for their enthusiastic support to the CPTEC team. Finally, appreciation is given to the local sponsors, including Petrobras and SBMET.



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TOVS STUDY CONFERENCE (ITSC-XVI)

Angra dos Reis, Brazil: 7-13 May 2008

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International TOVS Study Conference-XVI Working Group Report

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International TOVS Study Conference-XVI Working Group Report

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The Sixteenth International TOVS Study Conference

7 – 13 May 2008



ITSC-XVI Group Photo at Angra dos Reis, Brazil



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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Sixteenth International TOVS Study Conference, ITSC-XVI, was held near the town of Angra in Brazil from 7-13 May 2008. Around 130 participants attended the Conference and provided scientific contributions with 19 countries and 3 international organizations represented: Argentina, Australia, Brazil, Canada, China, France, Germany, Hungary, India, Italy, Japan, Norway, Poland, Russia, Sweden, Switzerland, Taiwan, United Kingdom, United States, ECMWF, EUMETSAT and WMO. The number of attendees was the highest ever. The Working Groups had very useful discussions, and it was again encouraging to see a large number of new younger scientists participating. This was the first opportunity for the conference to discuss the use of new data from MetOp-A, which was launched just after ITSC-XV, and it was exciting to see the substantial progress already achieved by several centres.

Most of the meeting was occupied with oral presentations and three poster sessions, one of which had short oral poster introductions, on a range of issues which included the following:

- Radiative transfer and surface modeling
- Climate applications
- ATOVS cloud studies
- Direct broadcast software, preprocessing and calibration and frequency protection (again dedicated to Guy Rochard)
- IASI
- Operational use of ATOVS
- Developments in use of ATOVS in NWP
- International issues and agency status reports
- Products from ATOVS
- Future sensors

There were 95 oral presentations, including 14 poster introductions, 16 working group and technical sub group presentations and 86 posters presented during the conference; the agenda is given beginning on page 87. All of the talks and many of the posters can be viewed at the ITWG Web site, located at <http://cimss.ssec.wisc.edu/itwg/>

Working Groups were formed to consider six key areas of interest to the ITWG, including Radiative Transfer and Surface Property Modelling; Use of ATOVS in Numerical Weather Prediction; Use of TOVS and ATOVS for Climate Studies; Advanced Sounders; International Issues; and Satellite Sounder Science and Products. The Working Groups reviewed recent progress in these areas, made recommendations on key areas of concern and identified items for action. Working Group reviews and recommendations comprise an important part of the ITSC-XV Working Group Report. A summary of the key points arising from the conference are listed below.

During the Conference, a session on Working Group status reports considered activities that had taken place since ITSC-XV in Maratea. This session also reviewed progress on the Action Items and Recommendations identified by the ITSC-XV Working Groups. Many of these items formed the basis for further discussion by the Working Groups at ITSC-XVI. Several technical sub-groups also met during ITSC-XVI to discuss developments and plans

concerning specific software packages, shared and in common use, and microwave frequency protection. Brief reports on these sub-group meetings are provided in section 3.

The conference also paid tribute to Izabela Dyras, an active member of the group, who died in 2007. During the conference banquet on Itanhanga Island, Bozena Lapeta, Paolo Antonelli and Tom Achtor recalled Izabela's life and her contribution both to ITWG and to developing the use of satellite data in Poland. She will be sadly missed by the ITWG.

1.2 SUMMARY OF MAJOR CONCLUSIONS

The ITSC-XVI presentations, posters, Working Group meetings and discussions documented significant issues and noted areas for future activity. In particular, it noted that:

1. LEO IR and MW sounding capability on three orbital planes is essential to proper sampling of atmospheric temperature and humidity vertical profiles. At present there is no IR sounding capability planned for the early morning orbit and the performance of the MIS sounding channels is yet to be assessed. The group recommended WMO, CGMS and CEOS investigate scenarios for sounding instruments in the early morning orbit.
2. The results of new observing system experiments presented at ITSC-XVI demonstrate that satellite data have a large impact on weather forecast accuracy and promising new results suggest the potential for future enhancements in the use of satellite sounder and imager data. It is crucial that future instruments as a baseline maintain, and if cost effective, improve upon the quality of AMSU and IASI.
3. Many NWP centres are now assimilating radiances operationally or experimentally from the Infrared Atmospheric Sounding Interferometer (IASI), and getting significant positive forecast impacts. The experience with AIRS was crucial to the rapid implementation of IASI.
4. The Regional ATOVS Retransmission Service, RARS, has continued to develop since ITSC-XV. The Asia-Pacific RARS service has continued to expand and more NWP centres are using the RARS data. RARS networks in S. America and Africa are now available. The group encouraged WMO and the space agencies to continue to develop this ATOVS retransmission service as a low cost means of providing more timely ATOVS data for 90% of the globe. The Southern Ocean and North Pacific were identified by one study as particularly needing RARS.
5. The group continues to strongly support the SafetyNet concept, which will allow rapid dissemination of global NPOESS data products, identifying it as one of the most attractive features of NPOESS. WMO and the RARS Implementation Group were invited to consider an expansion of RARS for NPP and NPOESS-C1 as SafetyNet will become fully operational only from NPOESS-C2 onwards.
6. An important issue for consideration is that when MODIS is retired, according to current plans, there will not be an imager in polar orbit with a channel in the water vapour band. This will degrade the accuracy of any polar satellite derived winds. Space agencies are urged to consider the best means for providing a polar orbiting imager with water vapour channels along with the conventional VIS and IR channels.

7. Further progress in the pre-processing of SSMIS data has been made with the development of the unified preprocessor, jointly developed by several centres with a strong interest in SSMIS data quality. More NWP centres are now able to use the DMSP-F16 SSMIS sounding channels operationally and progress is being made with DMSP-F17 SSMIS. The group encouraged the SSMIS cal/val team to make the data available from DMSP-F18 as early as possible after the launch to expedite their use in operational systems.
8. The group urged space agencies to use expertise from NWP centres throughout the cal/val phase for new instruments, as proved particularly successful for SSMIS and IASI.
9. The group encouraged the careful characterization of new satellite instruments, notably promoting the use of pre- and post-launch traceable calibration standards for future sounders.
10. The group noted that lossy datasets for advanced sounders may not be suitable for all applications and consequently recommended techniques for spatial as well as spectral thinning to be studied for distribution of advanced sounder data, notably IASI.
11. The community software packages (i.e., AAPP, IAPP, IMAPP) have been essential in the use of ATOVS, IASI, AIRS and MODIS data by the meteorological community. The group encouraged satellite agencies to continue to support these packages for existing missions and to develop and release pre-processing software packages (e.g., IPOPP) as soon as practical before launch.
12. The group urged space agencies to provide documentation on data formats well before launch to allow similar community software packages to be developed for planned new satellites (e.g., FY-3 and NPP).
13. The group noted the increasing threat of RF interference in microwave imager channels. All members were urged to lobby their respective radio communication authorities to support protection of the imager and sounder bands and specifically to identify useful bands between 275 and 3000 GHz and to undertake more detailed studies in support of 52.6-59.3 GHz and 86-92 GHz.
14. Satellite agencies were again encouraged to continue and expand their support for education and training of the next generation of remote sensing scientists.
15. It was also noted that research into truly lossless compression techniques continues in the wider scientific community. It is recommended that space agencies investigate both lossless and lossy data compression techniques which may be used to aid dissemination of advanced sounder observations.
16. Optimal use of community state-of-art software packages within the central operational processing for satellite programs has been raised again and the group is continuing to recommend to the space agencies to promote partnership in building environmental satellite systems where government, industry and university science communities share their expertise.

17. The time series of (A)TOVS now exceeds 29 years and the quality and number of climate products continues to grow. It was recognized that the fundamental instrument parameters of all the (A)TOVS sensors should be retained for future reprocessing efforts.
18. The group supported the continuing efforts to develop the GCOS Reference Upper Atmospheric Network (GRUAN) for climate with the primary objective of creating long term records of critical upper air measurements and associated error characteristics to support their continuing integration in climate applications and research.
19. The ITWG noted that the TOVS/ATOVS lower tropospheric climate data record is view geometry dependent and this product would be lost if there was a migration to a conical viewing geometry.
20. It was recognised that hyperspectral resolution imaging radiometers on geostationary platforms are likely to be an important part of the future global observing system. The group supported plans for operational missions but would also welcome a preparatory mission earlier than 2015 if possible.
21. The group noted that GPSRO data has allowed better characterization of biases in passive sounding data from 20-40 km and consequently operational continuity for COSMIC is now important to maintaining good quality passive upper level sounding data.
22. The success of the JAIVEx campaign in support of cal/val for IASI was reported at ITSC-XVI both in support of assimilation of IASI observations in NWP and to improve characterization of climate data records. The group urged similar campaigns for future instruments.
23. Many centres are experiencing difficulty using moisture-sensitive channels and the group urged more focused effort in this area and encouraged more exchanges of experience between centres.
24. Since ITSC-XV several centres have made significant progress in understanding and using cloud-affected radiances, with progress in radiative transfer, data assimilation and more sophisticated cloud screening. As a result, more satellite sounding data can be used.
25. The IASI and AIRS radiances assimilated are still a small fraction of those available, but some efforts are underway to allow a more complete use of the data (e.g., through use of reconstructed radiances or principal components).
26. The number of NWP centres using Level 1b ATOVS radiances in their variational data assimilation systems continues to grow but there are still centres which rely on the Level 2 retrievals provided by NESDIS.
27. The group recommended further studies on the optimization of the size of the advanced sounder fields of view using experience with the MetOp HIRS/4 and NOAA-17 HIRS/3 instruments.

1.3 FUTURE PLANS

The ITWG will continue to meet and inform the ATOVS community of the latest news and developments through its Web site currently maintained by the University of Wisconsin-Madison CIMSS and the email list also maintained by CIMSS. The 4th Hyperspectral Workshop to be held at EUMETSAT, Darmstadt, Germany 15-17th September 2008 was noted and ITWG undertook to assist coordination between this group, the AIRS science team, the IASI conference and the ITWG advanced sounder working group to ensure effective exchange of information. The ITWG will also be holding the second workshop on remote sensing and modeling of surface properties prior to ITSC-17 and tentatively scheduled for June 2009.

The website will continue to evolve to become an even more important tool for ITSC, with many new ideas proposed and endorsed at ITSC-16. This could include some interactive elements to the website (e.g., wiki).

The format of ITSC-16 was similar to previous meetings, but with a significant increase in numbers attending resulting in significant time pressure on the agenda. If the recommendation of the climate working group to attract significantly more climate scientists to ITSC-17 is successfully carried out, the climate session will have to be significantly longer. Therefore ITWG has to consider options for continuing to deliver a successful meeting which may require changes in structure, length or number of oral presentations. At ITSC-16 a partially successful experiment was carried out with the operational NWP session using a format of a longer, invited summary presentation, followed by short 3-minute poster presentations, followed by the poster session. It has been suggested this format could be extended to other sessions, e.g., the agency status reports and reports on software packages. The ITWG members expressed a strong preference to investigate this type of option before any move to parallel sessions is considered.

The ITSC-XVI Working Group Report and a Proceedings for ITSC-XVI from the papers submitted will be provided to attendees and other interested persons on CD-ROM. The oral and poster presentations from ITSC-XVI are already available as PDF files which can be downloaded from the ITWG Web site. The next meeting of the ITWG is tentatively scheduled to take place in February 2010, depending on final choice of venue. Topics of interest will include more extensive evaluation of MetOp data, initial assessment of FY-3 data and status of preparations for the NPP launch.

SUMMARY OF ACTIONS AND RECOMMENDATIONS

RADIATIVE TRANSFER AND SURFACE PROPERTY MODELLING

Action RTSP-1

Marco Matricardi to announce to the RTSP-WG when the latter several thousand profile data set, including the trace gases, is available.

Action RTSP-2

Tom Kleespies to document the various cloud droplet size distributions used for determining effective radius values.

Action RTSP-3

Paul van Delst to document available cloud profile datasets.

Action RTSP-4

Paul van Delst to complement the information on IR SRF and μ W frequencies for as many instruments as possible (current and historical) on the RTSP-WG website.

Action RTSP-5

Paul van Delst to continue working with IPO to obtain CrIS instrument response information for US NWP centres, and determine the path/timeline for dissemination by IPO of the information to non-US NWP centres.

Action RTSP-6

Paul van Delst to link the 2001 CrIS ATBD to the RTSP-WG website once it is determined if it is in the public domain.

Action RTSP-7

Paul van Delst to check with Walter Wolf (NOAA/NESDIS) on the status of CrIS sample datasets and data formats.

Action RTSP-8

Gang Ma to notify the RTSP-WG how to obtain the FengYun-3 instrument SRFs (IR) and frequencies (microwave) when they become publicly available after launch (likely August 2008).

Action RTSP-9

Roger Saunders to contact the Korean Aerospace Research Institute (KARI) to obtain the instrument spectral response information for the COMS imager (scheduled launch late 2009) when it becomes available.

Action RTSP-10

Alexander Uspensky to notify the RTSP-WG how to obtain the Electro-L (scheduled launch 2008) MSU-GS SRFs and the Meteor-M MTZVA frequencies when they become publicly available. Electro-L is scheduled to launch 2008; Meteor-M1 is scheduled to launch 2008, Meteor-M2 in 2010.

Action RTSP-11

Tom Kleespies to notify the RTSP-WG how to obtain the MetOp-B and NOAA-N' HIRS/4 and AVHRR/3 SRFs when they become publicly available.

Action RTSP-12

As per CWG Action item, Paul van Delst to make available results/discussions with NRL SSMIS investigators on how to best use the provided SSMIS bandpass information.

Action RTSP-13

Paul van Delst to make available on the RTSP-WG webpage references and/or links to the SSU and VTPR work described above.

Action RTSP-14

Raymond Armante to make available to the RTSP-WG the results of the LMD line mixing study when completed.

Action RTSP-15

Roger Saunders to provide a link to the CAVIAR results to be posted on the RTSP-WG website.

Recommendation RTSP-1 to fast RT modelers

To assess the impact of the use of different public spectroscopic databases in their fast models.

Action RTSP-16

Nicole Jacquinet to provide links to GEISA and HITRAN (and other databases if necessary) websites and other updated information of interest, as well.

Action RTSP-17

Paul van Delst to investigate a common format for optical properties data that will be made available on the RTSP-WG website.

Action RTSP-18

Yong Han to provide information and reference about the results from Yong Chen's study regarding the effect of spatial inhomogeneity when comparing cloudy calculations and observations. To be posted on the RTSP-WG website.

Action RTSP-19

Fuzhong Weng to provide a dataset for AMSU-A(Aqua) observations and cloud profile information retrieved from collocated CloudSat observations. This dataset will be made available via the RTSP-WG website.

Recommendation RTSP-2 to fast RT developers

Non-LTE effects should be included/parameterised in fast RT models. Progress on this issue (from the SARTA, RTTOV, and CRTM teams) should be reported before the next ITSC.

Action RTSP-20

Roger Saunders (MetOffice), Ben Ruston (NRL), Marco Matricardi (ECMWF), Louis Garand (Environment Canada), Gang Ma (for NMC) and Paul van Delst (NCEP/EMC) to

provide documentation of methodologies used in NWP centres to speed up the assimilation of radiances and quality control (for example parallel processing strategy, OpenMP, number of profiles per call, geographical separation of the data etc.). Specify any machine-dependent characteristics.

Recommendation RTSP-3 to fast RT modelers

Consider upwelling oceanic radiation (water leaving radiance) when designing the next generation of RT models that include the visible part of the spectrum.

Action RTSP-21

Roger Saunders (MetOffice), Ben Ruston (NRL), Marco Matricardi (ECMWF), Louis Garand (Environment Canada), Gang Ma (for NMC), and Paul van Delst (NCEP/EMC) to provide documentation of methodologies used in NWP centres to convert layer atmospheric state variables to level values.

Action RTSP-22

Following Action RTSP-17, Paul van Delst will make available on the RTSP-WG website, optical property data for non-spherical particles used at the JCSDA, as well as any supplied by other attendee's organisations.

Action RTSP-23

Ben Ruston to contact colleagues at CSU to obtain additional cloud optical property data for non-spherical particles.

Action RTSP-24

Pascal Brunel to provide the TRATTORIA-2008 workshop summary when it becomes available for inclusion on the RTSP-WG website.

Action RTSP-25

Ben Ruston and Filipe Aires to notify the RTSP-WG when the emissivity climatology intercomparisons and interface are completed.

Recommendation RTSP-4 to Co-Chairs of the second meeting on surface property modeling.

Plan the Second Workshop on Remote Sensing and Modeling of Surface Properties prior to ITSC-17 tentatively in June of 2009. The meeting will deal with retrievals and parameterizations of emissivity, bi-directional reflectance and land surface temperature.

Action RTSP-26

Co-Chairs of this workshop will make official announcement to ITWG and other NWP and satellite centers about the workshop information as soon as the date is firmed up.

Action RTSP-27

Paul van Delst to add JAIVEx link/POC to the RTSP-WG webpage.

TOVS/ATOVS IN CLIMATE

Recommendation Climate-1 to ET on Satellite Sounders

To recognise that if data are to be used for climate, given typical satellite refresh rates, inter-satellite biases need to be constrained within 10% of expected climate signal (e.g., if climate models predict a 0.2K/decade trend in brightness temperatures, then inter-satellite brightness temperature biases need to be constrained to within +/- 0.02K). This would necessarily include the impact of any change in measurement technology, viewing geometry, footprint etc. and the need to maintain the channel spectra. It is particularly applicable to heritage measures that offer the potential for monitoring of long-term climate changes. It is key that climate has a strong voice in such planning activities.

Action Climate-1

Jerome to communicate this recommendation to ET on Satellite Sounders.

Recommendation Climate-2 to satellite agencies

Agencies need to recognise the critical importance of actively supporting a long term calibration framework if their data are to prove of the envisaged high utility in climate monitoring. This would consist of a fully functioning GRUAN network of 40 very high quality ground cal/val sites run for climate and a precessing orbit satellite carrying a range of microwave and infrared radiometers/sounders and a GPS-RO.

Action Climate-2

ITWG CGMS representative to communicate recommendation Climate-2 to CGMS and request that it be on the agenda. Matt Menne as GCOS representative to ET-EGOS to communicate this recommendation at their next meeting.

Recommendation Climate-3 to AOPC WG-ARO

The Climate working group of ITWG recommends that GRUAN launch a subset of "Satellite overpass coincident" launches which would consist of dual launches at t-1 h and t as has been done for JAIVEx as well as the EUMETSAT IASI calibration and which have proven to be of high utility.

Recommendation Climate-4 to AOPC WG-ARO

One or more GRUAN sites should be sited in an area where there is a prevalence of each of the following: dust events, black carbon from seasonal burning, Indian Ocean brown cloud, to help fully characterise hyperspectral sounders in these challenging situations.

Recommendation Climate-5 to AOPC WG-ARO

GRUAN to recognise the vital role of CO₂ validation with measurements from the surface to the upper troposphere to support satellite based climate monitoring of changes.

Action Climate-3

Peter Thorne to report Recommendations Climate 3-5 to AOPC WG-ARO.

Recommendation Climate-6 to Climate Action Team for CEOS

We recommend that the HIRS data record be reanalyzed for cloud cover characteristics with more robust techniques, i.e., the trend in the frequency of Deep Convective Clouds (DCC).

Action Climate-4

J. Schulz to bring Recommendation Climate-6 to the attention of the leader of the Climate Action Team for CEOS climate Action-A3.

Recommendation Climate-7 to IPO

The climate working group recommends inclusion of an OMPS limb sounder on the NPOESS satellites to ensure our ability to monitor ozone changes over the coming decades.

Action Climate-5

Mitch Goldberg to be requested to communicate recommendation Climate-7 to IPO.

Recommendation Climate-8 to IPO

The capability to extract trace gas abundances and dust concentrations should be maintained and restored for CriS. Clean window channel 2616 wave number is also key for absolute calibration and should be included.

Action Climate-6

J. Schulz to pass on this recommendation to IPO through Mitch Goldberg.

Recommendation Climate-9 to EUMETSAT

The information loss resulting from using principal components instead of the full spectrum should be quantified with regards to climate study objectives before making any decision concerning the distribution of Level 1 data.

Action Climate-7

EUMETSAT to be informed of Recommendation Climate-9 through Dieter Klaes.

Recommendation Climate-10 to agencies

The ITWG climate working group supports the recommendation of the GCOS/WCRP AOPC-XIV and recommends to space agencies to include polarimetric devices to measure aerosol on operational satellites to complement observations of cloud properties and Earth Radiation Budget.

Recommendation Climate-11 to R/SSC-CM network

The R/SSC-CM network should include the relevant expertise from ITWG climate working group members when it formulates its first pilot activities. In particular, the activity on upper tropospheric humidity can strongly benefit from work done by ITWG group members.

Action Climate-8

J. Schulz to add to ITWG climate group web page and act as an international focus for the provision of information regarding current and future developments of the global network of R/SSC-CMs.

Recommendation Climate-12 to post-EPS Mission Team

The Climate working group recommends that for current and future missions all mission data will be completely archived at all processing levels, in particular Level 0, Level 1 (all processing levels) and Level 2, along with all necessary information to allow full reprocessing of the mission data.

Recommendation Climate-13 to post-EPS Mission Team

The Climate working group recommends to plan for reprocessing capabilities in the ground processing facilities of missions including full reprocessing of Level 1b at least at mission end.

Recommendation Climate-14 to post-EPS Mission Team

AMSU replacement on post-EPS must be cross-track to enable a continuation of the “lower tropospheric” retrieval which is viewing geometry dependent and to minimise the risk of change to other instruments which are tied in some sense to the AMSU footprint.

Recommendation Climate-15 to post-EPS Mission Team

Post-EPS to consider improving the radiometric noise of post-IASI in the 4 micron band, by at least a factor of 2, without degrading the spectral resolution so that it can be usefully utilised in CO2 monitoring.

Recommendation Climate-16 to post-EPS Mission Team

The coverage with simultaneous UV/VIS and IR observations for synergistic ozone and trace gases retrieval established by the MetOp system should be made available on future satellite systems for post-EPS systems. Depending on the launch schedule of the new missions the EPS system should be kept alive as long as possible.

Action Climate-9

Jörg Schulz to report climate recommendations 12 to 16 to post-EPS Mission Team.

Action Climate-10

ITWG CGMS representative (Mitch Goldberg) to report the non Post EPS specific issues in recommendations 12-16 to CGMS.

Recommendation Climate-17 to ITWG Co-Chairs

A very concerted effort should be made to increase the climate content and presence at future ITSC conferences so that a critical mass of climate scientists attend. The mix of operational and instrument expertise affords a unique opportunity to aid the production of climate quality data that it would be remiss not to act upon.

Action Climate-11

ITWG Co-Chairs to consider Recommendation Climate-16 and with help from climate WG members to attempt to significantly redress balance to more accurately reflect agency priorities on both operational and climate usage of the data at future ITSC meetings.

THE USE OF TOVS/ATOVS IN DATA ASSIMILATION/ NUMERICAL WEATHER PREDICTION (DA/NWP)

Action DA/NWP-1

When DMSP F17 data and also when UPP version 3 becomes available, Nancy Baker will notify users via the ITWG_NWP mailing list.

Recommendation DA/NWP-1 to all satellite agencies

Operational NWP centers to be part of the early cal/val operation for future missions and to receive near real time data before final quality of the data has been established.

Action DA/NWP-2

In order to set up list of international partners for cal/val of NPP/NPOESS instruments, members of the NWP WG will communicate their interest to the NWP WG Co-Chairs. The Co-Chairs will send this list to Karen Saint-Germain within the next week because in two weeks there is a peer review cal/val committee meeting. It should be noted that additions to the list at a later time are possible.

Action DA/NWP-3

Sid Boukabara to coordinate NPP/NPOESS data formats and information exchange (BUFR file content, line shapes, APCs, etc...) with ITWG WG.

Recommendation DA/NWP-2 to EUMETSAT and NESDIS

Delivery time is critical for NWP centers to enable the data to be used for nowcasting and short-range forecasts. Delays in ground-processing of observations prohibit the fulfillment of the strict data delivery requirements. The routing of data through the Svalbard station has been very beneficial for NOAA-18 and METOP. The WG recommends that EUMETSAT and NESDIS explore the possibility of sending the other still operating NOAA satellites (i.e., NOAA-15, 16, 17) through the Svalbard ground station. It is recognized that this is not trivial and may be costly and that the outcome may depend on a cost/benefit analysis.

Recommendation DA/NWP-3 to WMO

Continue to support fast delivery initiatives (RARS), extending where possible. However, the working group believes that the system should continue to be low-cost. Extension of RARS towards complete global coverage is encouraged until the point is reached where further improvements are no longer cost effective.

Recommendation DA/NWP-4 to EUMETSAT and IPO

The short operational delivery time of NPOESS data to NWP centers is an extremely attractive component of the system design. The Safety Net (NPOESS ground receiving system) is expected to be online with NPOESS satellite C2 in 2016. While the NPOESS delivery will be greatly improved, the METOP delivery will be substantially slower. The working group recommends the satellite agencies make every effort to improve the operational delivery of the METOP data. This includes the possibility of the Antarctic ground station, and the possibility for post-METOP-C satellites using the Safety Net ground system.

Recommendation DA/NWP-5 to EUMETSAT

EUMETSAT is considering the distribution of PCAs (up to 300-400 PCAs) over EUMETCast instead of the full set of channels to save bandwidth. However, some selected users may still be able to receive the full channel information. The NWP WG recommends that both the new data formats and the full set of channels be distributed for a six month testing period. A final decision on the way forward should be made after the evaluation of the testing.

Action DA/NWP-4

European NWP WG members to discuss Recommendation DA/NWP-5 with their EUMETSAT OPS WG representatives.

Recommendation DA/NWP-6 to NWP WG members

At the ITSC-15, it was recommended that a 15 IASI channel data set be used for near real time intercomparisons between different NWP centers. However, it was later noticed that only a few of the chosen 15 channels were included in either the EUMETSAT GTS data set (~300 channels) or the NESDIS (~600) data set. The working group reiterates the desirability of the intercomparison exercise.

Action DA/NWP-5

Fiona Hilton to select a new set (< 20) of IASI channels for intercomparison purposes. Fiona to give instructions on basic breakdown (e.g., clear, land, etc...) of profile types and the statistical variables (e.g., mean, standard deviation, histograms, diffusion diagram...) presented. It would be best if common formats were used but this is considered to be of lower priority. Links to the results will be put on the ITWG web site.

Action DA/NWP-6

Lars Fiedler (EUMETSAT) to put their IASI monitoring on their external web site.

Recommendation DA/NWP-7 to satellite agencies and WMO

The geostationary orbit is ideal for observing the rapidly changing components of the atmospheric and surface fields. The WG recommends the use of this orbit with high spectral resolution IR and/or microwave sounder/imager instruments. Ideally if both are possible the microwave and IR instruments should observe the same portion of the atmosphere at the same time.

Recommendation DA/NWP-8 to satellite agencies

The working group feels that the amount of information about current and future satellite systems and advanced notification of changes could be improved. Better communication is necessary for planning, preparation, and execution by the NWP community.

Action DA/NWP-7

NWP WG members to locate relevant satellite agency URLs and contact points where information can be found. The information will be obtained from space agencies through NWP WG members listed below.

Members to send URLs and contact points to Co-Chairs who will then put them on the ITWG web site. Chairs will then communicate with space agency contacts so that the ITWG_NWP mailing list can be added to their mailing list.

Action DA/NWP-7a

Fiona Hilton (UK MO) responsible for obtaining the information for EUMETSAT.

Action DA/NWP-7b

Peiming Dong (CAMO) responsible for obtaining the information for CMA.

Action DA/NWP-7c

Clemence Pierangelo (CNES) responsible for obtaining the information from CNES (www.smsc.cnes.fr).

Action DA/NWP-7d

Kozo Okamoto (JMA) responsible for obtaining the information from JAXA and JMA.

Action DA/NWP-7e

Min-Jeong Kim (NESDIS JCSDA) responsible for obtaining the information from KMA.

Action DA/NWP-7f

Alexander Uspensky (SRC Planeta) responsible for obtaining the information from ROSCOSMOS and ROSHYDROMET.

Action DA/NWP-7g

Godelieve Deblonde (EC) responsible for obtaining the information from the CSA.

Action DA/NEWP-7h

John Derber (NCEP) responsible for obtaining the information from NESDIS.

Action DA/NWP-7i

Karen Saint-Germain (IPO) responsible for obtaining the information from NPP/NPOESS.

Action DA/NWP-7j

Nancy Baker (US Navy NRL) responsible for obtaining the information from DMSP.

Action DA/NWP-7k

Dirceu Herdies (INPE/CPTEC) responsible for obtaining the information from INPE.

Action DA/NWP-8

Fiona Hilton to gather together information regarding what level of information messaging (METOP) is required by NWP centers and forward this information to EUMETSAT.

Recommendation DA/NWP-9 to ITWG CIMSS web site webmaster

It is recommended that WIKI capability be set up on the ITWG CIMSS web site (under the supervision of the Co-Chairs).

Action DA/NWP-9

NWP WG chairs to provide survey template (start with what Tony McNally has used so far) to be put on ITWG WIKI page and allow updating as operational systems change. NWP WG chairs remind NWP centers to update the table through ITWG_NWP mailing list every six months and before next ITSC meeting.

Action DA/NWP-10

All members of the ITWG NWP working group to examine mailing list for missing relevant e-mail addresses. WG Co-Chairs to maintain and update the email list.

Action DA/NWP-11

NWP WG Co-Chairs to ask developers of software packages to announce new software releases on ITWG NWP mailing list. Specifically, the following software packages have been identified: CRTM, RTTOV, IPOPP, AAPP, and NWP SAF news.

Action DA/NWP-12

NWP WG Co-Chairs to review the status of the actions and recommendations at regular intervals and email a status report to WG members and ITWG Co-Chairs via the ITWG_NWP mailing list.

Action DA/NWP-13

NWP WG Co-Chairs to solicit ideas through NWP WG mailing list for WG topics prior to ITSC-17.

Action DA/NWP-14

The NWP WG will set up an email distribution list for those interested in regional satellite DA and the list will be sent to the ITWG_NWP mailing list.

Action DA/NWP-15

Brett Candy and Roger Randriamampianina will work together to design single observation experiments in a global and regional model setting and the results will be accessible through the ITWG web site.

Action DA/NWP-16

As recommendations 2, 3, 4, and 7 (see above) do not have associated action items, the working group co-chairs will bring these to the attention of the relevant bodies.

ADVANCED SOUNDER WORKING GROUP REPORT

Recommendation AS-1 to the space agencies

In reaction to user requirements by the global and regional scale NWP community for more frequent observations of lower tropospheric moisture and temperature profiles, and for additional frequent monitoring of atmospheric dynamics, it is recognised that high spectral resolution imaging radiometers on geostationary platforms would be an important part of the future global observing system. It is therefore strongly recommended that operational missions, like MTG-IRS, be flown as soon as possible. Ideally, a demonstration mission should be conducted for risk reduction purposes, but should not delay the operational missions. GIFTS is the best current option for a demonstration mission.

Action AS-1

ITWG Co-Chairs to co-ordinate recommendations from this conference with those from the Winds Workshop and communicate to space agencies.

Recommendation AS-2 to the space agencies

The WMO IGeoLab concept should be supported.

Recommendation AS-3 to WMO

GIFTS should be considered as a candidate hyperspectral imager for the IGeoLab Molniya mission.

Recommendation AS-4 to data users

The group encourages pre- and post-launch instrument characterisation and traceable calibration. Requirements for the parameters to be characterised and their required accuracy and stability should be communicated from the users (i.e., NWP, RT modellers, climate researchers) to the data providers.

Recommendation AS-5 to data providers

To aid in early calibration and characterisation of new instruments, data should be released as early as possible to NWP centres.

Recommendation AS-6 to the space agencies and NWP centres

Cal/Val for advanced sounders needs to be an activity which receives sufficient resources. High-altitude airborne sensors, such as those associated with the NAST, S-HIS, and ARIES airborne sensors, and upper air reference networks need to be added to complementary data sources in order to validate the radiances and derived products to the very high accuracy and precision specified by the users. These campaigns should be coordinated with new satellite launches.

Recommendation AS-7 to space agencies, NWP centres and researchers

Case study data sets should be prepared and made freely available from these campaigns and the scientific community which is encouraged to use these data to determine instrument and forward model spectral characteristics and to improve retrieval and data assimilation procedures, with a workshop focused on case study applications of the data taking place after a couple of years.

Action AS-2

Jonathan Taylor to e-mail details of Joint Airborne IASI Validation Experiment (JAIVEx) data to the ITSC conference.

Recommendation AS-8 to space agencies

Future instruments should be carefully calibrated before launch. In particular, care must be taken to accurately establish the instrument field of view, as this procedure is far more accurate when performed on the ground rather than in orbit.

Recommendation AS-9 to the science community

The utility of applying the SNO (Simultaneous Nadir Observation) technique for an equatorial (inclination $<20^\circ$) LEO platform for the purpose of radiometric cross-calibration should be examined. Optimal orbital parameters (attitude and inclination), as well as sensor(s) type, should be determined so that recommendations for possible sensors on future equatorial satellites can be put forward. The CLARREO mission (which is primarily concerned with climate change and is currently planned to be in a 90 degree inclination orbit) partially fulfils these criteria and is a good first step.

Recommendation AS-10 to space agencies and NWP centres

Encourage studies to evaluate the full error covariance matrix of advanced sounder measurements and error introduced by forward models.

Recommendation AS-11 to members of the research community

Use the information from dedicated validation campaigns to better understand the full error covariance matrix of advanced sounder measurements and error introduced by forward models.

Action AS-3

Bill Smith to review and re-create this table with particular emphasis on establishing a link between instrument and geophysical measurement criteria (particularly WMO requirements).

Recommendation AS-12 to the space agencies

In order to ensure consistency of objectives and adequacy of the capabilities of various international contributions to the global observing system, it is recommended that space

agencies follow the ITWG guidance on desirable radiometric measurement requirements to be met or exceeded for advanced IR sounders to be carried on future polar and geostationary orbiting satellites.

Recommendation AS-13 to the research community and space agencies

It is recommended that relevant organizations conduct studies to identify the capabilities of microwave sounders and develop consensus user measurement requirements for future systems. This should be done for LEO as well as GEO. It is recommended that this information be consolidated in a table similar to that presented above for the IR sounder.

Action AS-4

Bjorn Lambrigsten and Bill Blackwell to prepare a draft table summarising the requirements for microwave sounding systems between instrument and geophysical measurement criteria (particularly WMO requirements). This should be communicated to the frequency-protection community.

Action AS-5

Advanced Sounder Working Group should review the tables produced by Actions AS-3 and AS-4.

Recommendation AS-14 to the scientific community

Further studies on optimisation of the size of advanced sounder fields-of-view and spatial contiguity need to be pursued, taking into account probable future advances in sounding techniques.

Recommendation AS-15 to IPO

CrIS measurements should be communicated from the satellite at full (as measured) spectral resolution.

Recommendation AS-16 to IPO

Further investigate communication of the full (as measured) CrIS spectrum.

Recommendation AS-17 to space agencies/IPO

The ability of conical sounders should be further studied using on-orbit data from new conical imager/sounders as it becomes available as well as data from existing sensors, to deliver sufficiently accurate observations for NWP in the light of the most recent results.

Recommendation AS-18 to space agencies/IPO

Future conical sounding missions should take full account of the experience gained in the post-launch analyses of existing operational conical imagers and sounders (including SSMIS, Windsat, TMI and AMSR) in the specification and design of instruments.

Recommendation AS-19 to the space agencies

Microwave sounders should be considered to always be flown with future advanced IR sounders, to provide simultaneous observations at the same time and at the same location.

Recommendation AS-20 to the space agencies

Future high spatial resolution imaging radiometers to be flown with advanced IR sounding instruments should possess channels primarily sensitive to lower tropospheric

emission to support the interpretation and enhance the use of advanced IR sounding spectrometer observations obtained for cloudy sky scene conditions.

Recommendation AS-21 to EUMETSAT

All MetOp Level 1 and Level 2 data should be distributed in near-real time from both satellites.

Recommendation AS-22 to NWP centres

Preferences for separation between the two satellites should be communicated to EUMETSAT.

Recommendation AS-23 to ITWG

Investigate the implications on developing innovative products from two MetOp satellites with 20-50 minute separation.

Recommendation AS-24 to space agencies

A fully operational constellation of GPS radio-occultation receivers provides useful calibration information for satellite sounders and thus the group recommends a follow-on to the current COSMIC constellation should be flown.

Recommendation AS-25 to space agencies

Environmental satellite systems should be developed by a partnership of government, industry and university science communities under the leadership and responsibility of government agencies.

Recommendation AS-26 to NWP centres

It is recognised that more efficient use of the full advanced IR sounder spectrum is desirable within NWP data assimilation. NWP centres are encouraged to consider research into the direct use of principal components and/or retrievals from advanced IR sounders in assimilation systems.

Recommendation AS-27 to retrieval providers

Provide full characterisation of retrieval schemes including observation error covariance matrix, averaging kernels, quality control, and cloud detection. This characterisation should be both theoretically derived and independently validated. Data should be available in suitable and timely format.

Recommendation AS-28 to the ITWG

Where possible, retrieval studies should be presented with averaging kernel and full error covariance estimates and validation.

Recommendation AS-29 to data providers

It is noted that the use of principal components to represent advanced sounder spectra carries the danger of the loss of signals that are not properly represented in the training set. Care must be taken to ensure that data compression methods used for archiving satellite data be lossless. Lossy compression of advanced sounder data for transmission may be acceptable for certain users. This question has become particularly pertinent in the context of continued distribution of IASI data in near real time.

Action AS-6

Ken Holmlund and the ASWG Co-Chairs should produce a table documenting the timeliness required (i.e., type of distribution) and the required fidelity of advanced sounder data as a function of user type (e.g., NWP, trace gas retrieval, climate applications) as a guide to space agencies on the most efficient strategy for data dissemination.

Action AS-7

ASWG and other working groups should critically review the table produced by AS-6.

Recommendation AS-30 to researchers

Consider possibilities for spatial compression at the data source.

Recommendation AS-31 to space agencies

Encourage further investigation of truly lossless data compression techniques.

Recommendation AS-32 to the research community

Continue work on infrared land surface emissivity databases including validation and intercomparison between techniques.

Recommendation AS-33 to the research community

Continue work on infrared land surface emissivity retrieval algorithms including validation, intercomparison between techniques and investigation of robustness to clouds in the instrument field-of-view.

Recommendation AS-34 to the research community

Databases of global infrared land surface emissivities should be represented in spectral resolution fine enough to resolve spectral features of the earth's surface. The use of EOF as an efficient way to model the spectral databases is encouraged but further verification study is recommended.

Recommendation AS-35 to the relevant chairpersons

It is recommended that there be co-ordination between the Advanced Sounders Working Group, the Hyperspectral Workshop, the IASI Conference and the AIRS science team.

Action AS-8

Advanced Sounder Working Group Co-Chairs should co-ordinate with the IASI conference chairs, the AIRS science team and Paolo Antonelli to suggest possible topics that should be covered at future workshops and conferences.

INTERNATIONAL ISSUES AND FUTURE SYSTEMS

Recommendation IIFS-1 to WMO and RARS partners

Welcoming the rapid progress of the RARS project to ensure timely availability of ATOVS data to NWP centres, and considering the demonstrated benefit to NWP, WMO and the RARS contributing organizations should pursue the implementation of the global RARS network with the aim to cover at least 90% of the globe for ATOVS data.

WMO and the RARS Implementation Group are invited to consider an extension of the RARS project towards including FY-3 sounding data when this data will be operationally available.

WMO and the RARS Implementation Group are invited to consider an extension of the RARS project towards including NPP and NPOESS sounding data as a gap filling measure until timely availability of this data can be ensured worldwide through the SafetyNet.

Action IIFS-1

WMO (J.Lafeuille), in collaboration with the IPO, to propose an extension of the RARS project to NPP and NPOESS sounding data at the December 2008 Direct Readout Conference, with the view to initiate action in 2009.

Recommendation IIFS-2 to space agencies

Space agencies, in consultation with WMO, CGMS and CEOS, to consider contributing to implement the Vision for the GOS and to ensure long-term continuity of its operational components.

Recommendation IIFS-3 to WMO and space agencies

To consider establishing a partnership to fly a preoperational hyperspectral sounder in geostationary orbit in advance of 2015, as a preparatory mission, in order to allow optimization of the implementation and use of the planned operational IR hyperspectral geostationary missions.

Recommendation IIFS-4 to IPO and other organizations

The expected performance of the MIS sounding channels should be evaluated in order to assess to what extent the requirements for microwave atmospheric temperature and humidity sounding will be met for the early morning orbit by NPOESS-C2 and, if relevant, to identify optimization measures or additional capabilities that should be implemented by 2025.

Recommendation IIFS-5 to WMO, CGMS, CEOS

Scenarios should be investigated to provide IR sounding capability from an early morning orbit.

Action IIFS-2

John Eyre to highlight the need for Water Vapour channel imagery and for observation of aerosols in the revised draft Vision for the GOS. (31 May 2008)

Action IIFS-3

John Eyre to distribute the (updated) draft Vision of the GOS to the ITWG list, with an explanatory note calling for comments. (30 June 2008)

Action IIFS-4

ITWG Members to send comments on the draft Vision for the GOS to J. Eyre (john.eyre@metoffice.gov.uk) and J. Lafeuille (JLafeuille@wmo.int). (15 August 2008)

Recommendation IIFS-6 to CGMS Satellite Operators

Satellite agencies operating environmental polar satellites to provide or continue to provide a Direct Broadcast capability on their polar environmental satellite systems, and to make available in a timely manner the Direct Broadcast data processing (L0 to L1, and/or L1 to L2) software, documentation, and related training.

Recommendation IIFS-7 to CGMS Satellite Operators

Satellite agencies operating environmental polar satellites to provide expected formats of Level 1b and Level 2 datasets at least one year prior to launch, and to establish web sites to provide detailed information on instruments, schedule, products and formats.

Action IIFS-5

The IPO (Karen St. Germain) to provide information on NPP/NPOESS real time Low Rate Data (LRD) & High Rate Data (HRD) formats and other relevant details by September 2008 and to make available the NPP pre-processing software as soon as practical before the launch of NPP.

Action IIFS-6

WMO (J. Lafeuille) to ask CMA to provide detailed information on FY-3A Direct Broadcast protocols, formats and schedules, with Level 0/1 test data sets and pre-processing software, as soon as practical in advance of the FY-3A operational phase.

Recommendation IIFS-8 to ITWG Members

Encourage and contribute to studies on RFI contamination impact on key applications (mainly in the 50-60 GHz and 86-92 GHz bands); reports on these studies should be available in advance of ITSC-17.

Action IIFS-7

Jean Pla to contact ITWG Members and seek comments on the table containing a preliminary identification of frequencies to be used for Earth Observation (research or operational applications) in the 275-3000 GHz range. (End May 2008)

Action IIFS-8

ITWG members to review the table containing a preliminary identification of frequencies to be used for Earth Observation (research or operational applications) in the 275-3000 GHz range. (15 July 2008)

Action IIFS-9

William Bell, Stephen English, in consultation with other ITWG Members, to identify the application(s) most sensitive to RFI contamination of the 86-92 GHz band. (November 2008)

Action IIFS-10

Jean Pla, Stephen English, Richard Kelley, in consultation with other ITWG Members, to propose a work plan for studies of the impact of RFI contamination of the 50-60 GHz and 86-92 GHz bands. (November 2008).

SATELLITE SOUNDER SCIENCE AND PRODUCTS

Action SSSP-1

L. Lavanant, T. Reale T. Achtor, B. Lapeta, N. Selbach, B. Bellon to

- Review and revise SSSP site cover page
- Provide brief descriptions of topic and sub-topic areas:
 - Products and Science (and respective products areas)
 - Scientific Processing Packages
 - Scientific Organizations – Programs
 - Current/Future instrument Characteristics/Status
 - Direct Readout Facilities
 - Cal/Val
 - DataSets
- Mailing list
- Web Site statistics

Action SSSP-2

The respective products under the products topic area shall be maintained by assigned WG members and will include contacting existing contributors to assure currency and to pursue additional inputs through Internet search. This will include a brief description of each product and revised categorization to identify among the following aspects: operational, research; global, regional, direct readout; weather, climate.

- Soundings (T. Reale, L. Zhou)
- Surface, Precipitation (S. Boukabara, L. Zhao)
- Clouds (L. Lavanant, F. Romano)
- Trace Gases (A. Kaifel and L. Zhou)
- Radiances (T. Reale, L. Lavanant)
- Radiation Budget (L. Zhao and L. Zhou) ... new product
- Winds (S. Boukabara)

Action SSSP-3

L. Lavanant, K Strabala, G. Weymouth, D Griersmith, G. Pujol, N. Atkinson, B. Bellon to

- Continue the search and solicitation of inputs from the global direct readout community via existing survey, Internet and other WG members (L. Lavanant)
- Specific identification and solicitation from sites in Hawaii, Guam, French Polynesia and Antarctica regions to improve RARS coverage (G. Weymouth, D. Griersmith, N. Atkinson)
- Identify direct readout sites in Latin American and African countries (G. Pujol and L. Lavanant)
- Review/revise tabular format to summarize direct readout sites and information (B. Bellon)
- Develop mailing lists/communication among identified direct readout sites and ITWG (L. Lavanant, K. Strabala)

Action SSSP-4

K. Strabala, J. Overton, L. Lavanant, L Gumley, N. Atkinson, D. Singh, *China, Russia*, B. Lapeta to review, update and restructure the direct readout processing packages topic area to clearly delineate latest status of available packages for processing existing and historical satellite observations and plans for future satellites.

Action SSSP-5

Session 11 speakers, Karen St Germain to

- Update/append scientific organizations web site links as needed (Canada, China are inoperative ...)
- Update Satellite programs and include links to polar satellite programs from China and India and Russia (all Session 11 speakers)
- Restructure web site (B. Bellon/L. Avila)

Action SSSP-6

D. Klaes, B. Bellon, T. Reale to

- Provide links for the monitoring of EUMETSAT MetOp instruments (D. Klaes, L. Fiedler)
- Restructure and clean up this topic area (B. Bellon)
- Identify selected portions of WMO web site (from J. LaFeuille) identifying current and planned satellite instruments, respective specifications and associated agency program for inclusion (T. Reale)

Action SSSP-7

K. St. Germain, N. Atkinson, P. Schlüssel, L. Gumley, A. Huang, J. Overton, L. Lavanant to

- Report on the strategy of ensuring local/global coherence for IMAPP (Terra/Aqua) (L. Gumley, A. Huang)
- Report on the strategy for FY-3 and NPP/NPOESS through contacts with national agencies and direct readout packages developers responsible for software and data output data formats (J. Overton, N. Atkinson)
- Provide status and (calibration) information on the SSSP web site (B. Bellon)
- Provide status/links concerning planned instrument co-registration onboard MetOp and planned NPP and NPOESS satellites (B. Bellon)

Action SSSP-8

- Routine data and software readers (Session 11 speakers)
- Pre-launch data – simulated data set (K. St Germain)
- Test data at the Level 1 and Level 2 (Session 11 speakers)
- EARS/RARS direct readout observations (via EUMETSAT, Tokyo and Melbourne) (D. Klaes, D. Griersmith)
- Ancillary (L. Lavanant, E. Borbas, A.K. Sharma)
- Selected Field experiment data (JAIVEX - B. Smith, S. Newman)
- Collocated satellite and ground-truth observations (T. Reale, L. Lavanant)
- Level 2 error characterizations ... (L. Zhou, T. Reale)

Recommendation SSSP-1 to NOAA and EUMETSAT

These agencies are encouraged to investigate or support research centers to investigate the impact of the 10km vs. 17km field of view with respect to improved cloud detection and cloud clearing (including potential synergy with respect to IASI and pending CrIS).

Action SSSP-9

T. Reale, L. Lavanant to

- Forward recommendation SSSP-1 to NOAA and EUMETSAT to investigate or support research centers to investigate the impact of the higher resolution (10km) HIRS on cloud detection and sounding products.
- Forward recommendation SSSP-1 to EUMETSAT scientists to quantify the impact of higher resolution HIRS with coincident IASI data on MetOp.
- Encourage studies concerning potential impact of intelligent pointing versus fixed FOV (CNES) and disseminate studies and reports that already exist on this subject (B. Smith, H. Bovensmann, L. Lavanant).

Action SSSP-10

- Update the existing NPROVS dataset link on the SSSP web site to include Aqua-AIRS, COSMIC, GOES and MetOp sounding intercomparison/analysis (T. Reale, L. Zhao, S. Boukabara, W. Wolf, B. Bellon)
- Update existing NPROVS analysis/validation (EDGE) link to include expanded capabilities as developed at NESDIS (T. Reale, L. Zhao, L. Zhou, S. Boukabara, W. Wolf, B. Bellon)
- Compile/availability of complete Level 2 products error characterization (L. Zhou, T. Reale)
- Identify/access of existing satellite program/agency collocated observations (T. Reale, L. Lavanant)
- Facilitate analysis of evolving historical collocation database and SNO dating from TOVS (1979) via NESDIS STAR computer/storage facility (T. Reale, L. Shi)
- Provide access/results concerning NOAA versus EUMETSAT case studies comparisons of respective Level 2 products (T. Reale)
- Establish link to GRUAN web site and pursue case study analysis at GRUAN sites concerning data synchronization and frequency protection studies (T. Reale, P. Thorne, D. Tobin, J. Pla, G. Kelley, N. Pougatchev)

Action SSSP-11

- Create web page for Data Analysis and Visualization Tools (T. Achtor, B. Bellon)
- Provide information on tools for Direct Broadcast processing packages ... (N. Selbach, N. Atkinson, T. Achtor, L. Lavanant)
- Provide sensor co-registration information (T. Kleespies)
- Seek information on Format Conversion software (T. Achtor, B. Bellon)

Action SSSP-12

- Educational programs at CIMSS (T. Achtor, P. Antonelli, K. Strabala)
 - COMET (T. Achtor, T. Reale, T. Mostek (UCAR))
 - EUMETSAT (D. Klaes, V. Gartner)
 - WMO (J. Lafeuille)
-

FREQUENCY MANAGEMENT

Recommendation FM-1

ITWG Members to encourage and contribute to studies on RFI contamination impact on key applications (mainly in the 50-60 GHz and 86-92 GHz bands); reports on these studies should be available in advance of ITSC-17.

Action FM-1

Jean Pla to contact ITWG Members and seek comments on the table containing a preliminary identification of frequencies to be used for Earth Observation (research or operational applications) in the 275-3000 GHz range. (End May 2008)

Action FM-2

ITWG members to review the table containing a preliminary identification of frequencies to be used for Earth Observation (research or operational applications) in the 275-3000 GHz range. (15 July 2008)

Action FM-3

William Bell, Stephen English, in consultation with other ITWG Members, to identify the application(s) most sensitive to RFI contamination of the 86-92 GHz band. (November 2008)

Action FM-4

Jean Pla, Stephen English, Richard Kelley, in consultation with other ITWG Members, to propose a work plan for studies of the impact of RFI contamination of the 50-60 GHz and 86-92 GHz bands. (November 2008)

DIRECT BROADCAST

Action DB-1

Liam Gumley to draft a report titled "Status of Current Polar Orbiting Satellite Systems for Direct Broadcast Atmosphere Products and Plans for Future Systems."

Action DB-2

John Overton, Nigel Atkinson, Frank Øynes, and Kathy Strabala to review the draft report and prepare it for presentation to the ITWG.

Action DB-3

Liam Gumley and John Overton to present the report and other relevant information in support of continued availability of direct broadcast to the WMO, GEO, IRC, and national space agencies.

Action DB-4

Kathy Strabala and Nigel Atkinson to draft a requirements document describing the needs of the DB atmosphere community for visualization.

Action DB-5

Liam Gumley and Nigel Atkinson to evaluate the NOAA and Met Office utilities for converting AIRS LIB data into BUFR and recommend one version for porting and release as part of AAPP, IMAPP, or IPOPP.

2. WORKING GROUP REPORTS

2.1 RADIATIVE TRANSFER AND SURFACE PROPERTY MODELLING

Web site: <http://cimss.ssec.wisc.edu/itwg/groups/rtwg/rtwg.html>

Working Group Members: Louis Garand (Co-Chair), Paul van Delst (Co-Chair), Raymond Armante, Eva Borbas, Pascal Brunel, Laure Chaumat, Fanny Duffourg, Yong Han, Nicole Jacquinet, Tom Kleespies, Alan Lipton, Xu Liu, Qifeng Lu, Gang Ma, Marco Matricardi, Stuart Newman, Eric Pequignot, Benjamin Ruston, Roger Saunders, Marc Schwärz, David Tobin, Peter Wang, Fuzhong Weng

2.1.1 Introduction

Two areas of discussion dominated the RTSP-WG meeting at ITSC-16: issues related to computing and validating cloudy radiances, and instrument characterization.

Regarding the former, it was felt that a comparison of cloudy radiance model results would be of limited use until common datasets – such as cloud optical property and cloud profile data – were available for participants. In addition, several members expressed the opinion that comparisons between models is not of as great a value as comparisons to observations, with the caveat that this is a more difficult problem since issues such as spatial inhomogeneity must be taken into account. Many of the action items from this meeting address the issue of assembling the relevant datasets.

With the expected launches of many new satellites over the next two years, the issue of obtaining the relevant sensor characteristics (spectral response functions for infrared instruments, and frequency information for microwave instruments) was discussed. Obtaining this information in a timely manner is very important for the development of the fast RT models such that various groups can evaluate the information content of the sensor data (both real and synthetic).

It was noted that much progress was accomplished in the area of surface emissivity modeling/mapping over land with global and regional datasets, notably hyperspectral IR, becoming available from various sources.

The new action items listed below are to be completed by May 2009.

2.1.2 Profile datasets

Marco Matricardi reported on two profile datasets: a dataset derived from model output consisting of 15000 profiles including latitude, longitude, surface (pressure, temperature, relative humidity at 2m; surface type) and cloud information (LWC, IWC, and cloud fraction) from which the new ECMWF 82-profile training set was extracted, and a several thousand profile dataset containing trace gas profiles.

Action RTSP-1

Marco Matricardi to announce to the RTSP-WG when the latter several thousand profile data set, including the trace gases, is available.

Xu Liu reported on the option to have the MOZART¹ data directly available on the RTSP-WG website. The data is a monthly average at 1.5° latitude resolution.

Regarding cloud profile datasets, the issue was raised on how to convert typical cloud parameters in NWP (such as CLW or IWP) into quantities such as effective radius that are required for some RT models – such as the CRTM. It was noted that some methodologies for doing this may not represent full natural variability.

Action RTSP-2

Tom Kleespies to document the various cloud droplet size distributions used for determining effective radius values.

CloudSat/Calypso retrieved cloud property datasets and ARM site measurements were identified as potential sources of additional cloud profile datasets.

Action RTSP-3

Paul van Delst to document available cloud profile datasets.

2.1.3 Instrument characteristics

It was noted that various instrument responses (SRFs for IR and frequencies for μ W) were difficult to find and in different formats.

Action RTSP-4

Paul van Delst to add the information on IR SRF and μ W frequencies for as many instruments as possible (current and historical) on the RTSP-WG website.

The CrIS instrument response is required by NWP centres to allow generation of fast RT model coefficients for use in data assimilation. Prior to the RTSP-WG meeting, fruitful discussions were had with IPO representatives to determine how to obtain the required CrIS information. Sample CrIS datasets and data formats were also brought up, although those subjects are somewhat outside the purview of the RTSP-WG and are already being addressed through other channels.

Action RTSP-5

Paul van Delst to continue working with IPO to obtain CrIS instrument response information for US NWP centres, and determine the path/timeline for dissemination by IPO of the information to non-US NWP centres.

Action RTSP-6

Paul van Delst to link the 2001 CrIS ATBD to the RTSP-WG website once it is determined if it is in the public domain.

Action RTSP-7

Paul van Delst to check with Walter Wolf (NOAA/NESDIS) on the status of CrIS sample datasets and data formats.

¹ Model of Ozone And Related species in the Troposphere. See: Hauglustaine, D. A., et al, *J. Geophys. Res.*, **103**(D21), 28291–28335 (1998).

The availability of other new instrument responses was discussed:

Action RTSP-8

Gang Ma to notify the RTSP-WG how to obtain the FengYun-3 instrument SRFs (IR) and frequencies (microwave) when they become publicly available after launch (likely August 2008).

Action RTSP-9

Roger Saunders to contact the Korean Aerospace Research Institute (KARI) to obtain the instrument spectral response information for the COMS imager (scheduled launch late 2009) when it becomes available.

Action RTSP-10

Alexander Uspensky to notify the RTSP-WG how to obtain the Electro-L (scheduled launch 2008) MSU-GS SRFs and the Meteor-M MTZVA frequencies when they become publicly available. Electro-L is scheduled to launch 2008; Meteor-M1 is scheduled to launch 2008, Meteor-M2 in 2010.

Action RTSP-11

Tom Kleespies to notify the RTSP-WG how to obtain the MetOp-B and NOAA-N' HIRS/4 and AVHRR/3 SRFs when they become publicly available.

The SSMIS F-17 and F-18 bandpasses are available, but it is not entirely clear how to use them. With respect to the CRTM, this issue also involves F-16 SSMIS where boxcar responses were used with the LBL transmittances. This was addressed at a CRTM Working Group meeting prior to ITSC-16.

Action RTSP-12

As per CWG Action item, Paul van Delst to make available results/discussions with NRL SSMIS investigators on how to best use the provided SSMIS bandpass information.

The availability of historical instrument responses was also discussed with respect to their use in reanalyses. Recent work by S. Kobayashi (JMA/ECMWF) and Q. Liu (NESDIS) regarding SSU, and L. Shi regarding VTPR was noted. Action RTSP-4 addresses making these instruments' SRFs available.

Action RTSP-13

Paul van Delst to make available on the RTSP-WG webpage references and/or links to the SSU and VTPR work described above.

2.1.4 Line by Line (LBL) modeling

Initial discussion focused on the current status of LBL models used for RT model training, kCARTA and LBLRTM (GENLN2 is no longer actively maintained).

kCARTA: (Note: this information is based on what RTSP-WG attendees knew – no kCARTA developer was present at ITSC-16) Observation minus kCARTA calculation residuals for IASI are being performed by Larrabee Strow's UMBC group and they appear

consistent with similar comparisons for AIRS. The modifications to the CO₂ line mixing made in SARTA based on AIRS is in the process of being transferred to kCARTA.

LBLRTM: AER, Inc continues to develop and support LBLRTM.

Action RTSP-14

Raymond Armante to make available to the RTSP-WG the results of the LMD line mixing study when completed.

Investigations into the H₂O continuum via CAVIAR², a consortium of researchers in the UK, are underway. Some initial laboratory measurements in the 3400-4000cm⁻¹ spectral region show that the H₂O continuum fits a dimer model better than the MT-CKD model.

Action RTSP-15

Roger Saunders to provide a link to the CAVIAR results to be posted on the RTSP-WG website.

The ARM program is funding the RHUBC-II³ field campaign (Co-PI's Dave Turner and Eli Mlawer) scheduled for Aug-Oct 2009 to characterize and improve the accuracy of RT and ice scattering models in the far infrared (>15μm).

The need to validate spectroscopic data was discussed. Modeling of hyperspectral instruments could potentially be sensitive to existing differences in spectroscopic databases⁴. The ability to select the best data from different spectroscopic databases (e.g., HITRAN and GEISA) for use in LBL model computations was highlighted. Diversification of the source of spectroscopic data is currently difficult because, for example, line mixing coefficients derived from one database may not be able to be used with potential superior spectroscopic data from another. In addition, the ability to "mix-and-match" the best data between spectroscopic databases can help identify where extra research is needed to improve the data.

Recommendation RTSP-1 to fast RT modelers

To assess the impact of the use of different public spectroscopic databases in their fast models.

Action RTSP-16

Nicole Jacquinet to provide links to GEISA and HITRAN (and other databases if necessary) websites and other updated information of interest, as well.

2.1.5 Fast RT modeling

It was noted that a standalone version of the Vertical Interpolator code developed by Yves Rochon⁵, and currently used in RTTOV-9, will be made available via the RTSP-WG website after ITSC-16.

The topic of relative comparisons between models for cloudy calculations was discussed (Recommendation RTSP-1 from ITSC-15). It was noted that these comparisons would be

² Continuum Absorption at Visible and Infrared wavelengths and its Atmospheric Relevance.

³ Radiative Heating in Underexplored Bands Campaign. See <http://acrf-campaign.arm.gov/rhubc>.

⁴ See Jacquinet-Husson et al, *JQSRT*, **109**, 1043-1059 (2008); Matricardi, M. ECMWF Tech.Memo. 525, May 2007.

⁵ See Rochon et al., *QJRM*, **133**, 1547-1558 (2007)

difficult to do in a way that any differences could be easily interpreted. It was stated that comparisons of cloudy model calculations with cloudy observations, while also quite difficult, would be a more useful task. Some issues with model/observation comparisons are the optical properties⁶ used by different models and spatial inhomogeneity (FOV effect) in the observations. Regarding the latter, Yong Chen (NESDIS/CIRA) has done work on this area making use of Cloudsat retrievals in collocation with AMSUA/MHS data (paper submitted to JGR).

Action RTSP-17

Paul van Delst to investigate a common format for optical properties data that will be made available on the RTSP-WG website.

Action RTSP-18

Yong Han to provide information and reference about the results from Yong Chen's study regarding the effect of spatial inhomogeneity when comparing cloudy calculations and observations. To be posted on the RTSP-WG website.

The first thing that would be required before embarking on these cloudy observation/calculation comparisons is an observation dataset that also includes cloud property information such as effective radius and water content profiles.

Action RTSP-19

Fuzhong Weng to provide a dataset for AMSU-A(Aqua) observations and cloud profile information retrieved from collocated CloudSat observations. This dataset will be made available via the RTSP-WG website.

Recommendation RTSP-2 from ITSC-15 was to incorporate non-LTE effects in fast RT models. This recommendation is carried over.

Recommendation RTSP-2 to fast RT developers

Non-LTE effects should be included/parameterised in fast RT models. Progress on this issue (from the SARTA, RTTOV, and CRTM teams) should be reported before the next ITSC.

Recommendation RTSP-3 from ITSC-15 was for NWP centres to document the methodologies used to speed up the hyperspectral radiance assimilation, specifically with regards to parallelisation and load balancing.

Action RTSP-20

Roger Saunders (MetOffice), Ben Ruston (NRL), Marco Matricardi (ECMWF), Louis Garand (Environment Canada), Gang Ma (for NMC) and Paul van Delst (NCEP/EMC) to provide documentation of methodologies used in NWP centres to speed up the assimilation of radiances and quality control (for example parallel processing strategy, OpenMP, number of profiles per call, geographical separation of the data etc.). Specify any machine-dependent characteristics.

Recommendation RTSP-4 from ITSC-15 was for fast RT modelers to consider upwelling oceanic radiation (water leaving radiance) when designing the next generation of RT models

⁶ Extinction coefficient, single scatter albedo, asymmetry parameter, and phase function parameterisation.

that include the visible part of the spectrum. Work on visible components of RT models is just beginning in most cases so the recommendation is carried over.

Recommendation RTSP-3 to fast RT modelers

Consider upwelling oceanic radiation (water leaving radiance) when designing the next generation of RT models that include the visible part of the spectrum.

Whether or not to use levels or layers as input to RT models was discussed. The choice depends on the application: CRTM was designed specifically for NWP so atmospheric state variable inputs are by layer; The RTTOV community extends much beyond NWP applications and thus level input was chosen. However, forecast models produce layer quantities so using an inputs-by-level RT in that application requires the layer inputs to be converted to levels – and the methodology used may be dependent on the layering scheme.

Action RTSP-21

Roger Saunders (MetOffice), Ben Ruston (NRL), Marco Matricardi (ECMWF), Louis Garand (Environment Canada), Gang Ma (for NMC), and Paul van Delst (NCEP/EMC) to provide documentation of methodologies used in NWP centres to convert layer atmospheric state variables to level values.

Addition of the Zeeman line splitting to RT models was discussed. Yong Han is working on adding the Doppler effect to his current SSMIS Zeeman model. It was noted that users will want to know what extra inputs are required in the Zeeman RT models. This should be addressed by the model documentation.

RT modeling for precipitating clouds was discussed. The speed of multiple-stream radiative transfer and access to optical property data for non-spherical particles were raised as concerns.

Action RTSP-22

Following Action RTSP-17, Paul van Delst will make available on the RTSP-WG website, optical property data for non-spherical particles used at the JCSDA, as well as any supplied by other attendee's organisations.

Action RTSP-23

Ben Ruston to contact colleagues at CSU to obtain additional cloud optical property data for non-spherical particles.

CNES organised at URY (France) in April 2008 a workshop TRATTORIA 2008 dedicated to radiative transfer in a terrestrial atmosphere for remote sensing. It gathered about 70 French scientists and a few experts from UK, Spain and Belgium. It permitted to establish the state of art in the various spectral domains and identify the priorities for future work in 3D models, parameterization and fast RTM.

Action RTSP-24

Pascal Brunel to provide the TRATTORIA-2008 workshop summary when it becomes available for inclusion on the RTSP-WG website.

2.1.6 Surface property modeling

Work on a generic interface to the emissivity climatology on the MetOffice NWP-SAF site is beginning as an NWP-SAF Visiting Scientist project. Ben Ruston, Eva Borbas, Filipe Aires, Fuzhong Weng, and Catherine Prigent are the principal investigators. Infrared intercomparisons should be completed around August 2008, and the interface (for infrared and microwave) should be available near May 2009. Eric Pequignot will also participate in the IR emissivity database design.

Action RTSP-25

Ben Ruston and Filipe Aires to notify the RTSP-WG when the emissivity climatology intercomparisons and interface are completed.

Work on comparisons between the NESDIS ocean microwave emissivity model, FASTEM-3, and the JPL two-scale surface model is scheduled, subject to funding availability, to resolve regional differences between them.

Recommendation RTSP-5 from ITSC-15 was to plan a second workshop on Remote Sensing and Modeling Surface Properties prior to ITSC-16. This recommendation is brought over.

Recommendation RTSP-4 to Co-Chairs of the second meeting on surface property modeling.

Plan the Second Workshop on Remote Sensing and Modeling of Surface Properties prior to ITSC-17 tentatively in June of 2009. The meeting will deal with retrievals and parameterizations of emissivity, bi-directional reflectance and land surface temperature.

Action RTSP-26

Co-Chairs of this workshop will make official announcement to ITWG and other NWP and satellite centers about the workshop information as soon as the date is firmed up.

2.1.7 Model intercomparisons

It was noted that the AIRS Intercomparison is continuing with investigators submitting results to the intercomparison webpage. Results for MODTRAN (Gail Anderson) and the MetOffice Principal Components RTM (Stephan Havemann) have been submitted.

2.1.8 Validation datasets

The JAIVEx dataset was discussed. Stuart Newman of the MetOffice is the point of contact to obtain the data, which is distributed via DVD. The data contains clear sky radiances, profile and surface data over both land and ocean. The ARIES measured ISRFs are included on the DVD.

Action RTSP-27

Paul van Delst to add JAIVEx link/POC to the RTSP-WG webpage.

2.2 TOVS/ATOVS IN CLIMATE

Web site: <http://cimss.ssec.wisc.edu/itwg/cwsg/>

Working Group members: Peter Thorne (Co-Chair), Jörg Schulz (Co-Chair), Hartmut Aumann, Denis Blumstein, Laure Chaumat, Cyril Crevoisier, Viju John, Anton Kaifel, Dieter Klaes, Steve Mango, Marc Schröder, Lei Shi, Lars Fiedler, Ramesh Singh, Roger Saunders

2.2.1 Introduction

TOVS and the follow-up ATOVS package has now been operational for nearly 30 years. In addition to these data there exists a wealth of operational and research satellite data from newer or short-term missions. Together these data have reshaped our understanding of climate variability and change. It is important to note that climate is not solely a concern about long-term changes and that even short-duration missions can be critical in elucidating upon important issues. However, the issues surrounding accurate long-term trend estimation are an inherently difficult problem and of primary interest to policy makers and therefore form the focus of much of what follows.

2.2.2 Review of recent advances in (A)TOVS climate datasets including errors in (A)TOVS climate datasets

Expertise within the group was limited to MSU/AMSU and HIRS climate datasets so these will be the focus here. Since the last ITSC two groups (RSS and UAH) have updated their MSU products although documentation of these effects is as yet to be forthcoming in the literature. Both groups have noted to users the existence of substantial drift (for climate) occurring in at least one of the current AMSU instruments that they utilise which raises questions about the accuracy of their monitoring of the scientifically and politically important recently reported “global cooling.” Between the four datasets that now exist there is agreement on the sign of long-term changes (troposphere warming, stratosphere cooling) but gross uncertainties remain in the long-term trends that preclude definitive statements regarding societally important questions such as whether troposphere-surface lapse rate changes are occurring as we expect (CCSP, 2006, Santer et al., 2008).

Using a simplified statistical model Thorne et al. (2007) showed that to retain trend fidelity in a resulting climate dataset once all intra-satellite impacts had been adjusted for (if this had not occurred the simplifying assumption was made that these would project onto the inter-satellite bias offset correction) the inter-satellite bias offset needed to be known to <10% of the expected climate signal for typical TOVS / ATOVS launch rates. This finding will be more generally applicable than to solely MSU. Such simple statistical analyses could and should be undertaken prior to embarking on dataset creation to ascertain whether a realistic answer can be achieved given the data issues which can often be grossly ascertained in advance.

Recommendation Climate-1 to ET on Satellite Sounders

To recognise that if data are to be used for climate, given typical satellite refresh rates, inter-satellite biases need to be constrained within 10% of expected climate signal (e.g., if climate models predict a 0.2K/decade trend in brightness temperatures, then inter-satellite brightness temperature biases need to be constrained to within +/- 0.02K). This would necessarily include the impact of any change in measurement technology, viewing geometry, footprint etc. and the need to

maintain the channel spectra. It is particularly applicable to heritage measures that offer the potential for monitoring of long-term climate changes. It is key that climate has a strong voice in such planning activities.

Action Climate-1

Jerome to communicate this recommendation to ET on Satellite Sounders.

For ATOVS instruments there is much current and planned work on intercalibration:

- Intercalibration for HIRS water vapor is done for TIROS-N through MetOp-A.
- Cooperation of NOAA NCDC, Met Office, and CM-SAF DWD to work on intercalibration issues related to HIRS and AMSU.

In particular, it is intended to:

- Use geostationary water vapor channels to assess the HIRS intersatellite bias and vice versa.
- Use diurnal cycle of upper tropospheric water vapour information from geostationary satellite observations to characterise orbital drift in HIRS data.
- Intercalibrate SSM/T2, AMSU-B, and MHS 183.31 +/- 1 GHz channel.

2.2.3 Plans for hyperspectral instruments, including archiving and products as well as climate studies

From the analysis of AIRS data it is obvious that the state of art of hyperspectral sounders has advanced to the point where absolute calibration accuracy of 100 mK can be reached with better than 10 mK/year stability. There are solid indications that a similar performance is being achieved by IASI. The operational and quasi-operational weather sounders can thus be expected to create climate quality data.

The integrity of this data set has to be protected. Any change in the spectral response function, spectral coverage, SNR or spatial response function intended to improve the operational weather sounding capability has to be reviewed by the climate community, to insure that an artifact free data set can be maintained (See recommendation Climate-1).

Error information for Level 2 products is a valuable source of information for climate studies and should be provided whenever possible. In particular, the 1DVAR retrieval scheme applied to IASI observations has the potential to provide error information on pixel basis. Currently, EUMETSAT is providing the diagonal of the error covariance but not off diagonal terms characterising vertical error correlation and correlations between temperature and humidity errors. However, based on the diagonal an error propagation study will be carried out at CM-SAF DWD with the aim to assign a more precise error measure to global climate products. This measure will combine retrieval errors and interpolation uncertainties.

2.2.4 Need for long-term calibration

The working group recognised the key importance of robust cal/val if we are to have any confidence in the long-term climate record from satellites. Without such a system being instigated, it was recognised that in all probability we will continue to wrestle with very large inherent uncertainties in the future climate record grossly reducing their utility. The working group supported the instigation of the GRUAN network to form the ground-based component whilst also noting the benefits that a precessing orbit satellite with high quality radiometers

and/or sounders as well as GPS-RO could bring. It was noted that to absolutely guarantee the satellite climate record it is not a case of either / or – both components would be required.

Recommendation Climate-2 to satellite agencies

Agencies need to recognise the critical importance of actively supporting a long term calibration framework if their data are to prove of the envisaged high utility in climate monitoring. This would consist of a fully functioning GRUAN network of 40 very high quality ground cal/val sites run for climate and a precessing orbit satellite carrying a range of microwave and infrared radiometers/sounders and a GPS-RO.

Action Climate-2

ITWG CGMS representative to communicate recommendation Climate-2 to CGMS and request that it be on the agenda. Matt Menne as GCOS representative to ET-EGOS to communicate this recommendation at their next meeting.

With respect to GRUAN plans, three specific items were raised:

1. It was strongly argued that there is a need for coincidence of radiosonde measurements as proven by EAQUATE, JAIVEx and other such campaigns.
2. For characterising hyper-spectral responses and monitoring trace gases, aerosols and dusts it was noted that one or more GRUAN sites should be sited in regions of complex chemistry and / or particulate characteristics.
3. It was noted that in the past few years, the ability of infrared sounders to retrieve a CO₂ integrated content in the troposphere has been established and several algorithms have been developed. However, the main problem faced by current retrievals of CO₂ from existing instruments (IR sounders) is the validation. This will still be an issue for future instruments which are to be launched in the near future (OCO, GOSAT).

Recommendation Climate-3 to AOPC WG-ARO

The Climate working group of ITWG recommends that GRUAN launch a subset of “Satellite overpass coincident” launches which would consist of dual launches at t-1 h and t as has been done for JAIVEx as well as the EUMETSAT IASI calibration and which have proven to be of high utility.

Recommendation Climate-4 to AOPC WG-ARO

One or more GRUAN sites should be sited in an area where there is a prevalence of each of the following: dust events, black carbon from seasonal burning, Indian Ocean brown cloud, to help fully characterise hyperspectral sounders in these challenging situations.

Recommendation Climate-5 to AOPC WG-ARO

GRUAN to recognise the vital role of CO₂ validation with measurements from the surface to the upper troposphere to support satellite based climate monitoring of changes.

Action Climate-3

Peter Thorne to report Recommendations Climate 3-5 to AOPC WG-ARO.

2.2.5 Clouds including status of assessment and future activities

The GEWEX cloud assessment main objective is to assess the reliability and quality of available global cloud datasets for climate studies (Co-Chairs: C. Stubenrauch, S. Kinne). The GEWEX cloud products are provided by the International Satellite Cloud Climatology Project (ISCCP), using data from a combination of polar orbiting and geostationary imagers. Other participants are: HIRS-NOAA, TOVS-PathB, PATMOS-x, SAGE, MODIS-CE, MODIS-Science Team, CALIPSO, CloudSat. Climatological averages of cloud amounts and properties, their regional, seasonal and diurnal variations as well as time series of these climatologies were analyzed. In a second step other cloud properties such as cloud thermodynamic phase, cloud optical thickness and effective particle size will be analyzed.

More information and results can be obtained at <http://climserv.ipsl.polytechnique.fr/gewexca>

After more than 25 years of (A)TOVS data, the question if the hydrological cycle is accelerated and if the frequency of severe storms increases with global warming is still not resolved. HIRS data could be used to elucidate upon this issue.

Recommendation Climate-6 to Climate Action Team for CEOS

We recommend that the HIRS data record be reanalyzed for cloud cover characteristics with more robust techniques, i.e., the trend in the frequency of Deep Convective Clouds (DCC).

Action Climate-4

J. Schulz to bring Recommendation Climate-6 concerning the potential of analysing deep convective clouds to the attention of the leader of the Climate Action Team for CEOS climate Action-A3 that is concerned with investigations of trends from combined imager and sounder measurements.

2.2.6 Ozone

Currently there is no evidence that the stratospheric ozone layer will recover soon and therefore it is necessary to continue to monitor the ozone layer in the stratosphere with future satellites.

The current MetOp satellite carries the GOME-2 and IASI instruments forming an advanced system for ozone profile retrieval in the UV/VIS and IR spectral region. The combination of both instruments enables the synergistic use of both instruments for ozone profile retrieval. It has already been proven with synthetic data that with a combined retrieval using UV/VIS and IR spectral data that ozone profile retrieval can significantly be improved in the free troposphere.

The working group noted with some regret that OMPS limb sounding capabilities will not be made available on NPOESS. This will significantly reduce ozone monitoring capabilities.

Recommendation Climate-7 to IPO

The climate working group recommends inclusion of an OMPS limb sounder on the NPOESS satellites to ensure our ability to monitor ozone changes over the coming decades.

Action Climate-5

Mitch Goldberg to be requested to communicate recommendation Climate-7 to IPO.

With current planning of the European PostEPS and GMES Sentinel 5 mission, there also exists the risk that a gap in simultaneous coverage with UV/VIS and IR observations may occur if the first PostEPS and GMES satellites will not be launched at the same time, i.e., within a few months. Additionally, studies must be performed on what temporal difference for UV/VIS and IR observations in a potential constellation can be tolerated without damaging the synergistic use of the instruments.

2.2.7 Carbon Dioxide, dust and trace gases

AIRS and IASI hyperspectral sounders can extract not only the total column abundance of CO₂, ozone, CO and dust, but can do so with about three layers of vertical resolution with the correct choice of frequency coverage and SNR. Changes in these quantities are of significant climate interest.

Recommendation Climate-8 to IPO

The capability to extract trace gas abundances and dust concentrations should be maintained and restored for CriS. Clean window channel 2616 wave number is also key for absolute calibration and should be included.

Action Climate-6

J. Schulz to pass on this recommendation to IPO through Mitch Goldberg.

The CO₂ signal contained in the infrared observations is small (about 0.3 K for a variation of 1% of CO₂). This means that PCA-like data potentially precludes studying small signals such as the CO₂ one.

Recommendation Climate-9 to EUMETSAT

The information loss resulting from using principal components instead of the full spectrum should be quantified with regards to climate study objectives before making any decision concerning the distribution of Level 1 data.

Action Climate-7

EUMETSAT to be informed of Recommendation Climate-9 through Dieter Klaes.

The GCOS/WCRP Atmospheric Observation Panel for Climate (AOPC) considered at its XIV session the current status and future plans for the observation of the Earth Radiation Budget. It stressed the need for complementing observations to properly understand ERB, such as aerosols and cloud properties. In particular, satellite-derived information on the absorption properties of aerosols are urgently required to better constrain aerosol radiative forcing.

Recommendation Climate-10 to agencies

The ITWG climate working group supports the recommendation of the GCOS/WCRP AOPC-XIV and recommends to space agencies to include polarimetric devices to measure aerosol on operational satellites to complement observations of cloud properties and Earth Radiation Budget.

Atmospheric aerosol radiative forcing is a major uncertainty in climate change (IPCC). Their effect in the infrared, even if not as important as in the shortwave, is poorly observed and understood. However, infrared sounders are of great interest to study atmospheric aerosol, both stratospheric and tropospheric, night and day, over land and sea. The remote sensing of atmospheric dust properties (altitude, optical depth, etc.) with AIRS on board Aqua is an example of the capability of infrared sounders to provide useful information to reduce the aerosol radiative forcing uncertainties. The AIRS dust climatology can be downloaded at <http://ara.lmd.polytechnique.fr>.

The synergetic use of active and passive observations is an asset for validating any cloud/aerosol climatology and such a synergetic use should be promoted in the future.

2.2.8 GSICS and R/SSC-CM

In 2007 WMO and several space agencies formulated an Implementation plan for the so called global network of Regional/Specialised Satellite Centers – Climate Monitoring (R/SSC-CM). The R/SSC-CM has the overall objective to facilitate a continuous and sustained provision of high-quality Essential Climate Variables (ECV) satellite products on a global scale including reprocessing. The first planning meeting was held at EUMETSAT on 15-16 April 2008 and defined five pilot activities concerning ECVs from the atmospheric domain:

- Cloud properties + aerosols
 - NOAA(proposal coordinator) + EUMETSAT (CM-SAF)
 - (may include Polar Winds and surface properties)
- SSM/I: total column water vapour, precipitation, liquid water path
 - NOAA + EUMETSAT (CM-SAF) (proposal coordinator) + CMA(precipitation)
 - (may include snow and sea ice)
- Surface albedo, clouds + aerosols from geostationary satellites
 - JMA + EUMETSAT(CF + CM SAF) (proposal coordinator) + NOAA + CMA
- Atmospheric Motion Vectors (AMV) + clear sky radiance
 - JMA + EUMETSAT (CF) (proposal coordinator) + NOAA + CMA
- Upper tropospheric humidity
 - JMA + EUMETSAT (CF + CM SAF) + NOAA(proposal coordinator) + CMA

Recommendation Climate-11 to R/SSC-CM network

The R/SSC-CM network should include the relevant expertise from ITWG climate working group members when it formulates its first pilot activities. In particular, the activity on upper tropospheric humidity can strongly benefit from work done by ITWG group members.

Action Climate-8

J. Schulz to add to ITWG climate group web page and act as an international focus for the provision of information regarding current and future developments of the global network of R/SSC-CMs.

2.2.9 General POST-EPS issues

The working group acknowledged that EUMETSAT is currently archiving all Metop-A mission data at all data processing levels, namely Level 0, Level 1a (counts at original instrument grid, navigation and calibration data appended), Level 1b (on original instrument grid, calibration applied, navigation appended), Level 1c for IASI (apodised spectra), and Level 2 (retrieved parameters).

Recommendation Climate-12 to post-EPS Mission Team

The Climate working group recommends that for current and future missions all mission data will be completely archived at all processing levels, in particular Level 0, Level 1 (all processing levels) and Level 2, along with all necessary information to allow full reprocessing of the mission data.

For climate application it is critical to process the data consistently. If during the lifetime of an instrument the ground processing switches to an improved algorithm, the entire data should be reprocessed. This decreases the likelihood of creating data where any climate signature is overwhelmed by software version changes. The policy is in place for the EOS Terra and Aqua missions. This cannot be done after the instrument team has been disbanded as essential knowledge is lost making the data virtually redundant for climate (e.g., VTPR). It is key to do this if the climate mission is to be fulfilled.

Recommendation Climate-13 to post-EPS Mission Team

The Climate working group recommends to plan for reprocessing capabilities in the ground processing facilities of missions including full reprocessing of Level 1b at least at mission end.

The working group raised substantial concerns about the status of the AMSU-A instrument replacement and particularly the debate as to whether this should be cross-track or conical scanning. As noted above, changes need to be minimised if there is to be any hope of retaining the climate signal, particularly if there is no robust cal/val system in place (which cannot be guaranteed at this time). In addition there are two substantial reasons why cross-track scanning should be retained:

1. The IASI / CrIS viewing geometry is designed to benefit from the AMSU footprint so changing the AMSU geometry will either reduce the utility of these measures or require a change in these instruments as well.
2. The politically important T2LT (lower troposphere) product includes differencing of nadir and off-nadir angles to reduce the stratospheric influence on channel 2 of MSU (5 on AMSU) and this could not be continued if there was a migration to conical viewing.

Recommendation Climate-14 to post-EPS Mission Team

AMSU replacement on post-EPS must be cross-track to enable a continuation of the “lower tropospheric” retrieval which is viewing geometry dependent and to minimise the risk of change to other instruments which are tied in some sense to the AMSU footprint.

Although the 4 micron band provides useful information on CO₂ (channels peaking lower in the troposphere), its use is prohibited for IASI due to too high a radiometric noise in IASI band 3.

Recommendation Climate-15 to post-EPS Mission Team

Post-EPS to consider improving the radiometric noise of post-IASI in the 4 micron band, by at least a factor of 2, without degrading the spectral resolution so that it can be usefully utilised in CO2 monitoring.

As noted in the ozone discussion synergistic UV/VIS and IR measures have distinct advantages. The group noted that these may not be flown on the same platform but rather as part of an EPS-train. Work is required to assess the sensitivity to this choice. Very substantial concern was also raised about the sustainability of the ozone record under such a strategy. These issues clearly require substantial further investigation if we are to ensure the continuation of our ozone monitoring capabilities.

Recommendation Climate-16 to post-EPS Mission Team

The coverage with simultaneous UV/VIS and IR observations for synergistic ozone and trace gases retrieval established by the MetOp system should be made available on future satellite systems for post-EPS systems. Depending on the launch schedule of the new missions the EPS system should be kept alive as long as possible.

Action Climate-9

Jörg Schulz to report climate recommendations 12 to 16 to post-EPS Mission Team.

Action Climate-10

ITWG CGMS representative (Mitch Goldberg) to report the non Post EPS specific issues in recommendations 12-16 to CGMS.

2.2.10 Reaction to GCOS-AOPC request to cover the climate theme more generally in ITWG climate working group

The working group noted the recent request from GCOS AOPC to cover the climate area more fully. The group noted that:

- There has been a substantial move over the TOVS era from operational usage to operational climate usage.
- This transition from operational to climate has very substantially lagged in the ITOVS composition.
- There is potentially substantial benefit to climate (and vice-versa) in bringing operational and climate applications together.
- The current climate presence is below critical mass and that as such the recommendations coming out are not generally carrying sufficient weight.

Two solutions were mooted: i) that ITWG limit its remit to operations and ii) that ITWG make a concerted effort to increase the climate presence at future meetings. The consensus was that the latter option would be preferable.

Recommendation Climate-17 to ITWG Co-Chairs

A very concerted effort should be made to increase the climate content and presence at future ITSC conferences so that a critical mass of climate scientists attend. The mix of operational and instrument expertise affords a unique opportunity to aid the production of climate quality data that it would be remiss not to act upon.

Action Climate-11

ITWG Co-Chairs to consider Recommendation Climate-16 and with help from climate WG members to attempt to significantly redress balance to more accurately reflect agency priorities on both operational and climate usage of the data at future ITSC meetings.

2.3 THE USE OF TOVS/ATOVS IN DATA ASSIMILATION/ NUMERICAL WEATHER PREDICTION (DA/NWP)

Web site: <http://cimss.ssec.wisc.edu/itwg/nwp/>

Working Group members: G. Deblonde (Co-Chair), J. Derber (Co-Chair), T. Auligne, N. Baker, B. Bell, N. Bormann, S. Boukabara, B. Candy, C. Côté, P. Dong, S. English, L. Fiedler, B. Harris, R. Hess, F. Hilton, M-J. Kim, B. Krzeminski, J. Le Marshall, S. Macpherson, T. Montmerle, R. Montroty, K. Okamoto, C. Pierangelo, R. Randriamampianina, A. Sharma, H. Sun, M. Uddstrom, G. Weymouth, B. Yan

2.3.1 Introduction

As in previous ITSC meetings, there were many substantive presentations at this meeting that indicated very positive results using satellite radiance data from many different instruments. This meeting concentrated on the use of the new data from the IASI instrument, the use of the new unified preprocessor for the SSMIS data and the use of cloudy radiances in NWP. Several operational centres showed quite positive results incorporating the long wave channels from the IASI instruments into their operational systems. The moisture channels appear to be more difficult to use with at least two centres reporting difficulty using some of the moisture channels. One center demonstrated problems using moisture channels with the adjoint sensitivity technique. The difficulties encountered may be because of correlated errors in the observational or representativeness error. It appears that it will be difficult to get useful information from the IASI shortwave channels because of the relatively large observational errors.

Results from the Unified Pre-Processor (UPP) applied to the SSMIS data were also presented. Pre-processing of the data was necessary because of several instrument problems for both F16 and F17. Use of the UPP data rather than the raw data appears to have made the temperature sounding channels useful for NWP. Additional enhancements to the UPP were discussed among attendees during the meeting.

Initial radiative transfer experiments including the effects of clouds indicate further progress has been made towards the potential future assimilation of cloudy radiances. These results indicate that radiative transfer models are now sufficiently accurate to begin the development of theoretically sound assimilation systems for clouds and precipitation. While significant progress has been made, the inclusion of clouds and precipitation remains a very difficult data assimilation problem and developments will be ongoing over at least the next five years.

Finally, the working group discussed making the NWP working group, NWP working group e-mail list and web pages more useful for the NWP community. Several recommendations about enhancements were made.

2.3.2 Evaluation and use of satellite radiance data in DA/NWP

A major justification for the development and launch of the TOVS/ATOVS instruments is their use in NWP. For that reason, improving the availability, quality, monitoring and use of the data is very important. The working group has noted several important developments since the last meeting. However, it was also noted by the working group that each satellite program has its own priorities and ways of doing things. Thus, many problems solved for one program come back in other programs. For that reason, it is important to continue to

encourage the satellite agencies to develop their programs in a way that provides maximum benefit.

The working group was encouraged to see the progress on a unified pre-processor for the SSMIS. The groups involved (NRL/Monterrey, Met Office, NESDIS) are to be complemented on their progress. Impacts from using the F16 unified preprocessor data within NWP models were shown and were encouraging. The availability of the F17 data was discussed. DMSP F17 raw data is flowing to NESDIS. Processing through UPP can commence after flight software modification is completed. Distribution of data in BUFR format should start within a month.

Action DA/NWP-1

When DMSP F17 data and also when UPP version 3 becomes available, Nancy Baker will notify users via the ITWG_NWP mailing list.

Several lessons were learned from the SSMIS experience. It was noted that the instrument problems overwhelmed the signal and required one to dig down deeply into instrument properties. As a result, it was concluded that it is critical that 1) instruments be characterized very well before launch and 2) that NWP requirements be fully taken into account in the design process. Several NWP centers got involved to make the data useful and they should be commended for their initiative and perseverance.

Recommendation DA/NWP-1 to all satellite agencies

Operational NWP centers should be part of the early cal/val operation for future missions and should receive near real time data before final quality of the data has been established.

The NPP/NPOESS system is at the stage where the cal/val procedures are being established. At this meeting, members of the IPO were present (a list of acronyms is provided in section 2.3.4). Discussions were directed toward ensuring the NWP centres are involved in the cal/val process and that the data flow and format are in place prior to the launch of the first instrument.

Action DA/NWP-2

In order to set up a list of international partners for cal/val of NPP/NPOESS instruments, members of the NWP WG will communicate their interest to the NWP WG Co-Chairs. The Co-Chairs will send this list to Karen Saint-Germain within the next week because in two weeks there is a peer review cal/val committee meeting. It should be noted that additions to the list at a later time are possible.

Action DA/NWP-3

Sid Boukabara to coordinate NPP/NPOESS data formats and information exchange (BUFR file content, line shapes, APCs, etc...) with ITWG WG.

The NWP WG expressed concerns about direct readout access through IPOPP because of the restrictions to IPO sanctioned components. Therefore, if IPOPP does not meet the requirements, then it was suggested that the NWP SAF software (to Level 1b) address the shortfalls.

The status of replacement for CMIS/NPOESS was also presented. Karen Saint-Germain announced that the government will lead the building of the initial MIS (Microwave Imager Sounder) unit. The Washington DC NRL laboratory was selected for this task. It is expected that follow-on units will be built by the private sector. The current baseline design includes AMSR-E, Windsat, SSM/I like capabilities, and SSMIS LAS (Low Atmospheric Sounding channels). Applications include soil moisture, polarimetric winds over water bodies, surface imagery, and lower atmospheric sounding.

The timely delivery of data remains a concern of the NWP working group. The timeliness requirements for the global models have tightened in some centres and for regional applications, the delivery of the data in time for use remains a challenge. The use of the RARS system has made quick delivery of data for the regional systems significantly better. The use of the Svalbard ground station has improved the delivery of the operational data stream for NOAA-18 and METOP.

Recommendation DA/NWP-2 to EUMETSAT and NESDIS

Delivery time is critical for NWP centers to enable the data to be used for nowcasting and short-range forecasts. Delays in ground-processing of observations prohibit the fulfillment of the strict data delivery requirements. The routing of data through the Svalbard station has been very beneficial for NOAA-18 and METOP. The WG recommends that EUMETSAT and NESDIS explore the possibility of sending the other still operating NOAA satellites (i.e., NOAA-15, 16, 17) through the Svalbard ground station. It is recognized that this is not trivial and may be costly and that the outcome may depend on a cost/benefit analysis.

Recommendation DA/NWP-3 to WMO

Continue to support fast delivery initiatives (RARS), extending where possible. However, the working group believes that the system should continue to be low-cost. Extension of RARS towards complete global coverage is encouraged until the point is reached where further improvements are no longer cost effective.

RARS distribution of Level 1B versus 1C data was discussed. Antenna Pattern Correction (APC) is at issue for some NWP centers. Current RARS system uses AAPP software to perform the APC. However, some centers use a different APC that is applied on the Level 1B NESDIS operational data stream. Hence for consistency, these centers would rather obtain RARS Level 1B data to be able to use the APC. The WG did not reach a consensus on preferring Level 1B or 1C.

A full orbit of HIRS data is needed for the operational calibration implying that the RARS data would not be distributed until one full orbit has been received. This would delay the distribution of all data (including AMSU) by at least ½ hour. The group felt that the HIRS calibration issue does not warrant a delay in the distribution of both AMSU and HIRS data.

Recommendation DA/NWP-4 to EUMETSAT and IPO

The short operational delivery time of NPOESS data to NWP centers is an extremely attractive component of the system design. The Safety Net (NPOESS ground receiving system) is expected to be online with NPOESS satellite C2 in 2016. While the NPOESS delivery will be greatly improved, the METOP delivery will be substantially slower. The working group recommends the satellite agencies make every effort to improve the operational delivery of the METOP data. This includes

the possibility of the Antarctic ground station, and the possibility for post-METOP-C satellites using the Safety Net ground system.

There was considerable discussion concerning the EUMETSAT plan to distribute IASI principal components (PCAs) rather than the individual channels.

Recommendation DA/NWP-5 to EUMETSAT

EUMETSAT is considering the distribution of PCAs (up to 300-400 PCAs) over EUMETCast instead of the full set of channels to save bandwidth. However, some selected users may still be able to receive the full channel information. The NWP WG recommends that both the new data formats and the full set of channels be distributed for a six month testing period. A final decision on the way forward should be made after the evaluation of the testing.

Action DA/NWP-4

European NWP WG members to discuss Recommendation DA/NWP-5 with their EUMETSAT OPS WG representatives.

The members of the NWP WG have found that intercomparisons between the various centres to be quite useful. The IASI instrument was thought to be a good opportunity for this intercomparison.

Recommendation DA/NWP-6 to NWP WG members

At the ITSC-15, it was recommended that a 15 IASI channel data set be used for near real time intercomparisons between different NWP centers. However, it was later noticed that only a few of the chosen 15 channels were included in either the EUMETSAT GTS data set (~300 channels) or the NESDIS (~600) data set. The working group reiterates the desirability of the intercomparison exercise.

Action DA/NWP-5

Fiona Hilton to select a new set (< 20) of IASI channels for intercomparison purposes. Fiona to give instructions on basic breakdown (e.g., clear, land, etc...) of profile types and the statistical variables (e.g., mean, standard deviation, histograms, diffusion diagram...) presented. It would be best if common formats were used but this is considered to be of lower priority. Links to the results will be put on the ITWG web site.

Action DA/NWP-6

Lars Fiedler (EUMETSAT) to put their IASI monitoring on their external web site.

The use of off-diagonal terms for the observation error covariance matrix (R) was briefly discussed. However, estimating the terms remains a difficulty requiring further research. Note that for the IASI instrument, the EUMETSAT archive contains estimates of the instrument (only) covariance matrix including apodization effects. However, representativeness errors are state dependent.

The reevaluation of the choice of AIRS channels (in reference to the ~300 channel set available on the GTS) was brought up. This may be a good idea but would imply significant adjustments to the processing and assimilation procedures at the operational centers. Most operational centers are moving on to newer instruments requiring urgent attention.

It is noted that the only planned GEO orbit high resolution IR sounders are the IRS on MTG and an instrument on FY4. We also note that the microwave plans are significantly behind.

Recommendation DA/NWP-7 to satellite agencies and WMO

The geostationary orbit is ideal for observing the rapidly changing components of the atmospheric and surface fields. The WG recommends the use of this orbit with high spectral resolution IR and/or microwave sounder/imager instruments. Ideally if both are possible the microwave and IR instruments should observe the same portion of the atmosphere at the same time.

2.3.3 Working group support for NWP community

The large number of instruments and agencies supplying data to the NWP community makes the use of the data a challenge. For this reason, the working group has formulated several recommendations and action items intended to improve the efficiency of the development.

Recommendation DA/NWP-8 to satellite agencies

The working group feels that the amount of information about current and future satellite systems and advanced notification of changes could be improved. Better communication is necessary for planning, preparation, and execution by the NWP community.

Action DA/NWP-7

NWP WG members to locate relevant satellite agency URLs and contact points where information can be found. The information will be obtained from space agencies through NWP WG members listed below.

Members to send URLs and contact points to Co-Chairs who will then put them on the ITWG web site. Chairs will then communicate with space agency contacts so that the ITWG_NWP mailing list can be added to their mailing list.

Action DA/NWP-7a

Fiona Hilton (UK MO) responsible for obtaining the information for EUMETSAT.

Action DA/NWP-7b

Peiming Dong (CAMS) responsible for obtaining the information for CMA.

Action DA/NWP-7c

Clemence Pierangelo (CNES) responsible for obtaining the information from CNES (www.smsc.cnes.fr).

Action DA/NWP-7d

Kozo Okamoto (JMA) responsible for obtaining the information from JAXA and JMA.

Action DA/NWP-7e

Min-Jeong Kim (NESDIS JCSDA) responsible for obtaining the information from KMA.

Action DA/NWP-7f

Alexander Uspensky (SRC Planeta) responsible for obtaining the information from ROSCOSMOS and ROSHYDROMET.

Action DA/NWP-7g

Godelieve Deblonde (EC) responsible for obtaining the information from the CSA.

Action DA/NEWP-7h

John Derber (NCEP) responsible for obtaining the information from NESDIS.

Action DA/NWP-7i

Karen Saint-Germain (IPO) responsible for obtaining the information from NPP/NPOESS.

Action DA/NWP-7j

Nancy Baker (US Navy NRL) responsible for obtaining the information from DMSP.

Action DA/NWP-7k

Dirceu Herdies (INPE/CPTEC) responsible for obtaining the information from INPE.

Volunteers are still needed for India, NASA, and RARS.

The availability of real time information on the status of the various instruments and platforms, while greatly improved, still is an area of concern for the working group. Since the data is distributed from a variety of agencies located around the world to all NWP centers, it is difficult to create a single distribution paradigm.

Action DA/NWP-8

Fiona Hilton to gather together information regarding what level of information messaging (METOP) is required by NWP centers and forward this information to EUMETSAT.

The ITWG NWP working group web pages and email list could be useful for the distribution of information among the NWP centres. The working group has noted that the contents and capabilities of these web pages have not kept up. A series of recommendations and action items were formulated to make better use of the web pages and email list.

Recommendation DA/NWP-9 to ITWG CIMSS web site webmaster

It is recommended that WIKI capability be set up on the ITWG CIMSS web site (under the supervision of the Co-Chairs).

Action DA/NWP-9

NWP WG chairs to provide survey template (start with what Tony McNally has used so far) to be put on ITWG WIKI page and allow updating as operational systems change. NWP WG chairs remind NWP centers to update the table through ITWG_NWP mailing list every six months and before next ITSC meeting.

Action DA/NWP-10

All members of the ITWG NWP working group to examine mailing list for missing relevant e-mail addresses. WG Co-Chairs to maintain and update the email list.

Action DA/NWP-11

NWP WG Co-Chairs to ask developers of software packages to announce new software releases on ITWG NWP mailing list. Specifically, the following software packages have been identified: CRTM, RTTOV, IPOPP, AAPP, and NWP SAF news.

Action DA/NWP-12

NWP WG Co-Chairs to review the status of the actions and recommendations at regular intervals and email a status report to WG members and ITWG Co-Chairs via the ITWG_NWP mailing list.

Action DA/NWP-13

NWP WG Co-Chairs to solicit ideas through NWP WG mailing list for WG topics prior to ITSC-17.

The challenges with the assimilation of radiance data in regional models were briefly discussed. It was noted that recommendations on the issue of bias correction can be found in the proceedings of the bias correction workshop held at ECWMF in 2005. The group noted that this was a large and a very complex problem and may benefit by more in depth discussion. This could be addressed in a regional satellite data assimilation workshop.

Action DA/NWP-14

The NWP WG will set up an email distribution list for those interested in regional satellite DA and the list will be sent to the ITWG_NWP mailing list.

A subgroup interested in regional satellite data assimilation was identified at the meeting consisting of M. Uddstrom, J. Derber, G. Deblonde, B. Harris, F. Hilton, R. Randriamampianina, T. Montmerle, B. Candy, K. Okamoto, N. Baker, S. English, R. Hess, and B. Yan.

A previous action item several ITSC meetings ago covered a single observation comparison between different NWP centers. Sue Ballard set up the comparison. It was noted that this is something that should be revisited since the use of data and background errors (e.g., flow-dependent) have changed substantially.

Action DA/NWP-15

Brett Candy and Roger Randriamampianina will work together to design single observation experiments in a global and regional model setting and the results will be accessible though the ITWG web site.

The format of the ITSC meeting was discussed and several options were discussed with the ITWG Co-Chair (S. English). It was suggested that if there are split sessions that a participant in each session be identified to write and present a comprehensive summary of the session to the full ITSC audience.

Action DA/NWP-16

As recommendations 2, 3, 4, and 7 (see above) do not have associated action items, the working group co-chairs will bring these to the attention of the relevant bodies.

2.3.4 List of Acronyms

AAPP: ATOVS and AVHRR Pre-processing Package

APC: Antenna Pattern Correction

BUFR: Binary Universal Form for the Representation of meteorological data

CAMS: Chinese Academy of Meteorological Sciences

CIMSS: Cooperative Institute for Meteorological Satellite Studies (University of Wisconsin-Madison)
CNES: Centre National D'Etudes Spatiales (France)
CRTM: Community Radiative Transfer Model
CSA: Canadian Space Agency
DA: Data Assimilation
DMSP: Defense Meteorological Satellites Program
EC: Environment Canada
EUMETSAT: European Organization for the exploitation of meteorological satellites
FY-4: Geostationary satellite from China
GTS: Global Telecommunications System
INPE: Instituto Nacional de Pesquisas Espaciais (Brazil)
ITSC: International TOVS Study Conference
IPOPP: International Polar Orbit Processing Package
IPO: Integrated Program Office
IRS: Infrared Sounder
ITWG: International TOVS Working Group
JAXA: Japan Aerospace Exploration Agency
JCSDA: Joint Center for Satellite Data Assimilation
JMA: Japan Meteorological Agency
KMA: Korean Meteorological Administration
MTG: Meteosat Third Generation
NCEP: National Centers for Environmental Prediction
NESDIS: National Environmental Satellites, Data, and Information Service
NPP: NPOESS Preparatory Project
NRL: Naval Research Laboratory
NPOESS: National Polar-orbiting Operational Environmental Satellite System
OPS: Operations
RARS: Regional ATOVS Retransmission Services
RTTOV: Radiative Transfer for TOVS
SAF: Satellite Application Facility
SMSC: Site des Missions Scientifiques du CNES
SRC Planeta: Scientific and Research Centre on Space Hydrometeorology "PLANETA"
Russian state organization established since 1974
UK MO: United Kingdom Met Office
UPP: Unified Pre-processor (SSMIS)
WG: Working Group

2.4 ADVANCED SOUNDER WORKING GROUP REPORT

Web site: <http://cimss.ssec.wisc.edu/itwg/aswg/>

Working Group members: Andrew Collard (Co-Chair), Bill Smith (Co-Chair), Filipe Aires, Paolo Antonelli, Arlindo Arriaga, Bill Blackwell, Hal Bloom, Denis Blumstein, James Cameron, Zhaohui Cheng, David Crain, Cyril Crevoisier, Steve English, John Eyre, Kenneth Holmlund, Allen Huang, Min Jeong-Kim, Allen Larar, John Le Marshall, Jun Li, Stephen Mango, Jean Pla, Nikita Pougatchev, Yanni Qu, Filomena Romano, Marc Schwärz, Haibing Sun, Jonathan Taylor, Stephen Tjemkes, David Tobin, Alexander Uspensky, Banghua Yan, Jie Zhang, Daniel Zhou, Lihang Zhou

This working group focuses on scientific issues affecting the optimal performance of advanced satellite sounder systems. The working group reviews the status of the development of advanced sounder systems and recommends changes pertaining to instrument specification, performance, data processing, and utilisation. For the purpose of this group, “Advanced Sounders” are defined as instruments that present significant new scientific and technological challenges and which require new methods for data processing and utilization. Thus, Advanced Sounders currently include high spectral/spatial resolution infrared and microwave sounders and active sensors.

2.4.1 Geostationary Advanced Infrared Sounders

The group recognised the importance of high spectral resolution imaging infrared radiometers on the future global observing system. The development of such instruments on the MTG and FY-4 satellite systems was strongly encouraged and supported. Ideally, these missions should be preceded by, but not dependent on, a demonstration mission. The existing GIFTS instrument is a particularly suitable candidate for such a demonstration mission in the near future.

Recommendation AS-1 to the space agencies

In reaction to user requirements by the global and regional scale NWP community for more frequent observations of lower tropospheric moisture and temperature profiles, and for additional frequent monitoring of atmospheric dynamics, it is recognised that high spectral resolution imaging radiometers on geostationary platforms would be an important part of the future global observing system. It is therefore strongly recommended that operational missions, like MTG-IRS, be flown as soon as possible. Ideally, a demonstration mission should be conducted for risk reduction purposes, but should not delay the operational missions. GIFTS is the best current option for a demonstration mission.

Action AS-1

ITWG Co-Chairs to co-ordinate recommendations from this conference with those from the Winds Workshop and communicate to space agencies.

2.4.1.1 IGeoLab

The group continues to support the IGeoLab initiative to promote international cooperation to place and demonstrate advanced sounders (e.g., GIFTS and MW) in geostationary orbit. A new IGeoLab mission has been proposed by Russia, Canada and Finland for 2012. A Molniya

orbit is proposed in order to provide many of the benefits of a geostationary platform at high latitudes.

Recommendation AS-2 to the space agencies

The WMO IGeoLab concept should be supported.

Recommendation AS-3 to WMO

GIFTS should be considered as a candidate hyperspectral imager for the IGeoLab Molniya mission.

2.4.2 Calibration and Validation of Advanced Sounder Data

The need for sufficient characterisation, calibration and validation of advanced sounder observations was recognised by the group. The importance of having an SI traceable calibration was emphasised, both for pre- and post-launch phases. The requirements for the parameters that need to be calibrated need to be communicated from the data users to the data providers.

Recommendation AS-4 to data users

The group encourages pre- and post-launch instrument characterisation and traceable calibration. Requirements for the parameters to be characterised and their required accuracy and stability should be communicated from the users (i.e., NWP, RT modellers, climate researchers) to the data providers.

The important role that NWP centres can have in assisting with the calibration and validation of new satellite instruments, such as IASI, was noted. It is therefore encouraged that data be available to NWP centres as early as possible before the instrument is declared operational.

Recommendation AS-5 to data providers

To aid in early calibration and characterisation of new instruments, data should be released as early as possible to NWP centres.

2.4.2.1 Field campaigns

The group noted that a variety of in-situ and complementary data sources are required for full validation of advanced sounders. Direct comparison with high-spectral resolution observations from aircraft under-flights of satellites provide valuable validation of absolute radiances, instrument line shapes, and derived products. Space agencies should provide adequate resources to allow full synergistic calibration activities.

Recommendation AS-6 to the space agencies and NWP centres

Cal/Val for advanced sounders needs to be an activity which receives sufficient resources. High-altitude airborne sensors, such as those associated with the NAST, S-HIS, and ARIES airborne sensors, and upper air reference networks need to be added to complementary data sources in order to validate the radiances and derived products to the very high accuracy and precision specified by the users. These campaigns should be co-ordinated with new satellite launches.

Recommendation AS-7 to space agencies, NWP centres and researchers

Case study data sets should be prepared and made freely available from these campaigns and the scientific community which is encouraged to use these data to determine instrument and forward model spectral characteristics and to improve retrieval and data assimilation procedures, with a workshop focused on case study applications of the data taking place after a couple of years.

Action AS-2

Jonathan Taylor to e-mail details of Joint Airborne IASI Validation Experiment (JAIVEx) data to the ITSC conference.

2.4.2.2 Experience from IASI calibration

The Working Group report from the previous meeting recommended that lessons learnt from establishing the in-orbit performance of IASI be used in pre-flight testing of future instruments. IASI underwent very careful ground calibration and the in-flight performance was very similar (if not slightly better). Calibration with different scene temperatures is important. Footprint shape determination, while costly to perform, is much more accurate when done on the ground.

Recommendation AS-8 to space agencies

Future instruments should be carefully calibrated before launch. In particular, care must be taken to accurately establish the instrument field of view, as this procedure is far more accurate when performed on the ground rather than in orbit.

2.4.2.3 Dedicated Satellite for cross-calibration

A high accuracy spectrometer, in a low inclination orbit (i.e., $<20^\circ$) would have the ability to cross-calibrate all polar orbiting satellites several times per day as well as geostationary satellites in different longitudinal sectors. These cross-calibrated radiances would be useful in the determination of biases between sensors on different satellite platforms and applying single station *in-situ* calibration to the entire constellation of satellites by linking cross-calibrated radiances with high temporal frequency. This may complement the existing and planned *in-situ* calibration campaigns for many separate satellites if the radiances from several satellites can be cross-calibrated with a single 'standard' satellite.

Recommendation AS-9 to the science community

The utility of applying the SNO (Simultaneous Nadir Observation) technique for an equatorial (inclination $<20^\circ$) LEO platform for the purpose of radiometric cross-calibration should be examined. Optimal orbital parameters (attitude and inclination), as well as sensor(s) type, should be determined so that recommendations for possible sensors on future equatorial satellites can be put forward. The CLARREO mission (which is primarily concerned with climate change and is currently planned to be in a 90 degree inclination orbit) partially fulfils these criteria and is a good first step.

2.4.2.4 Correlated noise from advanced infrared sounders

Spectrally correlated and spectrally uncorrelated noise component specification is fundamental to satellite observation systems and is a particularly important consideration for

the proper use of advanced infrared sounder data. This noise may be intrinsic to the instrument; may be introduced in post-processing; or may be caused by the forward model. Correlated instrument noise is best characterised through both ground-based measurements and in-flight measurements. Spectrally correlated and spectrally uncorrelated noise can be specified in-flight through analyses of calibration data and using Principal Component Analysis (PCA) of Earth scene measurements. Correlated forward model noise (which may include noise due to the effects of spectroscopic errors, cloud, aerosol and surface emissivity not being properly modelled) is best determined through inspection of the observations using the resources of NWP and dedicated validation campaigns.

Recommendation AS-10 to space agencies and NWP centres

Encourage studies to evaluate the full error covariance matrix of advanced sounder measurements and error introduced by forward models.

Recommendation AS-11 to members of the research community

Use the information from dedicated validation campaigns to better understand the full error covariance matrix of advanced sounder measurements and error introduced by forward models.

2.4.3 Objectives and Desirable System Requirements of Advanced Sounders

In order to ensure consistency of objectives and adequacy of the capabilities of various international contributions to the global observing system, the ITWG provides the following guidance on the primary measurement objectives and desirable radiometric measurement requirements to be met or exceeded for advanced IR sounders to be carried on future polar and geostationary orbiting satellites.

2.4.3.1 Advanced IR Sounder primary objectives

Polar Satellite Sounding Observations: The primary measurement objective for polar satellite sounding radiance observations is to infer temperature and water vapour profiles for Numerical Weather Prediction model initialization. The radiance spectra, or the retrieved profile data, to be assimilated need not be spatially contiguous for this and simultaneous microwave observations are generally available to assist in the interpretation of cloudy hyperspectral IR sounding data.

Geostationary Satellite Sounding Observations: The primary measurement objective of geostationary satellite sounding is the observation of lower and upper tropospheric temperature and water vapour dynamics, as needed to enable the nowcasting (i.e., short-term forecasting) of hazardous weather, and the production of water vapour tracer tropospheric wind profiles, used for regional and global NWP. Spatially contiguous, above cloud, sounding observations are needed to observe the atmospheric processes associated with storm systems and for tracing cloud and altitude resolved water vapour motion winds used for NWP.

Table 2.4-1 Measurement Thresholds for Future Advanced IR Sounders

Channel cm-1	$\delta\nu$ cm-1	Purpose	Polar		Geostationary			Remarks
			P	δS^1 km	P	δt^2 min	δS^3 km	
660-680	0.6	Strat. Temp.	1	~10 0	-	-	-	Polar satellite only
680-800	0.6	Trop. Temp	1	15	1	30	≤5	Fundamental Band ⁴
800-1000	0.6	T _s , H ₂ O, Cld	1	15	1	15	≤5	Fundamental Band ⁵ Cls, Sfc. T/Eemis. & H ₂ O
1000-1100	0.6	O ₃	1	15	3	30	~5	O ₃ , Stratospheric Wind
1100-1590	1.2	T _s , H ₂ O, Aerosol/Dust	1,2	≤15	2,1	≤15	≤5	Water Vapour Flux Trop. Wind Profiles ⁶
1590-2000	1.2	H ₂ O, T _s , Cld	2,1	≤15	1,2	15	≤5	Water Vapour Flux Trop. Wind Profiles ⁶
2000-2200	0.6 ⁷	CO, T _s , Cld	3	15	2	60	~5	Trace Gas/Air Quality
2200-2250	2.5	Trop. Temp	2	15	2	15	~5	Clear Ocean Day and Land/Ocean Night Utility ⁸
2250-2390	2.5	Strat. Temp.	4	100	-	-	-	Night-time Utility ⁸
2386-2400	2.5 ⁹	Trop. Temp	4	15	-	-	-	Night-time Utility ⁸
2400-2700	2.5 ¹⁰	T _s , Cloud	3	≤15	-	-	-	Clear Ocean & Night Land Utility ⁸

Table definitions: channel (spectral coverage), $\delta\nu$ (spectral resolution, unapodized for the case of an FTS, assuming an instrument self apodization of less than 5%), P (priority), δt (refresh rate), δS (footprint linear resolution). The values given are the threshold requirements with objectives being better by as much as practical from a technology and cost point of view. Priority 1 measurements are required to fulfill advanced sounding primary objectives.

¹ For cloud clearing, the highest spatial resolution is desired.

² Refresh rate for regional (3000 km x 3000 km) area coverage at full spectral resolution as desired for convective storm applications of the data (i.e., thermodynamic stability and water vapor flux measurement). Broader area coverage (e.g., 9000 km x 9000 km), with 30- to 60-minute refresh rates, is desired for temperature, moisture, and wind profile measurements for NWP applications, but these can be performed at lower spectral resolution (e.g., 2 x $\delta\nu$).

³ Spatial contiguity is required to observe atmospheric dynamical processes.

⁴ This band is fundamental for day/night high vertical resolution temperature profiles required for determining atmospheric constituent profile and cloud parameters from hyperspectral radiance emission measurements.

⁵ High spectral resolution is needed to resolve on-line/off-line radiance determinations of surface reflectance/emissivity and to separate water vapor/cloud/dust contributions.

⁶ High spectral resolution provides shortwave window observations, near the edges of these bands, as needed for cloud clearing. Either longwave (1100-1590 cm^{-1}) or shortwave (i.e., 1590-2000 cm^{-1}) sides of water vapor band can be priority 1. Having measurements covering both longwave and shortwave sides of the water vapor band will optimize the water vapor profile accuracy throughout the atmospheric column. Thus, if one side is chosen as Priority 1 then the other side becomes a Priority 2.

⁷ Spectral resolution resolves CO lines and provides shortwave window observations near 2000 cm^{-1} desired for cloud clearing, surface temperature, and cloud property estimation.

⁸ Reflected sunlight complicates the daytime utility of these data for cloudy sky and/or land surface conditions.

⁹ A spectral resolution of 0.05 cm^{-1} is desired to resolve the contribution from in-between the absorption lines.

¹⁰ The AIRS 2616 cm^{-1} channel, with 2.5 cm^{-1} resolution, has been found useful for cloud detection and sea surface temperature measurement.

Action AS-3

Bill Smith to review and re-create this table with particular emphasis on establishing a link between instrument and geophysical measurement criteria (particularly WMO requirements).

Recommendation AS-12 to the space agencies

In order to ensure consistency of objectives and adequacy of the capabilities of various international contributions to the global observing system, it is recommended that space agencies follow the ITWG guidance on desirable radiometric measurement requirements to be met or exceeded for advanced IR sounders to be carried on future polar and geostationary orbiting satellites.

2.4.3.2 Advanced Microwave Sounder objective

At ITSC-XIV, it was recommended that studies be conducted to identify the requirements for future microwave sounders, both for polar and geostationary orbits. These studies are still required.

Recommendation AS-13 to the research community and space agencies

It is recommended that relevant organizations conduct studies to identify the capabilities of microwave sounders and develop consensus user measurement requirements for future systems. This should be done for LEO as well as GEO. It is recommended that this information be consolidated in a table similar to that presented above for the IR sounder.

Action AS-4

Bjorn Lambrigtsen and Bill Blackwell to prepare a draft table summarising the requirements for microwave sounding systems between instrument and geophysical measurement criteria (particularly WMO requirements). This should be communicated to the frequency-protection community.

Action AS-5

Advanced Sounder Working Group should review the tables produced by Actions AS-3 and AS-4.

2.4.4 Configuration of Future Systems

2.4.4.1 Advanced Sounder field-of-view size and sampling interval

It was noted that the current fields-of-view size for advanced infrared sounders are larger than optimal to avoid cloud contamination. It was further noted that the optimal requirement for sounder fields-of-view size and sampling interval may evolve with future advances in sounding techniques for cloudy regions.

Recommendation AS-14 to the scientific community

Further studies on optimisation of the size of advanced sounder fields-of-view and spatial contiguity need to be pursued, taking into account probable future advances in sounding techniques.

2.4.4.2 CrIS spectral performance

It was noted that the performance of CrIS will be inferior to IASI both in terms of spectral resolution and spectral coverage.

High spectral resolution is important for obtaining high vertical resolution retrievals and for resolving spectral features of many trace gas species. The spectrum as measured by the CrIS instrument itself is of similar resolution to IASI, but the interferograms for the midwave and shortwave bands are truncated before being communicated to Earth - resulting in the degraded performance noted above. The group therefore encourages the full CrIS interferogram to be transmitted to Earth and for the CrIS measurements to be communicated to users with their full spectral information content for all three of its measurement spectral bands.

Unlike IASI, CrIS does not have contiguous spectral coverage but has gaps in the 8 μ m window and the shortwave side of the 6.3 μ m H₂O band. The latter region has already been shown to provide CO information from IASI and is also a source of information for near-surface humidity, N₂O and isotopic H₂O information. The group therefore recommends that further investigations be undertaken into the possibility of communicating the full CrIS spectrum.

Recommendation AS-15 to IPO

CrIS measurements should be communicated from the satellite at full (as measured) spectral resolution.

Recommendation AS-16 to IPO

Further investigate communication of the full (as measured) CrIS full spectrum.

2.4.4.3 Performance of conically-scanning microwave instruments

The group noted that recent studies have inferred that the impact of the DMSP SSMIS conically scanning microwave sounders is at present less than that of the cross-track sounders, the difference arising from the impact of solar intrusions (direct and reflected) onto the calibration blackbody. It was reported that these problems have been resolved for the DMSP F-18 SSMIS. The group therefore recommended that the performance of future conical sounders be reviewed after F-18 SSMIS data becomes available.

Recommendation AS-17 to space agencies/IPO

The ability of conical sounders should be studied further using on-orbit data from new conical imager/sounders as it becomes available as well as data from existing sensors, to deliver sufficiently accurate observations for NWP in the light of the most recent results.

Recommendation AS-18 to space agencies/IPO

Future conical sounding missions should take full account of the experience gained in the post-launch analyses of existing operational conical imagers and sounders (including SSMIS, Windsat, TMI and AMSR) in the specification and design of instruments.

2.4.4.4 MW Sounder deployment with future IR Sounders

It is desirable to fly microwave sounders with future IR sounders configured in such a way as to enable simultaneous observations (i.e., collocated in space and time). Cloud-clearing will be enhanced and sub-cloud level information will be provided for spatial and temporal continuity. Such MW observations are desired to be obtained together with the observations from future advanced IR sounders.

Recommendation AS-19 to the space agencies

Microwave sounders should be considered to always be flown with future advanced IR sounders, to provide simultaneous observations at the same time and at the same location.

2.4.4.5 Imagers with sounding channels to support future IR Sounders

High spatial resolution imaging radiometers which possess one, or more, lower tropospheric IR sounding channels (e.g., MODIS) provide valuable data for cloud-clearing and for the quality control of cloud-cleared radiances from advanced IR sounding instruments. Furthermore, for the case of complex partly cloudy scenes, where cloud clearing is unsuccessful, the imager sounding channel radiances provide valuable information for filling gaps in advanced sounder information otherwise lost below clouds. It is desirable that imaging radiometers fly with future IR sounders and that they possess sounding channels in addition to their “window” channels.

Recommendation AS-20 to the space agencies

Future high spatial resolution imaging radiometers to be flown with advanced IR sounding instruments should possess channels primarily sensitive to lower tropospheric emission to support the interpretation and enhance the use of advanced IR sounding spectrometer observations obtained for cloudy sky scene conditions.

2.4.4.6 Spacing of satellites when during MetOp overlap periods

MetOp-A and -B will be flying in parallel with the same equator-crossing time for up to five years after the launch of MetOp-B. As they will be using the same ground-based antenna, their orbits need to be separated by a minimum of 20 minutes and a maximum of 50 minutes. The desirable separation between the satellites for the joint use of the data for specifying

atmospheric dynamics (e.g., altitude resolved moisture tracked wind profiles, stability tendencies, etc.) should be determined by the NWP centres.

Recommendation AS-21 to EUMETSAT

All MetOp Level 1 and Level 2 data should be distributed in near-real time from both satellites.

Recommendation AS-22 to NWP centres

Preferences for separation between the two satellites should be communicated to EUMETSAT.

Recommendation AS-23 to ITWG

Investigate the implications on developing innovative products from two MetOp satellites with 20-50 minute separation.

2.4.4.7 On the continuation of the global GPSRO constellation

GPS radio occultation (GPS RO) observations are currently assimilated at a number of NWP centres. These measurements provide an important “anchor” for the bias correction of satellite radiance measurements as they are assimilated without bias correction and the active use of such data is important for NWP systems with adaptive bias correction schemes. The only dedicated GPS RO constellation (as opposed to individual satellites) is the six-satellite COSMIC mission, which is due to end in 2011. A fully operational follow-on to this mission is desirable.

Recommendation AS-24 to space agencies

A fully operational constellation of GPS radio-occultation receivers provides useful calibration information for satellite sounders and thus the group recommends a follow-on to the current COSMIC constellation should be flown.

2.4.4.8 Optimal use of community state-of-art algorithms and systems within prime contractor operational processing for satellite programs

Environmental satellite systems have historically been developed by a partnership of government (NASA, NOAA, and EUMETSAT, for example), industry and university science communities. While the technological expertise of industry is a key part of the entire system, industry is not well suited to supplying the broad perspective on the use of these future systems nor is it well suited to developing the necessary pre-launch simulations, ground data processing science algorithms, and associated data application approaches. The ITWG believes that approaches, which require prime contractors to implement operational systems without making full use of community advances in algorithm and data processing system development, decrease overall quality and usage of final data products and increase program risk.

This includes activities associated with pre-launch instrument simulations, proxy data generation, and processing algorithm development and testing, through post-launch infusion of algorithm advancements to enhance operational processing data product quality and utility. Not ensuring infusion of latest community advancements also inhibits the science community from acting as an objective, commercially neutral body in the development and implementation of future satellite systems.

Recommendation AS-25 to space agencies

Environmental satellite systems should be developed by a partnership of government, industry and university science communities under the leadership and responsibility of government agencies.

2.4.5 Exploitation of Advance Sounder Data

2.4.5.1 Distribution and optimal use of Advanced Sounder radiance data in NWP

The current use of advanced sounder data in NWP is very conservative. The limitations are the cost of radiative transfer modelling and the transfer of large observation datasets from the satellite agencies to the NWP centres. Full use of these data requires the efficient use of all the information in a compressed form. Candidates include Principal Component (PC), reconstructed radiances, and retrievals. Investigations with reconstructed radiances are in progress, as they are most similar to the data already being assimilated. It was recognised that the use of principal components and retrievals would present much larger scientific and technical challenges to the NWP community. In choosing the optimal strategy to use, consideration must be given to the specification of the observation error covariance matrix, averaging kernels, quality control, cloud detection and monitoring.

Recommendation AS-26 to NWP centres

It is recognised that more efficient use of the full advanced IR sounder spectrum is desirable within NWP data assimilation. NWP centres are encouraged to consider research into the direct use of principal components and/or retrievals from advanced IR sounders in assimilation systems.

Recommendation AS-27 to retrieval providers

Provide full characterisation of retrieval schemes including observation error covariance matrix, averaging kernels, quality control, and cloud detection. This characterisation should be both theoretically derived and independently validated. Data should be available in suitable and timely format.

Recommendation AS-28 to the ITWG

Where possible, retrieval studies should be presented with averaging kernel and full error covariance estimates and validation.

It was noted that the use of principal components to compress advanced sounder data is fundamentally a lossy technique. For many applications the small amount of lost information may be acceptable, but it can be problematic when the principal components have been generated in such a way that the desired signals are not present. For this reason, care must be taken that for general archiving of data, the compression scheme should be lossless. Datasets with lossy compression can be distributed if they are identified as such.

Recommendation AS-29 to data providers

It is noted that the use of principal components to represent advanced sounder spectra carries the danger of the loss of signals that are not properly represented in the training set. Care must be taken to ensure that data compression methods used for archiving satellite data be lossless. Lossy compression of advanced sounder data for transmission may be acceptable for certain users. This question has become

particularly pertinent in the context of continued distribution of IASI data in near real time.

Action AS-6

Ken Holmlund and the ASWG Co-Chairs should produce a table documenting the timeliness required (i.e., type of distribution) and the required fidelity of advanced sounder data as a function of user type (e.g., NWP, trace gas retrieval, climate applications) as a guide to space agencies on the most efficient strategy for data dissemination.

Action AS-7

ASWG and other working groups should critically review the table produced by AS-6.

It was noted that most discussion about compression of advanced sounder data concentrated on compression in the spectral domain. Simple methods of reduction of data volume by thinning are already in use (e.g., the dissemination of the warmest field-of-view in the AIRS footprint). It was suggested that more sophisticated methods for spatial compression may be possible, particularly for the case of hyperspectral imagers.

Recommendation AS-30 to researchers

Consider possibilities for spatial compression at the data source.

It was also noted that research into truly lossless compression techniques continues in the wider scientific community. It is recommended that space agencies investigate whether state-of-the-art lossless data compression techniques may be used to aid dissemination of advanced sounder observations.

Recommendation AS-31 to space agencies

Encourage further investigation of truly lossless data compression techniques.

2.4.5.2 Infrared Surface Emissivity

The accurate determination of the spectrum of land surface infrared emissivity is crucial to the determination of the near-surface atmospheric state from these data. Derivation of the land surface emissivity relies on the combination of a realistic first guess and an accurate retrieval algorithm. The presence of cloud in the field of view can affect the accuracy of the emissivity retrieval algorithm.

Recommendation AS-32 to the research community

Continue work on infrared land surface emissivity databases including validation and intercomparison between techniques.

Recommendation AS-33 to the research community

Continue work on infrared land surface emissivity retrieval algorithms including validation, intercomparison between techniques and investigation of robustness to clouds in the instrument field-of-view.

Recommendation AS-34 to the research community

Databases of global infrared land surface emissivities should be represented in spectral resolution fine enough to resolve spectral features of the earth's surface. The use of EOF as an efficient way to model the spectral databases is encouraged but further verification study is recommended.

2.4.6 Interaction with Other Bodies

The working group noted the upcoming 4th Hyperspectral Workshop to be held at EUMETSAT, Darmstadt, Germany on 15th-17th September 2008. As there are now two major conferences, at least, devoted to hyperspectral sounding - the Hyperspectral Workshop and the IASI conference - in addition to the Advanced Sounders Working Group, it was suggested that there be co-ordination between the organisers of these to ensure that the most important topics are discussed.

Recommendation AS-35 to the relevant chairpersons

It is recommended that there be co-ordination between the Advanced Sounders Working Group, the Hyperspectral Workshop, the IASI Conference and the AIRS science team.

Action AS-8

Advanced Sounder Working Group Co-Chairs should co-ordinate with the IASI conference chairs, the AIRS science team and Paolo Antonelli to suggest possible topics that should be covered at future workshops and conferences.

2.5 INTERNATIONAL ISSUES AND FUTURE SYSTEMS

Working Group members: John Eyre (Co-Chair), Jerome Lafeuille (Co-Chair), Bill Bell, Hal Bloom, David Griersmith, Richard Kelley, Thierry Phulpin, Jean Pla, Karen Saint-Germain, Peter Wilczynski

2.5.1 Scope

After reviewing the actions and recommendations of the previous meeting, and bearing in mind the agenda items of the forthcoming plenary sessions dealing with international issues and future systems, the WG agreed to focus its discussions on the following issues:

- Future perspective for the Regional ATOVS Retransmission Service (RARS)
- Vision for the space-based Global Observing System in 2025 and adequacy of current plans
- Direct Broadcast access to polar orbiter data
- Frequency management issues

It was furthermore agreed that Education and Outreach would best be addressed in the WG on Satellite Sounder Science and Products.

2.5.2 Future perspective for the RARS

The WG underlined the benefit of the RARS to enhance timely availability of ATOVS sounding data for regional and global NWP. It recalled recommendations of ITSC-15 to pursue the development of the RARS global network for a better coverage of the globe, while taking into account cost/benefit considerations since a 100% global coverage might not be achievable without unaffordable equipment and/or telecommunications costs.

It was recalled that RARS was a WMO project aiming to expand at global scale the concept initially implemented by EUMETSAT with EARS, i.e. to collect ATOVS data from various Direct Readout stations over a wide region and make this data available in near-real time over the GTS and possibly other means, in order to improve the timeliness with respect to global data. The current objective of RARS (as stated on the WMO RARS website) is to achieve 30 minutes timeliness for ATOVS data from 90% of the globe's surface. The current coverage is about 70% and is expected to exceed 80% within a year.

The WG welcomed this rapid progress. It noted that RARS had about doubled the amount of sounding data available to NWP centres before cut-off. The WG supported the objective to aim at 90% of global coverage.

The WG considered the potential expansion of the RARS objectives to include other sounding data beyond ATOVS. The applicability to IASI data was subject to the reactivation of Metop HRPT and the capability of RARS receiving stations to receive Metop. For the short term, the WG recalled that FY-3A was planned for launch by end of May 2008 and included an IR and MW sounding capability (IRAS, MWTS, MWHS) and a direct readout capability in X-band and L-band (MPT, AHRPT). While recognizing that FY-3A was an experimental satellite of a new series, it suggested that the RARS project take steps to make FY-3A sounding data timely available through the RARS.

For the longer term, the WG noted that the RARS should normally not be necessary for NPOESS data when the SafetyNet will be fully implemented, i.e. by the time NPOESS-C2 is launched. However it was stressed that the SafetyNet will not be available for NPP and that by the launch of NPOESS-C1 it would only be partly implemented with McMurdo and Svalbard but not all 14 stations. The WG thus recommended to initiate action in 2009 in order to be able to handle sounding data (CrIS, ATMS) from NPP and NPOESS as soon as possible. This would be a gap-filler until data timeliness can be ensured through the SafetyNet. Without aiming at global coverage, it would enhance the benefit of the NPP and NPOESS missions and minimize the negative impact of phasing out the last ATOVS instruments. The WG recognized that NPP Direct Broadcast in X-Band would require enhanced receiving and communications capabilities.

The following practical steps were suggested:

- At the forthcoming Direct Readout Conference in Miami, December 2008, to announce the initiative of a NPP/NPOESS RARS phase, identify the available or planned X-band receiving stations and call for contributions to this network.
- In the framework of the WMO RARS project, invite potential contributors to build this new phase of the RARS project following the successful example of the ATOVS phase.

The most efficient technical options (e.g., centralized or distributed processing) should be investigated, considering NWP requirements, data volumes and impact on telecommunications.

Recommendation IIFS-1 to WMO and RARS partners

Welcoming the rapid progress of the RARS project to ensure timely availability of ATOVS data to NWP centres, and considering the demonstrated benefit to NWP, WMO and the RARS contributing organizations should pursue the implementation of the global RARS network with the aim to cover at least 90% of the globe for ATOVS data.

WMO and the RARS Implementation Group are invited to consider an extension of the RARS project towards including FY-3 sounding data when this data will be operationally available.

WMO and the RARS Implementation Group are invited to consider an extension of the RARS project towards including NPP and NPOESS sounding data as a gap filling measure until timely availability of this data can be ensured worldwide through the SafetyNet.

Action IIFS-1

WMO (J.Lafeuille), in collaboration with the IPO, to propose an extension of the RARS project to NPP and NPOESS sounding data at the December 2008 Direct Readout Conference, with the view to initiate action in 2009.

2.5.3 Vision for the space-based GOS in 2025 and adequacy of current plans

The Vision is a new high-level architecture of the Global Observing System (GOS) that is being defined by WMO under the leadership of the Expert Team on Evolution of the GOS (ET-EGOS), with contributions from the Expert Team on Satellite Systems (ET-SAT) and

the Expert Team on Satellite Utilization and Products (ET-SUP) as concerns its space-based component. The initiative to develop this new Vision was taken in response to the requirements issued by GCOS in the Satellite Supplement to the GCOS Implementation Plan; it also takes into account the rapid evolution of users' requirements and of satellite capabilities since 2001 when the earlier Vision was developed.

The new Vision will expand the GOS from its initial scope on operational meteorology to a wider scope encompassing the observations needed for climate monitoring, and ultimately oceanography, hydrology, disaster management and other areas. An important change from the earlier Vision is that a number of observations of Essential Climate Variables that were so far provided by Research & Development missions should in the future be provided in an operational framework to ensure their continuity.

A draft is currently available from the Expert Teams and was brought to the attention of CGMS, CEOS and the WMO Consultative Meetings on High-level Policy on Satellite Matters. Once finalized, it will be submitted to the WMO Commission for Basic Systems (CBS) in March 2009. After endorsement by CBS, the Vision will be an important reference to ensure that there is no observation gap and that individual agencies' plans contribute in an optimal way to meet the global needs. The new GOS will be a major component of GEO's Global Earth Observation System of Systems (GEOSS).

The WG reviewed a document presenting the draft Vision and in particular its Table 2 summarizing the space-based component. The WG recalled Recommendation II/FS-3 from ITSC-15 on a water vapour channel centered at 6.7 microns and agreed that this should be specified in the Vision. It also suggested to emphasize the observation of aerosols. The WG then discussed the compliance of current satellite plans with the proposed Vision and identified two main issues: the availability of an IR hyperspectral sounder on all GEOs, and the Low Earth Orbit (LEO) sounding on three orbital planes including an early morning orbit.

Regarding hyperspectral IR capability on GEO satellites, the WG recalled that this was part of the Phase A baseline for EUMETSAT's Meteosat Third Generation (MTG) for 2018, was planned for CMA's FY-4-O (Optical series) in the 2015 timeframe, and was under consideration by JMA and JAXA for MTSAT follow-on. As concerns the GOES-R series, it was no longer planned for GOES-R but could be re-considered for GOES-S or beyond. The WG confirmed that an IR hyperspectral capability on all operational geostationary satellites should be required in particular for regional and convective-scale NWP and would help to overcome current limitations of rapidly evolving severe weather forecasting. In order to ensure an optimal preparation of the user community without delay, and as a risk reduction measure to refine the specifications of the relevant operational ground segments, the WG recommended proceeding with a preparatory mission in advance of 2015. Such a preparatory mission would further demonstrate the benefits of this capability thus strengthening the case to confirm or enhance current operational plans. The WG recalled that given the availability of a prototype and a proposed flight opportunity, such a preparatory mission could be considered for the 2010-2015 time frame with international partnership.

Regarding LEO IR and MW sounding capability on three orbital planes, the WG confirmed that this would be essential to ensure a proper temporal sampling of atmospheric temperature and humidity vertical profiles. The WG noted that such a capability was expected to be present on the mid-morning and afternoon orbits but not fully implemented on the early morning orbit. Indeed, no IR sounder was currently planned on the early morning orbit, and

there is currently no precise information on the expected performance of the MIS sounding channels of NPOESS-C2 and -C4. The WG thus recommended to investigate this aspect in detail and, if relevant, to consider optimization or enhancement of current plans.

In addition, while recognizing the potential value of a MW sounding/imaging capability from the geostationary orbit, the WG considered that the technology needed further development and demonstration before such a mission could be recommended in operational plans.

Recommendation IIFS-2 to space agencies

Space agencies, in consultation with WMO, CGMS and CEOS, to consider contributing to implement the Vision for the GOS and to ensure long-term continuity of its operational components.

Recommendation IIFS-3 to WMO and space agencies

To consider establishing a partnership to fly a preoperational hyperspectral sounder in geostationary orbit in advance of 2015, as a preparatory mission, in order to allow optimization of the implementation and use of the planned operational IR hyperspectral geostationary missions.

Recommendation IIFS-4 to IPO and other organizations

The expected performance of the MIS sounding channels should be evaluated in order to assess to what extent the requirements for microwave atmospheric temperature and humidity sounding will be met for the early morning orbit by NPOESS-C2 and, if relevant, to identify optimization measures or additional capabilities that should be implemented by 2025.

Recommendation IIFS-5 to WMO, CGMS, CEOS

Scenarios should be investigated to provide IR sounding capability from an early morning orbit.

Action IIFS-2

John Eyre to highlight the need for Water Vapour channel imagery and for observation of aerosols in the revised draft Vision for the GOS. (31 May 2008)

Action IIFS-3

John Eyre to distribute the (updated) draft Vision of the GOS to the ITWG list, with an explanatory note calling for comments. (30 June 2008)

Action IIFS-4

ITWG Members to send comments on the draft Vision for the GOS to J. Eyre (john.eyre@metoffice.gov.uk) and J. Lafeuille (JLafeuille@wmo.int) . (15 August 2008)

2.5.4 Direct Broadcast access to polar orbiter data

The WG reaffirmed Recommendation II/FS-4 from ITSC-15 to maintain a Direct Broadcast capability on all polar environmental satellites and to make available relevant processing software.

The WG noted that the user community was looking forward to the launch of FY-3A in May 2008 and Meteor-M1, later the same year. It expressed the wish that further details on format, transmission and processing software be made available as soon as possible to maximize the use of and benefit from these new missions.

The WG recalled that NPP was expected for launch in June 2010 and noted that information on NPP/NPOESS real time Low Rate Data (LRD) & High Rate Data (HRD) formats and other relevant details would be available through a website by September 2008 (date to be confirmed) and that the NPP pre-processing software was expected to be released by October 2009.

Recommendation IIFS-6 to CGMS Satellite Operators

Satellite agencies operating environmental polar satellites to provide or continue to provide a Direct Broadcast capability on their polar environmental satellite systems, and to make available in a timely manner the Direct Broadcast data processing (L0 to L1, and/or L1 to L2) software, documentation, and related training.

Recommendation IIFS-7 to CGMS Satellite Operators

Satellite agencies operating environmental polar satellites to provide expected formats of Level 1b and Level 2 datasets at least one year prior to launch, and to establish web sites to provide detailed information on instruments, schedule, products and formats.

Action IIFS-5

The IPO (Karen St. Germain) to provide information on NPP/NPOESS real time Low Rate Data (LRD) & High Rate Data (HRD) formats and other relevant details by September 2008 and to make available the NPP pre-processing software as soon as practical before the launch of NPP.

Action IIFS-6

WMO (J. Lafeuille) to ask CMA to provide detailed information on FY-3A Direct Broadcast protocols, formats and schedules, with Level 0/1 test data sets and pre-processing software, as soon as practical in advance of the FY-3A operational phase.

2.5.6 Frequency protection issues

The WG took note of the outcome of international activities to protect from contamination the frequency bands used for passive remote sensing. Strong efforts continue to be required at national level in support of these activities. The WG identified two issues requiring urgent attention: (i) the frequency range 275-3000 GHz and (ii) the quantification of impact of Radio-Frequency Interference (RFI) contamination.

The 275-3000 GHz frequency range

The WG recalled that, through the World Radio Conferences (WRC), the International Telecommunications Union (ITU) had agreed frequency allocations only up to 275 GHz. In 2011, the WRC-11 will address various agenda items including the use of the frequency range from 275 to 3000 GHz. It is important to identify the possible use of passive frequencies in this domain in order to request their protection at an early stage. A preliminary identification is provided in a working document "Preliminary document on the

passive bands above 275 GHz” available on the ITWG website:

<http://cimss.ssec.wisc.edu/itwg/groups/frequency/> (Annex 4 to Document 7C/32-E 11, ITU Radiocommunication Study Groups, April 2008). Comments should be expressed no later than July to allow preparing a synthesis for the Space Frequency Coordination Group (SFCG) meeting to be held in Quebec City in September 2008. The WMO Steering Group on Radio-Frequency Coordination should be informed in parallel.

RFI contamination impact

For currently allocated frequencies, including the case of frequency bands shared with other applications such as commercial telecommunications or unlicensed applications, the WG agreed that the current and/or potential impact of contamination should be evaluated and documented. It considered in priority the two following domains:

- 52.6-54.25 and 54.25-59.3 GHz bands, where RFI contamination is threatening the utilization of AMSU-A. The Met Office (UK) has performed a preliminary study on the impact of total loss of frequencies around 54 GHz.
- 86-92 GHz band, that is currently protected by the terms of footnote 5.340 (“All emissions are prohibited”). For this band which is used by several radiometer types, further investigation is needed to determine which environmental applications are the most sensitive to RFI contamination.

In line with previous recommendation II/FS-10 from ITSC-15, further studies should be conducted to assess the impact of corrupted data (perturbation exceeding the corresponding radiometric resolution of the passive sensor) on key applications. These studies should review available results, refine estimations as appropriate, highlight the impact on the end-user outcome and its significance at societal level.

Recommendation IIFS-8 to ITWG Members

Encourage and contribute to studies on RFI contamination impact on key applications (mainly in the 50-60 GHz and 86-92 GHz bands); reports on these studies should be available in advance of ITSC-17.

Action IIFS-7

Jean Pla to contact ITWG Members and seek comments on the table containing a preliminary identification of frequencies to be used for Earth Observation (research or operational applications) in the 275-3000 GHz range. (End May 2008)

Action IIFS-8

ITWG members to review the table containing a preliminary identification of frequencies to be used for Earth Observation (research or operational applications) in the 275-3000 GHz range. (15 July 2008)

Action IIFS-9

William Bell, Stephen English, in consultation with other ITWG Members, to identify the application(s) most sensitive to RFI contamination of the 86-92 GHz band. (November 2008)

Action IIFS-10

Jean Pla, Stephen English, Richard Kelley, in consultation with other ITWG Members, to propose a work plan for studies of the impact of RFI contamination of the 50-60 GHz and 86-92 GHz bands. (November 2008).

2.6 SATELLITE SOUNDER SCIENCE AND PRODUCTS

Web site: <http://cimss.ssec.wisc.edu/itwg/sssp/>

Working Group members: Tony Reale (Co-Chair), Lydie Lavanant (Co-Chair); Tom Achtor, Nigel Atkinson, Bill Bellon, Eva Borbas, Sid Boukabara, David Griersmith, Liam Gumley, Anton Kaifel, Richard Kelley, Tom Kleespies, Bozena Lapeta, John Overton, Nikita Pougatchev, Gloria Pujol, Filomena Romano, Roger Saunders, Nathalie Selbach, Devendra Singh, AK Sharma, Rodrigo Souza, Kathleen Strabala, Karen St. Germain, Fuzhong Weng, Gary Weymouth, Walter Wolf, Alexander Uspensky, Limin Zhao, Lihang Zhou

2.6.1 Introduction

The Working Group (WG) on Satellite Sounder Science and Products (SSSP) was formed to identify and promote international activities in the science of derived meteorological products from environmental satellite measurements. The learning environments associated with such work, both operational and research, on global, regional and local (direct readout) scales, are fundamental to improving our understanding and utility of such data in weather forecast and climate applications. They encompass a wide variety of activity, for example, the multiple parameters (temperature, moisture, precipitation, clouds, gases, etc.) produced, the different stages of scientific development and applications, and the numerous opportunities for cross validation and analysis. The main goal of SSSP is to facilitate access and dissemination of this information, mainly through our web site: <http://cimss.ssec.wisc.edu/itwg/sssp/>

The following report summarizes the topics of discussion, recommendations and actions from the SSSP working group meetings held at ITSC-XVI.

The main recommendations and actions focus on a re-structure of the web site main topic areas and organization of sub-topics within and distribution among WG members to perform these actions. All topic and sub-topic areas are also to include brief descriptions informing users of the purpose and content to be found in the respective areas.

2.6.2 Web Site Cover Page

Discussion/Recommendation

It was agreed that the web site cover page needs to be updated. All topic and sub-topic areas are also to include brief descriptions informing users of the purpose and content to be found in the respective areas. The WG mailing list and site statistics are also to be included.

Action SSSP-1

L. Lavanant, T. Reale T. Achtor, B. Lapeta, N. Selbach, B. Bellon to Review and revise SSSP site cover page

Provide brief descriptions of topic and sub-topic areas:

- **Products and Science (and respective products areas)**
- **Scientific Processing Packages**
- **Scientific Organizations – Programs**
- **Current/Future instrument Characteristics/Status**
- **Direct Readout Facilities**
- **Cal/Val**
- **DataSets**

Mailing list

Web Site statistics

2.6.3 Derived Product Categories

Recommendation/Discussion

Among the existing derived products categories (Sounding, Wind, Cloud, Precipitation, Surface, Gas, Radiance, Level 3) it was agreed to add Radiation Budget and to remove Level 3 users.

It was agreed to distribute among specific WG members the responsibility for contacting and as necessary updating existing contributions and to pursue the identification of new contributions.

It was agreed to categorize each contribution based upon Research, Operational, Global, Regional, Direct Readout, Weather and Climate.

Action SSSP-2

The respective products under the products topic area shall be maintained by assigned WG members and will include contacting existing contributors to assure currency and to pursue additional inputs through Internet search. This will include a brief description of each product and revised categorization to identify among the following aspects: operational, research; global, regional, direct readout; weather, climate.

- **Soundings (T. Reale, L. Zhou)**
- **Surface, Precipitation (S. Boukabara, L. Zhao)**
- **Clouds (L. Lavanant, F. Romano)**
- **Trace Gases (A. Kaifel and L. Zhou)**
- **Radiances (T. Reale, L. Lavanant)**
- **Radiation Budget (L. Zhao and L. Zhou) ... new product**
- **Winds (S. Boukabara)**

2.6.4 Direct Readout Facilities (RARS and EARS Networks)

Recommendation/Discussion

This topic area identifies local sites that are actively receiving, ingesting, processing and/or archiving polar satellite data facilitated via our HRPT survey to attain feedback and to update associated directories.

The identification and contact with HRPT, X-band direct readout facilities for operational and research polar orbiting satellites shall continue.

Sites comprising the EARS (EUMETSAT ATOVS Retransmission Service) HRPT network are identified with links. In parallel, the Asia-Pacific RARS (Regional ATOVS Retransmission Service) for the Southern Hemisphere is discussed but has wide coverage gaps. The identification of participating RARS sites is needed and requests for facilities within the Pacific (Hawaii, Guam, French Polynesia) and Antarctica regions to join RARS in the interest of further extending RARS coverage shall be pursued.

Special identification and coordination of direct readout stations in developing Latin American and African countries need to be pursued.

Broad revision of the direct readout topic area and sub-areas to include tabular listings of the subsets of sites as described above and associated inputs received, including the satellites, instrument data, processing packages, associated measurements and products, validation, distribution and site links will be pursued as feasible.

The wider goal is to develop/maintain direct readout facility correspondence with the hope to draw wider participation of this grass roots community to the ITSC conferences.

Action SSSP-3

L. Lavanant, K Strabala, G. Weymouth, D Griersmith, G. Pujol, N. Atkinson, B. Bellon to

- **Continue the search and solicitation of inputs from the global direct readout community via existing survey, Internet and other WG members (L. Lavanant)**
- **Specific identification and solicitation from sites in Hawaii, Guam, French Polynesia and Antarctica regions to improve RARS coverage (G. Weymouth, D. Griersmith, N. Atkinson)**
- **Identify direct readout sites in Latin American and African countries (G. Pujol and L. Lavanant)**
- **Review/revise tabular format to summarize direct readout sites and information (B. Bellon)**
- **Develop mailing lists/communication among identified direct readout sites and ITWG (L. Lavanant, K. Strabala)**

2.6.5 Direct Readout Scientific Processing Packages

Discussion/Recommendations

Software packages to ingest and process HRPT data from existing and planned satellites are needed by the direct readout community to create navigated, calibrated datasets and to derive products. The following packages are currently available at no cost to the international community.

1. The current AAPP software allows for the processing of locally received (and global from EUMETSAT and NOAA) MetOp observations up to Level 1d for IASI, HIRS, AMSU and MHS and up to Level 1b for AVHRR.
2. The International ATOVS processing package (IAPP) provides processing of AMSU-A, AMSU-B (MHS) HIRS and AVHRR derived products.
3. The International MODIS/AIRS Processing Package (IMAPP) provides ground stations the capability to ingest direct broadcast data from the NASA Terra and Aqua satellites and produce calibrated and geo-located MODIS/AIRS/AMSU/HSB/AMSR-E radiances and selected Level 2 products.
4. The International Polar orbiting Processing Package (IPOPP) is newly developed (alpha stage) for processing of Level 2 products from NPP/NPOESS VIIRS, CrIS and AMTS.

Other issues for consideration include:

The status and availability of ICI and 3I for ATOVS and expansion to process IASI needs to be obtained.

Knowledge of 1DVAR processing capabilities based on NWP a priori and/or NWP independent (climate, regression) a priori (and including the availability of coefficients as needed) also need to be obtained.

Plans for local processing systems using (as available) direct broadcast from Chinese FY-3,3A/B, India and Russian satellites need to be clarified.

Procedures for co-registering the AVHRR observations with IASI are done in AAPP. A similar procedure for GOME on MetOp remains an issue.

Wide review/restructuring of HRPT area segregated by processing up to the 1d Level and the Level 2 respectively shall be pursued.

Action SSSP-4

K. Strabala, J. Overton, L. Lavanant, L. Gumley, N. Atkinson, D. Singh, China, Russia, B. Lapeta to review, update and restructure the direct readout processing packages topic area to clearly delineate latest status of available packages for processing existing and historical satellite observations and plans for future satellites.

2.6.6 Scientific Organizations - Current and Future Weather Satellite Programs

Discussion/Recommendation

This topic area is intended to identify scientific organizations and respective links to identify status of current polar satellite programs (NOAA, EUMETSAT, NASA, China, India, Russia) and plans for future satellite programs.

Topic area contains several misplaced links to instrument descriptions, data access and scientific processing packages which are addressed elsewhere within the SSSP site and need to be removed.

It was agreed that the satellite survey previously forwarded to each agency as a guide toward their providing sufficient information is no longer needed and to be removed.

The sub areas for this topic are to include scientific organizations and satellite programs.

Action SSSP-5

Session 11 speakers, Karen St. Germain to

- **Update/append scientific organizations web site links as needed (Canada, China are inoperative ...)**
- **Update Satellite programs and include links to polar satellite programs from China and India and Russia (all Session 11 speakers)**
- **Restructure web site (B. Bellon/L. Avila)**

2.6.7 Current/Future Instrument Description/Status

Recommendation/Discussion

The topic area on instrument status includes links to identify NOAA and EOS satellite status and various links to indicate health and monitoring. Similar links for EUMETSAT MetOp are required.

There are also inappropriate links, for example, which identify calibration coefficients and other data useful for processing respective sensor data that need to be removed and/or relocated.

Better access and identification to routine, daily Level 1 monitoring (i.e., NWP-SAF) need to be appended.

Information on current and future instrument characteristics and associated agency programs, as identified through a specific link to WMO web site areas, should be created.

Topic area needs to be expanded to include polar satellites from India, Russia and China (supplemented through links to the WMO site).

Similarly, access to information concerning near term future satellites, for example NPP, FY-3A/B and NPP/NPOESS, is also needed to facilitate timely planning for the processing of these data. Most (all) of these are available on the WMO site.

Action SSSP-6

D. Klaes, B. Bellon, T. Reale to

- **Provide links for the monitoring of EUMETSAT MetOp instruments (D. Klaes, L. Fiedler)**
- **Restructure and clean up this topic area (B. Bellon)**
- **Identify selected portions of WMO web site (from J. LaFeuille) identifying current and planned satellite instruments, respective specifications and associated agency program for inclusion (T. Reale)**

2.6.8 Consistency between Direct Readout and Operational Scientific Processing

Recommendations/Discussion

The coherence between local and global processing packages with respect to the scientific algorithms and output data formats is important to facilitate their simultaneous assimilation into NWP and Climate models.

This has been taken into account, for example, in the development of MetOp operational and AAPP processing software for ATOVS and IASI pre-processing through Level 1c/1d which include format interface routines (in AAPP) to convert data from the core ground segment (CGS) to AAPP formats.

Similar efforts should be considered in conjunction with IMAPP (for MODIS, AMSU, AIRS) and for planned FY-3 and NPP/NPOESS (IPOP) processing systems.

We will encourage global centers and/or processing package providers (EUMETSAT, IPO, CIMSS) to incorporate available instrument co-registration procedures.

Action SSSP-7

K. St. Germain, N. Atkinson, P. Schlüssel, L. Gumley, A. Huang, J. Overton, L. Lavanant to

- **Report on the strategy of ensuring local/global coherence for IMAPP (Terra/Aqua) (L. Gumley, A. Huang)**
- **Report on the strategy for FY-3 and NPP/NPOESS through contacts with national agencies and direct readout packages developers responsible for software and data output data formats (J. Overton, N. Atkinson)**
- **Provide status and (calibration) information on the SSSP web site (B. Bellon)**
- **Provide status/links concerning planned instrument co-registration onboard MetOp and planned NPP and NPOESS satellites (B. Bellon)**

2.6.9 Datasets

Recommendation/Discussion

Formerly the topic was called “Useful Datasets for Satellite Processing”; it was discussed that this site’s scope should be widened to include the following:

- Routine data, including format descriptions and readers
- Pre-launch data, including simulated data sets
- Test data sets of Level 1 and Level 2
- Ancillary data
- Field experiment data (e.g., JAIVEX)
- Collocated observations, including satellite, NWP, ground truth
- Complete Level 2 error characterization

Routine data pertains to the ability to access (any time) the Level 1 and Level 2 products from global satellite and EARS/RARS programs (NOAA, NASA, EUMETSAT, China, India and Russia) along with data formats and as available software readers.

Pre-launch are the sets of simulated observations made available prior to launch for exercising newly developed software systems.

Test data at the Level 1 and Level 2 are to be made available by the global centers, RARS and EARS, perhaps once per six months via dedicated FTP site, and intended for coordinated system checkout.

Complete Level 2 error characterizations as described in Advanced Sounders recommendation.

Coefficients are those used in the respective processing ranging from calibration to those used for Level 2 (i.e., limb correction, RT bias, etc.).

Ancillary data describes global geographical (i.e., terrain, elevation, emissivity, atlas, etc.) and coefficients (i.e., spectral, limb correction, RT bias) that are useful for processing satellite observations.

Selected field campaigns include the satellite, and associated field campaign observations (underflight/overflight, radiosonde, dropsonde, surface observations, etc.).

Links to obtain collocated samples (daily, selected orbit or orbit segment) of raw (1a and 1b formats) and pre-processed (1c and 1d formats) data.

Links to obtain processed (Level 2) observations (temperature, moisture, cloud, precipitation, wind, gas...) as available from operational centers (NESDIS, EUMETSAT) and direct readout sites (EARS, RARS) is considered highly useful. Observations of immediate interest would include HIRS, AMSU-A and AMSU-B, MHS, AVHRR, MODIS, AIRS and IASI.

As appropriate, the site could include (particularly for Test data to check out the processing package) links to information concerning data format and optimally a software reader for the data.

Action SSSP-8

- **Routine data and software readers (Session 11 speakers)**
- **Pre-launch data – simulated data set (K. St. Germain)**
- **Test data at the Level 1 and Level 2 (Session 11 speakers)**
- **EARS/RARS direct readout observations (via EUMETSAT, Tokyo and Melbourne) (D. Klaes, D. Griersmith)**
- **Ancillary (L. Lavanant, E. Borbas, A.K. Sharma)**
- **Selected Field experiment data (JAIVEX - B. Smith, S. Newman)**
- **Collocated satellite and ground-truth observations (T. Reale, L. Lavanant)**
- **Level 2 error characterizations ... (L. Zhou, T. Reale)**

2.6.10 Impact of HIRS sounder FOV

The ITWG was a strong proponent of decreasing the field of view of HIRS from 17km to 10km, which was achieved for the HIRS-4 sounder on-board NOAA-18. The scientific impact of this change on cloud detection (and also cloud and sounding products) needs to be demonstrated. Agencies such as NOAA and CIMSS that are routinely involved in the processing and validation of scientific products from operational polar satellites provide a suitable environment for such investigations.

Unfortunately, the unstable operation of the HIRS onboard NOAA-18 prevented any meaningful evaluation using this satellite. However, the 10km resolution HIRS from MetOp can be used to measure impact with the potential for more meaningful results given the availability of concurrent HIRS and hyper-spectral infrared data from IASI. Unfortunately, direct comparisons against the lower resolution (17km) HIRS onboard NOAA-15 and 16 are also undermined by the relatively unstable operation of HIRS on those satellites; NOAA-17 has a stable HIRS but no AMSU-A which undermines cloud detection.

The Advanced Sounder WG also discussed this issue in relation to recommendations for the CrIS field of view size (see recommendation AS-7 from ITSC-XV). In this respect, comparisons of HIRS versus IASI performance can perhaps be utilized.

Also, some agencies (e.g., CNES) are studying the potential impact of an “intelligent” pointing view versus a fixed view; further study of this issue is encouraged.

Recommendation SSSP-1 to NOAA and EUMETSAT

These agencies are encouraged to investigate or support research centers to investigate the impact of the 10km vs. 17km field of view with respect to improved cloud detection and cloud clearing (including potential synergy with respect to IASI and pending CrIS).

Action SSSP-9

T. Reale, L. Lavanant to

- **Forward recommendation SSSP-1 to NOAA and EUMETSAT to investigate or support research centers to investigate the impact of the higher resolution (10km) HIRS on cloud detection and sounding products.**
- **Forward recommendation SSSP-1 to EUMETSAT scientists to quantify the impact of higher resolution HIRS with coincident IASI data on MetOp.**
- **Encourage studies concerning potential impact of intelligent pointing versus fixed FOV (CNES) and disseminate studies and reports that already exist on this subject (B. Smith, H. Bovensmann, L. Lavanant).**

2.6.11 Cal/Val

Recommendation/Discussion

It was agreed that routine access to currently available validation datasets of collocated radiosonde, operational polar satellite and numerical weather prediction soundings as compiled by operational agencies, for example NOAA, NASA and EUMETSAT, would provide users with important information to validate and tune their respective scientific algorithms and applications which utilize these observations.

The Cal/Val area contains a (preliminary) utility which allows users to interrogate collocations of NOAA operational ATOVS soundings and radiosondes over a one week period (March 2007). It was agreed to expand to compare/analyze radiosondes and NWP output versus an expanded suite of satellites including NOAA /ATOVS/ MIRS from NOAA-18 and MetOp satellites, GOES, Aqua-AIRS and COSMIC Level 2.

The usefulness of such collocation datasets to compute the complete error characterization of derived Level 2 should be pursued.

Historical Cal/Val studies using an evolving collocation data base at NESDIS (beginning with TOVS) and available Simultaneous Nadir Overpass (SNO) analysis (NESDIS) should be facilitated.

The Cal/Val area also contains several documents and web sites discussing emerging validation protocols associated with the evolving GCOS reference upper air network (GRUAN) that are also in need of updating, as well as some older documents that need to be removed.

Discussions entertained possible validation strategies to designate selected global target areas in the vicinity of evolving GRUAN sites for which “useful” data describing the surface information, cloud classification (including cloud nephel analyses), ambient weather (temperature, moisture, precipitation) could be integrated with the routinely available satellite Level 1 and 2 products from the global centers, EARS and RARS leading to potentially valuable research case studies (RT model, error characterizations, ...).

Action SSSP-10

- **Update the existing NPROVS dataset link on the SSSP web site to include Aqua-AIRS, COSMIC, GOES and MetOp sounding intercomparison/analysis (T. Reale, L. Zhao, S. Boukabara, W. Wolf, B. Bellon)**
- **Update existing NPROVS analysis/validation (EDGE) link to include expanded capabilities as developed at NESDIS (T. Reale, L. Zhao, L. Zhou, S. Boukabara, W. Wolf, B. Bellon)**
- **Compile/availability of complete Level 2 products error characterization (L. Zhou, T. Reale)**
- **Identify/access of existing satellite program/agency collocated observations (T. Reale, L. Lavanant)**
- **Facilitate analysis of evolving historical collocation database and SNO dating from TOVS (1979) via NESDIS STAR computer/storage facility (T. Reale, L. Shi)**
- **Provide access/results concerning NOAA versus EUMETSAT case studies comparisons of respective Level 2 products (T. Reale)**
- **Establish link to GRUAN web site and pursue case study analysis at GRUAN sites concerning data synchronization and frequency protection studies (T. Reale, P. Thorne, D. Tobin, J. Pla, G. Kelley, N. Pougatchev)**

2.6.12 Data Analysis and Visualization Tools (new)

Discussion/Recommendations

Discussions included the creation of a new topic area to provide information on visualization techniques and products. Numerous commercial packages exist to support data analysis and visualization (e.g., Matlab, IDL). There are also open source, no cost packages being developed to provide data analysis and visualization capabilities, such as McIDAS-V and IDV.

A web page to provide information on known visualization tools for processing packages and satellite data with brief descriptions of these tools and Internet links should be created.

Information and links to Format Conversion tools (NetCDF to BUFR, HDF to NetCDF, Binary to McIDAS-X) should be supplied.

Information on multiple sensor horizontal co-registration visualization packages (T. Klespies) for selected sensors should be provided.

Other information, to be contributed by ITWG members, will be added.

Action SSSP-11

- **Create web page for Data Analysis and Visualization Tools (T. Achtor, B. Bellon)**
- **Provide information on tools for Direct Broadcast processing packages... (N. Selbach, N. Atkinson, T Achtor, L. Lavanant)**
- **Provide sensor co-registration information (T. Kleespies)**
- **Seek information on Format Conversion software (T. Achtor, B. Bellon)**

2.6.13 Education

Discussion/Recommendations

Discussions included the creation of a new topic area in SSSP to provide access to education and training. This information was provided in the International Issues WG, but it was agreed by both WGs to move it to SSSP).

Initial discussions were to provide information on resources at CIMSS, the Cooperative Program for Meteorology Education and Training (COMET- UCAR), EUMETSAT and others to be determined on an ITWG/SSSP web page.

Action SSSP-12

- **Educational programs at CIMSS (T. Achtor, P. Antonelli, K. Strabala)**
- **COMET (T. Achtor, T. Reale, T. Mostek (UCAR))**
- **EUMETSAT (D. Klaes, V. Gartner)**
- **WMO (J. Lafeuille)**

3. TECHNICAL SUB-GROUP REPORTS

3.1 FREQUENCY MANAGEMENT

This technical working group, chaired by Jean Pla of CNES, met during ITSC-XVI. A comprehensive presentation was given on the latest status regarding microwave frequency protection for passive sounders during the ITSC-XVI conference and a paper containing detailed information is available in the conference proceedings. During the Conference, the following issues have been discussed.

- Review of the output of two major agenda items for the last World Radio Conference (WRC) that took place in October/November 2007.
- Presentation of one major issue for the next WRC in 2011.
- Study the impact on meteorological forecast and climate modeling of having corrupted measurements within the field of view of a passive radiometer.

The outputs of the last World Radio Conference (WRC)

The last World Radio Conference which took place in October-November 2007 (WRC-07), contained two agenda items (1.2 and 1.20) of major interest concerning the protection of passive services. Agenda item 1.2 dealt with in band sharing for the shared frequency bands 10.6-10.68 and 36-37 GHz with Fixed and Mobile Service. Agenda item 1.20 dealt with out of band emissions since the frequency bands under consideration are exclusive (status provided by 5.340: « All emissions are prohibited »), (1400-1427 MHz, 23.6-24 GHz, 31.3-31.5 GHz, 50.2-50.4 GHz and 52.6-52.8 GHz). For both agendas, a solution which was preferred by the space and meteorological agencies is the inclusion of mandatory limits in terms of power or radiated power of active services within the frequency bands of passive services within the Radio Regulations (RR).

The World Administrative Radio Conference in 1979 allocated both bands 10.68-10.7 and 36-37 GHz to the EESS (passive) on a co-equal basis with the FS and MS services. The objective of agenda item 1.2 was to review the sharing situation between passive and active services at 10.6 and 36 GHz and to propose, if necessary, adequate limits for MS and FS.

Allocations for EESS (passive) were established by WARC-79 at specific frequencies where passive sensing of important parameters are uniquely possible. These allocations were necessarily adjacent to allocations for active services, many of which have been implemented for active transmission systems that, like EESS (passive) measurements, are also vital to national economies, and safety-of-life applications in some cases.

Active systems in adjacent or nearby bands emit unwanted emissions (composed of spurious emissions and of out of band emissions) that fall within the EESS (passive) allocations. Detailed calculations have shown that those unwanted emissions are able to cause interference to passive sensors, therefore exceeding the thresholds contained in Recommendation ITU-R S.1029-2.

For all passive bands under the agenda items 1.2 and 1.20, the main objective of the Conference was to ensure equitable burden sharing for achieving compatibility between active and passive services. The results are as follows:

The **recommended levels** have been adopted for the following services and frequency bands.

- For the protection of the exclusive passive bands (footnote 5.340) 1400-1427 MHz (applicable to all active services around 1.4 GHz) and 31.3-31.5 GHz (for FSS in the 30-31 GHz band)
- The FS and MS services operating within the band 10.6-10.68 GHz.

The **mandatory limits** have been adopted for the following services and frequency bands.

- For FS and MS services operating within the band 36-37 GHz
- For the protection of the following exclusive passive frequency bands (5.340): 23.6-24 GHz (ISS below 22.55 GHz), 31.3-31.5 GHz (FS at 31-31.3 GHz), 50.2-50.4 GHz (for FSS below 50.2 and above 50.4 GHz) and 52.6-54.25 GHz (for FS below 52.6 GHz).

The issues of the next World Radio Conference (WRC)

The WRC-07 decided on the agenda of the future WRC to be held in 2011. Concerning the microwave passive bands, it is to be noted that one agenda in particular is of specific attention for ITWG members.

Agenda 1.6 will address the passive bands between 275 GHz and 3000 GHz. Space and meteorological agencies are invited to provide all elements concerning their future needs and usage about these frequencies. Passive bands need to be reviewed and clearly identified, without any firm allocation. Currently, within the RR, there are no allocations of frequencies between 275 GHz and 3 THz: there is just a footnote for frequencies between 275 GHz and 1 THz. This footnote needs to be updated and extended up to 3 THz.

Impact of corrupted measurements (non natural or derived from man made emissions)

The issue that needs to be clarified is: if the proposed limits, which are based on internationally agreed recommendations for the protection of microwave passive sensors are exceeded, what are the actual consequences in terms of reliability of the weather forecasting, climatology and monitoring of the environment? What are the consequences on the weather forecast if, for example, some sounder fields of view are corrupted with bad data due to non-natural emissions? It is now becoming urgent to get a good *quantitative* explanation of the various levels of degradation. Space and Meteorological Agencies have to bring evidence to the regulatory authorities that interference exceeding the levels quoted in the ITU recommendation, RS.1029-2, will corrupt the atmospheric measurements for weather forecasting and climate monitoring purposes.

It is recognized that the impact of potential interdependencies of interference in various passive bands is a complex issue that has not been studied thoroughly in the ITU-R including if the extent of interference in one band has any impact on measurements in another band. Specific actions and recommendations have been decided that appropriate studies should continue in order to properly assess the impact of corrupt data (exceeding the corresponding radiometric resolution of the passive sensor) showing the level of degradation of the NWP or climate modelling.

Recommendation FM-1

ITWG Members to encourage and contribute to studies on RFI contamination impact on key applications (mainly in the 50-60 GHz and 86-92 GHz bands); reports on these studies should be available in advance of ITSC-17.

Action FM-1

Jean Pla to contact ITWG Members and seek comments on the table containing a preliminary identification of frequencies to be used for Earth Observation (research or operational applications) in the 275-3000 GHz range. (End May 2008)

Action FM-2

ITWG members to review the table containing a preliminary identification of frequencies to be used for Earth Observation (research or operational applications) in the 275-3000 GHz range. (15 July 2008)

Action FM-3

William Bell, Stephen English, in consultation with other ITWG Members, to identify the application(s) most sensitive to RFI contamination of the 86-92 GHz band. (November 2008)

Action FM-4

Jean Pla, Stephen English, Richard Kelley, in consultation with other ITWG Members, to propose a work plan for studies of the impact of RFI contamination of the 50-60 GHz and 86-92 GHz bands. (November 2008)

3.2 DIRECT BROADCAST

Working Group members: Nigel Atkinson, Liam Gumley, John Overton, Frank Øynes, Kathy Strabala

The inaugural meeting of the ITWG Direct Broadcast Technical Subgroup was held at ITSC-16, Angra dos Reis, on May 10, 2008. The group met with the following as a suggested charter:

- Discuss issues related to reception and processing of direct broadcast from the NOAA POES, EOS Terra and Aqua, and EUMETSAT MetOp spacecraft;
- Provide a forum for feedback to software developers and mission support agencies for future polar environmental satellites (e.g., Fengyun, NPP, GCOM, Metop B, and NPOESS);
- Facilitate the use of direct broadcast data and atmosphere products.

The group suggested the following items for discussion:

Data Reception Issues

- Scheduling of data outages and global data playbacks
- Status of Terra/Aqua Mission Reviews
- Status of EOS instruments (MODIS, AIRS, AMSU, AMSR-E)
- Status of NOAA POES spacecraft and future launch schedules

Data Processing Issues

- Review of available software packages and versions (e.g., MODISL1DB, IMAPP, AAPP, IAPP)
- Ensuring L1B calibration algorithm and LUTs are up to date
- New products planned for release or desired by the community
- Algorithms developed in the community which could be packaged for release
- Recommendations on output formats (e.g., BUFR) for ingest into assimilation systems
- Understanding and preparing for future packages (e.g., IPOPP)
- Data sharing and distribution mechanisms, and sharing of atmosphere product algorithms and processing approaches.

It was recognized by the group that other working groups of the ITWG overlap these areas of interest. However, it was felt that a Direct Broadcast Subgroup would be a valuable addition to the ITWG in promoting the reception, processing, and continued availability of direct broadcast data from Terra, Aqua, Fengyun, MetOp, NPP, GCOM, and NPOESS. Polar orbiting satellites from other nations including China and Russia should also be included in the discussion. The group does not intend to focus on the “science” of algorithms, products, validation, or data assimilation. Instead, it intends to focus on all other issues relating to polar orbiting satellites which provide atmosphere products when received in real time via direct broadcast.

One priority for the group was to make sure that all members of the ITWG and their colleagues have all the information necessary to support DB reception and processing of atmosphere products from current polar orbiting satellites including NOAA POES, MetOp,

Terra, and Aqua. We focused on these satellites because in each case, processing software is freely available, atmosphere products can be derived from the instruments onboard, and the data are available in real-time without restrictions. To support this goal, the group agreed that it should write a report on the status of the current satellites used to acquire direct broadcast atmosphere products, and include the information needed to plan for the transition to the next generation of polar orbiters. Topics for inclusion in the report would include:

- Survey of current polar orbiting satellites with real-time direct broadcast which support atmosphere products
- Summary of instrument payloads and sensor capability on board each satellite
- Summary of direct broadcast vs. playback operations for each spacecraft
- Expected lifetime of each satellite and status of mission support
- Schedule for launches of future satellites of the same type
- Ground station requirements for receiving and processing data from the current satellite missions
- Survey of future polar orbiting satellite launch schedules, instrument payloads/capabilities, and expected lifetimes
- Survey of all known freely available software packages for processing data from current polar orbiting satellites in order to generate atmosphere and other relevant products
- Information on new software packages and enhancements to existing packages to support future polar orbiting satellites with direct broadcast capability and sensors required to generate atmosphere products.

Another goal of the group is ensure that the continued availability of direct broadcast on current and future polar orbiting satellites is promoted at a high level including the IAMAS, IUGG, ICSU, IGARSS, SPIE, AMS, WMO, GEO, IRC, and the national space agencies. To this end a copy of the report mentioned previously would be forwarded to the WMO for consideration by the Architecture and Data Committee of GEO. The group would also seek ways to make sure the status and future plans for polar orbiting missions coincide with the needs of the global community who receive and generate atmosphere products via direct broadcast.

The group discussed the short term need for utilities to convert DB products into formats required by the NWP community, including BUFR and GRIB. It was noted that both the UK Met Office and NOAA are working on such utilities. The group agreed to work with both agencies to come up with a common set of software which could be distributed as part of one of the supported processing packages (e.g., AAPP, IMAPP, or IPOPP). The group also agreed to work with NOAA on testing and distributing software utilities for converting NPP/NPOESS data products to NWP preferred formats.

The group recognized that DB users who use data from current polar orbiting satellites have certain requirements for generating image products from the data, including customizable projections and overlays. The group took an action to document the current visualization requirements of the DB community and make sure these requirements are available for review by developers of visualization software.

Action DB-1

Liam Gumley to draft a report titled “Status of Current Polar Orbiting Satellite Systems for Direct Broadcast Atmosphere Products and Plans for Future Systems.”

Action DB-2

John Overton, Nigel Atkinson, Frank Øynes, and Kathy Strabala to review the draft report and prepare it for presentation to the ITWG.

Action DB-3

Liam Gumley and John Overton to present the report and other relevant information in support of continued availability of direct broadcast to the WMO, GEO, IRC, and national space agencies.

Action DB-4

Kathy Strabala and Nigel Atkinson to draft a requirements document describing the needs of the DB atmosphere community for visualization.

Action DB-5

Liam Gumley and Nigel Atkinson to evaluate the NOAA and Met Office utilities for converting AIRS L1B data into BUFR and recommend one version for porting and release as part of AAPP, IMAPP, or IPOPP.

ITSC-XVI AGENDA

Tuesday 6 May 2008

15.00-19.00 Registration

Wednesday 7 May 2008

8.00 Registration (continues to 15:00)

8.30-8.35 Welcome Co-chairs Allen Huang, Stephen English

Local arrangements Dirceu Herdies, Rodrigo Souza,
Simone da Costa

8.35-8.55

“Facing the challenges of Meteorology in Tropical South America”

Maria Assunção Faus da Silva Dias - CPTEC/INPE Director

8.55-9.00 Review of agenda Co-chairs

9.00-10.15

Session 1: Guy Rochard session on direct broadcast packages, preprocessing, calibration and frequency protection.

Chairs: Pascal Brunel and Liam Gumley

- | | |
|-----------------------|---|
| 1.1 Kathleen Strabala | IMAPP: Software to Transform EOS Direct Broadcast Data into Science Products |
| 1.2 John Overton | International Polar Orbiter Processing Package (IPOPP) |
| 1.3 Nigel Atkinson | AAPP developments and experiences with processing MetOp data |
| 1.4 Liam Gumley | EOS Direct Broadcast Real-Time Products for the US National Weather Service |
| 1.5 Tom Achtor | McIDAS-V - An open source data analysis and visualization tool for multi and hyperspectral satellite data |

10.15-10.45 BREAK

10.45-11.30

Session 1: Guy Rochard session on direct broadcast packages, preprocessing, calibration and frequency protection (continued)

Chairs: Pascal Brunel and Liam Gumley

- | | |
|---------------------------|---|
| 1.6 Jean Pla | Passive microwave protection: results of WRC-07 and future work plan |
| 1.7 Richard Kelley | 3 rd Annual Passive Sensing Microwave Workshop Proceedings/Summary |
| 1.8 Bill Bell/Nancy Baker | SSMIS Calibration Anomalies: Observed F-16 and F-17 Anomalies, Detailed Analysis of the Root Causes, and the Path Forward |

11.30-12.15

Session 2: The Infrared Atmospheric Sounding Interferometer

Chairs: Thierry Phulpin and Dieter Klaes

- 2.1 Denis Blumstein IASI Performances on MetOp-A after one year in orbit
- 2.2 Lars Fiedler IASI L1 data quality and NRT monitoring at EUMETSAT
- 2.3 Peter Schluessel IASI Level-2 Product Processing at EUMETSAT

12.15-13.45 LUNCH (including poster preparation)

13.45-15.00

Session 2: The Infrared Atmospheric Sounding Interferometer (continued)

Chairs: Thierry Phulpin and Dieter Klaes

- 2.4 Nicole Jacquinet-Husson Spectroscopic database GEISA-2008 edition: content description and assessment through IASI/MetOp flight data
- 2.5 William Smith Joint Airborne IASI Validation Experiment (JAIVEx) - An Overview
- 2.6 Daniel Zhou Retrievals with the Infrared Atmospheric Sounding Interferometer and validation during JAIVEx
- 2.7 Paolo Antonelli Using JAIVEX data to evaluate the impact of PCA Noise Filtering on the High Spectral Resolution Physical Retrieval Algorithm
- 2.8 Stuart Newman Direct radiance validation of IASI - results from JAIVEx

15.00-15.30 BREAK

15.30-17.00

Session 2: The Infrared Atmospheric Sounding Interferometer (continued)

Chairs: Thierry Phulpin and Dieter Klaes

- 2.9 Xu Liu Retrieval algorithm using superchannels
- 2.10 Nikita Pougatchev Error Assessment and Validation of the IASI Temperature and Water Vapor Profile Retrievals
- 2.11 Fiona Hilton Assimilation of IASI Radiances at the Met Office
- 2.12 Andrew Collard Monitoring and Assimilation of IASI Radiances at ECMWF
- 2.13 Marc Schwärz Assimilation of IASI Data into the Regional NWP Model COSMO-EU: Status and Perspectives
- 2.14 Thierry Phulpin Atmospheric Chemistry using IASI / MetOp: Overview of initial results

17.00-18.30

Poster Session A and Icebreaker

Thursday 8 May 2008

8.30-10.15

Session 3: Atmospheric radiative transfer

Chairs: Marco Matricardi and Louis Garand

- 3.1 Paul van Delst and Yong Han Community Radiative Transfer Model (CRTM) Status
- 3.2 Roger Saunders What can RTTOV-9 do for me?
- 3.3 Marco Matricardi An assessment of the accuracy of the RTTOV fast radiative transfer model using IASI data.
- 3.4 Tom Kleespies Microwave Radiative Transfer at the Sub-Field-of-View Resolution
- 3.5 Qi Chengli Error analysis about using CO₂-absorbing band for temperature retrieval
- 3.6 Alan Lipton Fast Forward Modeling in Scattering Atmospheres with Optimum Spectral Sampling
- 3.7 Allen Huang Development of the Multilayer Cloudy Radiative Transfer Model for the GOES-R Advanced Baseline Imager

10.15-10.45 BREAK

10.45-11.45

Session 4: Surface emission and scattering

Chairs: Fuzhong Weng and Roger Saunders

- 4.1 Jun Li Retrieval of Global Hyperspectral Surface Emissivity Spectra from Advanced Infrared Sounder Radiance Measurements
- 4.2 Jonathan Taylor Using Hyperspectral IR Sounder Data Over Land - PC radiative transfer and 1d-Var.
- 4.3 Eric Pequignot Infrared continental surface emissivity spectra retrieved from IASI observations
- 4.4 Eva Borbas Recent updates of the UW/CIMSS high spectral resolution global land surface infrared emissivity database

11.45-13.15 LUNCH (including poster preparation)

13.15-15.00

Poster session B (including refreshments from 14:30)

15.00-17.00 ITSC-15 Action items presented by ITSC-15 WG co-chairs (10 minutes each)

Moderators: Allen Huang and Stephen English

RT WG (Louis Garand, Paul van Delst)

Climate WG (Jörg Schulz, Peter Thorne)

NWP WG (John Derber, Godelieve Deblonde)

Advanced sounder WG (Bill Smith, Andrew Collard)

International and future systems (Jerome Lafeuille, John Eyre)

Satellite sounder science and products (Tony Reale, Lydie Lavanant)

Technical sub-group reports (5 minutes each)

ATOVS direct broadcast packages

RTTOV

CRTM

Frequency protection

17.00-17.15 Working group formation

Evening: Luau from 19.00

Friday 9 May 2008

8.30-10.15

Session 5: Climate studies

Chairs: Jörg Schulz and Peter Thorne

- | | |
|-----------------------|---|
| 5.1 Viju John | Upper tropospheric humidity data set from operational microwave sounders |
| 5.2 Peter Thorne | What can the GCOS Reference Upper Air Network do for you? |
| 5.3 Lei Shi | Intersatellite Calibrated HIRS Upper Tropospheric Water Vapor |
| 5.4 Marc Schröder | Long-term application and evaluation of IAPP using global radiosonde and CHAMP measurements |
| 5.5 Tom Pagano | AIRS in Atmospheric and Climate Research |
| 5.6 Hartmut H. Aumann | The Frequency of Severe Storms in the Tropical Zone and Global Warming |
| 5.7 Jörg Schulz | Status of NPOESS Climate Instruments Remanifest |

10.15-10.45 BREAK

10.45-11.45

Session 6: Current use in NWP

Chairs: John Eyre and Nancy Baker

3 minute short presentation on current status from NWP centres supporting posters to be presented in special poster session.

- | | |
|-----------------------|--|
| 6.1 John Derber | Current status: a summary of the NWP survey (10 minutes) |
| 6.2 John Derber | NCEP: Progress and Plans for the use of radiance data in the NCEP global and regional data assimilation systems. |
| 6.3 Niels Bormann | ECMWF: The Use of satellite data at ECMWF |
| 6.4 Nancy Baker | NRL status report |
| 6.5 Brett Candy | Met Office: An Update on the Operational Use of Satellite Sounding Data at the Met Office. |
| 6.6 Thibaut Montmerle | MeteoFrance: Recent advances in the use of satellite data in the French NWP models |

- 6.7 Godelieve Deblonde Inclusion of new data types in the Canadian data assimilation system
- 6.8 Qifeng Lu CMA: Assimilating ATOVS data in numerical weather prediction model to improve Typhoon prediction in NSMC/CMA
- 6.9 Kozo Okamoto JMA: Assimilation of radiance data at JMA: recent developments and prospective plans
- 6.10 Thomas Auligne WRF: Direct Radiance Assimilation for WRF: Implementation and Initial Results
- 6.11 Martin Stengel HIRLAM (SMHI): The Assimilation of Clear-Sky Infrared Radiances in the HIRLAM Model
- 6.12 José A. Aravéquia Assimilation of AIRS radiances at CPTEC/INPE using the LETKF system
- 6.13 Roger Randriamampianina Use of satellite data in ALADIN/HARMONIE-Norway

11.45-14.00 LUNCH

Including **Poster session on current use of sounding data in NWP**

14.00-15.15

Session 7: Developments in use of sounding data in NWP and Environmental Prediction

Chairs: Dirceu Herdies and John Derber

- 7.1 Niels Bormann Recent developments in the use of ATOVS data at ECMWF
- 7.2 Bill Bell A Comparison of IASI water Vapour and SSMIS window channel impacts on NWP analyses and forecasts
- 7.3 Louis Garand Impact of combined AIRS and GPS-RO data in the new version of the Canadian global forecast model
- 7.4 Martin Stengel The Assimilation of Cloudy Infrared Radiances in the HIRLAM Model: Initial Experiences
- 7.5 Gang Ma Impact of VASS radiance of FY3 assimilation on numerical typhoon prediction

15.15-15.45 BREAK

15.45-17.00

Session 7: Developments in use of sounding data in NWP and Environmental Prediction (continued)

Chairs: Dirceu Herdies and John Derber

- 7.6 Brett Harris An Information Based Radiance Data Selection Scheme for Efficient Use of a Multi-Satellite Constellation
- 7.7 Benjamin Ruston Use of Hyperspectral IR Data in 4D Assimilation at NRL
- 7.8 Banghua Yan Intercomparison of the Cross-Track and Conical Scanning
- 7.9 Thomas Auligne Impact of AIRS and AMSU-A data in regional data assimilation over the Antarctic.

17.30-19.00 Working Groups

Evening: free to go to Angra dos Reis?

Saturday 10 May 2008

Working groups 9.00-12.00

12.00-13.00 LUNCH

13.30 Depart for boat tour of islands

18.00 Departure for those going direct to island for dinner

Group dinner on island (at end of tour for those going on the tour)

Sunday 11 May 2008

Day: Various activities, including trip to Paraty.

18.00-20.00 Working groups (or as arranged by WG co-chairs)

Monday 12 May 2008

8.30-9.15

Session 8: Cloud studies

Chairs: Sid Boukabara and Jun Li

- | | |
|-----------------------|---|
| 8.1 William Blackwell | Neural Network Estimation of Atmospheric Profiles Using AIRS/IASI/AMSU Data in the Presence of Clouds |
| 8.2 Lydie Lavanant | Using AVHRR radiances analysis for retrieving atmospheric profiles with IASI in cloudy conditions |
| 8.3 Arlindo Arriaga | CO2 Slicing Method for IASI |

9.15-10.00

Session 9: Developments in assimilation of sounding data in NWP in cloud regions

Chairs: Niels Bormann and Michael Uddstrom

- | | |
|-------------------|--|
| 9.1 R. Montroty | Impact of rain-affected microwave data assimilation on the analyses and forecasts of tropical cyclones |
| 9.2 Peiming Dong | Experiment of the Use of Satellite Microwave Data Affected by Cloud in Numerical Prediction |
| 9.3 Min-Jeong Kim | The inclusion of cloudy radiances in the NCEP GSI analysis system |

10.00-10.30 BREAK

10.30-11.00

Session 9: Developments in assimilation of sounding data in NWP in cloud regions (continued)

Chairs: Niels Bormann and Michael Uddstrom

- 9.4 John Le Marshall Using Clear and Cloudy AIRS Data in Numerical Weather Prediction
9.5 Sid Boukabara 1DVAR Pre-processing System for NWP Assimilation

11.00-12.30

Session 10: Other applications of sounder data

Chairs: Lydie Lavanant and Rodrigo Souza

- 10.1 Zhang Jie Effect and Improvement of Aerosol on Temperature Profile from MODIS
10.2 Fuzhong Weng Demonstration of DMSP Special Sensor Microwave Imager and Sounder (SSMIS) Products
10.3 Laure Chaumat Potential of CO₂ Retrieval from IASI
10.4 Filomena Romano Analysis of Arctic clouds by means of hyper-spectral satellite
10.5 Tony Reale NOAA Products Integrated Validation Dataset / Database

12.30-14.00 LUNCH

14.00-15.15

Session 10: Other applications of sounder data (continued)

Chairs: Lydie Lavanant and Rodrigo Souza

- 10.6 Cyril Crevoisier Midtropospheric CO₂ Concentration derived from infrared and microwave sounders. Application to the TOVS, AIRS/AMSU, and IASI/AMSU instruments.
10.7 Anton Kaifel NNORSY-GOME Ozone Profile Retrieval Products and Climatology
10.8 Ramesh Singh Pronounced Changes in Water Vapor, Ozone and Metrological Parameters Associated with Dust Storms Using MULTI SENSOR Data
10.9 Jun Li Advanced Infrared Sounding System for Future Geostationary Satellites
10.10 Raymond Armante Dust aerosol layer altitude from AIRS (01/2003 to 11/2007) and from Calipso (06/2006 to 11/2007): a comparison

15.15-15.45 BREAK

15.45-17.25

Session 11: Agency status report

Chairs: Jerome Lafeuille and Tom Kleespies

- | | |
|-------------------------|---|
| 11.1 John Eyre | Evolution of the Global Observing System (15 mins) |
| 11.2 David Griersmith | Status report on the Global RARS initiative (15 mins) |
| 11.3 Dieter Klaes | EUMETSAT (10 minutes) |
| 11.4 Hal Bloom | NOAA (10 minutes) |
| 11.5 Gang Ma | China (10 minutes) |
| 11.6 Alexander Uspensky | Russia (10 minutes) |
| 11.7 Devendra Singh | India (10 minutes) |
| 11.8 Kozo Okamoto | JMA and JAXA (10 minutes) |
| 11.9 Luiz Augusto | Brazilian Earth Observations Satellites (10 mins) |

17.25-17.55

Session 12: Future instruments

Chairs: Pete Wilczynski and Dieter Klaes

- | | |
|-----------------------|--|
| 12.1 Peter Wilczynski | The National Polar-Orbiting Operational Environmental Satellite System (NPOESS) and the NPOESS Preparatory Project (NPP) – Program status and international initiatives status |
| 12.2 Stephen Mango | The Joint Capabilities and Opportunities of Advanced Sounders on MetOp and NPOESS for NWP and Climate Monitoring In a GEOSS Era |

17.55-19.00 Working groups finalise reports

19.00 Churrasco

Tuesday 13 May 2008

8.30-9.30 Working Group reports

Co-chairs: Allen Huang and Stephen English

RT
Climate
NWP

09.30-10.00 BREAK

10.00-11.00 Working group reports

Co-chairs: Allen Huang and Stephen English

Advanced sounders
International
Sounder science and products
Direct Broadcast Technical Sub-group

11.00-12.00 Future meetings, other events relevant to ITWG

Plans for next meeting and closing remarks

Co-chairs: Allen Huang and Stephen English

12.00-13.00 LUNCH

Departures for Rio de Janeiro airport

Poster session A: Software packages, radiative transfer, NWP, environmental prediction.

A01 Fuzhong Weng	Radiative Transfer in Vertically Layered Soil
A02 Stephen Tjemkes	A clear sky radiative transfer model for MTG-IRS
A03 Stephen Tjemkes	Scenes Analysis for the Meteosat Third Generation Infrared Sounder Observations
A04 Fiona Hilton	Comparison of IASI radiances with models from seven operational centres
A05 Allen Larar	IASI Validation Studies using Airborne Field Campaign Data
A06 Stuart Newman	Identification of biases in the modelling of high peaking water vapour channels from IASI
A07 Simone da Costa	The water vapor continuum effect on the surface transmitted irradiance at 8 – 12 μ m atmospheric window
A08 Yong Han	The effect of Doppler shift due to Earth's spin on SSMIS UAS channels
A09 Yong Han	A fast radiative transfer model for AMSU-A channel 14 with the inclusion of the Zeeman-splitting effect.
A10 Pascal Brunel	A graphical user interface for RTTOV
A11 Laure Chaumat	4A/OP: An operational fast and accurate radiative transfer model for the infrared
A12 Xiaoqing Li	Forward Simulation for FY-3 MWS using RTTOV-7
A13 Fanny Duffourg	Convective-scale data assimilation of satellite infrared radiances over the Mediterranean: adaptation of the observation operator to the high-resolution
A14 Stephen English	A new method for estimating 1D-var B-matrix from 4D-var
A15 Stephen English	Potential enhancement of AMSU-A/MHS/ATMS baseline microwave humidity and temperature sounders
A16 Bill Bell/Nancy Baker	SSMIS Upper Atmosphere Radiance Assimilation: Preprocessing Requirements and Preliminary Results
A17 Bill Bell	The radiometric requirements for a post-EPS Microwave Sounder
A18 Carlos Bastarz	Evaluating the impact of the geopotential height profile data assimilation deriving from the AIRS/AQUA sensor by the CPTEC's RPSAS assimilation model
A19 Jairo Gomes Jr	Impact of ATOVS geopotential heights retrievals over analyses generated by RPSAS.
A20 Roger Randriamampianina	Investigating the assimilation of IASI data in a limited area model
A21 Brett Candy	Use of Regional Retransmission Networks in Global Data Assimilation
A22 Aurélie Bouchard	Satellite Data Assimilation over Antarctica: The Concordiasi Field Experiment
A23 Yann Michel	Case studies of 4D-Var assimilation of potential vorticity observations derived from image processing.
A24 James Cameron	Impact of variable O3 and CO2 on assimilation of high spectral resolution sounder data

A25 Luiz Sapucci	Impact analysis of assimilation of integrated water vapor estimates from AIRS/AMSU over Amazonian region
A26 Blazej Krzeminski	Towards better usage of AMSU observations over land at ECMWF
A27 Rita Valéria Andreoli	The relative contributions of the various observing systems in the CPTEC global data assimilation/forecast system
A28 Thomas Pangaud	Assimilation of cloudy AIRS observations in the French global atmospheric model ARPEGE
A29 Qifeng Lu	Data assimilation and use of EOS data in land surface model
A30 Ricardo Todling	The GMAO 4d-Var System
A31 Nancy Baker	NRL: Implementing Radiance Assimilation in NAVDAS-AR: Lessons Learned
A32 Michael Uddstrom	Environmental Forecasting at NIWA: A Progress Report

Poster session B: Instrument characterisation, future sensors, GOS design, trace gas studies, climate studies and sounder science and products.

B01 Paolo Antonelli	Fostering a new generation of Remote Sensing Scientists
B02 Allen Huang	Processing Package and Remote Sensing Training Workshops for International Direct Broadcast Users
B03 Thierry Phulpin	Report on the first International IASI Conference
B04 Thierry Phulpin	Synergy between IASI sounding and AVHRR imagery for the processing of IASI data in non-uniform scenes
B05 David Tobin	Validation of IASI spectral radiances using aircraft underflight data collected during JAIVEx
B06 David Tobin	Principle component analysis of IASI spectra with a focus on non-uniform scene effects on the ILS
B07 David Tobin	Evaluation of IASI and AIRS spectral radiances using Simultaneous Nadir Overpasses
B08 Zhaohui Cheng	The use of principal component analysis in monitoring IASI radiances and diagnosing climate anomaly
B09 Nathalie Selbach	Operational Processing of ATOVS data at the Satellite Application Facility on Climate monitoring
B10 Raymond Armante	Validation of level1b/1c LEO instruments in synergy with LEO/GEO companion instruments or in stand alone mode: Application to AIRS/Aqua, IIR/Calipso, IASI/Metop
B11 Raymond Armante	Cloud properties from AIRS and evaluation with Calipso
B12 Cyril Crevoisier	A quantitative link between CO ₂ emissions from tropical vegetation fires and the daily tropospheric excess (DTE) of CO ₂ seen by NOAA-10 (1987-1991)
B13 Clemence Pierangelo	SIFTI : a Static Infrared Fourier Transform Interferometer dedicated to ozone and CO pollution monitoring
B14 Alexander Uspensky	Derivation of tropospheric carbon dioxide and methane concentrations in the boreal zone from satellite-based hyper-spectral infrared sounders data
B15 Devendra Singh	Total ozone depletion due to tropical cyclones over Indian Ocean

- B16 Bozena Lapeta From TOVS to ATOVS based ozone monitoring – implication for the quality and homogeneity
- B17 Rodrigo Augusto Ferreira de Souza Preliminary comparisons between the CO retrievals from AIRS and the CO CATT-BRAMS model estimations over the Amazon region during the 2002 dry-to-wet season.
- B18 Kung Hwa Wang Multi-satellite observation on upwelling after the passage of typhoon Hai-Tang in the southern East China Sea
- B19 Filipe Aires Retrieval of atmospheric water vapour profile using the Megha-Tropiques
- B20 Luiz Augusto Toledo Machado The use of HSB to derive the integrated water vapor content: an example using the RACCI/LBA experiment
- B21 William Blackwell High-Resolution Passive Millimeter-wave Measurements from Aircraft: Validation of Satellite Observations and Radiative Transfer Modeling
- B22 Dieter Klaes Synergetic Operational Earth observations with Metop-A instruments
- B23 Gary Weymouth Australian Bureau of Meteorology Satellite Data Exchange and Use.
- B24 Simon Elliot Operational dissemination of IASI data using principle component compression.
- B25 A. K. Sharma NOAA/NESDIS Updates on Operational Sounding Data Products and Services
- B26 Limin Zhao Operational Implementation of Integrated Microwave Retrieval System
- B27 Lihang Zhou Enhancements of the AIRS Eigenvector Regression Algorithm
- B28 Sid Boukabara Global Coverage of Total Precipitable Water using the Microwave Integrated Retrieval System (MIRS)
- B29 Haibing Sun CrIS Radiance Simulations in Preparation for Near Real-Time Data Distribution
- B30 Tom Kleespies Serendipitous Characterization of the Microwave Sounding Unit during an Accidental Spacecraft Tumble
- B31 Hartmut H. Aumann A Geostationary Microwave Sounder for NASA and NOAA
- B32 Louis Garand A Canadian satellite mission for continuous imaging of the northern latitudes
- B33 Tom Achtor Examining the mid winter severe weather outbreak of 7 January 2008 using high resolution data with McIDAS-V
- B34 Bill Bellon The ITWG website
- B35 Norman Grant Sub-mm Wave Micromachined Free-Standing Frequency Selective Surfaces

ITSC-XV ABSTRACTS

SESSION 1

1.1: IMAPP: Software to Transform EOS Direct Broadcast Data into Science Products

Presenter: Kathleen Strabala

Kathleen Strabala, Liam Gumley, Allen Huang, Elisabeth Weisz, Jun Huang

The International Moderate Resolution Imaging Spectroradiometer / Atmospheric Infrared Sounder (MODIS/AIRS) Processing Package (IMAPP) provides users with EOS satellite Terra and Aqua direct broadcast antennae the capability to create environmental products from the downlinked raw data. This effort is funded by NASA and freely distributed by the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison. This presentation will include a description of the current suite of MODIS, AMSR-E and AIRS science product software packages concentrating on the recent release of a completely repackaged MODIS Level 2 suite as well as a number of IMAPP product applications. Funding for this effort has been renewed through 2010; a number of new products including synergistic MODIS/AIRS retrieval algorithms and numerical weather prediction models that assimilate IMAPP products will be included in future package releases.

1.2: International Polar Orbiter Processing Package (IPOPP)

Presenter: John Overton

John Overton, Bill Thomas, Patrick Coronado, Kelvin Brentzel, Liam Gumley, Allen Huang

The International Polar Orbiter Processing Package is a software package that is critical to the Direct Broadcast (DB) user community throughout its transition from EOS to NPOESS. IPOPP is the primary processing package that will enable the DB community to process, visualize, and evaluate NPOESS Preparatory Project (NPP) Sensor and Environmental Data Records

Why is IPOPP Needed?

- Meets high expectations by DB community for mission continuity from EOS to NPOESS
- Integrates Multi-disciplined science processing packages such as IMAPP (Atmosphere),

SeaDAS (Ocean) and MODIS Land Rapid Response (Land)

- Provides DB community with user friendly processing packages for global as well as regional optimized value added applications
- Enables global feedback loop for NPP CAL/VAL campaigns
- Enable DB users to contribute their regional validated processing approaches/products to assist and improve global CAL/VAL efforts
- Initiates role of research to operations provider for Direct Readout Mission
- Facilitates the adoption/adaptation of DB regional optimized research/unique processing approaches to enhance functionality and capability
- Enables industry to productize government provided algorithms into commercial product lines which offer choice to all users

Who is the DB Community?

- Direct Broadcast Community includes US Department of Commerce, US Department of Defense, US Department of Agriculture, US Department of Interior, NASA, Environmental Protection Agency, International Meteorological Agencies, Universities, and Commercial Vendors IPOPP Architecture

1.3: AAPP developments and experiences with processing MetOp data

Presenter: Nigel Atkinson

Nigel Atkinson, Pascal Brunel, Philippe Marguinaud and Tiphaine Labrot

Version 6 of the ATOVS and AVHRR Preprocessing Package (AAPP) was released in October 2006, shortly before the launch of the MetOp-A satellite. The talk will describe the capabilities of the software and give examples of its use in an operational context. Data types now processed by AAPP include: - direct broadcast HRPT from NOAA satellites - Level 0 files from MetOp AHRPT (AMSU, MHS, HIRS, AVHRR, IASI) - global level 1b ATOVS data from NOAA - global ATOVS and IASI data from EUMETSAT (BUFR format) - global MetOp and NOAA-18 AVHRR data from EUMETSAT (EPS format) - regional ATOVS data (BUFR format - e.g. EARS and RARS) During the commissioning phase of MetOp-A the Level 0 processing capabilities of AAPP were fully tested, including the IASI local processor OPS-LRS. Unfortunately the MetOp-A AHRPT primary transmitter failed on 4th July 2007, so there has been no Level 0 data since then.

At the Met Office, assimilation of IASI data became operational in November 2007. This is using an AAPP-based preprocessor in which AMSU is mapped to the IASI grid and the IASI data are thinned spatially and spectrally via a channel selection. Principal Components compression is also available, and to support this an updated set of eigenvectors has been made available to users, based on 6 months of IASI data. The talk will describe the properties of these eigenvectors. Another activity in which AAPP is a key component is the WMO initiative to develop Regional ATOVS Retransmission Services (RARS). Two networks have come on-line during 2007 - the Asia-Pacific RARS and the South American RARS. These complement the EARS network established by EUMETSAT in 2002. RARS data have been operationally assimilated at the Met Office since November 2007. Also the data quality is monitored routinely by the NWP SAF and a selection of results are made available on the NWP SAF web site. Finally, the next major release of AAPP is planned to coincide with the launch of NPP (late 2009). AAPP will not process the direct broadcast data directly but the intention is that it will be able to read the level 1 ATMS/CrIS/VIIRS products from IPOPP (being developed by NASA and the University of Wisconsin), as well as the global ATMS/CrIS radiances to be distributed by NOAA.

1.4: EOS Direct Broadcast Real-Time Products for the US National Weather Service

Presenter: Liam Gumley

Liam Gumley, Kathy Strabala, Jordan Gerth, Scott Bachmeier, Russ Dengel, and Jerrold Robaidek

The Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison operates an EOS Direct Broadcast ground station which receives data in real time from the Terra and Aqua spacecraft. Data from the MODIS, AIRS, AMSU, and AMSR-E instruments are processed in real time to create a range of products. Recently, the National Weather Service (NWS) in the US Central Region has started to use several of the real time MODIS products from SSEC in their forecast operations. In addition, the NWS office at Kennedy Space Center is now using real-time products to support NASA Space Shuttle launch, abort, and landing operations. This presentation will provide an overview of the DB processing infrastructure at SSEC, starting from acquisition of raw satellite data, through product generation on a cluster computing system, to product dissemination via the NWS Advanced Weather Interactive Processing System (AWIPS) at NWS forecast offices.

Examples of NWS applications for EOS real-time products will be presented, including nighttime fog detection, daytime high temperature forecasting, and precipitation type and duration forecasting.

1.5: McIDAS-V - A powerful data analysis and visualization tool for multi and hyperspectral environmental satellite data

Presenter: Thomas Achtor

Thomas H. Achtor, Thomas D. Rink, David Parker and Thomas M. Whittaker

The Man computer Interactive Data Access System (McIDAS) project began over 30 years ago at the University of Wisconsin-Madison to analyze and visualize data from the first generation of geostationary weather satellites. McIDAS continues to provide a strong data analysis and visualization capability for the current environmental satellites. However, the next generation of operational remote sensing instruments under development for the NPOESS and GOES-R programs require software tools with expanded capability and performance to support innovative techniques for developing algorithms, visualizing data and products, and validating results. A project is underway at SSEC to develop the fifth generation of McIDAS, a java-based, open-source system for multispectral and hyperspectral researchers and algorithm developers that will provide powerful new data manipulation and visualization tools to work in this data rich environment. NASA EOS MODIS and AIRS data as well as MSG SEVERI and METOP IASI data are now being used in conjunction with in situ and gridded data to develop new analysis and product validation techniques in the McIDAS-V environment. This new data analysis and visualization system will support both researchers and operational users of the advanced measurement systems on METOP, NPOESS and GOES R. A review of the current state of McIDAS-V will be presented as well as plans for future development to support polar and geostationary environmental satellite programs.

1.6: Passive Microwave Protection: Results of WRC-07 and Future Work Plan

Presenter: Jean Pla

Jean Pla

The microwave passive frequency bands that are essential for the retrieval of physical parameters such soil moisture, ocean salinity, water vapour

content, temperature from the ground up to the atmosphere or Earth's surface are divided into two categories of frequency bands according to the international regulation (Radio Regulation or RR) and fall within the category of Earth Exploration Satellite Service or EESS(passive). These data are collected through the use of passive radiometers mounted on satellite platforms. Purely exclusive frequency bands are dedicated to passive services only: in those bands, sharing is not possible since "all emissions are prohibited". Shared frequency bands have the characteristics to have both passive services and active services. The last World Radio Conference took place in November 2007 (WRC-2007) and essential results have been obtained concerning the protection of some passive bands: limits and levels for in band sharing for the shared frequency bands 10.6-10.68 and 36-37 GHz with Fixed and Mobile Service, limits and levels for out of band emissions for exclusive passive frequency bands (1400-1427 MHz, 23.6-24 GHz, 31.3-31.5 GHz and 50.2-50.4 GHz). The paper will explain the main results obtained at the last WRC-07 concerning those frequency bands. The last WRC-2007 conference also provided the agenda for the next WRC-2011. Two items will need to be discussed at the next ITSC Conference. Agenda item 1.8 deals with regulatory issues relative to the fixed service between 71 and 238 GHz. The protection of the passive bands within this frequency range will be addressed. The first frequency band that is under consideration is the 86-92 GHz exclusive band that is widely used by many passive sensors. Technical compatibility activity with nearby active services are currently on going. However, in addition to this essential activity, it is necessary to answer the following question: if the proposed limits, which are based on international agreed recommendations for the protection of microwave passive sensors, are exceeded, what are the actual consequences in terms of reliability of the weather forecasting, climatology and monitoring of the environment? Preliminary work has been done in some cases, but it will be necessary to draft a precise future workplan, with a focus on some frequency bands, especially for example the 86-92 GHz band which is under consideration within ITU-R. Other frequency bands will also be discussed. Agenda 1.6 will address the passive bands between 275 GHz and 3000 GHz. Space and meteorological agencies are invited to provide all elements concerning their future needs and usage about these frequencies. Passive bands need to be reviewed and clearly identified, without any firm allocation.

1.7: 3rd Annual Passive Sensing Microwave Workshop Proceedings/Summary

Presenter: Richard Kelley

Richard Kelley

The efforts of the (international) Space Frequency Coordination Group (SFCG) and International Telecommunications Union-Radio (ITU-R) prompted the conduct of a NOAA Passive Sensing Workshop last year. The workshop's objective was to finalize the results of two previous workshops. It also focused on the introduction and discussion of technical papers on the identification, evaluation and utilization of particular passive sensing microwave bands, emphasizing bands above 275 GHz. This paper summarizes the workshop and provides a table which is an initial guide for updating ITU-R recommendations RS.515, RS.1028, and RS.1029. Workshop attendees recommended several changes and some additions to the existing table. Variables addressed were vegetation biomass, cirrus cloud, ice water path, cloud ice, cloud liquid water, height and depth of melting layer, precipitation, soil moisture, and the water vapor profile. Observations of these variables spanned the range of 1.37 to 882 GHz. It is hoped that the presentation of these workshop results will lead to discussions of needs for additional table entries as the changes to the ITU-R recommendations go forward.

1.8: SSMIS Calibration Anomalies: Observed F-16 and F-17 Anomalies, Detailed Analysis of the Root Causes, and the Path Forward

Presenter: Bill Bell/Nancy Baker

S. Swadley, G. Poe, D. Kunkee, W. Bell, S. Brown, I. Prata, E. Long, and D. Boucher

Detailed descriptions and comparisons of the observed F-16 and F-17 SSMIS radiometric calibration anomalies uncovered during the Calibration and Validation (Cal/Val) efforts are presented. As previously described for F-16, two principal anomalies were detected: an intermittent solar intrusion to the warm load calibration target; and reflector emission due to solar heating of the reflector face itself. The solar intrusion anomaly is readily evident in the time series of the individual channel radiometer gains, and can result in as much as a 1.5 K peak depression in the observed scene temperatures. A Fourier based filtering mitigation strategy has been implemented to perform the gain filtering in the SSMIS ground processing software for the sensor data records (SDRs). Performance of the F-17 hardware modifications designed to

inhibit the direct solar intrusions is presented. The reflector emission bias is a function of both the frequency dependent reflector emissivity and the difference between the reflector face and Earth scene temperatures. Warm biases of 1-2.5 K in the 50-60 GHz channels and up to 5 K in the high frequency channels (150-183 GHz) are observed. These anomalies correspond to reflector emissivities of ~0.015 at 50 GHz to as high as 0.07 at 183 GHz. For F-16 the reflector thermal cycle and resulting emission anomaly is driven by earth and/or spacecraft shadow, and is a maximum when the reflector face is directly illuminated by the sun. F-17 is in the terminator orbit configuration and shading due to the solar panel array dominates the thermal cycle of the SSMIS main reflector. Investigations were performed to directly measure the effective surface electrical conductivity of the main reflectors to determine the root-cause of the apparent high emissivities. Techniques were developed to perform laboratory measurements of the remaining SSMIS flight-unit reflectors have indicated the feasibility of low surface electrical conductivities of the F-16 and F-17 reflectors (i.e., less than 1.0 MS/m) compared with pure aluminum (36 MS/m). Low conductivities were also evident on the reflectors intended for use on other precision space-based microwave radiometer systems. Procedures to determine the electrical conductivity of the reflectors are now part of the pre-flight analysis for future SSMIS instruments. Methods have also been developed to strip existing coatings and re-coat the reflectors to meet the necessary electrical conductivity criteria (~18 MS/m) for a negligibly emissive reflector. The main reflector of the third SSMIS instrument (F-18) scheduled for launch in mid 2008 has been replaced with a spare reflector having significantly higher conductivity (17-18.5 MS/m) is expected to reduce the on-orbit reflector emission to a negligible level.

SESSION 2

2.1: IASI Performances on MetOp-A after one year in orbit

Presenter: Denis Blumstein

Denis Blumstein, Eric Pequignot, Bernard Tournier, Roger Fjortoft, Lars Fiedler, Ines Gaudel, Claire Baque, Laurence Buffet, Thierry Phulpin, Carole Larigauderie

The Infrared Atmospheric Sounding Interferometer (IASI) is a key element of the payload embarked on METOP series of European meteorological polar-orbit satellites. IASI provides very accurate information about the atmosphere, land and oceans for weather predictions, climate and atmospheric

chemistry studies. IASI measurements is designed to retrieve temperature and humidity profiles with a vertical resolution of one kilometer and an average accuracy of one Kelvin and 10 %, respectively. The IASI measurement technique is based on passive IR remote sensing using a precisely calibrated Fourier Transform Spectrometer operating in the 3.7 – 15.5 μm range and an associated infrared imager operating in the 10.3-12.5 μm range. The optical configuration of the sounder is based on a Michelson interferometer. Interferograms are processed by the onboard digital processing subsystem which performs the inverse Fourier Transform and the radiometric calibration. The integrated infrared imager allows the coregistration of the IASI soundings with the AVHRR imager onboard METOP. The first METOP satellite was successfully launched on the 19th of October 2006. The first interferogram was received at the CNES IASI TEC on the 27th of November 2006 and the first spectra were produced on board 2 days later. Dissemination of the data by Eumetsat began on the 24th of May 2007 in trial dissemination mode and was declared operational the 26th of July 2007 by Eumetsat and CNES. This paper provides an overview of the status of the instrument after 18 months in orbit and summarises the radiometric, spectral and geometric performances of the IASI instrument observed during this period. The spectral calibration is better than 2.10^{-6} and the radiometric absolute calibration is better than 0.5 K at 280K. There is no detectable evolution of these performances with time. In addition to the planned long term availability of the measurements (more than 15 years), this stability shows that IASI data are very well suited to calibrate other sensors and a reliable source of information for climate monitoring. Some slight evolutions of the Level 1 processing algorithms are nevertheless proposed for day 2 following some recommendations provided by the users, in particular at the Anglet Conference, and to facilitate the monitoring of the IASI performances by the TEC. An overview of these evolutions is provided. A companion paper presents the Near Real Time monitoring of the Level 1 IASI products at EUMETSAT and the anticipated improvements of these products for day 2.

2.2: IASI L1 data quality and NRT monitoring at EUMETSAT

Presenter: Lars Fiedler

Lars Fiedler, Yakov Livschitz, Eric Pequignot, Denis Blumstein, Tim Hultberg and Francois Montagner

The Infrared Atmospheric Sounding Interferometer (IASI) is part of the payload of Metop-A, the first of three satellites of the EUMETSAT Polar System (EPS). METOP-A was launched on 19th of October 2006. The IASI instrument has been switched on the 26th of October 2006 and generated the first interferogram on the 27th of November 2006. EUMETSAT started the trial dissemination of IASI L1 products on the 24th of May 2007. The IASI L1 products have been declared operational at the 26th of July 2007 by EUMETSAT and CNES after intensive evaluation during the Cal/Val period. The product quality of IASI L0 and L1 products are monitored in near real time (NRT) at EUMETSAT. This paper gives an overview of the NRT monitoring concept. Results from the first 9 month of IASI L1 operational data processing and NRT monitoring at EUMETSAT are presented. Results from radiance monitoring based on the RTIASI model using NWP forecast data as input are given. EUMETSAT and CNES are currently preparing the so-called Day 2 products content for the IASI L1 products. It is foreseen to start operational processing of Day 2 IASI L1 products at EUMETSAT in 2009. The anticipated improvements of the IASI L1 products will be presented.

2.3: IASI Level-2 Product Processing at EUMETSAT

Presenter: Peter Schlüssel

Peter Schlüssel, Thomas August, Arlindo Arriaga, Xavier Calbet, Tim Hultberg, Olusoji Oduleye

The IASI (Infrared Atmospheric Sounding Interferometer) Level 1C data are processed in near real time to Level 2 (geophysical products) in the EUMETSAT Polar System's Core ground segment and disseminated to the users via the EUMETCast system. The Level-2 processor ingests the IASI data along with information from the companion instruments AVHRR (Advanced Very High Resolution Radiometer), AMSU-A (Advanced Microwave Sounding Unit A), and MHS (Microwave Humidity Sounder). The processor functionality can be broadly broken down into three parts, the pre-processing, the cloud-detection, and the retrieval step. The level 2 processing starts

with a pre-processing. The processing options are read from a user-configurable auxiliary data set. All necessary data are accepted from the input streams and are checked for availability, validated against thresholds, and co-located on IASI footprints by interpolation or nearest match-up. A radiance tuning is applied to the IASI spectra to account for biases between the natural and the modelled radiative transfer. A number of cloud detection tests are executed, based on IASI data alone, or using IASI in combination with AVHRR and/or ATOVS. The AVHRR scenes analysis is used to determine cloud amount, cloud height distribution, and the number of cloud formations within an IASI field of view. If clouds are detected, a CO₂ slicing method, adapted for the use with interferometric data, is applied to determine cloud height and amount. The cloud phase is determined by applying thresholds on brightness-temperature differences in the infrared window. Flags are generated or updated to reflect the cloud situation and to modify the choice of the retrieval method accounting for the actual cloud condition. Different retrieval types are utilised, chosen according to data availability and cloud conditions. In the cloud-free case the parameters to be derived are temperature and water-vapour profiles, ozone amounts in deep layers, columnar amounts of carbon monoxide, methane, and nitrous oxide, surface temperature, and surface emissivity at different wavelengths. In cloudy situations, the number of retrieved parameters can change according to cloud amount and user choice. It is foreseen that parameters are derived above clouds only or in case of low cloud amounts, that a cloudy retrieval is performed. The retrieval techniques implemented are statistical retrievals based on EOF regression and artificial neural network methods for the first retrieval, and a variational Marquardt-Levenberg method employing a sub-set of IASI channels. It is possible that different choices can be made depending on the parameter to be derived and on cloud condition. The processor is being optimised and validated with data from short-range NWP forecast and dedicated field campaigns.

2.4: Spectroscopic database GEISA-2008 edition: content description and assessment through IASI/MetOp flight data

Presenter: N. Jacquinet-Husson

N. Jacquinet-Husson, V. Capelle, L. Crépeau, N.A. Scott, R. Armante, A. Chédin

The principal purpose of spectroscopic parameter compilations, in spectroscopic databases, is to provide the necessary molecular absorption input for transmission and radiance codes. In this

context, GEISA (Gestion et Etude des Informations Spectroscopiques Atmosphériques: Management and Study of Spectroscopic Information), initiated in 1976, is a computer-accessible spectroscopic database, designed to facilitate accurate forward radiative transfer calculations using a line-by-line and layer-by-layer approach. Remote sensing of the terrestrial atmosphere has advanced significantly in recent years, and this has placed greater demands on the compilations in terms of accuracy, additional species, and spectral coverage. Actually, the performance of instruments like AIRS (Atmospheric Infrared Sounder -<http://www-airs.jpl.nasa.gov/>), in the USA, and IASI (Infrared Atmospheric Sounding Interferometer -<http://earth-sciences.cnes.fr/IASI/>) in Europe, which have a better vertical resolution and accuracy, compared to the previous satellite infrared vertical sounders, is directly related to the quality of the spectroscopic parameters of the optically active gases, since these are essential input in the forward models used to simulate recorded radiance spectra. Currently, GEISA is involved in activities related to the assessment of the capabilities of IASI through the GEISA/IASI database derived from GEISA2. Since the Metop (<http://www.eumetsat.int>) launch (October 19th 2006), GEISA/IASI is the reference spectroscopic database for the validation of the level-1 IASI data, using the 4A radiative transfer model3 (4A/LMD [http://ara.lmd.polytechnique.fr](http://ara.lmd.polytechnique.fr;); 4A/OP co-developed by LMD and NOVELTIS - <http://www.noveltis.fr/>) with the support of CNES (2006). The updated 2008 edition of GEISA (GEISA-08), a system comprising three independent sub-databases devoted, respectively, to line transition parameters, infrared and ultraviolet/visible absorption cross-sections, microphysical and optical properties of atmospheric aerosols, will be described with special emphasis given to GEISA/IASI. Results of critical assessments of the spectroscopic databases such as GEISA, HITRAN and MIPAS, in terms of spectroscopic line parameters archived will be presented. Spectroscopic parameters quality requirement will be discussed in the context of comparisons between observed or simulated Earth's atmosphere spectra. GEISA is implemented on the CNES/CNRS Ether Products and Services Centre WEB site (<http://ether.ipsl.jussieu.fr>), where all archived spectroscopic data can be handled through general and user friendly associated management software facilities. More than 350 researchers are registered for on line use of GEISA. Refs: 1. Jacquinet-Husson N., N.A. Scott, A. Chédin, L. Crépeau, R. Armante, V. Capelle, J. Orphal, A. Coustenis, C. Boone, N. Poulet-Crovisier, et al. THE GEISA SPECTROSCOPIC DATABASE: Current and future archive for Earth and planetary atmosphere studies. JQSRT 2008, doi:10.1016/j.jqsrt.2007.12.015 2. Jacquinet-

Husson N., N.A. Scott, A. Chédin, K. Garceran, R. Armante, et al. The 2003 edition of the GEISA/IASI spectroscopic database. JQSRT, 95, 429-67, 2005. 3. Scott, N.A. and A. Chedin, 1981: A fast line-by-line method for atmospheric absorption computations: The Automatized Atmospheric Absorption Atlas. J. Appl. Meteor., 20,556-564.

2.5: Joint Airborne IASI Validation Experiment (JAIVEx) - An Overview

Presenter: W. Smith Sr.

W. Smith Sr., A. Larar, J. Taylor, H. Revercomb, D. Zhou, X. Liu, D. Tobin, S. Newman, S. Kireev, P. Schlüssel, X. Calbet, S. Mango, and K. St. Germain

The Joint Airborne IASI Validation Experiment (JAIVEx) was held during April and May 2007. Eight days of coincident MetOp satellite IASI and WB-57 aircraft NAST-I/S-HIS interferometer data were obtained over the DoE ARM CART-site and the Gulf of Mexico. Coincident dropsondes and remote sensing surface and atmospheric data were provided by the UK BAe-146 aircraft, which under flew the MetOp and WB-57. An overview of the JAIVEx field program and early validation results obtained from the rich JAIVEx data set are presented.

2.6: Retrievals with the Infrared Atmospheric Sounding Interferometer and validation during JAIVEx

Presenter: Daniel K. Zhou

Daniel K. Zhou, Xu Liu, Allen M. Larar, William L. Smith, Jonathan P. Taylor, Peter Schlüssel, L. Larrabee Strow, and Stephen A. Mango

The Joint Airborne IASI Validation Experiment (JAIVEx) was conducted during April 2007 mainly for validation of the IASI on the MetOp satellite. IASI possesses an ultra-spectral resolution of 0.25 cm⁻¹ and a spectral coverage from 645 to 2760 cm⁻¹. Ultra-spectral resolution infrared spectral radiance obtained from near nadir observations provide atmospheric, surface, and cloud property information. An advanced retrieval algorithm with a fast radiative transfer model, including cloud effects, is used for atmospheric profile and cloud parameter retrieval. This physical inversion scheme has been developed, dealing with cloudy as well as cloud-free radiance observed with ultraspectral infrared sounders, to simultaneously retrieve surface, atmospheric thermodynamic, and cloud microphysical parameters. A fast radiative transfer model, which applies to the cloud-free and/or

clouded atmosphere, is used for atmospheric profile and cloud parameter retrieval. A one-dimensional (1-d) variational multi-variable inversion solution is used to improve an iterative background state defined by an eigenvector-regression-retrieval. The solution is iterated in order to account for non-linearity in the 1-d variational solution. It is shown that relatively accurate temperature and moisture retrievals can be achieved below optically thin clouds. For optically thick clouds, accurate temperature and moisture profiles down to cloud top level are obtained. For both optically thin and thick cloud situations, the cloud top height can be retrieved with relatively high accuracy (i.e., error < 1 km). Preliminary retrievals of atmospheric soundings, surface properties, and cloud optical/microphysical properties with the IASI observations are obtained and presented. These retrievals are further inter-compared with those obtained from airborne FTS system, such as the NPOESS Airborne Sounder Testbed – Interferometer (NAST-I), dedicated dropsondes, radiosondes, and ground based Raman Lidar. The capabilities of satellite ultra-spectral sounder such as the IASI are investigated.

2.7: Using JAVIEX data to evaluate the impact of PCA Noise Filtering on the High Spectral Resolution Physical Retrieval Algorithm

Presenter: Paolo Antonelli

Paolo Antonelli, Dave Tobin, Bob Knuteson, Steve Dutcher, and Hank Revercomb

PCA has been demonstrated to be a powerful approach to characterize and reduce the random component of the instrument noise for high spectral resolution Grating and FTS infrared instruments. While the impact of a PCA based noise filter at radiometric level has been investigated quite extensively, its impact on the accuracy of the retrieved atmospheric variables is still unclear and not widely tested. By using S-HIS and IASI data collected during the JAVIEX field campaign, this work aims to evaluate the impact of the PCA-based noise filter on the accuracy of the Physical Retrieval Algorithm used to invert the radiances into the atmospheric variable space.

2.8: Direct radiance validation of IASI - results from JAIVEx

Presenter: Stuart Newman

Stuart Newman, Fiona Hilton, Andrew Collard, Jonathan Taylor, Bill Smith, Allen Larar

The Joint Airborne IASI Validation Experiment (JAIVEx) was conducted in April-May 2007. The campaign brought together a comprehensive set of measurements from the MetOp satellite, two research aircraft and ground-based instrumentation. As well as IASI on MetOp, interferometers were flown on the NASA WB-57 and UK FAAM BAe 146 aircraft, providing collocated radiance measurements from all three platforms. In addition, dropsondes and in situ sensors on the FAAM 146 allowed the atmospheric state to be well characterised during the radiometric observations. Flights over the Gulf of Mexico and the ARM CART instrument site in Oklahoma provide case studies over both ocean and land. Line-by-line forward modelling results will be presented to demonstrate validation of the spectral and radiometric accuracy of IASI.

2.9: Retrieval algorithm using superchannels

Presenter: Xu Liu

Xu Liu, Dan Zhou, Allen Larar, Bill Smith, Peter Schlüssel

Recent progress in using PCRTM super channel retrieval methodology will be discussed. Results applying the retrieval algorithm to IASI and NAST-I will be shown.

2.10: Error Assessment and Validation of the IASI Temperature and Water Vapor Profile Retrievals

Presenter: Nikita Pougatchev

N. Pougatchev, T. August, X. Calbet, T. Hultberg, P. Schlüssel, and B. Stiller

The Infrared Atmospheric Sounding Interferometer (IASI) Level 2 products generated by Product Processing Facility (PPF) at EUMETSAT comprise retrievals of vertical profiles of temperature and water vapor. The L2 data were validated through assessment of their error covariances and biases using radiosonde data for the reference. The reference radiosonde data set includes dedicated launches as well as the ones performed at regular synoptic times. For optimal error estimate the

linear statistical Validation Assessment Model (VAM) was used. The model establishes relation between the compared satellite and reference measurements based on their relations to the true atmospheric state. The VAM utilizes IASI averaging kernels and statistical characteristics of the ensembles of the reference data to allow for finite vertical resolution of the retrievals and temporal non-coincidence. The paper presents the validation results for different geographical locations and discusses potential use of the VAM estimated error covariances and biases for applications such as NWP, satellite intercalibration, and Earth System studies.

2.11: Assimilation of IASI Radiances at the Met Office

Presenter: Fiona Hilton

Fiona Hilton (Met Office), Nigel Atkinson (Met Office), Andrew Collard (ECMWF)

Data from the Infrared Atmospheric Sounding Interferometer (IASI) onboard MetOp has been assimilated at the Met Office in both Global and North Atlantic and European (NAE) configurations since November 2007. It has been a considerable challenge to reduce data volumes to a manageable level within the constraints of the forecast system and this paper will summarise the processing methodology employed. The results of pre-operational trials of IASI assimilation will be discussed. The Global configuration delivered a substantial impact on forecasts. In contrast, although improvements to the large scale fields (e.g. PMSL and Geopotential Height) were also seen in the NAE configuration, no forecast impact was seen for variables such as visibility and rain-rate.

2.12: Monitoring and Assimilation of IASI Radiances at ECMWF

Presenter: Andrew Collard

Andrew Collard and Tony McNally

IASI data at full spatial and spectral resolution have been arriving in near real time at ECMWF via the EUMETSAT EUMETCAST system since February 2007. Real time monitoring of a subset 366 channels commenced on 8th March 2007. Monitoring of radiance departures indicates that IASI data quality is good with biases and standard deviations comparable with or better than AIRS in the longwave temperature sounding band. An initial assimilation trial with 168 channels in the

15micron CO₂ band (a region considered particularly important following experience with AIRS) has yielded significant positive impact on forecast scores. Following this result the assimilation of these IASI channels became operational at ECMWF on 12th June 2007. Enhancements on this initial system including the use of the water vapour channels will be discussed.

2.13: Assimilation of IASI Data into the Regional NWP Model COSMO-EU: Status and Perspectives

Presenter: Marc Schwärz

Marc Schwärz and Reinhold Hess

This work will present a first setup of the assimilation of IASI data into the regional NWP model COSMO-EU of "Deutscher Wetterdienst" (DWD). The assimilation scheme utilized at DWD is a combination of Nudging with a 1D-VAR step (utilizing the EUMETSAT NWP SAF 1D-VAR software package). The combination of these procedures should test and demonstrate the possible usage of measurements which are connected to the model variables by non-linear operators (as IASI data are). The work will present the initial setup of the assimilation scheme for IASI data. The implementation of the bias correction scheme after Harris and Kelly (2001), using two different layer thicknesses of the model, the total column water vapor, and the surface temperature as bias predictors, is described. In addition, the Cloud detection algorithm after McNally and Watts is utilized (distributed by EUMETSAT NWP SAF). As forward model used in the 1D-VAR step the new version of RTTOV (RTTOV-9-beta) was implemented. The work will show first impact experiments based on the described scheme focused on the used channel sets. Finally, the optimization of the used nudging weights and the inclusion of cloudy and partly cloudy measurements, respectively, the next steps planned, are addressed.

2.14: Atmospheric Chemistry using IASI / MetOp: Overview of initial results

Presenter: Thierry Phulpin

Cathy Clerbaux, Pierre-Francois Coheur, Solène Turquety, Juliette Hadji-Lazaro, Daniel Hurtmans, Catherine Wespes, Hervé Herbin, Ariane Razavi, Maya George, Anne Boynard, Andrzej Klonecki, and T. Phulpin

MetOp, the first European meteorological platform on a polar orbit was launched on October 19, 2006. The platform carries a series of instruments, including IASI, the Infrared Atmospheric Sounding Interferometer designed and built by the French spatial agency CNES. IASI consists of a Fourier transform spectrometer, which measures radiance spectra of the Earth-atmosphere system between 645 and 2760 cm^{-1} in the thermal infrared, at a spectral resolution of 0.5 cm^{-1} (apodised). The nadir-looking geometry of IASI, combined with an across-track scanning mode reaching 48° on both sides, allows global coverage to be achieved in twelve hours. The first IASI spectra were delivered from mid July 2007. This work exhibits the first results acquired by analyses of IASI spectra, using retrieval tools dedicated both to operational and scientific processing, analysis of peculiar spectra in calibration mode, or images. We show that the extended spectral coverage of IASI provides unique information on the concentration distribution of numerous tropospheric species, impacting on climate (H_2O , CO_2 , N_2O , CH_4 , CFCs) or on chemistry (O_3 , CO , HNO_3). For most of these gases we demonstrate that vertical profiling is possible. IASI is shown to be very useful to monitor volcanic SO_2 . The emphasis of this work is put on preliminary analyses of O_3 , CO , CH_4 distributions on local to global scales, acquired during the first months of IASI operation, and also on CFCs and SO_2 .

SESSION 3

3.1: Community Radiative Transfer Model (CRTM) Status

Presenters: Paul van Delst and Yong Han

Paul van Delst and Yong Han

The Community Radiative Transfer Model (CRTM) is the operational model developed jointly by the partners of the US Joint Center for Satellite Data Assimilation (JCSDA) and JCSDA-funded research groups. This talk will discuss the current status and future development plans for the CRTM. The current implementation includes modules to

compute atmospheric transmittances, optical parameters for several cloud and aerosol types, surface emissivity and reflectivity for ocean, land, ice and snow surface types, and a multiple stream radiative transfer solution. The current CRTM supports many infrared and microwave sensors, including hyperspectral sensors such as AIRS and IASI. The ongoing and planned development of the CRTM includes the implementation of a transmittance model for SSU that takes the leakage of the CO_2 cell pressure into account, improvements in the CompactOPTRAN transmittance model, implementation of multiple atmospheric transmittance algorithms such as those used in RTTOV and SARTA, implementation of an algorithm to add extra layers at the top-of-atmosphere (TOA) as required to prevent large valued temperature Jacobians at TOA, implementation of a new low-frequency microwave sea surface emissivity model, implementation of a fast radiative transfer model that takes the Zeeman effect into account, investigation of a new infrared land surface emissivity model from NRL, improvement of the computational efficiency of the current Advanced Doubling-Adding (ADA) radiative transfer solver, and implementation of the Successive Order of Interaction (SOI) radiative transfer solver developed at the University of Wisconsin.

3.2: What can RTTOV-9 do for me?

Presenter: Roger Saunders

Roger Saunders, Marco Matricardi, Peter Rayer, Alan Geer, Deborah Salmond, Niels Bormann, Pascal Brunel and Philippe Marguinaud

The development of the fast radiative transfer model RTTOV, promoted by the NWP-SAF and other EUMETSAT sponsored activities, has continued since the release of RTTOV-8 in November 2004. Over 290 users worldwide have received a copy of the RTTOV-8 code. The RTTOV model is used for radiance assimilation in NWP models, simulating current and future satellite observations and as part of a physical retrieval scheme. The new version of RTTOV is RTTOV-9 which was released recently by the NWP SAF and is available to users free on request from the NWP SAF web site at www.nwpsaf.org. The major enhancements of RTTOV-9 over RTTOV-8 are: - Inclusion of a multiple scattering parameterisation for cloudy and aerosol infrared radiance calculations - Incorporation of cloudy radiance calculations within RTTOV allowing elimination of RTTOV_CLOUD wrapper code - Linear in tau approximation for the Planck function to improve the accuracy of the radiance

computation - The curvature of the earth and refraction can now be optionally included in the optical path calculation. - Include reflected solar radiation for short-wave infrared wavelengths - More 'active' trace gases (i.e., CO, CH₄, N₂O) - Further optimisation of optical depth computations for all gases (initially only for AIRS and IASI) - Improved microwave simulations by including updated spectroscopy in the coefficient files. - Minor improvements to RTTOV_SCATT code (new Mie tables) - Simplified interface to avoid need to specify polarisation - Change of user interface to allow profiles on user defined pressure or sigma levels and better mapping of computed jacobians on to user levels - Improved performance over RTTOV-8 on vector machines and improved memory management. The new RTTOV-9 model has been extensively validated and results of the validation will be shown. Development of the RTTOV-9 code continues and users will be invited to make comments on the plans for RTTOV-10 which will also be presented at the conference.

3.3: An assessment of the accuracy of the RTTOV fast radiative transfer model using IASI data.

Presenter: Marco Matricardi

Marco Matricardi

The fast radiative transfer model RTTOV has been validated for the channels of the Infrared Atmospheric Sounding Interferometer (IASI). IASI radiances measured in clear sky conditions have been compared to RTTOV radiances using as state vector profiles from the ECMWF analysis. Bias calculations were performed over water and during night. Results for an earlier version of RTTOV based on the GENLN2 line-by-line model have been compared to results obtained using the most recent version of RTTOV based on the LBLRTM line-by-line model and trained using a new set of diverse atmospheric profiles using molecular parameters from different spectroscopic databases. The impact on the results of different formulations of the water vapour continuum model has also been assessed.

3.4: Microwave Radiative Transfer at the Sub-Field-of-View Resolution

Presenter: Thomas J. Kleespies

Thomas J. Kleespies

The Advanced Microwave Sounding Unit has a nadir resolution of 50 km increasing to 155x82 km

at edge of scan. Modern numerical weather prediction models are or beginning to exceed this resolution. Ancillary databases, such as digital elevation maps are available with a resolution of a few meters. This paper presents a method of using the measured antenna pattern of the AMSU in conjunction with a digital elevation model to perform radiative transfer over coastlines and other inhomogeneous terrain.

3.5: Error analysis about using CO₂-absorbing band for temperature retrieval

Presenter: Qi Chengli

Qi Chengli, Ma Gang, Liu Hui, Zhang Peng

In the past more than 30 years, the traditional temperature retrieval method is using the infrared channels on CO₂-absorbing band, meanwhile in the current several decades, the column contents of CO₂ have noticeably increased. So in the retrieval method it is no more accurate for the forward calculation that generate fast transmittance coefficients using fixed content CO₂ column contents. Using the updated CO₂ column contents to calculate fast transmittance coefficients and perform the bias estimation of simulated satellite observed measurements, and derive the temperature retrieval results. Comparison between the traditional temperature retrieval results and that with adjusted satellite observed brightness temperature show the error results.

3.6: Fast Forward Modeling in Scattering Atmospheres with Optimum Spectral Sampling

Presenter: A. Lipton

Jean-Luc Moncet, G. Uymin, and A. Lipton

Assimilation of cloudy radiances and retrieval of cloud properties require a radiative transfer method that is accurate and computationally fast. An efficient treatment of scattering is one necessary element of the modeling. Another requirement is an efficient method to represent the spectral response of a channel, without resorting to numerical integration over a fine grid of monochromatic points covering the channel response function. Optimum Spectral Sampling (OSS) has been established as a very accurate and fast method to handle the spectral response and radiative transfer in clear and cloudy atmospheres. This paper describes progress in development and testing of OSS extensions to cloudy atmospheres where scattering is significant. OSS computes the radiance for a channel as a weighted average of

results from radiative transfer calculations at a relatively few monochromatic points, where the points and their weights are determined by optimization. The OSS optimal selection process can be performed in a localized manner, where the search for the optimal points is restricted to the spectral range of finite response for the channel. Another mode (described at ITSC-14) is the implementation of generalized training, where the search for optimal points for a channel is bounded only by the range of spectral response of all the channels together. A clustering approach makes the search process efficient. With generalized training, only ~250 spectral points are needed for the full AIRS channel set, which is an average of ~0.1 points per channel. For cloudy skies, OSS weights derived with generalized training from clear-sky optimization are not always accurate. The optical properties of clouds may vary substantially across the range of spectral points that contribute to a channel, and the properties will vary with the microphysical properties of the clouds and their spatial distribution. A variety of cloud conditions can be mixed into the training set, to seek spectral points and weights that are accurate for cloudy and clear atmospheres, but the performance in clear atmospheres tends to be degraded by the inclusion of cloudy atmospheres. Because cloud optical properties are spectrally smoother than molecular absorption, the cloudy profiles are less demanding, and a set of weights that achieves a specified accuracy overall will not necessarily achieve that accuracy for the clear-sky subset of training cases. To address this issue, we require that the accuracy threshold be met simultaneously for each subset (clear sky, ice cloud, liquid cloud, ice+liquid cloud). In addition, we have implemented a segmented version of generalized training by breaking the spectrum into intervals of ~20 cm⁻¹ and applying the generalized training method to the channels in each interval independently. In such intervals, the variations in cloud properties have an impact on radiances that is quasi-linear. This capability was originally introduced for land applications to handle spectral variations of surface emissivities, and for cloud it may well be that we could use wider intervals. This approach gives a lower computational gain than the fully generalized training, but gives increased robustness for clear and cloudy atmospheres. For AIRS, this method yields ~1 spectral point per channel. For an instrument with broader response functions, such as MODIS, the number of required nodes per channel can be up to about 25. In such cases, the radiative transfer integration becomes the dominant element of the computation time. An option for speeding up the OSS RT calculations in scattering atmospheres consists of predicting a multiple-scattering increment relative to non-scattering radiances. Under such a scheme, radiance calculations in non-

scattering conditions (these include treatment of cloud absorption) are performed for all the nodes, which is fast, and the full scattering calculations are performed only for a few selected predictor nodes optimally selected among the original set of OSS nodes used by this channel. The difference between the monochromatic radiances obtained with scattering and without scattering for this selected subset of nodes is used to predict a scattering correction for the channel. In tests with MODIS thermal channels, the accuracy of this OSS approach can exceed the accuracy of the commonly used band-transmittance parameterization method with an average of 1.7 scattering calculations per MODIS channel. This OSS method is particularly advantageous for reflective surfaces with low optical depths. For mini-AIRS, it is expected that this approach, combined with the generalized training, may require much less than one multiple-scattering calculation per channel.

3.7: Development of the Multilayer Cloudy Radiative Transfer Model for the GOES-R Advanced Baseline Imager

Presenter: Allen Huang

Bormin Huang, Yong-Keun Lee, Allen H.-L. Huang, and Mitchell D. Goldberg

Surface, aircraft and satellite observations show that many cloud types can appear simultaneously at the same location but at different altitudes. Furthermore, clouds may be continuous or broken at a given cloud level within a sensor's field of view. Therefore, it is desirable that a general radiative transfer model can deal with multilayer cloudy atmospheres for remote sensing applications. Multilayer cloudy systems can be complicated even for a non-scattering atmosphere. It can be shown that forming a two- and three-layer cloud system yields 10, and 218 combinations, respectively. The satellite cloud detection or cloud property retrieval algorithms (e.g. the CO₂-slicing method, the N* methods) which have been widely used for a single-layer or a simple two-layer overcast cloud system are not applicable to more complicated multilayer cloudy systems. In support of GOES-R Advanced Baseline Imager (ABI) for remote sensing of cloudy atmospheres, we develop a generalized multilayer cloudy radiative transfer model. The model is not too complicated that it makes the cloudy retrieval problems unmanageable, while generalized enough to handle multilayer clouds with the definition of the effective cloud emissivity to include the multiple scattering effects. The clear-sky atmosphere is a special case of this model where the cloud fractions are reduced to zero.

SESSION 4

4.1: Retrieval of Global Hyperspectral Surface Emissivity Spectra from Advanced Infrared Sounder Radiance Measurements

Presenter: Jun Li

Jun Li and Jinlong Li

Global hyperspectral surface emissivity map has been generated using Atmospheric InfraRed Sounder (AIRS) radiance measurements. Single field-of-view physical retrieval algorithm (Li et al. 2007: Geophysical Research Letters) was used for retrieving the global hyperspectral IR emissivity product. Collocated operational MODIS (Moderate Resolution Imaging Spectroradiometer) cloud mask product with 1 km spatial resolution is used for AIRS sub-pixel cloud detection (Li et al. 2004: Journal of Applied Meteorology); only AIRS radiances from clear skies are used for the IR surface emissivity retrieval. The 8-day (01 – 08 January 2004) composite of AIRS emissivity retrievals agrees well with the operational MODIS emissivity product at a few broad spectral bands. The spatial and spectral features of the derived emissivity spectra over desert and other regions well reflect the surface property and ecosystem conditions. The method can also be applied to process IASI (Infrared Atmospheric Sounding Interferometer) radiances with full IR spectral coverage. The global hyperspectral IR emissivity map is very important for assimilating radiances over land, retrieving other products such as dust properties and cloud properties using IR radiances.

4.2: Using Hyperspectral IR Sounder Data Over Land - PC radiative transfer and 1d-Var.

Presenter: Jonathan P Taylor

Jonathan P Taylor, Stephan Havemann, Jean-Claude Thelen

The Met Office started assimilating IASI data from the Metop platform in November 2007 and trials have shown it to have a big impact on NWP skill. However, current assimilation techniques only allow 183 of the 8461 available channels on IASI to be utilised and these are only assimilated in cloud free conditions. Over land the number of channels is reduced further to around 40 that have their peak sensitivity at altitudes above 400hPa. A novel new principal component radiative transfer scheme has been developed and coupled with a version of the UM 1d-Var code. Using this new technique we demonstrate the ability to use hyperspectral sounder data over all cloud free

scenes including those over land. In this presentation results using around 4000 channels from the Airborne Research Interferometer Evaluation System (ARIES) on the FAAM BAe146 research aircraft will be presented showing the skill in retrieving temperature, water vapour and ozone profiles simultaneously with spectrally resolved land surface emissivity and land surface temperature all of which are required to utilise satellite data over land within an NWP environment. The presentation will conclude with a presentation on the future direction of this research which includes the simulation of cloud affected radiances using principal component radiative transfer.

4.3: Infrared continental surface emissivity spectra retrieved from IASI observations

Presenter: E. Péquignot

E. Péquignot, A. Chédin, N. A. Scott

Infrared Atmospheric Sounding Interferometer (IASI) is a key element of the payload onboard METOP series of European meteorological polar-orbit satellites. The first METOP satellite was successfully launched on 19th of October 2006. In this paper, IASI observations over land are interpreted in terms of surface emissivity spectra at a resolution of 0.05 μm and skin temperature. For each IASI observation, an estimation of the atmospheric temperature and water vapor profiles is first obtained through a proximity recognition within the Thermodynamic Initial Guess Retrieval (TIGR) climatological library of about 2300 representative clear sky atmospheric situations. With this a priori information, all terms of the radiative transfer equation are calculated by using the 4A line-by-line radiative transfer model. Then, surface temperature is evaluated by using a single IASI channel (channel 699 at 12.203 μm) chosen for its almost constant emissivity with respect to soil type. Emissivity is then calculated for a set of 97 atmospheric windows (transmittance greater than 0.5) distributed over the IASI spectrum. The overall infrared emissivity spectrum at 0.05 μm resolution is finally derived from a combination of high spectral resolution laboratory measurements of various materials carefully selected within the MODIS/UCSB and ASTER/JPL emissivity libraries.

4.4: Recent updates of the UW/CIMSS high spectral resolution global land surface infrared emissivity database

Presenter: Eva E Borbas

Eva E. Borbas; Robert O. Knuteson, Suzanne W. Seemann, Elisabeth Weisz, Leslie Moy

An accurate infrared land surface emissivity product is critical for deriving accurate land surface temperatures, needed in studies of surface energy and water balance. Current sensors provide only limited information useful for deriving surface emissivity and researchers are required to use emissivity surrogates such as land-cover type or vegetation index in making rough estimates of emissivity. Inaccuracies in the emissivity assignment can have a significant effect on atmospheric temperature and moisture retrievals. To accurately retrieve atmospheric parameters, a global database of land surface emissivity with fine spectral resolution is required. An accurate emissivity is also required for any application involving calculations of brightness temperatures such as the assimilation of radiances into climate or weather models. At the Cooperative Institute of Meteorological Satellite Studies (CIMSS), University of Wisconsin, the so-called UW/CIMSS Baseline Fit (BF) global infrared land surface emissivity database was developed. The monthly, global database has been available since 2006 at the <http://cimss.ssec.wisc.edu/iremis/> website and includes data for each month from October 2002 at ten wavelengths (3.6, 4.3, 5.0, 5.8, 7.6, 8.3, 9.3, 10.8, 12.1, and 14.3 microns) with 0.05 degree spatial resolution. The BF approach uses selected laboratory measurements of emissivity to derive a conceptual model, or baseline spectra, and then incorporates MODIS MYD11 measurements at six wavelengths to adjust the emissivity at 10 hinge points. These wavelengths were chosen to capture as much of the shape of the higher resolution emissivity spectra as possible between 3.6 and 14.3 microns. As a recent effort at the UW/CIMSS, an algorithm was developed to derive a high spectral resolution (HSR) IR land surface emissivity from a combination of HSR laboratory measurements of selected materials, and the UW/CIMSS Baseline Fit (BF) global infrared land surface emissivity database by using a principal component analysis (PCA) regression. The first Principal Components of 123 selected laboratory spectra (in this study the wavenumber resolution between 2-4cm⁻¹, at 416 wavenumbers) were regressed against the 10 hinge points of the monthly UW/CIMSS BF emissivity. The algorithm to extract the high spectral resolution emissivity database from the UW/CIMSS BF emissivity dataset will be available in early 2008. In the presentation, after the

introduction of the emissivity database, the impacts of varying the emissivity on the calculated top-of-atmosphere BT across the infrared spectral regions are examined, then an analysis of the effects of a change in emissivity on retrieved temperature and moisture profiles will be presented. At the end this MODIS-based emissivity database will be compared to the HSR emissivity database derived from AIRS measurements.

SESSION 5

5.1: Upper tropospheric humidity data set from operational microwave sounders

Presenter: Viju John

V. O. John, S. A. Buehler, M. Kuvatov, M. Milz, B. J. Soden, and D. L. Jackson

Microwave radiation measured around 183.31 GHz by operational weather satellites can be used to derive Upper Tropospheric Humidity (UTH). This presentation gives details of a new UTH data set derived from Advanced Microwave Sounding Unit - B (AMSU-B) instruments on board NOAA (15, 16, and 17) satellites for 8 years (2000-2007). In contrast to UTH data sets derived from infrared measurements, the new data set is less affected by clouds. The maximum uncertainty due to clouds is estimated as 10 %RH in deep convective areas. We also show that the data from the three satellites are consistent with mean relative differences less than 4+/-7%. Comparisons with Radiosonde measurements and infrared UTH measurements show consistent results with previous studies.

5.2: What can the GCOS Reference Upper Air Network do for you?

Presenter: Peter Thorne

Abstract not available.

5.3: Intersatellite Calibrated HIRS Upper Tropospheric Water Vapor

Presenter: Lei Shi

Lei Shi and John J. Bates

Intersatellite calibration is carried out for the clear-sky HIRS upper tropospheric water vapor (UTWV) channel measurement. As the intersatellite biases are scene temperature dependent, an algorithm is developed to account for the varying biases with respect to brightness temperature. The bias

correction data are derived based on overlaps of monthly means of each 10-degree latitude belt. For the colder temperature range, data from the simultaneous nadir overpass observations are incorporated. The HIRS measurements from NOAA-6 to NOAA-17 are calibrated to a baseline satellite by correcting the intersatellite biases. The time series of the intersatellite calibrated HIRS UTWV data from 1979 to present is constructed and anomaly data are computed. The anomaly time series is used to track tropical waves and variabilities. The HIRS UTWV anomaly data are particularly useful in monitoring Madden-Julian oscillation and various equatorial waves.

5.4: Long-term application and evaluation of IAPP using global radiosonde and CHAMP measurements

Presenter: Marc Schröder

Marc Schröder, Jörg Schulz, Markus Jonas, Ralf Lindau

The major objective of the Satellite Application Facility on Climate Monitoring (CM-SAF) is the exploitation of satellite observations to derive information on key climate variables of the Earth system. The CM-SAF focuses on the atmospheric part of the Essential Climate Variables defined within the framework of the Global Climate Observing System (GCOS). Among other methods the CM-SAF operationally applies the International ATOVS Processing Package (IAPP) to retrieve humidity and temperature profiles from ATOVS observations onboard NOAA-15, -16, and -18. A kriging routine is applied to the swath based retrievals in order to determine daily and monthly averages on a global grid. Furthermore, the profiles are vertically integrated and averaged to provide column integrated water vapour as well as humidity and temperature values for 5 layers and at 6 layer boundaries. Currently the years 2004-2007 had been processed, and a reprocessing event will go back to 1998 in the near future. The evaluation of temperature and humidity Climate Data Records (CDRs) for the period 2004-2007 is carried out using global radiosonde observations that meet the quality standards of the GCOS Upper Air Network (GUAN). The evaluation is extended by utilising CHALLENGING Minisatellite Payload (CHAMP) observations for the years 2004 and 2005. The evaluation considers biases, RMSE, and mean absolute deviations and separates between global and zonal values. The maximum average bias of column integrated and layer integrated water vapour between ATOVS and GUAN radiosondes is 0.5 kg/m² and 0.8 kg/m² (850-700 hPa), respectively. For the layer averaged temperatures

we find a maximum bias of -1.1 K (300-200 hPa). The RMSE of water vapour exhibits an annual cycle with a maximum in summer months and a maximum of zonal RMSE around the equator with some variation depending on the month. The exemplary comparison of ATOVS and CHAMP data confirms above findings. When future progress in inter-calibration efforts leads to improved homogenised radiances, reprocessing of ATOVS observations can be carried out easily and will lead to CDRs with at least the accuracy as presented above. Currently CM-SAF is working on an automated evaluation of temperature and humidity products with radiosonde profiles from reference stations.

5.5: AIRS in Atmospheric and Climate Research

Presenter: Hartmut H. Aumann

Tom Pagano, Bjorn Lambrigtsen, Mous Chahine, Eric Fetzer

The Atmospheric Infrared Sounder (AIRS), the first of a new generation of hyperspectral infrared sounders, was launched on the NASA Aqua platform in 2002 and has operated flawlessly ever since. With its extremely high spectral resolution – 2378 channels between 3.7 and 15.4 microns – and very stable and accurate radiometric measurements it has been possible to produce atmospheric data sets of unprecedented coverage, accuracy and resolution. Assimilation of the observed radiances into numerical weather prediction models – now done on a routine basis at a number of the world's major weather prediction centers – has already had a major impact on global weather forecast accuracy and range. Now, derived data sets are also beginning to play a major role in atmospheric research, ranging from process studies related to the hydrologic cycle to climate research related to greenhouse and other trace gases. These data sets, which include global 3-dimensional temperature and water vapor fields that are as accurate as can be obtained with the highest quality radiosondes – but with daily global coverage, are enabling studies that were previously not possible. The AIRS data sets are freely available from NASA and now cover the period from September 2002 to the present. A new version of the data processing system – V5 – was recently implemented and is now used to process all current and past data to the highest quality. We describe the data sets and results of efforts to validate them and discuss research problems that they can be used to address. The work reported on here was performed at the Jet Propulsion Laboratory, California Institute of Technology under a contract with the National Aeronautics and Space Administration.

5.6: The Frequency of Severe Storms in the Tropical Zone and Global Warming.

Presenter: Hartmut H. Aumann

Hartmut H. Aumann

Data from the Atmospheric Infrared Sounder show that the frequency of severe storms in the tropical zone increases by 3.6% per 0.1 K of warming of the zonal mean surface temperature. With global warming at the 0.1 K/decade rate, this corresponds to an increase in severe tropical storms of 3.6% per decade. This rate is consistent with the increase in precipitation deduced from SSMI data with the assumption that 30% of the total precipitation over tropical oceans is associated with severe storms.

5.7 Status of NPOESS Climate Instruments Remanifest

Presenter: Jörg Schulz

Abstract not available.

SESSION 6

6.1: Current Status: a summary of the NWP Survey

Presenter: John Derber

Abstract not available

6.2: Progress and Plans for the use of radiance data in the NCEP global and regional data assimilation systems

Presenter: J. Derber

J. Derber, R. Treadon, D. Kleist, M. Rancic

Significant changes in the use of radiance data at NCEP have been developed and are in the process of being implemented. These developments include the use of new satellite data (METOP, SSMIS), improvements in the bias correction and quality control, enhancements in the inclusion of the surface signal in the simulated radiances, the introduction of improved radiative transfer and advances in the data assimilation techniques. Details of some of these changes (e.g., new satellite data and improved radiative transfer) are covered in other talks at this meeting. This presentation will present an overview of the changes and present the impact of these changes on the overall data assimilation and forecast system. In addition,

specific details of the enhancements to the bias correction technique, improvements in the incorporation of the surface signal and the significant changes in the data assimilation technique will be presented. Finally future plans for operation assimilation of satellite sounder data will be briefly discussed.

6.3: The Use of satellite data at ECMWF

Presenter: Niels Bormann

Abstract not available.

6.4: NRL Status Report

Presenter: Nancy Baker

Abstract not available.

6.5: An Update on the Operational Use of Satellite Sounding Data at the Met Office

Presenter: Brett Candy

Brett Candy, Steve English, Fiona Hilton, James Cameron, Amy Doherty, T. R. Sreerekha, William Bell and Nigel Atkinson

This talk will give a snapshot of the sounding instruments used operationally in the Met Office global model. Since the last ITSC meeting a major forecast impact has come from the use of the instruments onboard METOP-A. However several other important updates have been introduced that increase the number of observations from existing instruments. These include the use of high peaking channels from AIRS over land and the reintroduction of the HIRS instruments on NOAAs 16 & 17 and AMSU-B on NOAA-17. Channel usage and observation errors have also had to be revised following very large analysis increments in the upper stratosphere around the winter pole.

6.6: Recent advances in the use of satellite data in the French NWP models

Presenter: Thibaut Montmerle

Rabier, F., Auger, L., Fourrié, N., Gérard, E., Guidard, V., Karbou, F., Michel, Y., Moll, P., Montmerle, T., Payan, C., Poli, P.

The use of satellite data in the French NWP models at global and regional scales is described. In the last year, a lot of effort had been dedicated to the assimilation of data from the MetOp satellite

(ATOVS, ASCAT and IASI). The operational assimilation of ATOVS and ASCAT has been performed. The assimilation of IASI data and the more extensive use of AIRS data is currently pre-operational. Another major milestone has been the operational use of GPS radio-occultation data from the COSMIC, CHAMP and GRACE satellites mid-2007. METEOSAT CSR data are also being introduced in the global model (in the regional model ALADIN, a fine resolution radiance product provided by the CMS in Lannion is used instead). GPS ground-based data have been used in both models since 2006. In terms of algorithmic development, an improved parametrisation of microwave emissivity has allowed a better use of these data over land, as investigated in particular over Africa during the AMMA field experiment period. Another major development was the introduction of a variational bias correction algorithm based on the one developed at ECMWF, for radiance bias correction. This change was quite positive in terms of forecast scores in the global model.

6.7: Inclusion of new data types in the Canadian data assimilation system

Presenter: Godelieve Deblonde

Nicolas Wagneur, L. Garand, J. Aparicio, A. Beaulne, M. Buehner, J.-M. Bélanger, D. Anselmo, G. Deblonde, J. Hallé, P. Koclas, R. Sarrazin, and G. Verner

The Canadian data assimilation system is now benefiting from several new data types: Quikscat oceanic winds, radiances from seven SSM/I channels, and 87 AIRS channels. Extreme scan angles from AMSU-A and AMSU-B are also assimilated, which increases by about 25 % the volume of these data. In addition, the radiative transfer model was upgraded to RTTOV-8 along with a new vertical interpolator. The poster will present the impact of these new data as evaluated in a parallel run which was run from January to April 2008. At the time of this writing, results are clearly positive in the Southern hemisphere and closer to neutral in the Northern Hemisphere. In the Tropics, a large improvement in the geopotential bias is noted. It is planned to continue that parallel run with the inclusion of GPS radio-occultation data assimilated up to 30 km. Results on the impact of these data should be available at the time of the conference.

6.8: Assimilating ATOVS data in numerical weather prediction model to improve Typhoon prediction in NSMC/CMA

Presenter: Lu Qifeng

Lu Qifeng, Wu Xuebao, Zhang Fengying, Zhang Peng, Dong Chaohua

Tropical cyclones form over the seas: a typical data-sparse region for conventional observations. Therefore, satellites, especially with microwave sensors, are ideal for cyclone studies. The advanced microwave sounding unit (AMSU), in addition to providing very valuable data over non-precipitating cloudy regions, can provide very high horizontal resolution of the temperature and humidity soundings. Such high-resolution microwave data can improve the poorly analyzed cyclone. In order to solve the difficult problem of typhoon track prediction due to the scarcity of conventional data over the tropical ocean, in this paper, the No. 0709 typhoon Shengpa of 12-19 August 2007 is studied and an experiment of the typhoon track prediction is made with the direct use of the Advanced TIROS-N Operational Vertical Sounder (ATOVS) microwave radiance data (AMSU) on NOAA-18 in three-dimensional variational data assimilation. The prediction result shows that the skill of the typhoon track prediction with the ATOVS microwave radiance data is much better than that without the ATOVS data. The direct assimilation of ATOVS microwave radiance data is an available way to solve the problem of the sparse observation data over the tropical ocean, and has great potential in being applied to typhoon track prediction.

6.9: Assimilation of radiance data at JMA: recent developments and prospective plans

Presenter: Kozo Okamoto

Kozo Okamoto, Hiromi Owada, Toshinobu Ishibashi, Takumu Eagawa and Masahiro Kazumori

Recent developments and prospective plans on the satellite data assimilation, especially regarding radiance data, are presented. After the last conference in October 2006, JMA introduced various data into our operational global 4D-Var data assimilation system. The data include: AP-RARS/EARS ATOVS radiances, ATOVS radiances onboard NOAA18 and Metop, MTSAT-1R water vapor channel radiances, and refractivities of CHAMP GPS radio occultation. Above all, Metop ATOVS (AMSU-A and MHS) has the greatest positive impact on forecasts, especially on the forecast of geopotential height, in

our cycle experiments. Radiance assimilation method of hyperspectral IR sounders, such as AIRS, has been developed and its encouraging results are obtained. SSMIS radiances were added to the current radiance assimilation of SSMI, TMI and AMSR-E. It was proved to improve typhoon track forecasts slightly. A new global forecast model with the resolution of TL959L60, which was implemented in November 2007, is also briefly presented.

6.10: Direct Radiance Assimilation for WRF: Implementation and Initial Results

Presenter: Thomas Auligne

Zhiquan Liu, Hui-Chuan Lin, Dale Barker, Thomas Auligne, Xiaoyan Zhang

Weather and Research Forecast (WRF) model as well as its variational assimilation system (WRF-Var) is widely used by both research community and the operational NWP centers in US (Air Force Weather Agency) as well as a number of international WRF partners in Asia, the Middle East, and Europe. A general satellite radiance assimilation framework has been developed in the WRF-Var system in the past two years. The WRF-Var radiance assimilation capability was designed for meeting requirements of both basic research and operational applications, which will be available to research community with the next WRF release. This presentation will begin with an overview of radiance assimilation capabilities in WRF-Var, including the core component -- Fast Radiative Transfer Model (RTM), air-mass dependent bias correction algorithm, quality control and observation error tuning and so on. In particular, two widely used RTMs, RTTOV developed by EUMETSAT in Europe and CRTM developed by JCSDA in USA, are incorporated into WRF-Var system. A preliminary comparison between RTTOV and CRTM will be present. Recent results on assimilating microwave radiance data to improve Hurricanes track and intensity forecast will be also presented. Results for the Katrina case show that assimilating AMSU-A radiance improves both track and intensity forecast, even most data are discarded over Hurricane vortex area. One will also present a cloud/rain affected radiance assimilation scheme, which uses total cloud water as the control variable and a warm-rain physics process to partition total water to moisture and hydrometeor increments.

6.11: The Assimilation of Clear-Sky Infrared Radiances in the HIRLAM Model

Presenter: Martin Stengel

Martin Stengel, Per Dahlgren, Magnus Lindskog, Per Unden, Nils Gustafsson

The limited-area numerical weather prediction model HIRLAM has been adjusted to make use of the infrared (IR) radiances measured by SEVIRI on-board the MSG satellites. Therefore, the HIRLAM variational data assimilation system has been modified to take advantage of this additional observation type. Especially 4D-Var frameworks, which is one option in HIRLAM's assimilation system, are assumed to be capable of utilizing the information content provided by SEVIRI with its high temporal resolution. For the time being, only the two water vapour channels are considered. Observation impact studies have been carried out for different time periods using 3D-Var and 4D-Var. For 3D-Var the nearest SEVIRI timeslot is chosen, whereas for 4D-Var SEVIRI data from six slots are used, which are equally distributed over the 6 hour assimilation window. For these experiments, all cloud contaminated pixels had been rejected. Generally, the impact studies show a neutral to slightly positive impact of SEVIRI's clear sky infrared data on analysis and forecast fields. In all studies, the system seems to be able to use SEVIRI observations to decrease an upper-tropospheric humidity bias in the NWP model, which is found when comparing model fields and colocated radiosondes. This impact is visible up to 48 hours integration time with a decreasing magnitude. In addition, we find a slight positive impact on geopotential height and mean sea level pressure forecasts. This impact is a bit more distinct for 4D-Var and during summer. These results, as well as examples of preceding data preparation steps such as spatial thinning and quality checks, will be presented.

6.12: Assimilation of AIRS Radiances at CPTEC/INPE using the LETKF system

Presenter: José Aravéquia

Abstract not available.

6.13: Use of satellite data in ALADIN/HARMONIE-Norway

Presenter: Roger Randriamampianina

Abstract not available.

SESSION 7

7.1: Recent developments in the use of ATOVS data at ECMWF

Presenter: Niels Bormann

Niels Bormann, Blazej Krzeminski, Peter Bauer, and Tony McNally

The ATOVS family of instruments continues to provide important information for Numerical Weather Prediction. Currently, ECMWF assimilates ATOVS data from six polar orbiting satellites, with data from 5 AMSU-A, 4 AMSU-B/MHS, and 2 HIRS instruments. The talk gives an overview of some recent developments in the operational use of ATOVS data at ECMWF. These include the swift introduction of METOP ATOVS data into operations after a brief monitoring period, use of data from the Pacific-RARS system, the revision of quality control and bias corrections for HIRS data, and the upgrade of the radiative transfer model to RTTOV-9.

7.2: A Comparison of IASI water Vapour and SSMIS window channel impacts on NWP analyses and forecasts

Presenter: W. Bell

W. Bell, F. Hilton, S. English, B. Candy, S. Swadley

In order to gain insight into the complex impacts of water vapour information from microwave window channels in NWP a study was undertaken to compare the performance of clear sky IASI 6.7 μm water vapour channels with SSMIS window channels (19-37 GHz) in the Met Office global forecast model using a 4D-Var assimilation scheme. Theoretical calculations show IASI to have more skill in determining the vertical moisture structure in the atmosphere relative to the information available from microwave window channels. The proximity of MetOp-A IASI and F-16 SSMIS orbit planes allows the compilation of a dataset of co-located observations which facilitates a comparison of SSMIS and IASI driven moisture increments in 4D-Var. Qualitatively there is agreement throughout the troposphere in all latitude bands with positive correlations between IASI and SSMIS moisture increments. In terms of forecast impacts both observation types (i.e., IASI water vapour channels and SSMIS window channels) show disappointingly weak forecast impacts on large scale fields using conventional (sonde and surface) observationally based verification measures. There is evidence of more significant impacts on short range (T+24hour)

precipitation fields, especially in the tropics, and these impacts have been verified subjectively using a near real time precipitation analysis generated from TRMM, AMSR-E, SSMI and AMSU-B.

7.3: Impact of combined AIRS and GPS-RO data in the new version of the Canadian global forecast model

Presenter: Louis Garand

L. Garand, J. Aparicio, M. Buehner, G. Deblonde, M. Roch, S. MacPherson, C. Charette, A. Beaulne

GEM-Strato is a new version of the global Canadian forecast model with top raised from 10 Hpa to 0.1 Hpa. This allows to assimilate 35 additional AIRS channels on top of the currently used 87 channels. As well GPS radio-occultation refractivities are assimilated up to 3 hPa (40 km). Background error statistics were revised, with added localization of the vertical correlations. The separate and combined impacts are evaluated in 3D-FGAT assimilation cycles.

7.4: The Assimilation of Cloudy Infrared Radiances in the HIRLAM Model: Initial Experiences

Presenter: Martin Stengel

Martin Stengel, Per Dahlgren, Magnus Lindskog, Per Unden, Nils Gustafsson

Efforts have been made at SMHI to examine the utilisation of measured infrared radiances in the presence of clouds in the limited-area numerical weather prediction model HIRLAM. Since a certain portion of observations are located in cloudy areas, many observations are rejected in the first place. We have started to investigate under which circumstances observations in cloudy conditions could be used. A first strategy focuses on low level clouds. Here, the assimilation of infrared sounding channels seems to be less problematic, as far as their sensitivity to the cloud layers is negligible. Nevertheless, the filtering of those cases relies on the information about the vertical location of the clouds. This can possibly be optimized when providing more accurate information to keep as many useful observations as possible. Next to a fixed cloud top pressure (CTP) limit, the comparison of the derived CTP and the local Jacobians at observation point could be more effective as criteria in this context to identify such not-radiance-affecting clouds. Additionally, we consider clouds, whose effect on the radiance is small, which can possibly be parameterized properly in the observation operator by a simple

cloud assumption. First assimilation experiments, using SEVIRI's water vapour channels, have been carried out and initial results will be shown. Furthermore, we investigate the feasibility to extend the observation operator to include a simplified moist physics scheme. This framework can also be used to determine the sensitivity of modelled clouds (and subsequent simulated cloudy radiances) to the model variables. Under certain conditions, this could then be used to assimilate cloud-affected infrared radiances. Statistics of these modelled clouds in NWP model space and in observation space, as well as the sensitivity of simulated cloudy radiances will be discussed. Preliminary 1D-Var studies are currently being conducted and will be presented.

7.5: Impact of VASS radiance of FY3 assimilation on numerical typhoon prediction

Presenter: Ma Gang

Ma Gang Zhang Fengying Li Xiaoqing etc.

A set of transmittance coefficients of IRAS (InfRared Atmospheric Sounder), MWTS (MicroWave Temperature Sounder) and MWHS (MicroWave Humidity Sounder) used in RTTOV7 has been build by multivariate linear regression analysis in line-by-line radiative transfer models. Comparison of 43 profiles of the channel radiance from these line-by-line models and those from RTTOV7 shows that bias are less than 0.7K for all the 20 infrared channels of IRAS and are less than 0.3K for all the 9 channels of MWTS and MWHS. With RTTOV7 and the new transmittance coefficients, a new satellite data assimilation module has been set up to directly assimilate VASS (Atmospheric Vertical Sounding System) radiance of FY3 into GRAPES 3DVar system. Because the radiance bias of infrared channels are less than 3K while those for microwave channels are less than 0.03K between ATOVS and VASS, quality control of the radiance and bias correction to simulated VASS radiance have been introduced in terms of ATOVS radiance assimilation. Radiance of ATOVS have been use to generate VASS radiance based on the spectral characteristics of the VASS instruments in a typhoon case. Then, new initial temperature, water vapor and wind fields for GRAPES model can be produced by directly assimilating these VASS radiance. Numerical tests show positive effect on typhoon track prediction by using those satellite data in GRAPES.

7.6: An Information Based Radiance Data Selection Scheme for Efficient Use of a Multi-Satellite Constellation

Presenter: Brett Harris

Brett Harris, Chris Tingwell and Peter Steinle

In this study we investigate a new data selection scheme using level-1D ATOVS radiances derived using the European ATOVS and AVHRR Processing Package (AAPP), in the Global Assimilation and Prediction (GASP) system. Using the GASP assimilation and prediction systems at a resolution of T239/L60, we investigate the most efficient way to utilise HIRS, AMSU-A and AMSU-B/MHS radiances from the NOAA-16, 17 and 18 satellites plus MetOp-A and also AMSU-A from AQUA. At present, instead of the traditional two fully operational NOAA polar orbiting ATOVS satellites, we have three partially functional platforms. Each satellite has problems ranging from very noisy HIRS on NOAA-16/18, to total sensor failure such as with AMSU-A on NOAA-17. We also have the option to use the AMSU-A instrument on the AQUA/EOS satellite as well as the full ATOVS suite from the MetOp-A satellite. While the GASP analysis assimilates retrieved profiles from a 1DVAR system, necessitating thinning to 250km, most 3D/4D-VAR systems also have to thin satellite data to a separation greater than the original footprint. A method that chooses soundings of the highest information content, will achieve the best analysis, while minimising the time taken processing the data. This data selection method utilises a ranking system that depends on the satellite characteristics, the atmospheric conditions and the surface type for each sounding. The algorithm chooses the sounding with the highest rank within a given radius, which is then presented to the assimilation system. In the current 1DVAR system, this pre-thinning algorithm is able to achieve a reduction of over 30% in total runtime, without any reduction in forecast skill. In the future, as the Bureau moves to the new Australian Community Climate Earth-System Simulator (ACCESS) regime, utilising the OPS/VAR/UM from the Met Office, we will also wish to incorporate a subset of AIRS radiances from AQUA, as well as IASI data that will be available from MetOp-A.

7.7: Use of Hyperspectral IR Data in 4D Assimilation at NRL

Presenter: Benjamin Ruston

Benjamin Ruston, Nancy Baker, William Campbell, Tim Hogan, Xu Liu

A newly developed weak-constraint 4D-Var system is in parallel pre-operational testing at the Naval Research Laboratory. The NRL Atmospheric Variational Data Assimilation System – Accelerated Representer (NAVDAS-AR) is targeted to be the next generation assimilation system for the US Navy replacing the 3D-Var NAVDAS system within the next year. In particular, NAVDAS-AR scales much better to the high data volumes encountered working with hyperspectral instruments such as AIRS and IASI. The NAVDAS-AR system has been configured to use both the JCSDA Community Radiative Transfer Model (CRTM) and RTTOV-8.7 and a brief comparison of the two will be presented. The adjoints of NAVDAS-AR and the Navy Operational Global Atmospheric Prediction System (NOGAPS) are used to produce observation sensitivities for all simulated channels allowing for additional guidance in channel selection for assimilation. Primary channel selection begins by identifying the spectral region of interest for assimilation. The assimilation has focused initially on the longwave CO₂ channels in the 13-15 micron range. Further channel selection is done by leveraging advice from other modeling centers (UK-Met Office and ECMWF), examining Jacobians for sensitivity above the model top, and the use of the NAVDAS-AR and NOGAPS adjoint sensitivities. Quality control is being done primarily by the NWP-SAF released cloud detection package for high resolution infrared sounders. Results of the assimilation runs will present standard diagnostics including the 500hPa anomaly correlations from the Northern and Southern hemispheres, vector wind RMS from 850 hPa, and tropical cyclone tracks from the 2007 season for AIRS assimilation only. Lastly, Xu Liu, a visitor from NASA Langley has incorporated the principle component version of the CRTM (pCRTM) to be used with NAVDAS-AR and IASI data. This allows direct assimilation of principle components rather than individual channels. These results are contrasted with the results from the conventional channel style assimilation runs in both computational efficiency and most importantly in NWP performance.

7.8: Intercomparison of the Cross-Track and Conical Scanning

Presenter: Banghua Yan

Banghua Yan, Fuzhong Weng, and John Derber

The NOAA Advanced Microwave Sounding Unit (AMSU) and DMPS Special Sensor Microwave Imager/Sounder (SSMIS) instruments have similar temperature and water vapor sounding channels but different cross-track and conical scan geometries. For cross-track scanning, the angle of earth incidence varies, resulting in angle-dependent weighting function and satellite measurements for a given frequency. For conical scanning, a fixed angle of incidence and a vertical axis of rotation are used, in which the viewing area and slant path remains nearly constant. The differences in this scan geometry can result in differences in impacts on model forecasts. Distinct bias correction and quality control schemes also must be utilized for AMSU and SSMIS data due to differences in error characteristics of the satellite data. These error characteristics and different bias correction and quality control schemes associated with AMSU and SSMIS data can further result in different impacts on Numerical Weather Prediction (NWP). To quantify characteristics of cross-track and conical scanning satellite microwave sounding impacts, AMSU and F16 SSMIS measurements are assimilated separately into National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) associated with Gridpoint Statistical Interpolation (GSI) subsystem. In this process, the current bias correction and quality control schemes for AMSU and SSMIS data in GSI are assessed, and the data usage in GSI and impacts of each instrument of measurements on various analysis variables and forecast score in GFS are estimated by carrying out a set of assimilation experiments for both winter and summer seasons. Since the original F16 SSMIS atmospheric sounding channels display persistent radiance anomalies, the F16 SSMIS data used in this study is corrected using both the Calibrated Temperature Data Record (CTDR) by applying the Naval Research Laboratory (NRL) and United Kingdom Met Office (UKMO) unified SSMIS preprocessor and the National Environmental Satellite, Data, and Information Service (NESDIS) SSMIS preprocessor.

7.9: Impact of AIRS and AMSU-A data in regional data assimilation over the Antarctic

Presenter: Thomas Auligne

Thomas Auligne, Hui Shao, Dale Barker, Zhiquan Liu and Hui-Chuan Lin

The Antarctic Mesoscale Prediction System (AMPS) is an experimental, real-time numerical weather prediction capability that provides a twice-daily forecast covering Antarctica. The current version uses the regional mesoscale model Weather Research and Forecasting (WRF). The model can be initialized through a variational assimilation system (WRF-Var), which involves specific background error statistics. The impact of observations from the Atmospheric Infrared Sounder (AIRS) and the Advanced Microwave Sounding Unit (AMSU) is studied for the Antarctic region. Temperature and water vapor information are retrieved through the latest version of AIRS Standard Retrieval Products from NASA. The quality of the data is assessed for high latitudes and errors associated with these quantities are estimated. The performance of retrievals is then compared to the direct assimilation of radiances. Objective methods are used to estimate the radiance error statistics and to perform quality control. A cloud detection scheme is developed for AIRS and adapted to the polar regions where clouds are often more difficult to identify. The relevance of cloud-cleared radiances is also studied. Finally, a significant effort is focused on systematic errors in the innovations, which are a major problem for data assimilation in the polar regions. In particular, we will show results from the combination of a variational bias correction of observations with estimations of model bias.

SESSION 8

8.1: Neural Network Estimation of Atmospheric Profiles Using AIRS/IASI/AMSU Data in the Presence of Clouds

Presenter: William J. Blackwell

William J. Blackwell, Frederick W. Chen, and Michael Pieper

A novel statistical method for the retrieval of atmospheric temperature and moisture (relative humidity) profiles has been developed and evaluated with sounding data from the Atmospheric InfraRed Sounder (AIRS) and the Advanced Microwave Sounding Unit (AMSU) on the NASA Aqua satellite and the Infrared Atmospheric Sounding Interferometer (IASI) and

AMSU on the EUMETSAT MetOp-A satellite. The present work focuses on the cloud impact on the AIRS and IASI radiances and explores the use of stochastic cloud clearing mechanisms together with neural network estimation. A stand-alone statistical algorithm will be presented that operates directly on cloud-impacted AIRS/AMSU and IASI/AMSU data, with no need for a physical cloud clearing process. The algorithm is implemented in three stages. First, the infrared radiance perturbations due to clouds are estimated and corrected by combined processing of the infrared and microwave data using a Stochastic Cloud Clearing (SCC) approach. The cloud clearing of the infrared radiances was performed using principal components analysis of infrared brightness temperature contrasts in adjacent fields of view and microwave-derived estimates of the infrared clear-column radiances to estimate and correct the radiance contamination introduced by clouds. Second, a Projected Principal Components (PPC) transform is used to reduce the dimensionality of and optimally extract geophysical profile information from the cloud-cleared infrared radiance data. Third, an artificial feedforward neural network (NN) is used to estimate the desired geophysical parameters from the projected principal components. The performance of the method was evaluated using global (ascending and descending) EOS-Aqua orbits co-located with ECMWF forecasts (generated every three hours on a 0.5-degree lat/lon grid) and radiosonde observations (RAOBs) for a variety of days throughout 2003, 2004, and 2005. Over 1,000,000 fields of regard (3x3 arrays of footprints) over ocean and land were used in the study. The performance of the SCC/NN algorithm exceeded that of the AIRS Level 2 (Version~4) algorithm throughout most of the troposphere while achieving approximately four times the yield. Furthermore, the SCC/NN performance in the lowest 1 km of the atmosphere greatly exceeds that of the AIRS Level 2 algorithm as the level of cloudiness increases. The SCC/NN algorithm requires significantly less computation than traditional variational retrieval methods while achieving comparable performance, thus the algorithm is particularly suitable for quick-look retrieval generation for post-launch CrIMSS performance validation. Recent work has focused on retrieval performance in "problem areas" over land, near the poles, elevated terrain, etc. Retrieval performance has been improved by stratifying the neural network training data into distinct groups based on geographical (latitude, for example), geophysical (atmospheric pressure, for example), and sensor geometrical considerations (scan angle, for example.) Performance using IASI/AMSU has also been evaluated, with emphasis on the impact of vibration-induced noise on the cloud-clearing accuracy. In this talk, the algorithm methodology

will be briefly reviewed, including a discussion of implementation differences for AIRS and IASI. Algorithm performance will then be discussed and compared with other methods. This work was sponsored by the National Oceanic and Atmospheric Administration under Air Force contract FA8721-05-C-0002. Opinions, interpretations, conclusions, and recommendations are those of the authors and not necessarily endorsed by the United States Government.

8.2: Using AVHRR radiances analysis for retrieving atmospheric profiles with IASI in cloudy conditions

Presenter: L. Lavanant

L. Lavanant

Developments are on-going at Météo-France/CMS for the processing of the IASI/AMSU/MHS sounders over Europe for helping French forecasters. A preliminary atmospheric retrieval scheme in clear and cloudy conditions is defined and its implementation in progress. This paper focuses on the processing of the IASI IR spectra in cloudy conditions. The processing of the AVHRR imager mapped inside the IASI fov allows to detect small amount of clouds and to determine the number of cloud layers and their cloud top temperature if they are black-body. Also possible is the hyper-fast treatment of the AVHRR clusters performed within the OPS IASI pre-processor and available at a global scale on the GTS and EUMETCast in the BUFR format. The CO₂-slicing method based on a selection of IASI sounding channels is applied to homogeneous and semi-transparent cloudy situations to access cloud parameters when AVHRR methods fails. Systematic comparisons of observations to synthetic IASI spectra using retrieved cloud parameters allow to estimate the cloud information accuracy. The previous cloud information is used for the retrieval of the atmospheric profile in cloudy conditions from a selection of IASI channels. Two methods are compared. First, only the non-contaminated channels are selected above the cloud using the ECMWF method and the 1DVar retrieval process is done in clear conditions. Second, the cloud top pressure and effective cloud amount from the AVHRR/CO₂-slicing method are used in the cost function of the 1DVar method. In that case more informative channels above/in the cloud are used. Status on these developments and preliminary accuracy assessment on meteorological situations of NWC interest will be presented.

8.3: CO₂ Slicing Method for IASI

Presenter: Arlindo Arriaga

Arlindo Arriaga, Peter Schlüssel, Xavier Calbet, Thomas August, Olusoji Oduleye, Tim Hultberg

Slicing Method for IASI Arlindo Arriaga, Peter Schlüssel, Xavier Calbet, Thomas August, Olusoji Oduleye, Tim Hultberg EUMETSAT, Am Kavalleriesand 31, 64297 Darmstadt, Germany
ABSTRACT The retrieval of the cloud top pressure and effective cloud amount within the fields of view of IASI is supported with the CO₂ slicing method, based upon its classical version with a fixed number of pre-selected sampling frequencies. A few tests are implemented in the respective algorithm to characterize the feasibility of its application to a particular situation, as well as to refine further the selection of sampling frequencies, to account for temperature inversions in the lower troposphere, and for quality control purposes. The thermodynamic structure of the atmosphere and the surface skin temperature are available as forecasts from ECMWF, and the model outgoing cloud free radiance is computed with the RTIASI-4. The surface emissivity is modelled either for a rough sea surface or for a land surface with different fractional land type coverage corresponding to the scene within the IASI IFOV. The pre-selection of a set of fixed sampling frequencies is performed with a simple methodology, whose application has been supported by two large data sets with a large variety of surface-atmosphere-clouds scenarios, covering the whole globe and all seasons of the year. The criterion to select such a set of frequencies for retrievals is based on a trade off between the accepted lowest significance of a pre-defined critical retrieval error and the accepted percentage of scenarios left as non-retrievable. The results achieved with the present algorithm are based upon a pre-selected set of 41 CO₂ sampling frequencies between 707.5 and 756.0 cm⁻¹. The distribution of the retrieval error computed for realistic scenarios with multilevel ice or water clouds shows low bias (below 15 hPa) for cloud tops between 200 and 700 hPa, and respective cloud amounts not lower than 40%. The results achieved with a much larger data set of sampling frequencies have shown only marginal improvements. Broad results over different cloud fields have shown good spatial consistency with respect to co-located AVHRR images within the channels in the visible (0.6 μm) and infrared (10.8 μm) windows. The retrieval error is evaluated with cloud-radar measurements during an atmospheric sounding campaign at Lindenberg, Germany, from June to September 2007, in support of the validation of Metop products.

SESSION 9

9.1: Impact of rain-affected microwave data assimilation on the analyses and forecasts of tropical cyclones

Presenter: Remi Monroty

R. Monroty, F. Rabier, S. Westrelin, G. Faure

Tropical cyclones are tremendous natural hazards that threaten coastal populations worldwide. The purpose of this study is to perform data impact studies with the Aladin Reunion Limited Area Model, with a focus on the Indian Ocean area and a 3DVar data assimilation. Studies are performed for several storms of the 2006/2007 cyclonic season of the South West Indian Ocean basin. This last season proved to be very active with 10 named storms, 4 of which attained the major hurricane wind threshold of 50m/s. Satellite data has proven most invaluable when trying to initialize Numerical Weather Prediction (NWP) models since the oceanic zones over which the cyclones develop are, by nature, data sparse. Yet, the occurrence of clouds or rain proves to be a challenge when trying to assimilate satellite data: non linear processes dominate and the use of refined, costly numerical methods might be required. These computational costs are usually found to be prohibitive and cloudy/rainy data assimilation usually is a missing component in most operational centres. This proves to be of critical importance when dealing with tropical cyclones because their dynamics take place in the core, consistently missed by observations. Of the few centres that do not suffer from this crucial observational lack, the European Centre for Medium Range Weather Forecasting (ECMWF) has implemented a 1DVar inversion for cloudy/rainy areas which uses complex moist physical schemes to retrieve a Total Column Water Vapour (TCWV) equivalent from the rainy radiances, which is then used as pseudo-observation in the 4DVar assimilation. In order to alleviate the constraints posed by such a costly 1DVar inversion, we investigated an alternative to this approach. A statistical multi-linear regression that fits TCWV with the brightness temperatures of the SSM/I instrument in cloudy/rainy conditions is used, relying on the ECMWF analyses during a learning period. The convergence of the regression is investigated, and the tuning of the TCWV assimilation is performed. The resulting data are shown to be of good quality and to alter the hydrological cycle of the resulting analyses. The algorithm is then applied to combine clear-sky radiances with cloudy/rainy TCWV in the 3DVar data assimilation scheme. Impacts of further observations and pseudo-observations such as a 3D wind bogus and microwave SST are also

conducted, both in terms of forecast impacts and of measures of data impact. High resolution forecasting nested from the 10km runs is also investigated in the AROME model.

9.2: Experiment of the Use of Satellite Microwave Data Affected by Cloud in Numerical Prediction

Presenter: Peiming Dong

Peiming Dong, Jianwen Liu, Qiang Ren, Xue Jishan

Currently, only cloud-cleared satellite data are used in most data assimilation systems. The observations in cloud area imply much information to weather system and numerical forecast. The use of satellite data affected by cloud will be one of the effective technological methods to improve the accuracy of numerical weather forecast continuously [1-2]. CRTM (Community Radiative Transfer Model), being developed currently in Joint Center for Satellite Data Assimilation (JCSDA) USA, is designed to make use of satellite data under all weather conditions. By including scattering and emission from the earth's atmosphere, along with its flexible interface, advances radiative transfer physical processes and efficiency of numerical computational schemes, it is expected to produce significant impacts on utilization of current and future satellite instruments [3]. The CRTM is implemented in our Grapes-3dvar [4], a three dimensional variational data assimilation system developed by Chinese Academy of Meteorological Sciences, to conduct research associated with the use of satellite data, especially the data affected by cloud and rain. Our studies include two parts. The use of ATOVS microwave satellite data affected by cloud is investigated firstly based on the present cloud examination scheme. Following the simulation of satellite observation in cloudy area is verified by using CRTM. Taking the Typhoon 0604 "Bilis" as research case, a group of experiments associated with the cloud examination and channel selection are designed (see Table 1). The cloud examination methods include scattering index, precipitation probability and precipitation examination et al.. Different satellite data affected by cloud are used in data assimilation system by different cloud examination and channel selection scheme. The distribution of satellite data used with the weather system and bias between simulated bright temperature and observation and the analysis increment are examined, together with their influences on the numerical forecast of Typhoon Bilis's three periods, corresponding to formation, maturation and landing, respectively. With the cloudy and rainy information as input to CRTM,

the satellite brightness temperature is simulated including the radiant efficiency of cloud and precipitation particle. This information is provided by WRF model forecast output. The simulated bright temperature is compared with that of observation to show how the simulation of satellite observation in cloudy and rainy area is improved. Following, the error characteristics of simulated cloudy satellite data are investigated. It is expected that these investigation could provide the meaningful guide on the use of satellite data used by cloud and push the use of cloudy radiances directly in NWP model and enhance the impacts of satellite data that have been demonstrated through clear radiance assimilation. Key Words: ATOVS; Cloud; CRTM; Grapes-3dvar; Numerical Prediction; Typhoon

9.3: The inclusion of cloudy radiances in the NCEP GSI analysis system

Presenter: Min-Jeong Kim

Min-Jeong Kim, Fuzhong Weng, and John Derber

The impact of AMSU-A, AMSU-B and MHS radiance on numerical weather predictions has been found to be significant. The major limitation on the use of these data has been the presence of clouds. In the Joint Center for Satellite Data Assimilation (JCSDA) we have begun to develop the capability to use the information from cloudy microwave radiance in the NCEP Gridpoint Statistical Interpolation (GSI) analysis system. Radiance data assimilation in cloudy regions requires rapid and accurate radiative transfer and radiance gradient models. The Community Radiative Transfer Model (CRTM) was developed at the JCSDA for use in the radiance assimilation problem and has incorporated appropriate physics for a vertically stratified scattering and emitting atmosphere. This CRTM is employed in this study to calculate radiances and Jacobians at various microwave wavelengths for radiance assimilation under all weather conditions. In the first part of this study, the sensitivity of CRTM calculated radiances to the cloud variables are presented and the accuracy of CRTM calculated Jacobians for cloud profiles are evaluated. In the second part, methodologies for the cloudy radiance related bias corrections in the GSI are addressed. Preliminary results showing the impacts of cloudy radiance assimilation on analysis fields and forecast results will be presented.

9.4: Using Clear and Cloudy AIRS Data in Numerical Weather Prediction

Presenter: John Le Marshall

J. Le Marshall, J. Jung, M. Goldberg, C. Barnett, W. Wolf, J. Derber and S. Lord

The Atmospheric Infrared Sounder (AIRS) (Aumann et al. 2003, Chahine et al., 2006) was launched in 2002 on AQUA, the second of the EOS polar-orbiting satellites. The AIRS was the first of a new generation of meteorological advanced sounders able to provide hyperspectral data for operational and research use. Here, we briefly review the first assimilation trials to use full spatial resolution and higher spectral resolution hyperspectral radiance data, available in real time from the AIRS. The result from these assimilation trials was significant improvement in forecast skill in the National Centers for Environmental Prediction (NCEP) Global Data Assimilation System (GDAS), compared to the global system without AIRS data over both the northern and southern hemispheres. A second trial was an experiment which showed the advantage of using all AIRS fields of view in analysis as opposed to the use of sampled fields of view (typically one-in-eighteen) often used by Numerical Weather Prediction (NWP) Centers. Another trial showed the benefit of using hyperspectral data with expanded spectral coverage. We then describe recent experiments where radiances, derived from cloudy AIRS fovs and which represent the radiance emanating from the clear part of the cloudy fov, have been assimilated for global NWP. The beneficial impact of these data in the GDAS is recorded. The impact indicates the potential benefit of using cloudy hyperspectral radiances routinely in global NWP. In support of this hyperspectral data assimilation activity attention has also been paid to the detection of cloud effects, the use of stratospheric radiances and estimation of surface temperature and emissivity.

9.5: 1DVAR Pre-processing System for NWP Assimilation

Presenter: S.-A. Boukabara

S.-A. Boukabara and F. Weng

A 1DVAR system was developed to process spaceborne microwave measurements. The particularity of the system is its potential applicability in cloudy and precipitating conditions. The Microwave Integrated Retrieval System (MIRS) solves for the inversion of the radiative transfer equation by finding radiometrically appropriate profiles of temperature and moisture and cloud parameters as

well as surface emissivity spectrum and skin temperature. The inclusion of the emissivity spectrum in the solved-for state vector makes the system applicable globally with the only differences between land, ocean, sea-ice and snow backgrounds residing in the covariance matrix chosen to constrain spectrally the emissivity spectrum. The forward operator used in the MIRS is the Community Radiative Transfer Model (CRTM) which provides both radiances and derivatives with respect to all geophysical parameters to be inverted, including hydrometeors. The computation of the derivatives (k-matrix) is performed using tangent linear and adjoint approaches. When used in absorption-only mode, it is found that convergence of the system is reached globally, even in coastal areas, with pockets of non-convergence being highly correlated to cases of precipitation, suspicious measurements and generally with any situation that the forward operator can not handle properly. The system convergence is modulated by computed instrument errors and by estimated modeling errors. The fitting of the measurements could be made stricter by reducing the assumed modeling errors, making the convergence stricter. The system is applied routinely to NOAA-18 and Metop-A AMSU and MHS sensors and the assumed modeling errors are around one Kelvin in all situations, except for the temperature-sounding channels, where they are estimated to be lower (between 0.17 and 0.45 Kelvin depending on the channel). It is suggested in this paper that the system could be an excellent tool to pre-process and filter microwave data for Numerical Weather Prediction (NWP) assimilation applications, based on the convergence metric. An additional benefit would be obviously to get an estimate of the geophysical state before starting the assimilation. This might be very useful especially if there is an interest in assimilating measurements taken in cloudy, rainy conditions and/or if there is interest in extending the assimilation over non-standard surface backgrounds.

SESSION 10

10.1: Effect and Improvement of Aerosol on Temperature Profile from MODIS

Presenter: Zhang Jie

Zhang Jie, Li Jun, Zhang Qiang

Based on statistical synthetic regression algorithm from America, temperature and moisture profile of atmosphere is retrieved from the Moderate Resolution Imaging Spectroradiometer (MODIS) longwave infrared radiances, on the basis of profile result, spectrum transmittance is estimated by using

Pressure-Layer Fast Algorithm for Atmospheric Transmittances(PFAAST), then, temperature profile is retrieved by using Nonlinear physical retrieval algorithm. The results show that atmosphere temperature above the top of boundary layer is well retrieved, the error is within 2K, in boundary layer, retrieval error is large, the error is positive correlated with aerosol optical depth and estimated error of skin temperature, but it is not correlated with atmosphere water vapor mixing ratio. According to theory of radiative transfer equation, the research analyze effect of aerosol optical depth on retrieval error, moreover, the sensitivity of which with weighting functions are analyzed. Finally, aerosol optical depth is used for improving on atmospheric transmittance and physical algorithm, the results show that temperature profile can reflect real value of atmospheric temperature within boundary layer after improving on aerosol effect.

10.2: Demonstration of DMSP Special Sensor Microwave Imager and Sounder (SSMIS) Products

Presenter: Fuzhong Weng

Fuzhong Weng, Ninghai Sun, Sid Boukabara, Ralph Ferraro, Limin Zhao

US DMSP program has recently successfully launched the F-16 and F-17 satellites where the Special Sensor Microwave Imager/Sounder (SSMIS) is on board. This instrument is providing atmospheric sounding up to 100 km from a conical scanning mode at the first in addition to various environmental products such as cloud and precipitation. Thus, DMSP F-16 and -20 satellites will become a vital component in the polar-orbiting satellite constellation in the coming decade after a restructure to National Polar-orbiting Environmental Satellite System (NPOESS). Especially, F-17 and -19 satellites will uniquely provide sounding from their early morning orbits (5:30am, descending) where NOAA (future NPOESS) and MetOp will cover the afternoon and mid-morning orbits. In the past 20 years, NOAA has accumulated great experiences from operational uses of satellite microwave measurements. Since 1990s, we provided continual supports to the DMSP program through participating in SSM/I calibration and validation (Cal/Val) and delivered several versions of SSM/I algorithms to the Fleet Numerical Meteorology and Oceanography Center (FNMOC) for operational implementation. At National Environmental Satellites, Data, and Information Service (NESDIS), we are routinely producing monthly SSM/I products from 1987 to today and have being

archived the data at National Climate Data Center (NCDC). These activities will be continued and expanded to include more end-to-end responsibility from radiance calibration, product developments and data assimilation into weather and climate models. NESDIS is responsible for developing enhanced products from operational satellites to meet the requirements of NOAA users as well as international community. This overview will summarize the recent SSMIS research and development activities at NOAA/NESDIS. Currently, SSMIS products are being experimentally generated through its microwave integrated retrieval system (MIRS). SSM/I-like products include cloud liquid water, total precipitable water, precipitation, sea ice cover, snow concentration, and surface wind speed, surface emissivity at window frequencies (from 19 to 91 GHz). SSMIS sounding products include temperature, water vapor, and hydrometeor profiles. Several experiments are also conducted at the Joint Center for Satellite Data Assimilation (JCSDA) to prove the impacts of direct assimilation of SSMIS radiances on global and hurricane field analysis. It is shown that the hurricane warm core at the upper troposphere and improved temperature and wind fields at surface are dramatically improved after SSMIS radiances are assimilated.

10.3: Potential of CO₂ Retrieval from IASI

Presenter: L. Chaumat

L. Chaumat, O. Lezeaux, P. Prunet, B. Tournier, F.-R. Cayla, C. Camy-Peyret and T. Phulpin

A specific processing of the high resolution infrared spectra, based on Discrete Fourier Transform (DFT) filtering to efficiently exploit the CO₂ information of the IASI spectrum, is used to retrieve CO₂ from IASI. Inversion experiments on a representative set of real data are performed to quantify the precision and quality of retrieved CO₂ concentration. This analysis shows that one can retrieve the mean atmospheric CO₂ concentration from a single IASI spectrum with a precision better than 2 ppmv, i.e., better than 1 %. These results are compared and consolidated with information content analysis and inversion based on simulations, in order to fully specify and characterize the IASI CO₂ product, in terms of error figure, weighting function, profile information. In particular, the possibility to derive CO₂ profile information from IASI (about 3 pieces of information) is demonstrated.

10.4: Analysis of Arctic clouds by means of hyper-spectral satellite

Presenter: F. Romano

F. Romano, E. Di Tomaso, E. Ricciardelli and V. Cuomo

Polar regions are usually characterized by cold and high reflective surfaces (ice and/or snow), very low humidity, and presence of ground and elevated temperature inversions, hence the detection of polar clouds with passive satellite observations presents several difficulties. First, there is little visible and thermal contrast between clouds and the background surface. Moreover, due to the presence of temperature inversion, clouds are not always identified as colder than the background. In addition, low humidity causes polar clouds to be optically thin; also polar clouds are usually composed of a mixture of ice and water, which leads to an unclear spectral signature. Single and bi-spectral threshold methods are sometimes inappropriate due to large variability of surface emissivity and cloud conditions. Uncertainties related to surface emissivity may play an important role, since spectral emissivity for ice/snow surfaces may differ significantly depending upon microphysical properties. More recently, the availability of hyper-spectral observations (e.g. AIRS and IASI) have increased the potential of polar cloud detection, but there are still fairly large uncertainties, especially in the case of thin clouds and weak inversions. In this paper, we present some new tests to detect clear and cloudy case studies collected in the Arctic. Ground-based active and passive measurements, CPR (Cloud Profiling Radar) and CALIOP (Cloud Aerosol Lidar with Orthogonal Polarization) are used to investigate the advantages and limitations of different IASI cloud detection tests.

10.5: NOAA Products Integrated Validation Dataset / Database

Presenter: Tony Reale

Tony Reale, Bomin Sun, Frank Tilley and Michael Pettey

Strategies to process, screen, collocate and analyze multiple data platforms of ground truth (radiosondes, GPS and NWP) and weather satellite (ATOVS, MetOp, GOES, Aqua-AIRS and COSMIC) observations and preliminary results are presented. Plans to migrate from the existing sounding profile oriented dataset (Phase-1) to more generalized sensor oriented radiometric database (Phase-2) are outlined. The status of historical

collocation database generation at NOAA-STAR (beginning with TOVS in 1979) is also presented in context of the longer term goal of producing consistent historical observations for tracking the performance of past, present and next generation sensor and product capabilities consistent with GEOSS (and climate).

10.6: Midtropospheric CO₂ Concentration derived from infrared and microwave sounders. Application to the TOVS, AIRS/AMSU, and IASI/AMSU instruments

Presenter: Cyril Crevoisier

C. Crevoisier, A. Chédin, N. A. Scott, G. Dufour, R. Armante, and V. Capelle

Combined use of infrared measurements, sensitive to both temperature and carbon dioxide (CO₂) variations, and of microwave measurements, only sensitive to temperature, allows deriving information on CO₂ concentration in the mid-to-upper troposphere. Using a non linear inference scheme based on neural networks, four years (1987-1991) of TOVS observations, as well as five years (2003-2007) from the AIRS/AMSU instruments have been interpreted in terms of midtropospheric CO₂ integrated content. Following the launch of the hyper-spectral infrared sounder IASI, together with AMSU, on board ESA/MetOp on October 2006, a set of IASI channels presenting optimum characteristics for CO₂ estimation has been selected, based on a systematic sensitivity study of the observations to CO₂, temperature, and other absorbers. Due to a better spectral coverage and a lower instrumental noise, the CO₂ fields retrieved from IASI show a lower variability than those from AIRS. The first ten months of CO₂ retrieved from IASI will be presented and compared with corresponding retrievals from AIRS, as well as with simulations from atmospheric transport and in situ data.

10.7: NNORSY-GOME Ozone Profile Retrieval Products and Climatology

Presenter: Anton Kaifel

Anton Kaifel, Jasmine Kaptur

The Neural Network Ozone Retrieval System (NNORSY) developed by ZSW was successfully applied to long term TOVS data for total ozone column retrieval and to GOME Level 1 spectra for total column and ozone profile retrieval. This presentation will focus on NNORSY-GOME ozone profiles retrieval and resulting products of the latest

reprocessing of global GOME data in the time range 1995 to 2003. Beside ozone profile retrieval itself in a second step an new approach based on neural network technique for a dynamic ozone profile climatology was undertaken yielding to an easy to use software package for the dynamic NNORSY ozone profile climatology. NNORSY for GOME is a very fast ozone profile retrieval scheme based on neural networks. For training, ozone measurement data from ground based (e.g. ozone sondes and lidar) and satellite (e.g. SAGE, HALOE, POAM) based ozone profile measurements are used. In the first step we developed a special training procedure based on RPROP which is able to deal with incomplete target data without loss of generalization ability during application and in the second we established a two stage quality control (QC) procedure for ozone profile measurement data where the second stage is based on partial neural network training to find outlier and additional measurement errors that passed the first QC stage. After training application to GOME data is very fast. A whole GOME orbit with full spatial resolution can be processed in less than 1 minute and therefore NNORSY-GOME ozone profile retrieval can easily be applied in real-time with minimal costs on a simple workstation computer. NNORSY-GOME was already implemented in near-real-time at DLR-DFD but the service was stopped in June 2003 when the data recorder on ERS2 failed. Within the ESA project CHEOPS-GOME ZSW reprocessed of all available GOME Level 1 data at full spatial and temporal resolution up to June 2003 yielding to NNORSY-GOME Version 3 global 8 year ozone profile data. Beside the ozone profile information from ground up to 61 km height with a sampling rate of 1 km the data comprises for each profile level an ozone profile error estimation and contains temperature profile data derived from GEOS 4 model data. This data set was used to training different neural works without satellite instrument data yielding to the new dynamic NNORSY ozone profile climatology. Depending on which user input information is available, the NNORSY-CLIMATOLOGY does not only consider standard input information such as date, time and geographical position but also optional dynamic input parameters like total ozone column and/or temperature profile into account which represents the current state of the atmosphere. Due to this option of respecting dynamic parameters this new approach exploits the supplied dynamic information leading to a significant gain of accuracy in climatological ozone profile retrieval. Each climatology product is delivered with ozone profile information as well as according standard deviations. If no input temperature profile is provided the NNORSY-CLIMATOLOGY delivers a climatological temperature profile as well. The presentation will

show comparison of derived ozone profile data with independent data sources for single measurements as well as for long term time series of different regions and ozone profile regimes. It can be shown that the neural networks are able to compensate for GOME instrument degradation and calibration uncertainties if parameters about the GOME instrument (e.g. time in orbit) are supplied as input to the neural network trained with real ozone profile measurement data. The climatology ozone profile data are compared with measured time series as well as with classical lookup-up-table climatology products. Current developments for NNORSY are underway for ozone profile retrieval and near-real-time application from SCIAMACHY data and we are looking forward to implement NNORSY for the new atmospheric sounding instruments IASI and GOME-2 MetOp satellite in an new synergistic approach using UV and IR sounding data.

10.8: Pronounced Changes in Water Vapor, Ozone and Metrological Parameters Associated with Dust Storms Using MULTI SENSOR Data

Presenter: Ramesh P. Singh

Ramesh P. Singh, Anup K. Prasad, Ritesh Gautam and Menas Kafatos

During the pre-monsoon season, the Indo-Gangetic plains is affected by the dust storms that affect the daily life of million people living in the Indo-Gangetic plains. These dust storms significantly affect the air quality, hydrological cycle and climatic conditions. The dust storms are originated from the Arabia peninsula and neighboring countries in the western parts of India. The multi sensor (MODIS, AIRS, MISR, AMSR, SSM/I, CALIPSO, TOMOS, OMI AURA) data for the period 2000 – 2006 show pronounced changes in the surface, aerosol, ozone, cloud, snow cover and meteorological parameters. The detailed analysis of these parameters have revealed that soon after the dust storm water vapor and ozone column enhanced and meteorological parameters (air temperature, relative humidity) change significantly at the pressure level 500 – 700 hPa. The changes in the surface, atmosphere and meteorological parameters will be discussed in the melting of snow cover and its consequence in hydrological cycle and climatic conditions. The radiative forcing calculations have shown changes in the surface and top of atmosphere forcing associated with the dust storms.

10.9: Advanced Infrared Sounding System for Future Geostationary Satellites

Presenter: Jun Li

Timothy J. Schmit, Jun Li, James J. Gurka, Jaime Daniels, Mitch Goldberg

The United States Geostationary Operational Environmental Satellite (GOES) Sounders (GOES-8/9/10/11/12) have provided hourly infrared (IR) radiances and derived products over the continental U.S. (CONUS) and adjacent oceans for over 14 years. The GOES-10 sounder now also provides hourly coverage over South America. The products derived include: clear-sky radiances; temperature and moisture profiles; Total Precipitable Water vapor (TPW) and layer PW; atmospheric stability indices such as Convective Available Potential Energy (CAPE), Lifted Index (LI) and K-Index; cloud-top properties; water vapor motion winds through radiance tracking; and total column ozone. These products are used in numerical weather prediction (NWP), short range forecasts and nowcasts, including severe weather forecasts. While broadband geo-sounding has proven useful, hyperspectral IR sounding will provide measurements that serve user requirements much better. Developing a GOES IR sounding capability with high temporal, spatial, and spectral resolutions is very important for supporting regional and convective-scale NWP over CONUS, as it will provide unprecedented detail on 3D fields of wind, temperature, and humidity. Nowcasting and very-short range forecasting (VSRF) will also benefit from these 3D fields from the monitoring of moisture convergence and convective instability and improving warnings of location and intensity of convective storms. The combination of high spectral and temporal resolution will allow resolving the critical low-level moisture. Studies with available aircraft and satellite data have demonstrated the importance of geostationary hyperspectral IR radiances and products on severe storm forecasts. The benefits of a spaceflight demonstration in parallel with any operational program would be enormous.

10.10: Dust aerosol layer altitude from AIRS (01/2003 to 11/2007) and from Calipso (06/2006 to 11/2007): a comparison.

Presenter: Raymond Armante

S. Peyridieu, A. Chédin, C. Pierangelo, R. Armante and N. Lamquin

Mean infrared (10 μm) dust aerosol layer optical depth and altitude are retrieved over the tropics

(30°S–30°N) for five years of Atmospheric Infrared Sounder (AIRS) observations covering the period January 2003 to December 2007. Retrieved optical depths show a very good correlation with the Moderate resolution Imaging Spectroradiometer (MODIS-Aqua) retrieved visible optical depths during the dust season. AIRS simultaneously retrieved mean dust layer altitude are then compared to Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP/CALIPSO) aerosol layer retrieved altitude for the period June 2006 to November 2007. Results for a region of the north tropical Atlantic downwind of the Sahara show a remarkably good agreement between the two products and demonstrate the capability of passive infrared sounders to accurately retrieve the mean dust layer altitude. An interesting conclusion is the fact that if the AOD clearly decreases from Africa to Caribbean as a result of transport and dilution, altitude does not exhibit a significant regular decrease. This is in agreement with in situ measurements made during the Puerto Rico Dust Experiment (PRIDE) campaign.

SESSION 11

11.1: Evolution of the Global Observing System

Presenter: John Eyre

John Eyre and Jerome Lafeuille

In 2002, the Commission for Basic Systems (CBS) of WMO adopted a “Vision for the Global Observing System (GOS) to 2015”. This vision covers both space-based and ground-based observing systems. Since 2002, there has been considerable development in thinking about the future of the GOS: the potential of several new observing systems to make substantial contributions to the GOS has emerged, and the GOS has been asked to respond to user requirements for an increased range of applications, in particular those of climate monitoring. These developments have prompted an activity within WMO to refresh the Vision for the GOS. By the end of 2008, CBS is expected to endorse a new “Vision for the GOS in 2025”, following discussion with a wide range of stakeholders. A draft of the new Vision for the GOS will be presented, with particular emphasis on the space-based component and on those systems in which ITWG members have considerable expertise. ITWG will be invited to comment on this draft, as part of the current discussion process.

11.2: Status report on the Global RARS initiative

Presenter: David Griersmith

Regional ATOVS Retransmission Services (RARS) are operational arrangements for rapid delivery of satellite data to the global community (especially NWP Centres). In particular the services involve acquisition of polar-orbiting satellite data over a wide region containing a network of NOAA/METOP ground reception stations with subsequent fast delivery to users. The Global RARS system comprises several regional RARS (e.g., Europe including North America, Asia-Pacific, and South America) each of which involves acquisition of satellite data from HRPT stations in that Region. The data are then locally processed and passed to a regional Processing Centre that is responsible for overall coordination, for near-real time concentration of local data from the direct readout stations and for rapid delivery of consistent sets of data covering the region, for use throughout the region and worldwide. The impact of the global RARS system has been significant through improvements in NWP modelling since much larger quantities of sounder data have become available for assimilation. This paper will present a status report on the global RARS including recent developments in the Asia-Pacific Region and RARS planned evolution.

11.3: EUMETSAT Plans

Presenter: Dieter Klaes

Dieter Klaes

This paper gives an overview on EUMETSAT programmes, both mandatory and optional. EUMETSAT is currently operating the Meteosat-6/7 and the two satellites of the second generation Meteosat Second Generation (MSG-1, and 2) which have been renamed as Meteosat-8 and Meteosat-9 respectively. The MSG-3/4 satellites are under storage or production respectively. The MSG Programme has been developed in co-operation between EUMETSAT and ESA. EUMETSAT developed jointly with ESA the EUMETSAT Polar System (EPS). After the launch of Metop-A, the first of a series of three satellites in October 2006, the system is operational and provides all planned products to the Users. The EUMETSAT Advanced Retransmission Service (EARS) continued its operational services and provides observations from partner HRPT (High Resolution Picture Transmission) stations. Jason-2 is EUMETSAT's first optional programme, which will provide operational Ocean Surface

Topography information services, the launch is planned for summer 2008. Preparations for Meteosat Third Generation (MTG) and Post EPS are under way.

11.8: Agency status reports: JMA and JAXA

Presenter: Kozo Okamoto

Kozo Okamoto

Current status of the Multi-functional Transport Satellite-1R (MTSAT-1R) and MTSAT-2 and future plans of MTSAT follow-on satellite of Japan Meteorological Agency (JMA) are presented. Plans of earth observing satellites of the Japan Aerospace Exploration Agency (JAXA) are also presented. They include the Greenhouse gas Observing Satellite (GOSAT) launched in Japanese fiscal year (JFY) 2008, the Global Change Observation Mission-Water (GCOM-W) carrying the Advanced Microwave Scanning Radiometer-2 (AMSR-2) in JFY2011 and a Japanese and European joint satellite of the Earth Clouds, Aerosol and Radiation Explorer (EarthCARE) carrying the Cloud Profiling Radar (CPR) in JFY2013, and the Global Precipitation Measurement (GPM) proposed jointly with the U.S. They are all going to be substantially beneficial to assimilation, climate monitoring and model validation.

SESSION 12

12.1: The National Polar-orbiting Operational Environmental Satellite System (NPOESS) and the NPOESS Preparatory Project (NPP) – Program Status and International Initiatives Status

Presenter: Peter A. Wilczynski

Peter A. Wilczynski

A Presidential Decision Directive (PDD), signed in May of 1994, directed the convergence of the polar orbiting weather satellites systems into a single national system. The Integrated Program Office (IPO) within NOAA was established in October 1994 as a result of the signing of a tri-agency Memorandum of Agreement (MOA) in May 1994. The new converged system was identified as the National Polar-orbiting Operational Environmental Satellite System (NPOESS). The IPO is staffed with representatives of NOAA, Department of Defense and NASA. This unique tri-agency office has the mission to provide a converged polar-orbiting operational, environmental satellite system that meets user community requirements. The NPP

is a joint-agency mission intending to serve the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO) and the National Aeronautics and Space Administration (NASA) and their user communities. The NPP provides the Earth science community with data continuity and also provides the IPO and its users a risk reduction demonstration of capabilities for critical NPOESS instruments. NPOESS was formally restructured in 2007. This restructure has changed the NPOESS and NPP payload compliments and has changed the anticipated launch dates. All these changes impact NPOESS-NPP data users as they prepare to receive data from this next generation polar-orbiting system. As a result of the restructure, the NPOESS Program Executive Office (PEO) initiated installing additional ground resources in Antarctica to capture Europe's current MetOp satellites, thus potentially reducing data latency by almost half of the current timeliness. This capability could be operational by 2012. Additionally, the PEO office is actively engaged internationally to seek other sources of satellite data to compliment NPOESS. For example, the PEO office and NOAA are actively discussing how to have JAXA's GCOM series of satellites compliment the NPOESS constellation. This paper shall briefly discuss NPOESS-NPP program status as well as a comprehensive update on international activities that will positively affect our world-wide data users.

12.2: The Joint Capabilities and Opportunities of Advanced Sounders on MetOp and NPOESS for NWP and Climate Monitoring In a GEOSS Era

Presenter: Stephen A. Mango

Stephen A. Mango

NPOESS, the National Polar-orbiting Operational Environmental Satellite System, managed by the Integrated Program Office [IPO], is structured as an operational, long-term, environmental, satellite monitoring system for weather, climate, and several other application/discipline areas for the "Next Generation" (~2009-2029). The IPO is developing for a 1st generation NPOESS a suite of advanced, atmospheric sounding/probing instruments as a major part of the next generation meteorological, environmental and climate operational satellite system in polar, low earth orbit [LEO]. The CrIS, Cross-track Infrared Sounder, an Advanced Technology Microwave Sounder [ATMS], an Ozone Mapping & Profiler Suite [OMPS], a MIS [Microwave Imager and Sounder] and a VIIRS – Visible and Infrared Imager and

Radiometer. In addition, the 2nd generation NPOESS – post 2025, is already in its very early conceptual phase.

The European community, EUMETSAT, European Organization for the Exploitation of Meteorological Satellite Systems, has already launched (October 2006) the first of three next generation, operational polar-orbiting LEO system, MetOp, as part of its European Polar System [EPS]. MetOp has a highly capable FTS sounder, IASI [Infrared Atmospheric Sounder Interferometer], an Advanced Microwave Sounding Unit [AMSU], a Global Ozone Monitoring Experiment [GOME], a GNSS Receiver for Atmospheric Sounding [GRAS] and an Advanced Very High Resolution Radiometer [AVHRR]. EUMETSAT is already in the Mission Formulation stage for their 2nd generation EPS – post 2020.

The combined MetOp and NPOESS sounders, which will be in complementary polar orbits, will represent a very significant combined capability and set of opportunities to establish a formative GEOSS grand sounding “system”.

This paper will focus on:

1. the projected joint capabilities, synergies and opportunities of advanced sounders on MetOp and NPOESS during the emerging GEOSS era for primarily NWP and climate monitoring, namely – the IASI, AMSU, GOME and GRAS on MetOp and the CrIS, ATMS, OMPS and MIS on NPOESS.
2. the different requirements for the MetOp and NPOESS sounding sensors which will actually facilitate the the cross-calibration of the sounders of a formative GEOSS system .
3. the different requirements for the MetOp and NPOESS sounding products which will actually facilitate an initial formulation of common requirements for the sounding products for GEOSS sounders and provide an opportunity for the mutual validation of the sounding products.

ITSC-16 POSTER PRESENTATIONS

SESSION A

A01: Radiative Transfer in Vertically Layered Soil

Presenter: Fuzhong Weng

Fuzhong Weng

At thermal wavelengths, the upwelling radiation at surface is often expressed as a product of emissivity and surface temperature. For a vertical stratified medium (e.g. permittivity varies with soil depth), the emissivity at the surface is normally calculated from Fresnell formula. For an electromagnetic (EM) wave that does not penetrate through soil (e.g. zero transmissivity), the emissivity and reflectivity equals unit. However, when the EM wave penetrates through the medium, the emitted radiation must be considered from the energy contributed from the deeper layers and can be calculated from variable radiative transfer schemes. This study will investigate on uses of auxiliary soil information to quantify the optical parameters used in surface radiative transfer schemes. The impacts of this newly developed approach on simulations of the radiances at the top of the atmosphere will be also discussed.

A02: A clear sky radiative transfer model for MTG-IRS

Presenter: Stephen Tjemkes

Stephen Tjemkes, Jochen Grandell and Rolf Stuhlmann

In support of the development of an end-to-end processing chain for METEOSAT Third Generation Infrared Sounder (MTG-IRS) candidate mission EUMETSAT has procured the radiative transfer model based on the Optimal Spectral Sampling (OSS) method from Atmospheric and Environmental Research, Inc. To build confidence in this radiative transfer code, a comparison has been performed involving results generated by OSS and results generated by LBLRTM for real IASI observations, and for MTG-IRS simulations for a number of atmospheric clear sky conditions. In addition to results for the upwelling radiance at top of the atmosphere, also jacobians for a number of state variables are included in the comparison.

A03: Scenes Analysis for the Meteosat Third Generation Infrared Sounder Observations

Presenter: Stephen Tjemkes

Stephen Tjemkes, Jochen Grandell, Phil Watts and Rolf Stuhlmann

EUMETSAT prepares for the next generation of geostationary satellites. Among the three candidate missions is an infrared sounder. The preparatory activities for especially this candidate mission will greatly benefit from exploring the hyperspectral IASI observations. The MTG-IRS candidate mission observations would be used to monitor vertical distributions of temperature and moisture. Although there are a number of promising activities, regarding the retrieval of thermodynamical properties from all sky observations, initially these temperature and moisture profiles will be derived from cloud free spatial samples. Thus an accurate scenes analysis is required to classify each observation according to its cloud amount. McNally and Watts (2003) described a cloud detection algorithm for high spectral resolution infrared sounders. To understand the performance of this algorithm in relation to a possible application to MTG-IRS observations, a number of tasks have been performed. First, in order to increase the confidence in the performance of this cloud detection algorithm, it was applied to IASI observations and compared to results of other scenes analysis methods like the CO2 slicing method and the operational cloud mask derived from collocated AVHRR observations. Results of this comparison will be presented during the presentation, as well as results of the method when applied to IASI as a proxy for MTG-IRS. This means that the spectral coverage of the original IASI data is reduced to match the MTG-IRS coverage, and also the spectral sampling is modified according to the MTG-IRS specifications. The effect of these modifications on the performance of the cloud detection is presented.

A04: Comparison of IASI radiances with models from seven operational centres

Presenter: Fiona Hilton

Fiona Hilton (Met Office), Andrew Collard (ECMWF), Lars Fiedler (EUMETSAT), Vincent Guidard (Meteo-France/GMAP), Sylvain Heilliette (Environment Canada), Lydie Lavanant (Meteo-France/CMS), Benjamin Ruston (NRL)

Bias and noise in IASI spectra may be identified by comparing the data with radiances calculated from

forecasts and analyses from Numerical Weather Prediction (NWP) models. The bias and standard deviation of fit against model fields are compared for seven operational centres: the Met Office, ECMWF, EUMETSAT, Meteo-France/GMAP, Meteo-France/CMS. Good agreement is found between IASI and NWP fields, showing that IASI is performing within its specification. Areas of the spectrum where the comparisons differ or agree can be used to investigate whether errors arise from the NWP model, the spectroscopy or the instrument.

A05: IASI Validation Studies using Airborne Field Campaign Data

Presenter: Allen Larar

Allen M. Larar, Daniel K. Zhou, Xu Liu, William L. Smith, Henry E. Revercomb, Jonathan P. Taylor, Stuart Newman, Peter Schüssel, and Stephen A. Mango

Measurement system validation is critical for advanced satellite sensors to improve observations of the Earth's atmosphere, clouds, and surface for enabling enhancements in weather prediction, climate monitoring capability, and environmental change detection. Field campaigns including satellite under-flights with well-calibrated FTS sensors aboard high-altitude aircraft are an essential part of the validation task. This presentation focuses on IASI validation studies performed using data from the recently-completed Joint Airborne IASI Validation Experiment (JAIVEx) field campaign. Methodology developed and employed herein for IASI radiance validation will be discussed along with recent results.

A06: Identification of biases in the modelling of high peaking water vapour channels from IASI

Presenter: Stuart Newman, Fiona Hilton

Stuart Newman, Fiona Hilton, Andrew Collard

A major challenge in NWP is the assimilation of IASI water vapour channels. Results from the Joint Airborne IASI Validation Experiment (JAIVEx), utilising NWP model field data from the Met Office and ECMWF, show that upper atmospheric humidity is often not well represented in NWP models, with consequences for radiative transfer modelling in this spectral region. Observed minus background biases from NWP assimilation schemes are compared with biases derived from JAIVEx case studies. It will be shown that the findings from JAIVEx, though geographically and seasonally isolated, provide a useful insight into the

source of spectral biases in the water vapour spectral region on a global scale.

A07: The water vapor continuum effect on the surface transmitted irradiance at 8 – 12 μm atmospheric window

Presenter: Simone M. S. da Costa

Simone M. S. da Costa, Keith P. Shine, Juan C. Ceballos and Rodrigo A. F Souza

The continuum of the atmospheric water vapor plays important role in the 8-12 μm infrared window by absorbing the warmer radiation from the surface and re-emitting it at cooler temperature. This study aims to present an estimate of the continuum effect on the surface transmitted irradiance (STI, in Wm^{-2}). Irradiances were calculated based on the state-of-the-art line-by-line radiation model; 12-year climatological dataset from ECMWF reanalyzes and clouds from the International Satellite Cloud Climatology Project (ISCCP). Results show that the global annual mean surface transmitted irradiance at the top of the atmosphere is around 65 Wm^{-2} for clear sky, and decreases to 22 Wm^{-2} due to clouds. The water vapor continuum absorbs more than 60% of the clear sky surface transmitted irradiance at the tropics, around 20 % at mid-latitudes and around 7 % at the poles. The stronger effect on the lower latitudes is because self-broadened continuum absorption is proportional to the square of the partial pressure of the water vapor. Future work will extend the analyses of the effect of water vapor continuum absorption on the satellite signal (i.e., brightness temperature/ radiance).

A08: The effect of Doppler shift due to Earth's spin on SSMIS UAS channels

Presenter: Yong Han

Yong Han

In the previous ITSC, we presented a report on a fast radiative transfer model for the SSMIS upper-atmosphere sounding (UAS) channels that are affected by Zeeman-splitting. In the model the Doppler shift of the radiance spectrum due to Earth's spin is neglected. Since then, further studies have been carried out to address several important issues, including the impacts of neglecting the Doppler shift on radiance simulations. We will show that the Doppler shift can have an impact of $\sim 2 \text{ K}$ in brightness temperature near the edges of the scan lines and in low latitude regions, and present the requirements and solution to take the

frequency-shift into account. This study also provides evidence from the UAS channel measurements that indicate the correct polarization of the receivers, as different documents have disagreed whether the receivers is left- or right-circularly polarized.

A09: A fast radiative transfer model for AMSU-A channel 14 with the inclusion of the Zeeman-splitting effect

Presenter: Yong Han

Yong Han

In the previous ITSC, we presented a report on a fast radiative transfer model for the SSMIS upper-atmosphere sounding channels that are affected by Zeeman-splitting. Recently, we have extended the work to AMSU-A channel 14, which has a weak but measurable dependence on the Earth magnetic field and its orientation relative to the sensor's observation direction. To take the Zeeman-splitting effect into account, Liebe added in his 1993 model a correction term in the line width formula to roughly estimate the line behavior. However, application of this model to AMSU-A channel 14 may produce significant errors in radiance simulations, larger than the model when the correction term is removed. In this presentation, we will present a radiative transfer model for rapid radiance calculations that correctly describes the Zeeman-splitting effect. We will also describe the behavior of the radiance in the presence of Earth's magnetic field and quantify the difference between the model with and without the inclusion of the Zeeman-splitting effect.

A10: A graphical user interface for RTTOV

Presenter: Pascal Brunel

Philippe Marguinaud, Pascal Brunel

RTTOV is the radiative transfer model developed by the NWP SAF. The project has decided to create a graphical user interface to run the RTTOV model. We have chosen to develop an interface based on the Linux Desktop (Gnome/KDE). This interface will allow users to edit RTTOV initial conditions (atmospheric profiles, ground parameters, etc...) run the RTTOV model efficiently (keeping coefficients in memory, possibly using multithreading) and view the results (radiances, transmittances). Our poster will present the principles of this interface, and we intend to have a laptop running a demo as well.

A11: 4A/OP: An operational fast and accurate radiative transfer model for the infrared

Presenter: L. Chaumat

L. Chaumat, C. Standfuss, B. Tournier, R. Armante and N.A. Scott

4A/OP is a user-friendly software for various scientific applications, co-developed by LMD (Laboratoire de Meteorologie Dynamique) and NOVELTIS with the support of CNES (the French Space Agency). NOVELTIS is in charge of the industrialization and the distribution of the LMD 4A radiative transfer model. 4A (4A stands for Automatized Atmospheric Absorption Atlas) is a fast and accurate line-by-line radiative transfer model particularly efficient in the thermal infrared region of the spectrum. NOVELTIS has created an "operational" version of this code called 4A/OP. The 4A/OP software is a version of the 4A code for distribution to registered users. This version is regularly updated and improved and contains a graphical user interface and a reference documentation. The associated Website <http://www.noveltis.fr/4AOP/> includes an on-line registration form. 4A/OP has the official support of CNES for radiative transfer applications in the infrared. This software is used by several research groups and can be integrated in operational processing chains. In particular, 4A/OP is the reference radiative transfer model for IASI level 1 Cal/Val and level 1 operational processing. Thanks to the computation of Jacobians, the model can also be coupled with an inversion algorithm for the atmospheric constituent retrieval from infrared radiance measurements.

A12: Forward Simulation for FY-3 MWHS using RTTOV-7

Presenter: Xiaoqing Li

Xiaoqing Li, Gang Ma, Fengying Zhang, Xuebao Wu

MWHS (MicroWave Humidity Sounder), together with MWTS (MicroWave Temperature Sounder) and IRAS (Infrared Atmospheric Sounder), constitutes vertical atmospheric sounding system (VASS) in FY3, the next generation polar orbit meteorological satellite of China. MWHS can provide three-dimensional distribution of global atmospheric humidity for all weather. Before research has been performed on forward simulation for MWHS by using RTTOV-7, Liebe-MPM89 and Liebe-MPM92 are used to compute line-by-line transmittances. Based on these transmittances, spectral parameters for MWHS and predictors

defined in RTTOV-7, coefficients are calculated by a multiple linear regression model. In order to compare with AMSU-B, standard atmospheric profile of the United States is used to generate the weighting function of MWHS. After profiles in TIGR43 dataset are selected to yield the fast transmittances coefficients for MWHS, validation is performed by comparing the brightness temperature and the transmittances calculated by RTTOV7 and generated by the Line-by-line model.

A13: Convective-scale data assimilation of satellite infrared radiances over the Mediterranean: adaptation of the observation operator to the high-resolution.

Presenter: Fanny Duffourg

Fanny Duffourg, Véronique Ducrocq, Nadia Fourrié, Geneviève Jaubert and Vincent Guidard

Fine scale phenomena are still badly grasped whereas they are an important challenge to take up. For that reason, some meteorological centers have recently developed numerical weather prediction models with a kilometric mesh that explicitly resolve moist convective processes. With this higher resolution, new problems, particularly in assimilation, have appeared. For example, the model mesh is now smaller than any satellite observation spot. As a consequence, we need to gather model information from different grid points to simulate correctly the brightness temperature measured. This issue is examined more specifically for the newly developed convective scale 3D-Var data assimilation system of Météo-France: AROME. In AROME, satellite observations are simulated thanks to the RTTOV radiative transfer model. The brightness temperature is estimated at the center of the satellite observation spot using the four closest model columns surrounding this point. This interpolation procedure comes from previous assimilation systems for which the model mesh was larger than the observation spot. But with fine scale data assimilation systems such as AROME (2.5 km), such a procedure is no longer valid as a single AIRS or IASI observation spot covers more than 12 model grid-points at nadir. That is why, in this study, we explore different ways of aggregating the model information within a satellite spot in order to better represent the whole atmosphere sounded at once by these instruments. We then compare the different brightness temperatures obtained by using RTTOV with these different aggregating methods. The first results show almost no differences for temperature channels (the differences in brightness temperature are smaller than 0.1 K) but bigger ones (from 0.5 K to 1 K) for water vapour channels in

some places where important gradients in the humidity field are present.

A14: Potential enhancement of AMSU-A/MHS/ATMS baseline microwave humidity and temperature sounders

Presenter: Stephen English

Abstract not available.

A15: A new method for estimating 1D-var B-matrix from 4D-var

Presenter: Stephen English

Stephen English and Marek Wlasak

Abstract not available.

A16: SSMIS Upper Atmosphere Radiance Assimilation: Preprocessing Requirements and Preliminary Results

Presenter: Bill Bell/Nancy Baker

S. Swadley, N. Baker, G. Poe, K. Hoppel, Y. Han, S. Mahmood and W. Bell

The SSMIS Upper Atmosphere Sounding (UAS) channel set provides the first operational measurements of microwave radiation emitted by the earth's atmosphere at mesospheric altitudes. The SSMIS receives polarized radiation in the 60 GHz oxygen complex, specifically the 7+, 9+, 15+ and 17+ O₂ lines. Significant hardware and scientific technical challenges arise from microwave temperature sounding of the mesosphere. These include 1) addressing the impact of large Noise Equivalent Temperature Difference (NEDT) associated with narrow channel bandwidths; 2) achieving high channel center frequency stability; 3) compensation of large spacecraft-induced Doppler shift; 4) better characterization the Zeeman splitting of the oxygen absorption lines; 5) development of a fast polarimetric radiative transfer model (RTM). Preliminary global simulation results comparing the fully polarized NRL Line-by-Line (LBL) RTM with the fast RTM including Zeeman effects (CRTM-Z) showed the two models agreed to under a 1.0 K RMS, but the bias patterns indicated both residual geomagnetic and earth rotation Doppler signatures. Earth rotation Doppler signatures were shown to be significant when circular polarized radiation is being measured. The preliminary global simulations were performed using ECMWF analyses merged with COSPAR climatology above

~80 km level, and showed OB-BK biases in the 10-15 K for the highest peaking UAS channels. Results using the fast RTM with Zeeman effects to map the model backgrounds into SSMIS brightness temperatures for both NRL's high-altitude global NWP model (NOGAPS-ALPHA) and the new L70 Met Office global forecast model (model lid at ~80km) will be presented. Details of the SSMIS UAS preprocessing steps required prior to assimilation will also be presented.

A17: The radiometric requirements for a post-EPS Microwave Sounder

Presenter: Bill Bell

Abstract not available.

A18: Evaluating the Impact of the Geopotential Height Profile Data Assimilation Deriving from the AIRS/AQUA Sensor by the CPTEC's RPSAS Assimilation Model

Presenter: Carlos Frederico Bastarz

Carlos Frederico Bastarz, Dirceu Luis Herdies, Jairo Geraldo Gomes Junior, Luiz Fernando Sapucci, Rita Valéria Andreoli, Rita Micheline Dantas Ricarte

Due to improve the weather forecast through the geopotential height profiles data assimilation, this paper aims to present a case study occurred in the south of Brazil considering a period of the winter season (in the Southern Hemisphere), when strong raining events were occurred. This season were characterized by the incursion of several frontal systems which caused low temperatures, several strong raining and storms. The assimilation system used to data assimilation were the CPTEC's Data Assimilation System, the RPSAS – Regional Physical-Statistical Assimilation System, based on the DAO's Assimilation System (PSAS). In this process, the geopotential height profile were assimilated during the period and some of the results show that the 1-3 days forecast are improved for some variables like temperature and precipitable water for the analysis.

A19: Impact of ATOVS geopotential heights retrievals over analyses generated by RPSAS.

Presenter: Jairo Geraldo Gomes Junior

Jairo Geraldo Gomes Junior, Weber A. Gonçalves, Rita V. Andreoli, Dirceu L. Herdies, Carlos F. Bastarz, Henrique M. J. Barbosa, Luiz F. Sapucci and Aimone S. Tomita L.

South America and adjoining oceans are known by having a very irregular and sparse meteorological data acquiring net and this fact implies a worse performance for Numerical Weather Prediction models operated by most of Weather Prediction Centres than it should be in terms of computational capability. However, this lack of in situ observations has been treated by the usage of satellite-processed radiance. In this work, conventional data (e.g. from surface and oceanic stations, airplane and radiosondes) and ATOVS retrievals, in form of geopotential heights, were assimilated by RPSAS (Regional Physical-Space Statistical Analyses System) at CPTEC (Center of Weather Prediction and Climate Studies – Centro de Previsão do Tempo e Estudos Climáticos) and some verifications were done with RPSAS' outputs to quantify the impact of the assimilated data over its analyses. And also a case study was carried out about a frontal system that intruded Brazil in 09JUL2007. Some compares to a control experiment without ATOVS profiles, as Mean Absolute Error, took place to observe the impact of these retrievals in the analyses generated by the RPSAS. Furthermore, an Analyses Impact (AI) were calculated by taking the NCEP analyses as a "perfect" representation of the atmosphere state at some synoptic times during the period of 01st to 20th of July/2007. The results showed that the incremental outputs of RPSAS were coherent with the spatial distribution of retrievals assimilated, but the AI showed that the data assimilated do not improved all the analyses fields, even when they were related to a very sparse-data in situ areas, like over Atlantic Ocean.

A20: Investigating the assimilation of IASI data in a limited area model

Presenter: Roger Randriamampianina

Roger Randriamampianina

The assimilation of IASI data in the ALADIN/Norway data assimilation system at the Norwegian Meteorological Institute is being carried out in the frame of the THORPEX-IPY Norway project. This project aims to improve the accuracy of high-impact weather forecasts in the Arctic

region. The use of limited number of channels is being tested at the first stage using all the available IASI field of view. The next step concerns evaluation of the use of IASI data applying different bias correction techniques.

A21: Use of Regional Retransmission Networks in Global Data Assimilation

Presenter: Brett Candy

Brett Candy, Steve English and Nigel Atkinson

Along with other global NWP centres the Met Office routinely assimilates data from Regional ATOVS Retransmission (RARS) networks, such as the EARS service provided by EUMETSAT. Recently additional data has been made available for the Asia-Pacific region and Brazil. In this study we investigate the forecast impact of using this data in addition to the standard global ATOVS datasets. We also examine the forecast benefit if all ATOVS data arrived in time to make the main forecasts. This latter study gives insight into other geographical areas in which a RARS network would be useful.

A22: Satellite Data Assimilation over Antarctica: The Concordiasi Field Experiment

Presenter: Aurélie Bouchard

Aurélie Bouchard, Florence Rabier, Vincent Guidard, Fatima Karbou, Nadia Fourrié, Thomas Pangaud

In the framework of the International Polar year, a field experiment will take place in Antarctica, during the Austral Spring 2008: Concordiasi (<http://www.cnrm.meteo.fr/concordiasi>). There will be an increase in the number of observations over Antarctica such as driftsondes or radiosoundings at Concordia and Dumont D'Urville during the campaign. Thanks to these additional in-situ observations, studies will be performed in order to improve the assimilation of infrared and microwave observations over the high latitude. One of the major aims of this campaign is the validation of the assimilation of IASI (Infrared Atmospheric Sounding Interferometer) radiances. The most important problem for the infrared satellite observations is the cloud detection and especially stratospheric polar cloud (PSC) for these cold areas. Different methods such as Cloud Detect (McNally and Watts, 2003) or Co2 slicing (Chahine, 1974; Lavanant 2002) can be applied. Based on the conclusions of this preliminary work, a cloud detection method, for the high latitudes,

will be tried in a future work. Moreover, new methods have been developed within the constraints of 4D-Var to help the assimilation of the microwave observations (Karbou et al. 2006). These methods have been successfully tested at a global scale and have shown to be beneficial to our 4D-Var system. However, due to the complexity of snow covered areas, further developments are still needed in order to better describe the surface over Antarctica. Focusing on this specific area, we will explore how a better modelling of the emissivity and/or the skin temperature could help the assimilation of microwave surface and sounding channels. The impact on our 4D-Var system will be also examined.

A23: Case studies of 4D-Var assimilation of potential vorticity observations derived from image processing.

Presenter: Yann Michel

Y. Michel and F. Bouttier

Short-range forecasts errors occurring in numerical weather prediction are often diagnosed by forecasters as being displacement errors: forecast locations of meteorological structures are displaced from their observations, and this displacement can be evaluated through inspection of satellite images. However, current representation of background error are based on Gaussian assumptions, and linear or weakly non-linear data assimilation schemes are used to correct errors. This hypothesis is more and more critical as resolution increases and as the meteorological situation evolves more and more non-linearly. Therefore, high resolution forecasts models of strongly non-linear processes, such as thunderstorms or tropical cyclones, need a different, more realistic initialization. Some methods have been developed to identify and correct the position and amplitude of storm-scale thunderstorms and of tropical cyclones, including bogussing practices and variational assimilation of simulated observations. Despite the growing number of radiance data being assimilated, global models sometimes fail to predict mid-latitude cyclogenesis, even if the upper or lower level precursors are visible in the images from advanced sounders or geostationary satellites. Different operational procedures, often based on potential vorticity inversion, have been developed to exploit the link between water vapour images and the initial state of the upper level of the troposphere. Our goal is to build observations of potential vorticity that correct the displacement and amplitude error of the dry intrusions using a image satellite processing technique. An algorithm developed for the identification and tracking of dry

intrusions in water vapour imageries is used to define potential vorticity pseudo-observations in the upper troposphere. A simple object-based methodology produces observations that are built to locally correct the amplitude and displacement errors as diagnosed from the comparison of the trajectories in the image processing tool. An approximate form of Ertel potential vorticity operator is used to incorporate the pseudo-observations inside a 4D-var assimilation scheme. It is applied to real cases of cyclogenesis forecasts and within an operational data assimilation scheme, the high resolution (20 km over Europe) global model ARPEGE. Experiments on several cases studies highlight the ability of the algorithm to correct locally the tropopause and to partially improve the forecasts of the cyclogenesis. Advantages and drawbacks of this procedure are finally discussed.

A24: Impact of variable O3 and CO2 on assimilation of high spectral resolution sounder data

Presenter: J. Cameron

J. Cameron, S. English, F. Hilton, E. Pavelin

The bias of AIRS observations relative to observations simulated from the Met Office global model show both seasonal variations and an on-going trend. Some of these changes are clearly caused by upgrades to the model but others are due to variable gases and in particular O3 and CO2. The variations that have been observed are displayed and possible approaches to reduce the effect of variable O3 and CO2 are presented.

A25: Impact Analysis of Assimilation of Integrated Water Vapor Estimates from AIRS/AMSU over Amazonian Region

Presenter: Luiz Fernando Sapucci

Luiz Fernando Sapucci; Dirceu Luis Herdies, Rita Valéria Andreoli; Renata Weissmann, B. Mendonça, Rodrigo Augusto F. de Souza; Sérgio Henrique S. Ferreira, José Antônio Aravéquia.

The Amazonian region is one of the most humid of the planet [Integrated Water Vapor (IWV) median values are in the order of 50 kg m⁻²] and it is also characterized by large space-time variability in the humidity fields. The cause of this large variability is the intense convective activity associated with the great humidity potential generated by high temperatures. Consequently, in the Numerical Weather Prediction the usage of initial conditions

with errors in characterizing humidity over Amazonian region can generate erroneous precipitation forecast in the some areas over South American continent. In this aspect, there are two important points. The first point is the most realistic atmospheric state depends significantly on available data, and the second one is the low density of conventional information in the Amazonian region. Data from Atmospheric InfraRed Sounder/Advanced Microwave Sounding Unit (AIRS/AMSU) incorporate the most recent inversion procedure, which are able to produce IWV values of good quality over continental areas. Nowadays, this sensor is one of the most important sources of humidity over Amazonian region. Within this context, the present study investigates the impact on humidity forecast over Amazonian region with the inclusion of IWV estimate from AIRS/AMSU in the CPTEC data assimilation system: Physical-space Statistical Analysis System (PSAS). Two different cyclic processes using Atmospheric Global Circulation Model CPTEC/COLA were carried. In the first cyclic process all available data were assimilated, such as geopotential height from temperature profiles measured by NOAA/ATOVS [Advanced TIROS Vertical Operational Sounder]; derived surface winds from Quik Scatterometer; Cloud Track Wind from geostationary satellites; conventional data (SYNOP, BUOY SHIP, radiosonde, aircraft, pilot balloons); and IWV values over ocean region from the SSMI/DMSP (Defense Meteorological Satellite Program). In the other cyclic process the same data set was assimilated with the IWV values from AIRS/AMSU. The results obtained applying factor separation show that the inclusion of IWV-AIRS values present a significant impact in the IWV values from initial conditions over Amazonian region, the which is also observed in the short-range predictions of humidity. Some studies are being carried out using rainfall data from TRMM Passive Microwave Sensor to evaluate this impact on precipitation forecast.

A26: Towards better usage of AMSU observations over land at ECMWF

Presenter: Blazej Krzeminski

Blazej Krzeminski, Niels Bormann, Fatima Karbou, Jean-Noel Thepaut, Atony McNally and Peter Bauer

Assimilation of AMSU observations over land at the ECMWF has been limited in case of channels receiving strong contribution from the surface. This is due to the difficulties in accurately estimating surface emissivity in the microwave frequencies. Currently used ECMWF land surface emissivity

models and their limitations will be discussed. There is an ongoing effort to improve the emissivity estimations. Retrieving emissivities from the observations in the microwave window region showed to be a promising approach. Issues covered in the presentation also include correction of biases and the quality control of the observations over land in the context of Numerical Weather Prediction.

A27: The Relative Contributions of the Various Observing Systems in the CPTEC Global Data Assimilation/Forecast System

Presenter: Rita Valéria Andreoli

Rita Valéria Andreoli, Sérgio Henrique S. Ferreira, Luiz Fernando Sapucci, Dirceu Luis Herdies, Rodrigo Augusto Ferreira de Souza, Renata Weissmann Borges Mendonça, José Antônio Aravéquia

A series of data withholding experiments was conducted with the Global Physical-space Statistical Analysis System (GPSAS) - a combination of the Spectral Atmospheric Global Circulation Model (CPTEC/COLA) with the Physical-space Statistical Analysis System (PSAS) -, with the purpose of assessing the relative contributions of the several types of observation within the context of the CPTEC data assimilation system. In these experiments one or more type of observation is removed from the assimilation cycle and the impact on the forecast skill indicates the effectiveness of that source of observation in the system. The major observing system included the conventional data (SYNOP, BUOY, SHIP, radiosonde, aircraft, pilot balloons), and satellite data (ATOVS and AIRS/AMSU retrievals, QuikScat wind, Cloud Track Wind and Total Precipitation Water from SSM-I sensor). The experiment including all these data is called control experiment and it is used as reference. The experiments involving "data denied" indicated that conventional data including all surface observations (SYNOP, SHIP, BUOY), rawinsonde and aircraft data, are the primary source of information utilized by GPSAS in the Northern Hemisphere. The largest impact in the Southern Hemisphere (SH) was obtained when all satellite-derived retrieval data were removed. Additional experiments were performed to assess the impact of removing ATOVS and AIRS/AMSU retrievals data individually. The results showed that withholding the AIRS/AMSU retrievals has a greater impact than withholding the ATOVS retrievals data. This disparity may be associated to fact that the AIRS/AMSU retrievals are reported in assimilation cycle as it independent observation of the model,

while ATOVS retrievals were anchored in the first guess field generated by model. Over the South America, AIRS/AMSU retrievals and conventional data present similar contribution and have a positive impact on all range forecast (1-5 days). Besides it is found that all the types of observations generally contribute in a positive way to the overall improvement of the CPTEC forecast system. However, is important to note that the impact of several observations varies depending on the chosen verifying variable, vertical level or forecast period.

A28: Assimilation of cloudy AIRS observations in the French global atmospheric model ARPEGE

Presenter: T Pangaud

T. Pangaud, N. Fourrié, V. Guidard, F. Rabier

Infrared and microwave clear-sky observations from polar orbiting satellites are assimilated in the French numerical weather prediction (NWP) model ARPEGE through a 4 dimensional variational (4D-Var) assimilation scheme. They represent an important source of information. Since the end of 2006, a few stratospheric channels of the Atmospheric InfraRed Sounder (AIRS) are assimilated in ARPEGE. Moreover, a large majority of measurements from such advanced infrared sounders are affected by clouds, and cloud contaminated observations are currently rejected by the data assimilation system. As it is now well known that the sensitive regions, where cyclogenesis occur, are often cloudy, this motivates our research efforts to assimilate AIRS cloudy radiances inside the 4D-Var assimilation scheme. The observation operator which simulates the radiances from model fields include a radiative transfer model, RTTOV in the case of ARPEGE. Since clouds can affect the infrared observations, a cloud detection is necessary before data are assimilated. Several cloud detection schemes have been used over sea: a cloud detection scheme based on channel ranking, called Cloud-Detect, from the ECMWF; a CO₂-slicing method and a cloud detection based on the simulation of the sea surface temperature. Previous studies have shown that the two first cloud detection schemes are the most accurate ones. This paper focuses on the validation of both schemes applied to AIRS, by using independent data coming from the MODIS imager and from the POLDER radiometer. The validation of the cloud top pressure will also be discussed. Two approaches may be tested for the assimilation of cloudy AIRS radiances : the first one uses the cloud top pressure and the cloud cover derived from the CO₂-slicing technique (CO₂-slicing

outputs are directly used by RTTOV to simulate the cloud-affected spectrum). In the second one, CO₂-slicing outputs are adjusted by a prior 1D-VAR before being used by RTTOV. Preliminary experiments have been done which consisted in assimilating AIRS radiances, including those contaminated by clouds between 600 and 950 hPa, only over sea for 54 stratospheric and tropospheric peaking channels. A slightly positive impact in temperature and in geopotential is found for the first method. The impact of the cloudy assimilation on cloud fields in ARPEGE will also be studied in this paper.

A29: Data assimilation and use of EOS data in land surface model

Presenter: Lu Qifeng

Lu Qifeng, Yang Zhongdong, Tang Shihao, Zhang Peng, Lu Naimeng

For the land products retrieved from the remotely sensed datasets better using in the land surface model and weather/climate model, Land Data Assimilation Systems (LDAS) based on EnKF Technology and Community Land Model, has been developed at NSMC/CMA. In the context of numerical weather prediction applications, LDAS can provide optimal estimates of land surface state initial conditions by integrating with an ensemble of land surface models, the available atmospheric forcing data, remotely sensed observations of precipitation, radiation and some land surface parameters such as land cover and leaf area index. The validation from Yucheng comprehensive experiment site indicates that the preliminary results obtained are still inspiring. There are still many detailed work to do for the routine operation of LDAS, such as how to get dynamic P in 3dvar, how to select the spacing interpolation algorithm, etc.

A30: The GMAO 4d-Var System

Presenter: Ricardo Todling

Ricardo Todling and Yannick Tremolet

The fifth generation of the Goddard Earth Observing System (GEOS-5) Data Assimilation System (DAS) is a 3d-var system that uses the Grid-point Statistical Interpolation (GSI) system developed in collaboration with NCEP, and a general circulation model developed at Goddard, that includes the finite-volume hydrodynamics of GEOS-4 wrapped in the Earth System Modeling Framework and physical packages tuned to provide

a reliable hydrological cycle for the integration of the Modern Era Retrospective-analysis for Research and Applications (MERRA). This MERRA system is essentially complete and the next generation GEOS is under intense development. A prototype next generation system is now complete and has been producing preliminary results. This prototype system replaces the GSI-based Incremental Analysis Update procedure with a GSI-based 4d-var which uses the adjoint of the finite-volume hydrodynamics of GEOS-4 together with a vertical diffusing scheme for simplified physics. As part of this development we have kept the GEOS-5 IAU procedure as an option and have added the capability to experiment with a First Guess at the Appropriate Time (FGAT) procedure, thus allowing for at least three modes of running the data assimilation experiments. The prototype system is a large extension of GEOS-5 as it also includes various adjoint-based tools, namely, a forecast sensitivity tool, a singular vector tool, and an observation impact tool, that combines the model sensitivity tool with a GSI-based adjoint tool. These features bring the global data assimilation effort at Goddard up to date with technologies used in data assimilation systems at major meteorological centers elsewhere. Various aspects of the next generation GEOS will be discussed during the presentation at the Workshop, and preliminary results will illustrate the discussion.

A31: Implementing Radiance Assimilation in NAVDAS-AR: Lessons Learned

Presenter: Nancy Baker

Nancy Baker, Ben Ruston, Tim Hogan and Tom Rosmond

NAVDAS – the NRL Atmospheric Variational Data Assimilation System – is an observation space 3dvar system and provides the initial conditions for the U.S. Navy’s global NWP model (NOGAPS) and mesoscale model (COAMPS®). NAVDAS was designed to be the precursor for the 4dvar assimilation system NAVDAS-AR (Accelerated Representer). Because NAVDAS was designed to accommodate variable grid dimensions and map projections, the observation pre-processing is separate from the 3D-Var solution, which in turn is separate from the final mapping of correction vector into model space. The observations types are pre-processed independently, then combined into single file containing the observation and ancillary information needed for the 3D-Var solution. For satellite radiances, the pre-processor routine includes the quality control, observation selection and thinning, bias correction, radiance monitoring

and Jacobian calculation using a fast radiative transfer model. One advantage to this approach is that it easily allows radiance observations to be passively monitored, rather than assimilated, by the operational assimilation/forecast model without appreciably affecting the total run time of the system. For example, with NOAA-18 AMSUA-A, we were able to move from passive monitoring to active assimilation within three weeks of the data becoming operationally available (and without operational code changes). While this approach provides flexibility for the development of new observation pre-processors, it has contributed to unexpected difficulties during the implementation of radiance assimilation with NAVDAS-AR. The initial NAVDAS-AR implementation followed the operational NAVDAS configuration. The NOGAPS fields are output on 30 fixed pressure levels at 0.5 σ resolution, and the 3-, 6-, 9-hour forecast fields from the previous update cycle are interpolated in space and time to the observation location. Within NAVDAS-AR, the observations are binned within 30 minute windows, and the background values are interpolated from the model Gaussian grid/sigma level fields. Differences between background fields used in the observation pre-processors and the NOGAPS trajectory lead to systematic differences in the computed brightness temperatures, inconsistencies with bias corrections and degraded forecast skill. We will present our diagnostic results and solutions, which have involved a re-examination of the role of observation pre-processors for data monitoring and selection, quality control, and bias correction. We have also encountered various difficulties upgrading our radiative transfer model from RTTOV-6, and results from assimilation tests using the JCSDA Community Radiative Transfer Model and RTTOV-8.7 will be presented. Finally, the differences in observation impact (computed using adjoint methods) between NAVDAS and NAVDAS-AR will be presented and discussed.

A32: Environmental Forecasting at NIWA: A Progress Report

Presenter: Michael Uddstrom

Michael Uddstrom, Hilary Oliver, Stuart Moore, Stuart Webster, Phil Andrews, Vanessa Sherlock, Trevor Carey Smith, Richard Turner, Mike Revell, Ed Yang and Martyn Clark

The New Zealand Limited Area Model (NZLAM) is an operational implementation of the Met Office Unified ModelTM (i.e., OPS, VAR (FGAT7), UM, SCS) on a 12 km resolution domain using a 6 hour assimilation cycle. NZLAM predictions are also being used to forecast weather impacts, including

river flood. In the context of New Zealand's complex and steep topography and short rise time catchments, flood forecast accuracy is very sensitive to timing and magnitude errors in quantitative precipitation forecasts (QPF), which in turn are sensitive to the accuracy of the analysis and (NWP) model resolution. The poster outlines the operational NWP system, information delivery system and indicative verification statistics, and reports on data assimilation and model resolution experiments carried out to better understand forecast accuracy constraints.

SESSION B

B01: Fostering a new generation of Remote Sensing Scientists

Presenter: Paolo Antonelli

Paolo Antonelli, Steve Ackerman, Leanne Avila, Steve Dutcher, Liam Gumley, Allen Huang, Jean Phillips, Hank Revercomb, Tom Rink, Kathy Strabala, Bill Smith, and Paul Menzel

At the ITSC-XV we indicated that in addition to focusing on the design and development of future instruments and the associated data processing algorithms, SSEC also pursues educational goals by spreading environmental awareness and emphasizing the relevance of satellite remote sensing of the Earth in a wide variety of activities. Following the example of the distribution of the TOVS processing package and the personal efforts of SSEC and CIMSS leading scientists in the eighties, some of SSEC's recent training efforts have reached out to an international audience interested in theoretical and operational aspects of remote sensing. In the last two years SSEC and CIMSS have continued teaching weeklong remote sensing seminars that provide a broad fundamental perspective to young researchers as well as to graduate students around the World. Lectures are supplemented with laboratory exercises that emphasize investigation of high spatial resolution (MODIS) and high spectral resolution (AIRS, IASI) data; more recently high temporal resolution data (SEVIRI, GOES) have also been added. During 2006 and 2007, SSEC and CIMSS scientists, in collaboration with EUMETSAT and NOAA, have attempted to bring greater understanding of remote sensing technology to the international community, and to African and South American scientists in particular with the unchanged goal of helping in fostering a new generation of environmental scientists.

B02: Processing Package and Remote Sensing Training Workshops for International Direct Broadcast Users

Presenter: Allen Huang

Allen Huang, Liam Gumley, Kathy Strabala, and Tom Rink

Since 2004 SSEC/CIMSS has conducted international direct broadcast (DB) training workshops centered around the DB receiving countries/sites. So far six (6) DB workshops have been conducted at Perth/Australia, Nanjing/China, Beijing/China, Chung-Li/Taiwan, Andoya/Norway and Pretoria/South Africa. One additional workshop under the GEOSS initiative was conducted at Cachoeira Paulista/Brazil. These workshops focus on the complete end-to-end processing of the data into geophysical products. Basic remote sensing principals, algorithm theory, and limitations and applications of the products are taught in lectures followed by hands-on computer laboratory exercises. The user friendly visualization software tool HYDRA is freely distributed for students in the class room and allows examination of data and products at the pixel level for the purpose of manipulating and interrogating DB measurements, imagery, and products. SSEC/CIMSS is devoted to continue this kind of training workshop tailored for the international DB community as part of an ongoing effort to maintain and expand the use of the International MODIS/AIRS Processing Package (IMAPP), and in preparation for the development of the future International Polar Orbit Processing Package (IPOPP) for the National Polar-orbiting Operational Environmental Satellite System (NPOESS).

B03: Report on the first International IASI Conference

Presenter: Thierry Phulpin

Thierry Phulpin (CNES), Dieter Klaes (EUMETSAT) and Peter Schlüssel (EUMETSAT)

The First international IASI conference, organized by CNES and Eumetsat, took place in Anglet (France) from 13 to 16 November 2007, only one year after the successful launch of the IASI instrument on the MetOp-A platform. It is a credit to CNES and Eumetsat and to the manufacturers of IASI that so soon after launch users are already making significant use of IASI data and were able to present exciting first results. The main topics of the conference were: the performance of IASI, the impact of IASI on NWP, the clouds and surface

parameters, climate and atmospheric chemistry. The performance of IASI was assessed by the IASI Technical Center in CNES and validated against NWP model output and airborne and balloon coincidence flights. The results showed that the radiometric performance of IASI is better than 0.5K, likely between (0 and 0.2 K). ECMWF was the first to assimilate IASI data and showed already a significant impact of IASI on NWP – the largest single impact of any instrument despite coming on top of existing systems. The high spectral resolution of IASI is already showing benefits with several users describing techniques to use this information to retrieve surface and cloud properties – paving the way for even greater use of IASI data in NWP. Other sessions during the conference concentrated on retrieval of cloud and aerosol properties and on the growing number of trace gases that can be detected in IASI data. This highlights another critical role of IASI in the monitoring of the Earth's climate over a long time period. The IASI Sounding Science Working Group is called to maintain a coordination on the development of IASI products and will assist CNES and Eumetsat to organize the 2nd conference in 2009.

B04: Synergy between IASI sounding and AVHRR imagery for the processing of IASI data in non-uniform scenes

Presenter: Thierry Phulpin

P. Prunet, S. Bijac, J. Donnadille, D. Coppens, B. Tournier, O. Lezeaux, P. Prunet, S. Bijac, J. Donnadille, D. Coppens, B. Tournier, O. Lezeaux

A processing chain for the infrared sounding measurements above heterogeneous scenes was developed for IASI. It makes use of the information provided by a co-registered imager for characterizing the sounder sub-pixel information in terms of homogeneous radiative surfaces, and for extracting the sounder spectrum component associated with each homogeneous surface. Such a processing is required for any exploitation of non-homogeneous pixel measurements. This processing is applied for validation on a representative set of measured IASI spectra. The first results on partially cloudy scenes indicate that the global percentage of IASI measurements exploitable for atmospheric parameter retrieval and NWP assimilation should be increased by a factor of 3. This preliminary validation also suggests that improved geophysical products (e.g., low troposphere constituent concentration, surface properties classification) could be derived from this processing.

B05: Validation of IASI spectral radiances using aircraft underflight data collected during JAIVEx

Presenter: David Tobin

David Tobin, Hank Revercomb, Fred Best, Joe Taylor, Steve Dutcher, Bob Knuteson, William Smith

Direct airborne validation of radiances from the new IASI interferometer sounder on Metop was successfully performed during the Joint Airborne IASI Validation Experiment (JAIVEx) conducted 14 April - 4 May 2007. The experiment included the NASA WB57 aircraft carrying the UW Scanning HIS, the LaRC NAST-I, and the MIT/LL NAST-Microwave, flown in coordination with the Facility for Airborne Atmospheric Measurements BAe146-301 carrying the ARIES interferometer plus a wide range of in situ instrumentation and dropsondes. This presentation focuses on validation of IASI spectral radiances using the high altitude aircraft observations and a double observed minus calculated analysis technique. Results for various JAIVEx flights will be presented.

B06: Principle component analysis of IASI spectra with a focus on non-uniform scene effects on the ILS

Presenter: David Tobin

David Tobin, Hank Revercomb, Paolo Antonelli

Exploiting the inherent redundancy in hyperspectral observations, Principle Component Analysis (PCA) is a simple yet very powerful tool not only for noise filtering and lossy compression, but also for the characterization of sensor noise and other variable artifacts using Earth scene data. This presentation will include a description of our approach for dependent set PCA of IASI radiance spectra, characterization of the IASI sensor noise using PCA, and the characterization and removal of spectral artifacts due to scene inhomogeneity.

B07: Evaluation of IASI and AIRS spectral radiances using Simultaneous Nadir Overpasses

Presenter: David Tobin

David Tobin, Hank Revercomb, Fred Nagle, Robert Holz

We present direct comparisons of high spectral resolution radiance observations from today's two advanced infrared sounders. Observations collected

by the Atmospheric Infrared Sounder on the NASA Aqua platform and by the Infrared Atmospheric Sounding Interferometer on the METOP-A platform for Simultaneous Nadir Overpasses (SNOs) are intercompared and, with knowledge of the different characteristics of each sensor, are evaluated to assess the spectral and radiometric accuracy of each set of observations. Preliminary results show no significant trend in the results versus time and mean channel by channel differences typically less than 0.2K.

B08: The use of principal component analysis in monitoring IASI radiances and diagnosing climate anomaly

Presenter: Zhaohui Cheng

Zhaohui Cheng, Lihang Zhou, Thomas King, Walter Wolf, Mitch Goldberg, Chris Barnet and Haibing Sun

Principal component analysis (PCA) is a useful technique in analyzing high spectral infrared radiance data (such as AIRS, IASI) due to the high correlation among the different spectral channels. IASI 8461 channels can be well represented by relatively few empirical orthogonal functions (EOFs), also called principle components. Each IASI spectrum can be expressed as a linear function of these EOFs by a unique set of coefficients. These coefficients are also called principal component scores (PCS). Reconstructed radiances and PCS can be used to estimate instrument noise and detect anomalies by comparing reconstructed with the original spectra. NOAA/NESDIS has made the IASI level 1C data products operationally available since October, 2007. NOAA/NESDIS/STAR has used PCA to process the real IASI data for the data monitoring and quality control for a couple of months. PCS and the corresponding reconstruction scores are computed in near real time. A web site was built to monitor the global IASI observations, IASI reconstructed radiances and reconstruction score on daily basis. Large reconstruction bias can be used to identify the suspicious channels/bands and climate anomalies. Monthly monitoring of statistics of IASI radiances had also been implemented in this visualization system. Static PCS are very stable over time. However, when some special event occurs, the anomaly signature of PCS will appear in the reconstruction scores. The STAR IASI monitoring system indicated that there was a big bias of reconstruction scores over the Ionian Sea between south Italy and Greece (around 19E, 39N) on Nov. 24th, 2007. More investigations showed that there was a high SO₂ area due to the eruption of a volcano. The PCS level 1C product is a critical

factor in regression retrieval. The accuracy of PCS will affect the quality of the level 2 products. The case study to be presented will show the effect of a climate anomaly event like above mentioned volcano case on the reconstruction scores. We will also show that by added this event to the training dataset, that we can dramatically decrease the reconstruction errors.

B09: Operational Processing of ATOVS data at the Satellite Application Facility on Climate monitoring

Presenter: Nathalie Selbach

Nathalie Selbach and Petra Fuchs, DWD

The Satellite Application Facility on Climate Monitoring (CM-SAF) generates, archives and distributes widely recognized high-quality satellite-derived products and services relevant for climate monitoring in an operational mode. Products covering cloud, radiation and humidity parameters are derived from different operational satellite and sensor types. The International ATOVS Processing package (IAPP) is applied for the retrieval of humidity and temperature parameters. Currently, data from ATOVS onboard NOAA 15,16 and 18 are used for the generation of global environmental data records in near real time at the CM-SAF. It is intended to include data from ATOVS onboard the Metop in the operational processing. Daily and monthly products including mean value and error information are provided to the user in a 90 km x 90 km sinusoidal projection. The current status and future plans concerning the ATOVS processing routines at CM-SAF will be presented from the operational point of view.

B10: Validation of level1b/1c LEO instruments in synergy with LEO/GEO companion instruments or in stand alone mode: Application to AIRS/Aqua, IIR/Calipso, IASI/Metop.

Presenter: R. Armante

R. Armante, N.A. Scott, V. Capelle, L. Crépeau, N. Jacquinet, A. Chédin

High spectral resolution instruments as AIRS/Aqua or IASI and companion instruments on board Metop or other instruments of the A-Train (IIR/Calipso) etc. support the scientific community data requirements for weather forecasting and climate research. Such researches require quality data, well controlled (identification of systematic biases or spurious trends or variability). As an heritage of similar process for long term satellite data analysis (TOVS data of the NOAA/NASA

Pathfinder programme, a five year-period of AIRS/Aqua data or, more recently IIR /Calipso) LMD is developing control of IASI channels primarily relevant to its own retrievals of level2 products: GHG (CO₂, CO, CH₄, ...), clouds, aerosols and surface characteristics. This is obtained through the coupling of a validated and stable forward model (the LMD 4A model) with collocated ancillary or auxiliary data or instruments (LEO or GEO, radiosondes, analyses). The detection of bias, trends etc. from cloud free day/night land/sea spectra is performed globally or over selected areas. Validation approach – including the validation of the forward model itself - and results will be discussed. Relevance of such an approach to the GSICS (Global Space-Based Inter-Calibration System) mission and goals will also be discussed.

B11: Cloud properties from AIRS and evaluation with Calipso

Presenter: R. Armante

C. J. Stubenrauch, S. Cros, N. Lamquin, R. Armante, A. Chédin C. Crevoisier, and N. A. Scott

Since May 2002 the Atmospheric Infrared Sounder (AIRS), in combination with the Advanced Microwave Sounder Unit (AMSU), onboard the NASA Aqua satellite provides measurements at very high spectral resolution of radiation emitted and scattered from the atmosphere and surface. The instrument was developed to provide atmospheric temperature and water vapour profiles at a vertical resolution of about 1 km and 2 km, respectively, but the high spectral resolution of this instrument also allows the retrieval of cloud properties (especially cirrus), aerosol and surface properties as well as the quantity of trace gases. We present a cloud property retrieval scheme, which is based on a weighted 2 method using channels around the 15 micron CO₂ absorption band, to determine effective cloud emissivity and cloud pressure. The influence of channel choice, cloud detection, spatial resolution and of assumed atmospheric profiles on the retrieval are discussed. The retrieval scheme is applied to all spots, without distinction between cloudy or clear sky spots. Cloud detection plays an important role in the cloud property retrieval: the tighter the cloud detection the larger the average cloud pressure and low cloud amount, because partly cloudy spots are identified as low clouds. To be independent on cloud detection thresholds which vary regionally and seasonally, a posteriori cloud detection is developed by comparing cloud pressure differences between AIRS and collocated L2 data from the Cloud-Aerosol Lidar with Orthogonal Polarization

(CALIOP) onboard CALIPSO, both instruments part of the A-Train, for January and July 2007. This cloud detection is based on the coherence of cloud emissivity at different wavelengths and on brightness temperature heterogeneity. At the same time, CALIOP is used to evaluate the AIRS cloud altitude. Results are also compared to cloud properties from AIRS L2 products (version 5) and from the Moderate Resolution Imaging Spectroradiometer (MODIS) of the same time period, as well as to the cloud climatologies of the International Satellite Cloud Climatology Project (ISCCP) and TOVS (TIROS-N Operational Vertical Sounder) Path-B. The seasonal cycles of high, midlevel and low cloud amount in the tropical and subtropical regions are compared to the one of CALIPSO, using one year of data (August 2006 to July 2007) to results of cloud climatologies.

B12: A quantitative link between CO₂ emissions from tropical vegetation fires and the daily tropospheric excess (DTE) of CO₂ seen by NOAA-10 (1987-1991)

Presenter: Cyril Crevoisier

A. Chédin, N. A. Scott, R. Armante, C. Pierangelo, C. Crevoisier and P. Ciais

Four years of monthly mean mid-tropospheric CO₂ columns over the tropics have been retrieved from evening and morning observations of NOAA-10 (1987-1991). The difference between these two columns shows a “Daily Tropospheric Excess” (DTE) up to 3 ppm over regions affected by fires. At regional scale over Africa, America, and Australia, the variations of the DTE are in good agreement with those of independently derived biomass burning CO₂ emissions. In particular, a strong correlation ($R^2 \sim 0.8$) is found between regional mean DTE and fire CO₂ emissions values from the Global Fire Emissions Data base (GFEDv2) even though the two products span over periods ten years apart from each other. The DTE distribution over Africa is in good agreement with interannual variation of climate as indicated by temperature, precipitation and ENSO index. For instance, the southern hemisphere experiences 20% more fire activity during El Niño conditions than during La Niña conditions and the reverse for the northern hemisphere, even if the estimated one sigma uncertainty on the DTE remains close to the DTE ENSO variability. The physical mechanism linking DTE with emissions is not fully elucidated. Hot convective fire plumes injecting CO₂ into the troposphere during the afternoon peak of fire activity, seen by the satellite at 1930 LT, and then being diluted by large scale atmospheric transport, before the next satellite pass at 0730 LT, could

explain the tight observed relationship between DTE and fire CO₂ emissions. Through the reprocessing of the 25-year archive of TOVS observations, the DTE data may prove very useful to quantitatively reconstruct fire emission patterns before the ATSR and MODIS era when better quality fire count and burned area data became available.

B13: SIFTI : a Static Infrared Fourier Transform Interferometer dedicated to ozone and CO pollution monitoring

Presenter: C. Pierangelo

C. Pierangelo, P. Hébert, C. Camy-Peyret, C. Clerbaux, P. Coheur, T. Phulpin, L. Lavanant, T. Tremas, P. Henry, A. Rosak

Measuring pollutants concentrations in the boundary layer of the atmosphere is a major challenge for air quality. Infrared sounding, providing vertically resolved profiles for several trace gases in the troposphere, is a must for pollution observation. In this framework, CNES is currently leading a phase-A study for SIFTI, a Static Infrared Fourier Transform Interferometer devoted principally to ozone and CO measurements in the thermal (TIR) and short-wave infrared (SWIR). We will first describe the high-level mission requirements, including orbital considerations like the revisit frequency or the need for cloud-free observations. Instrument specifications, like spectral band position, spectral resolution, radiometric noise, are then derived from the precision needed in CO and ozone profile retrievals. The sensitivity of the profile retrievals, given in terms of vertical sensitivity and errors, to instrument performances are studied using the optimal estimation theory. The instrument concept proposed by CNES, an interferometer with no moving part, based on scaled mirrors, is a simple and efficient solution to meet these requirements and obtain very high resolution spectra (below 0.1 cm⁻¹) with a high signal-to-noise ratio. Spectra are measured within two thermal infrared bands (for CO and O₃) and one optional shortwave infrared band (for CO and CH₄) for synergetic more accurate SWIR/TIR inversion of CO profile. Thanks to an intelligent pointing mechanism based on real-time analysis of observations from an imbedded infrared imager, the probability of clear sky is dramatically increased. An optimization of the instrument, based on an irregular but well-chosen sampling of the interferogram, opens the way to still higher quality profiles.

B14: Derivation of tropospheric carbon dioxide and methane concentrations in the boreal zone from satellite-based hyper-spectral infrared sounders data

Presenter: Alexander Uspensky

Alexander Uspensky, Alexey Rublev, Alexander Kukharsky, Sergey Romanov

The development of space-borne hyper-spectral IR sounders (AIRS/EOS-Aqua, IASI/MetOp) opens new opportunities for detecting the variations of atmospheric carbon dioxide (CO₂) and methane (CH₄) concentrations. The capabilities to retrieve atmospheric column-average CO₂ mixing ratio QCO₂ and similar average mixing ratio QCH₄ for CH₄ from satellite measurements is of significant importance in the context of global carbon cycle research, climate change studies and due to sparse network of ground-based CO₂&CH₄ observations. This poster presents an updated status of QCO₂ and QCH₄ retrieval schemes based on the clear-sky AIRS and IASI data inversion algorithms. The presentation first describes the approach developed for clear-sky or cloud-cleared AIRS data inversion and retrieval of the QCO₂. The sensitivity studies (using FRTM SARTA simulations) enabled to select a set of CO₂-dedicated channels in both SW and LW regions with strong signal responses to CO₂ concentration changes and weak signal responses to variations of interfering factors, i.e. surface temperature T_s, water vapor(QH₂O(p)) and ozone (QO₃(p)) profiles. To retrieve the QCO₂, the original method has been proposed based on the iterative least squares physical inversion algorithm. Its important features are as follows: clear-sky or cloud-cleared AIRS spectra and AIRS-based Level 2 retrievals (T_s, QH₂O(p), QO₃(p)) together with AMSU-based and "AIRS-independent" temperature (T(p)) profile retrievals are utilized as input data; a radiative tuning is applied to the AIRS data in CO₂-dedicated channels to account for biases between actual and synthetic spectra; initialization of the iterative inversion algorithm is carried out through a correct choice of the QCO₂ first guess; the inter-consistency check between AIRS LW- and SW-based QCO₂ retrievals as well as the spatial and temporal filtering of the results are performed for the cluster of AIRS sounding points. The validation effort carried out with real AIRS data for two areas in the boreal zone of Western Siberia (Novosibirsk and Surgut regions) and for 10 months of year 2003 demonstrates that the retrieved monthly-averaged QCO₂ values reproduce seasonal variations of CO₂ column amounts (in a layer between ~3,5 km and about 7-8 km) with a precision about 3.0 ppmv comparing to in-situ airborne observations. We discuss also how the above methodology can be applied to IASI data

inversion and provide some examples of QCO₂ retrievals. The sensitivity studies (using FRTM simulations) enabled to specify the preliminary list of LW CO₂dedicated channels (some channels have central wave numbers close to those for AIRS CO₂channels). The adjustment of AIRS data inversion technique to IASI data requires accurate knowledge of T_s, T(p), QH₂O(p), QO₃(p) in sounding points. One possible option is to utilize the IASI-based Level 2 retrievals (T_s, QH₂O(p), QO₃(p)) together with collocated ATOVS-based T(p) retrievals; another one is to use NWP output products as ancillary information. Now both options are under consideration. Along with this we study the way how to suppress the effect of T(p) uncertainties on the signal variations in the CO₂-dedicated channels (time and space averaging, building of super- channel). With respect to the QCH₄ retrieval from AIRS and IASI data the approach is being developed based upon the application of iterative physical inversion algorithm to clear-sky AIRS or IASI data in 3 CH₄ – dedicated super- channels. The measurements in super-channels, that are generated as linear combinations of data in T- and CH₄-dedicated channels with wave numbers 706.5&1332.5, 715.25&1341.75, and 714.0&1346.75 cm⁻¹ respectively, have reduced sensitivity to T(p) uncertainties. It should reduce the effect of inaccurate profile T(p) knowledge in sounding points on accuracy of QCH₄ retrievals. The performance of the retrieval algorithm is evaluated in the case study experiment on the base of dataset of quasi-synchronous and collocated IASI and AIRS data complemented with AIRS-based L2 retrievals. The first experimental retrievals of QCH₄ from AIRS and IASI data are consistent to each other, that seems promising.

B15: Total ozone depletion due to tropical cyclones over Indian Ocean

Presenter: Devendra Singh

Devendra Singh and Sanjiv Nair

We have analyzed the perturbations in the total ozone due to four severe Tropical Cyclones formed over Arabian Sea and Bay of Bengal. Total Ozone data derived from Total Ozone Mapping Spectrometer instrument aboard Earth Probe satellite was used for this study. The daily total ozone anomalies have been calculated for the life span of each tropical cyclone. These anomalies were observed local in character and moved with the tropical cyclone. Further, these anomalies have been found related to the intensification of the cyclonic system. In general, negative anomalies were observed to be more than 20 Dobson units at

the time of maximum intensity of cyclones. The variations in daily total ozone anomalies, from development to intensification stage and then to decaying stage of each cyclone have brought out clearly the impact of tropical cyclone on the total ozone, which got depleted, considerably over the affected region.

B16: From TOVS to ATOVS based ozone monitoring – implication for the quality and homogeneity

Presenter: B. Lapeta

B.Lapeta, Z.Ustrnul

The satellite monitoring of the total ozone content over Poland has been performed with the use of NOAA/TOVS data since 1993. The total ozone time series has been evaluated and homogenised using ground measurements. Meanwhile, the new generation of NOAA satellite with ATOVS instrument were launched implying the changes both, in type of data and software applied for ozone retrievals. Therefore, the quality of the total ozone amount derived from TOVS and ATOVS data for the period with simultaneous measurements, July 2005 – May 2007, was studied and the results will be presented in the paper. The analysis was performed for monthly mean values using the ground total ozone measurements from Belsk (21E; 51N). Furthermore, effect of the transition from TOVS to ATOVS data on the total ozone series homogeneity will be discussed.

B17: Preliminary Comparisons Between the CO Retrievals from AIRS and the CO CATT-BRAMS Model Estimations over the Amazon Region During the 2002 Dry-to-wet Season

Presenter: Rodrigo Augusto Ferreira de Souza

Rodrigo Augusto Ferreira de Souza, Jurandir Ventura Rodrigues, Karla M. Longo, Saulo R. Freitas, Plínio C. Alvalá, Rudinei M. de Oliveira

The high concentration of aerosol particles and trace gases observed in the Amazon and Central Brazilian atmosphere during the dry season is associated with intense anthropogenic biomass burning activity. The biomass burning emissions have a strong impact on the tropospheric and stratospheric chemical composition and are an important agent of weather and climate change. Therefore, the estimation of the amounts inject into the atmosphere at regional as well as global scales is needed. During the past decade, trace gas abundance in the troposphere were obtained from

sparsely distributed measurement sites, and observations were mostly confined to the surface. The advent of downward looking instruments to probe the troposphere from polar-orbiting satellites has increased our ability to access the impact of human activities on the chemical composition of the atmosphere and on the climate changes. In this work the CO retrievals from AIRS/AQUA are compared with estimations of CO using the Coupled Aerosol and Tracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System (CATT-BRAMS) for the dry-to-wet transition season of 2002 over the Amazon region. In general, the results showed a relatively good agreement between both estimates, particularly in the mid-troposphere.

B18: Multi-satellite observation on upwelling after the passage of typhoon Hai-Tang in the southern East China Sea

Presenter: Kung Hwa Wang

Yi Chang, Ming-An Lee, Kung Hwa Wang

The serial remote sensing based imageries clearly revealed large scale of upwelling within large regional enhancement of chlorophyll-a (Chl-a) concentration in the southern East China Sea (ECS) after the passage of super typhoon Hai-Tang in July 2005. After the typhoon on July 22, the upwelling area (< 26°C) expanded rapidly to 9146 km² on the shelf-break. The large increased upwelling persisted for more than a week. Ocean color images also revealed that high Chl-a concentration of >3.0 mg/m³ appeared in the shelf region, where the high Chl-a pattern matched the upwelling in terms of location and time. On the other hand, a large offshore SST cooling was also observed mainly to the right of typhoon track on July 20, it lasted in a period of 2-3 days. Utilization of AVHRR, MODIS, AMSRE and SeaWiFs, this paper provides clear and high-resolution evidence that typhoon significant increased upwelling and Chl-a concentration in the southern ECS. Key word: Remote sensing, upwelling, chlorophyll-a, southern East China Sea, typhoon Hai-Tang.

B19: Retrieval of atmospheric water vapour profile using the Megha-Tropiques

Presenter: Filipe Aires

Filipe Aires, Frédéric Bernardo, Hélène Brogniez, and Catherine Prigent

Megha-Tropiques (MT) is a French/Indian mission designed to study the energy and water cycle in the

Tropics. Its launch date is expected to be March 2009. This CNES/ISRO platform possesses two microwave instruments: - a cross-track sounder, SAPHIR, for the retrieval of atmospheric water vapour (6 channels in the 183 GHz band); - and a conical scanning imager, MADRAS, designed mainly to study precipitation and cloud properties, with 9 channels (18.7, 23.8, 36.5, 89 and 157 GHz with vertical and horizontal polarizations, except for the 23.8). In this study, we combine Saphir and Madras observations for the retrieval of atmospheric water vapour over ocean and land and for clear sky. The statistical inversion scheme is developed using a synthetic data simulated with the RTTOV radiative transfer model. The atmospheric temperature profiles from the ECMWF forecast are used as auxiliary information. Furthermore, a microwave surface emissivity atlas is utilized over land to better constrain the surface contribution in surface sensitive channels. These auxiliary information are added to Madras and Saphir observations to feed a neural network retrieval scheme that estimates the atmospheric water vapour profile. The synergy of the two microwave instruments comes from the sounding abilities of Saphir added to the vertically integrated water vapour information derived from Madras. Together with the development of the retrieval scheme, an information content analysis is conducted. In particular, the vertical resolution is optimized with respect to the retrieval capability of Saphir. In parallel, we perform a sensitivity analysis with respect to the various sources of uncertainty, i.e. satellite observations or auxiliary information. The evaluation of the retrieval algorithm is performed using AMSR-E and HSB observations that have roughly the same viewing geometry than Saphir and Madras (cross-track for HSB; conical for AMSR-E) and provide similar observations of the atmosphere. Radiosonde measurements are also utilized.

B20: The Use of HSB to Derive the Integrated Water Vapor Content: An Example Using the RACCI/LBA Experiment

Presenter: Luiz Augusto Toledo Machado

Wagner Flauber Araújo Lima and Luiz Augusto Toledo Machado

This work presents the capability of the HSB (Humidity Sensor Brazil) channel in retrieving Integrated Water Vapor Content. The data analyses of this study have been carried out in two stages: firstly using simulations of the HSB channel brightness temperatures from RTTOV radiative model, and secondly, using data from the "RACCI/LBA" (Radiation, Cloud, and Climate

Interactions/Large Scale Biosphere Atmospheric Experiment in Amazônia) experiment in Rondônia, during the period of September and October 2002. The results show the potential of the 183 ± 1 , 3×10^7 GHz channels in retrieving middle and upper tropospheric water vapor for clear sky situations. The estimation of integrated water vapor contents in the atmosphere using HSB channels was not possible due to the absence of troposphere low level information, where most of the water vapor is concentrated. The 150 GHz channel, which has the maximum peak of its weight function next to the surface, is strongly influenced by the surface emissivity.

B21: High-Resolution Passive Millimeter-wave Measurements from Aircraft: Validation of Satellite Observations and Radiative Transfer Modeling

Presenter: William J. Blackwell

R. Vincent Leslie, Laura J. Bickmeier, William J. Blackwell, and Laura G. Jaiaram

The NPOESS Aircraft Sounder Testbed-Microwave (NAST-M) passive microwave spectrometer suite was used to help validate the radiometers (AMSU and MHS) on the MetOp-2/A satellite. Underflights of MetOp-2/A were made by the WB-57 high-altitude research aircraft during the Joint Airborne IASI Validation Experiment (JAIVEx – Apr. 2007). Microwave data from other satellites (Aqua, NOAA-16, and NOAA-17) will also be presented. Also, NAST-M data is used to validate the parameter tuning in a scattering Radiative Transfer Algorithm (RTA) coupled with a cloud circulation model. The NAST-M instrument suite includes a total of four spectrometers, with three operating near the oxygen lines at 50–57, 118.75, and 424.76 GHz, and a fourth spectrometer centered on the water vapor absorption line at 183.31 GHz. The NAST-M 54-GHz spectrometer has five channels corresponding to the AMSU-A instrument, and the 183-GHz spectrometer has three channels corresponding to the MHS instrument (or AMSU-B). This enables radiance-to-radiance comparisons, which can circumvent potential pitfalls and modeling errors that can be introduced when simulating spaceborne radiances. All four of NAST-M's feedhorns are co-located, and have 3-dB (full-width at half-maximum) beamwidths of 7.5° , which translates to ~ 2.5 -km nominal pixel diameter at nadir incidence. The four feedhorns are directed at a single mirror that scans cross-track beneath the aircraft, spanning ± 65 degrees. The NAST-M sensor is mounted on an aircraft platform with a typical cruising altitude of 17-20 km, which results in a nominal swath

width of 100 km. The high-altitude platform enables high spatial and temporal coincidence with satellite measurements, and NAST-M's 100-km swath width provides complete coverage of both AMSU and MHS nadir footprints. The paper will detail the essential techniques used to correct for the difference in altitude and view angle between the satellite and aircraft sensors along with procedure for co-locating NAST-M measurements with satellite measurements. The radiance-to-radiance comparisons will be evaluated against a purely simulated validation technique. The RTA parameter tuning utilizes the MM5 regional-scale circulation model to generate atmospheric thermodynamic quantities (for example, humidity and hydrometeor profiles). These data are then input into the Rosenkranz multiple-stream initial-value RTA [Rosenkranz, 2005] to simulate at-sensor millimeter-wave radiances at a variety of viewing geometries. The simulated radiances are filtered and resampled to match the sensor resolution and orientation. While the parameters chosen in the circulation model are important, the focus of the current work is the parameter selection in the RTA, and we aim to extend the work of Surussavadee and Staelin to higher spatial resolutions (from 15 km to 2 km) and frequencies (from 183 GHz to 425 GHz). The RTA parameters are optimized by co-locating the model data with observations from the NAST-M instrument and choosing the parameters for which the RMS deviation between the simulated and actual brightness temperatures is minimized. The optimization is performed numerically with parameter sweeps using the MIT Lincoln Laboratory LLGrid High Performance Computing Facility, which consists of approximately 1000 Xeon processors. Over a dozen storms consisting of over 5,000 precipitation-impacted pixels have been studied. Comparisons of the observed versus calculated brightness temperatures will be presented. This work was sponsored by the National Oceanic and Atmospheric Administration under Air Force contract FA8721-05-C-0002. Opinions, interpretations, conclusions, and recommendations are those of the authors and not necessarily endorsed by the United States Government.

B22: Synergetic Operational Earth observations with Metop-A instruments

Presenter: Dieter Klaes

Dieter Klaes

Metop satellites are the European contribution to the space-based global observing system and to the joint European/US operational polar satellite

system. Metop covers the mid-morning (9:30) orbit, whereas the US continues to cover the afternoon orbit with the NOAA satellites. Metop-A provides advanced observations of temperature and humidity profiles, wind, ozone and other trace gases. The instrumentation of Metop is a judicious balance between continuity of known instruments and novel observations, notably the hyperspectral thermal infrared observations with IASI and radio occultation measurements. The Metop instruments have a great potential to provide synergetic measurements. Some of the instruments are synchronized (IASI, AMSU, MHS) or co-registered (AVHRR via the Integrated IASI Imager). IASI is expected to provide trace gas information, as is also the GOME-2 instrument. By flying different instruments on the same platform a large potential exists to combine measurements from different instruments and improve products. An example could be Ozone vertical information with GOME/IASI, the combination of IASI/GRAS (high vertical sampling at high accuracy) and others. The poster will provide an overview on the EPS/Metop system and the payload, and illustrate the synergetic potential of the instruments.

B23: Australian Bureau of Meteorology Satellite Data Exchange and Use

Presenter: Gary Weymouth

Gary Weymouth, Anthony Rea, David Griersmith, Ian Grant, Chris Tingwell, AP-RARS participants, other Bureau staff

The Australian Bureau of Meteorology has recently improved its use of locally-received ATOVS data in NWP, with significant positive impact. Additionally, the Bureau both supplies and receives Asia Pacific Regional ATOVS Retransmission Service (AP-RARS) data. This data also has shown positive impact on local and international NWP, and is produced using AAPP. The AP-RARS network has expanded, with stations added from New Zealand, Singapore, Japan (Siyowa in Antarctica), Korea and Hong Kong, in addition to stations in Australia, Japan and China. During 2008, additional AP-RARS stations are expected to include Townsville (Australia), Casey and Davis (Antarctica). Provision of AP-RARS data from Noumea and Tahiti has been announced for some future date, and data from Fiji, Honolulu, and either Guam or the Marshall Islands is under investigation. The WMO goal for ATOVS availability on the various RARS networks is 90% global coverage with less than 30 minutes latency. The Bureau is also implementing X-band reception sites in Melbourne (Crib Point, March 2008), Darwin (June 2008) and Casey (summer 2008/9).

Satellite data should be received from terra, aqua, NPP, NPOESS, FY3 and possibly other satellites. One of the drivers of this program is to improve the timely availability of hyperspectral satellite data for NWP. The data is also expected to be used for oceanography and other purposes. GPS precipitable water estimates are in test production, while production and NWP use of GPS RO soundings are under investigation.

B24: Operational dissemination of IASI data using principle component compression.

Presenter: Simon Elliott

Simon Elliott, Tim Hultberg and Peter Schlüssel

In response to the request of its users to revisit the dissemination strategy for IASI data, EUMETSAT plans to begin the dissemination of level 1 data (spectra) using principal component compression. The principal component scores will be calculated using a robust training set, and disseminated in near real time both globally via the GTS and via EUMETSAT's DVBS multicast system, EUMETCast. The data will be encoded in BUFR and will comprise around 180 principal component scores per spectrum. Several technical issues are currently being addressed, such as the possible prior separation of the spectra into distinct bands, the distribution of the residuals and the exact number of scores to be used.

B25: NOAA/NESDIS Updates on Operational Sounding Data Products and Services

Presenter: A.K. Sharma

A.K. Sharma

The National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services (NOAA/NESDIS) has been a pioneer in producing and distributing atmospheric sounding data products as a part of its operation for operating a fleet of civilian, Polar Orbiting Environmental Satellites (POES) and providing users and researchers a suite of operational atmospheric and environmental data products. Sounding Data Products are being generated from the advance TIROS Operational Vertical Sounder (ATOVS), onboard NOAA polar orbiting satellites (NOAA-15, NOAA-16, NOAA-17, and NOAA-18), and Infrared Atmospheric Sounding Interferometer (IASI) onboard Meteorological Operational Satellite (MetOp-1). ATOVS consists of three instruments, Advanced Microwave Sounding Units (AMSU), AMSU-A

and AMSU-B, and a High-resolution Infrared Radiation Sounders (HIRS) instrument. NOAA-18 launched in May 2005 contains the Advanced Very High Resolution Radiometer (AVHRR/3), HIRS/4, AMSU-A, and the Microwave Humidity Sounder (MHS) instruments. AMSU-B has been replaced by MHS for deriving the sounding data products on NOAA-18. HIRS/4 on NOAA-18 has not been stable and has encountered numerous problems to prevent using its data in ATOVS processing. A new data distribution technique, Data Distribution Server (DDS), has been employed at the NOAA/NESDIS Environmental Satellites Processing Center (ESPC) for distributing the soundings data. This presentation will include the discussion on the ESPC system architecture involving sounding data processing and distribution for Infrared Atmospheric Sounding Interferometer (IASI), improvements made for data quality measurements, pipeline processing and distribution via DDS, and user timeliness requirements envisioned from the next generation of satellites. There have been significant changes in the operational system due to system upgrades, algorithm updates, and value added data products and services. User requirements for data products and services for sounders like ATOVS and IASI would help us determine the products and services required from the next generation of sounders such as Cross-Track Infrared Sounder/ Advanced Technology Microwave Sounder (Cris/ATMS) as planned for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program and the future missions of the European Organization for the Exploitation of Meteorological (EUMSAT) satellites. The operational IASI systems producing level 2 data will also be discussed.

B26: Operational Implementation of Integrated Microwave Retrieval System

Presenter: Limin Zhao

Limin Zhao, Aiwu Li and Jiang Zhao

The MIRS is a state-of-the-art retrieval system developed to support POES, MetOp, DMSP, NPP/NPOESS programs at NESDIS in generating operational temperature, water vapor, and hydrological parameters from microwave sensors. It is based on an assimilation-type scheme and capable of optimally retrieving atmospheric and surface state parameters simultaneously. It provides enhancements to the NESDIS current operational surface and precipitation products from Microwave Surface and Precipitation Products System (MSPPS), and also generates temperature and moisture profiles in all weather and over all-surface

conditions. The MIRS aims to produce the operational microwave sounding, surface and precipitation products from different sensors cross several satellites, so its products are being developed and implemented into operation through a multi-years stratified phase approach. Recently, the MIRS was successfully transitioned into operation at NESDIS. Its Phase-I and -II products from POES and MetOp were declared operational, and have been made available to both real-time users and climate users through NESDIS Environment Satellite Processing Center (ESPC) Data Distribution Server (DDS) and Comprehensive Large Array-data Stewardship System (CLASS). In this presentation, we will discuss the transition of MIRS from research to operation, its operational implementation procedures, products validation, monitoring and dissemination. Detailed information on the operational MIRS, its products and their application in supporting NESDIS precipitation operation will also be presented.

B27: Enhancements of the AIRS Eigenvector Regression Algorithm

Presenter: Lihang Zhou

Lihang Zhou, Zhaohui Cheng, Thomas King, Walter Wolf, Mitch Goldberg, Xingpin Liu Fengying Sun, Chris Barnet and Haibing Sun

The differences between observed and simulated AIRS spectra, acquired from validation campaigns, are very small (usually decimals of degree in brightness temperature); this encourages the development of a physically-based regression. The physical regression coefficients are derived by first acquiring an ensemble of truth data, simulating ensemble spectra with the latest AIRS science team rapid radiative transfer algorithm, and then generating the regression coefficients. The truth data is consist of a set of radiosonde/rocketsonde temperature and moisture profiles, collocated with forecast model fields as well as other routine observations. The training set is augmented with representative profiles of CO₂ and other greenhouse gases. The physically-based algorithm is tested and validated on our global multi-years re-processing dataset. Results and comparisons with the current regression algorithm will be presented.

B28: Global Coverage of Total Precipitable Water using the Microwave Integrated Retrieval System (MIRS)

Presenter: S.-A. Boukabara

S.-A. Boukabara, K. Garrett, C. Kongoli, B. Yan, P. Pellegrino, F. Weng and R. Ferraro

This study focuses on the performances of the total precipitable water (TPW) operational product, generated using the Microwave Integrated Retrieval System (MIRS) at NOAA/NESDIS. These retrievals are made operationally available over ocean and also, experimentally, over land, coast, sea ice and snow surfaces. MIRS is a 1DVAR inversion scheme that employs the Community Radiative Transfer Model (CRTM) as the forward operator. It solves simultaneously for the surface and the atmospheric parameters in a consistent fashion. The surface is represented by its temperature and emissivity spectrum. The main difference between retrieval over land and that over ocean is confined to the shape of the spectral constraint imposed on the emissivities being retrieved. This renders the retrieval of atmospheric profiles over different surfaces, trivial. The main challenge becomes simply the determination of the appropriate constraint for each type of surface background. Although MIRS retrieves the entire temperature and moisture profiles, we will focus in this study on the assessment of the TPW retrieval over all-surfaces, namely ocean, sea-ice, land, coast and snow. Note that the TPW is not retrieved independently in MIRS, but is rather a vertical integration of the retrieved moisture profile. The assessment of the performances is done using NOAA-18 and METOP-A AMSU/MHS data. The retrievals are compared to the NCEP Global Data Assimilation System (GDAS) outputs and to a network of radiosondes, encompassing a wide variety of meteorological situations. Specific comparisons over a one-year period, to data from three Atmospheric Radiation Measurement (ARM) sites (Southern Great Plains, Northern Alaska and Tropical Western pacific) are also presented. It is found that TPW accuracy over snow and sea-ice backgrounds is higher than that over non-frozen land surfaces, consistent with expectations determined in simulation. Over ocean, the MIRS retrievals are also compared to operational products, namely the Microwave Surface and Precipitation Products System (MSPPS). Visual inspections of TPW fields seem to indicate that MIRS is consistent with meteorology, with no apparent discontinuity of moist/dry fronts at the boundaries of surface backgrounds. This adds confidence that MIRS is functioning as expected and suggests that coastal retrievals might also be accurate. In this case, the retrieved surface

emissivity spectrum handles the mixed terrain within the pixels, avoiding therefore a contamination of the TPW. The statistical performances are broken down by surface type.

B29: CrIS Radiance Simulations in Preparation for Near Real-Time Data Distribution

Presenter: Haibing Sun

Haibing Sun, Kexin zhang Lihang Zhou W. Wolf T. King C. Barnet, and M. Goldberg

A simulation system is under development to support pre-launch preparations for the Cross-Track Infrared Sounder (CrIS) NOAA Unique near real-time processing and distribution system. CrIS, a Michelson interferometer infrared sounder with over 1305 channels per spectrum, will fly on the NPOESS satellite series that is dedicated to the operational meteorology and climate monitoring. It will replace the AIRS and HIRS as the next generation operational infrared remote sensor to provide improved measurements of the temperature and moisture profiles in the atmosphere. The CrIS simulation system will emulate the instrumental and orbital characteristics of the CrIS instrument on NPOESS. The utilities of this system are: (1) to provide simulated observation radiances that support NOAA Unique product (cloud clearing and trace gases) development and testing, (2) to provide a robust data distribution environment for development and testing of the CrIS data sub-setting system, and (3), most importantly, to allow for a smooth transition of the CrIS NOAA Unique Product processing system from the development environment to the operational environment. Details of the simulation system shall be presented.

B30: Serendipitous Characterization of the Microwave Sounding Unit during an Accidental Spacecraft Tumble

Presenter: Thomas J. Kleespies

Thomas J. Kleespies

In September 2006 the NOAA-14 spacecraft suffered a hydrazine thruster failure. A locked valve apparently failed, releasing to space hydrazine which had remained in the line from early orbit operations, sending the spacecraft in a tumble. Most of the instruments were in their normal scanning mode at the time. Through the extraordinary efforts of the Satellite Operations Control Center engineering staff, the spacecraft recovered from the tumble and resumed nominal station keeping. Data were collected and

downloaded to the Command and Data Acquisition stations until the instruments were turned off to conserve power. The Microwave Sounding Unit is very important for climate studies in that it has collected a twenty-eight year atmospheric temperature time series. This accident presented a wonderful opportunity to collect data of the MSU viewing deep space and permitted characterization of side-lobes and asymmetries. This paper presents an analysis of such data collected from the MSU during the tumble, and compares it with that taken from a planned maneuver in August 2006.

B31: A Geostationary Microwave Sounder for NASA and NOAA

Presenter: Hartmut H. Aumann

Bjorn Lambrigtsen

At the 2007 AMS Annual Meeting the National Research Council, an arm of the National Academy of Sciences, released its just completed report on a “decadal survey” of NASA and NOAA Earth space missions that had been under way for two years. Among the 15 missions that the NRC recommended that NASA undertake was one called the “Precipitation and All-weather Temperature and Humidity” mission (PATH). A “MW array spectrometer” was identified as the presumed instrument payload for PATH. Such an instrument, called the Geostationary Synthetic Thinned Aperture Radiometer (GeoSTAR), has been developed at NASA’s Jet Propulsion Laboratory, and it is likely that it will be implemented for a space mission in the near future. First conceived in 1998 for a NASA New Millennium Program mission and subsequently developed in 2003-2006 as a proof-of-concept prototype under the NASA Instrument Incubator Program, it will fill a serious gap in our Earth remote sensing capabilities – namely the lack of a microwave atmospheric sounder in geostationary orbit. GeoSTAR is a microwave sounder with the same capabilities as have been available on low earth orbiting (LEO) satellites for nearly 10 years with the Advanced Microwave Sounding Unit (AMSU) system and soon to be succeeded by the Advanced Technology Microwave Sounder (ATMS). Providing such a capability in geostationary orbit (GEO) has long been a goal for NOAA and NASA, since the GEO vantage point offers key advantages over LEO – such as a continuous view of the entire life cycle of storms and hurricanes. Due to the very large antenna aperture needed for a microwave sounder to provide the required spatial resolution, it has not been possible to develop such instruments for GEO. Only infrared sounders have been feasible, but they are severely hampered by clouds – which is not a problem for microwave sounders.

GeoSTAR overcomes those difficulties by using a new approach to synthesize a large aperture, and the development of the GeoSTAR concept therefore makes a GEO microwave sounder possible. This was clearly viewed by the NRC as a very important breakthrough, and plans for a PATH mission are now under development. GeoSTAR will meet all key requirements of such a mission, and because of the substantial investment NASA has already made in GeoSTAR technology development, this concept is now at the necessary maturity for implementation in the next decade. NOAA is keenly interested in GeoSTAR as a potential payload on a future series of geostationary weather satellites and has closely monitored the technology development since 2003 and is considering flying a demonstration mission. An intriguing possibility is to fly GeoSTAR as a Mission Of Opportunity on one of the first two satellites in the new geostationary satellite series now being developed by NOAA, the GOES-R series. The first two satellites will have unallocated payload space available due to the cancellation of the Hyperspectral Environmental Suite (HES), and this space could be used for a GeoSTAR demonstration mission. In such a scenario NASA would build the GeoSTAR instrument and NOAA would provide platform and launch services. GeoSTAR will provide a number of measurements that are crucial for the monitoring and prediction of hurricanes and severe storms – including hemispheric 3-dimensional temperature, humidity and cloud liquid water fields, rain rates and rain totals, tropospheric wind vectors, sea surface temperature, and parameters associated with deep convection and atmospheric instability – everywhere and all the time, even in the presence of clouds. GeoSTAR, with its ability to map out the three-dimensional structure of temperature, water vapor, clouds, precipitation and convective parameters on a continual basis, will significantly enhance our ability to observe hurricanes and other severe storms and would greatly improve the GOES-R capabilities in these areas. We discuss the GeoSTAR concept and basic design, the performance of the prototype, and the most important science applications that will be possible with GeoSTAR. The work reported on here was performed at the Jet Propulsion Laboratory, California Institute of Technology under a contract with the National Aeronautics and Space Administration.

B33: A Canadian satellite mission for continuous imaging of the northern latitudes

Presenter: Louis Garand

Louis Garand, Guennadi Kroupnik, Ron Buckingham, Alexander P. Thrischenko

The Polar Communications and Weather (PCW) mission of the Canadian Space Agency has the dual goal of providing communications and weather information pertaining to latitudes 50-90 N in continuous fashion from two satellites in a highly elliptical orbit. The presentation will focus on the meteorological aspect of the mission, its uniqueness and motivation. The main payload will be an advanced radiometer providing imagery with a refresh time of the order of 15 minutes. An industrial consortium is currently evaluating the various aspects of the mission based on user requirements defined by Environment Canada and other federal departments. PCW could be realized as early as 2013, either as a standalone Canadian mission or with international partners.

B33: Examining the mid winter severe weather outbreak of 7 January 2008 using satellite data with McIDAS-V

Presenter: Thomas Ahtor

Thomas Ahtor, Kathleen Strabala, Jason Brunner

On 7 January 2008 a strong mid latitude cyclone swept across the midwest United States producing an outbreak of severe weather that resulted in 48 tornadoes spanning an area from southeast Wisconsin through Eastern Oklahoma. There were two tornadoes in southeast Wisconsin, an EF1 and an EF3 which damaged or destroyed 105 homes and injured 15 people. There had previously been only 1 tornado reported in Wisconsin's history in the month of January (150+ years). This poster will review this very unusual severe weather event, and apply various satellite imager and sounder products, some which are available to forecasters in real time, to help identify key features of the event.

B34: The ITWG Web Site

Presenter: Bill Bellon

Leanne Avila, Bill Bellon, Stephen English, Allen Huang, Tom Ahtor, Roger Saunders

For the past six years, the CIMSS webmaster has maintained and updated the ITWG Web site. Following an initial major redesign, the site has

grown considerably. In particular, the pages devoted to the conferences have grown to accommodate more information to keep the community informed of updates, as well as to serve as a central location to host conference presentations, posters, Working Group reports, Proceedings, and even photos from participants. In addition, several more Working Groups have created pages and/or redesigned their sites, and continue to add more details about their activities and research. Working with the co-chairs, the webmaster has sought to create a more useful forum for the ITWG community via the Web site, updating the site more frequently to encourage users to continue to visit. We have continued to find ways to enhance the usefulness of the site with input from the community.

B35: Sub-mm Wave Micromachined Free-Standing Frequency Selective Surfaces

Presenter: Norman Grant

The spectral transmittance of a frequency selective surface (FSS), which consists of two free-standing arrays of short-circuited nested annular slots, is presented.

The FSS was designed to provide a minimum of 20 dB isolation between the frequency bands 316.5–325.5 and 349.5–358.5 GHz when the filter operates in the TE and TM plane at 45° incidence.

Experimental results, which are in close agreement with the computed transmission coefficients, show that the maximum insertion loss is 0.9 dB, and the minimum cross-polar discrimination is at least 21 dB in the passbands.

The FSS yields virtually identical spectral responses in the two polarisation planes over the frequency range 315–359 GHz.

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