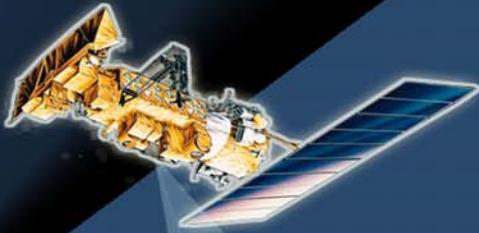




Sharing ideas, plans and techniques

to study the earth's weather

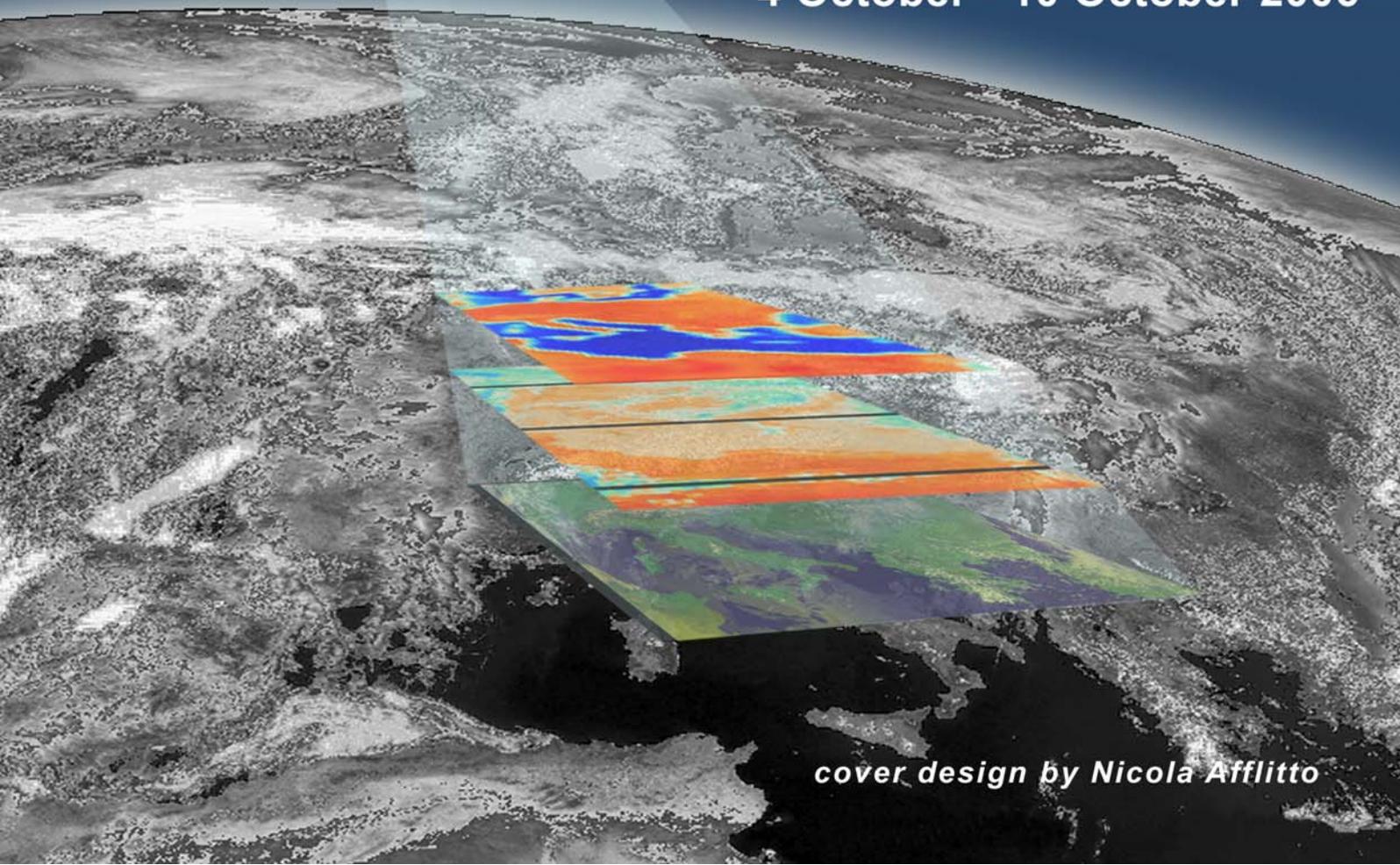
using space-based observations



***A Report on
the Fifteenth International
TOVS Study Conference***

Maratea, Italy

4 October - 10 October 2006



cover design by Nicola Afflitto

A Report on The Fifteenth International TOVS Study Conference

**Maratea, Italy
4-10 October 2006**

Conference sponsored by:

- IMAA / CNR
- Met Office (U.K.)
- University of Wisconsin-Madison / SSEC
- NOAA NESDIS
- EUMETSAT
- World Meteorological Organization
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- CNES
- ABB Bomem
- Dimension Data
- LGR Impianti
- Cisco Systems and
- VCS

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February 2007

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 and moisture fields on numerical weather prediction (NWP) and climate studies.

The Fifteenth International TOVS Study Conference (ITSC-XV) was held at the Villa del Mare near Maratea, Italy from 4 to 10 October 2006. This conference report summarises the scientific exchanges and outcomes of the meeting. A companion document, *The Technical Proceedings of The Fourteenth International TOVS Study Conference*, contains the complete text of ITSC-XV 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 Maratea. An active and mature community of TOVS and ATOVS data users now exists, and considerable progress and positive results were reported at ITSC-XV in a number of areas, including many related to the ATOVS system, use of AIRS measurements, and to the other current and impending advanced sounders.

ITSC-XV was sponsored by industry, government agencies and a university, including, VCS Engineering, CNES, Kongsberg Spacetec AS, ABB, ITT Industries, the Met Office (U.K.), the University of Wisconsin-Madison Space Science and Engineering Center, the World Meteorological Organization, EUMETSAT, and NOAA/NESDIS. The support of these groups is gratefully acknowledged. We wish to thank the local organising committee from the Italian National Research Council, Institute of Methodologies for Environmental Analysis (CNR/IMAA), located in Potenza, Basilicata, Italy, especially to Dr. Filomena Romano for her exceptional effort and talent in leading the local organization. Finally, appreciation is given to local sponsors, including Dimension Data, LGR Impianti, Cisco Systems, Basilicata Turistica, Provincia di Potenza and Regione Basilicata Assessorato Infrastrutture.



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International TOVS Study Conference - XV

4 -10 October, Maratea, Italy



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TOVS STUDY CONFERENCE (ITSC-XV)

Maratea, Italy: 4 – 10 October 2006

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International TOVS Study Conference-XV Working Group Report

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International TOVS Study Conference-XV Working Group Report

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The Fifteenth International TOVS Study Conference

4 – 10 October 2006



ITSC-XV Group Photo at Villa del Mare, Maratea, Italy



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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Fifteenth International TOVS Study Conference, ITSC-XV, was held near the town of Maratea in southern Italy from 4 – 10 October 2006. Around one hundred and ten participants attended the Conference and provided scientific contributions. Sixteen countries, and three international organizations were represented: Australia, Brazil, Canada, China, France, Germany, Hungary, India, Italy, Japan, Norway, Poland, Russia, Sweden, United Kingdom, United States, ECMWF, EUMETSAT and WMO. The number of attendees has remained at a consistent level over the past 3 meetings. The Working Groups had very useful discussions and it was encouraging to see a large number of new younger scientists participating. Originally it was hoped that the conference attendees would be able to learn about the launch of Europe's first polar orbiting meteorological satellite, MetOp-A, but unfortunately it was delayed until after the conference.

Most of the meeting was occupied with oral presentations and two poster sessions on a range of issues which included the following:

- Radiative transfer and surface modeling
- Climate applications
- ATOVS cloud studies
- Direct broadcast software, education and frequency protection (dedicated to Guy Rochard)
- Preprocessing and calibration
- Operational use of ATOVS
- Developments in use of ATOVS in NWP
- International Issues and Agency Status Reports
- Products from ATOVS
- MetOp Developments
- Future sensors

There were 77 oral and 50 poster presentations during the conference; the agenda is given in Appendix A. 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-XIV in Beijing. This session also reviewed progress on the Action Items and Recommendations identified by the ITSC-XIV Working Groups. Many of these items formed the basis for further discussion by the Working Groups at ITSC-XV. Several technical sub-groups also met during ITSC-XV to discuss developments and plans concerning specific software packages, shared and in common use. Brief reports on these sub-group meetings are provided in section 3.

The conference also paid tribute to Guy Rochard, a recent ITWG Co-Chair who had attended nearly every conference, who died suddenly in November 2005. A special session was dedicated to direct broadcast software, education and frequency protection, the main areas in which Guy was actively involved in his career. In addition during the conference banquet several members of the group recalled Guy's life and his major contributions to the atmospheric sounding community. He will be sadly missed by the ITWG.

1.2 SUMMARY OF MAJOR CONCLUSIONS

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

1. The results of new observing system experiments presented at ITSC-XV 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 AIRS.
2. Many NWP centres are now assimilating radiances from the advanced infrared sounder, AIRS, and getting significant positive forecast impacts. The use of the warmest field of view, in the AMSU-A footprint, recommended at the last conference has replaced the centre field of view used initially.
3. The AIRS radiances assimilated are still a small fraction of those available but some efforts are underway to allow a more complete use of the AIRS data (e.g. through use of reconstructed radiances).
4. Many NWP centres are ready to assimilate IASI radiances once they become available with the help of NESDIS who have provided a simulated IASI dataset. A channel sub-set of about 300 IASI radiances has been identified for distribution to NWP centres on the GTS.
5. The number of NWP centres using level 1b ATOVS radiances in their variational assimilation systems continues to grow but there are still centres which rely on the level 2 retrievals provided by NESDIS.
6. The Regional ATOVS Retransmission Service, RARS, has been significantly developed since ITSC-XIV. The EUMETSAT EARS service has continued to expand and more NWP centres are using the EARS data. The Asia-Pacific RARS has started operations and NWP centres are already beginning to assimilate ATOVS data from this new data stream. RARS networks in S. America and Africa are being planned. 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 over most of the globe.
7. The group also noted the good progress by NOAA to reduce the delay in the NOAA blind orbits for the global dataset by using the Svalbard ground station. This should become operational in early 2007.
8. 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.
9. It was noted that the SSM/I sensor on DMSP-F15 was no longer being used by users due to the beacon interference with the 23GHz channel. A process to clean up the data was presented at the conference which should be made available to the users to allow them to assess if they can start to use data from this satellite again.
10. Considerable progress in the pre-processing of SSMIS data has been made with at least one NWP centre now able to use the sounding channels operationally. Further improvements to the pre-processing were identified during the conference. The group encouraged the SSMIS cal/val team to make the data available from DMSP-F17 as early as possible after the launch to expedite their use in operational systems.

11. A third high spectral resolution sounder workshop was held at Madison, Wisconsin, USA in April 2006 to allow a more detailed discussion of scientific issues related to advanced sounders with many eminent scientists attending. These workshops also educate and train young scientists entering the field.
12. An ITWG workshop on remote sensing and modeling of surface properties was held in Paris, France in June 2006 allowing a focused discussion on this aspect of radiative transfer in order to facilitate more use of the sounder data over land. It is planned to hold another workshop in early 2008.
13. The community software packages (i.e. AAPP and IAPP) for processing locally received ATOVS data have been upgraded to allow data to be processed from MetOp, including IASI. The updates will shortly be available for free distribution to users. This kind of ATOVS processing software has been essential in the use of ATOVS data by the meteorological community.
14. A freely available software package for processing locally received MODIS and AIRS data is being used by many countries for imagery and for Level 2 products. This IMAPP software also adds applications from AMSR-E. Future development of DB packages for MetOp-IASI, NPP and NPOESS are planned.
15. 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).
16. The group noted the increasing threat of RF interference in microwave imager channels as demonstrated by AMSR-E, and all members were urged to lobby their respective radio communication authorities to support protection of the imager and sounder bands.
17. A presentation on the need to foster training on remote sensing measurement systems and products to young scientists was given and the group agreed to enhance its efforts in education and training through a dedicated section of the Web site. A workshop to co-ordinate satellite meteorology training was also proposed along with the possibility of certification of some courses. Satellite provider agencies were encouraged to continue and expand their support for education and training of the next generation of remote sensing scientists.
18. It was recommended that as the NOAA-18 HIRS is not providing good data the HIRS on MetOp should be used with the new 10km field of view to allow comparisons with the 17km field of view on NOAA-17 HIRS to identify the yield of cloud free radiances. This field of view difference should be studied to consider the requirement for the field of view size for future sounders.
19. The group was pleased to note that the Integrated Program Office (IPO) has decided to put NPP into a PM ascending orbit as recommended by the ITWG at ITSC-XIV to provide continuity with Aqua/AIRS. This will help to ensure at least long term atmospheric sounder coverage in 2 orbits.
20. The time series of (A)TOVS now exceeds 27 years and the quality and number of climate products continues to grow. One sign of the importance of climate studies to society, is that there are now efforts emerging to support the routine, operational production of TOVS Climate Data Records at several centers. It was recognized that the fundamental instrument parameters of all the (A)TOVS sensors should be retained for future reprocessing efforts.
21. The group supported the continuing efforts to develop the GCOS Atmospheric Reference Observation Network (GARON) 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.

22. The ITWG recommended that satellite agencies support the new WMO Global Space based Inter-calibration System (GSICS) to improve the accuracy of global satellite observations for weather, climate and environmental applications through an operational inter-calibration of the space component of the World Weather Watch (WWW)'s GOS and GEOSS.
23. The recent NOAA-14 pitch maneuver to investigate the calibration of the radiometers was welcomed as a useful end of life activity and may provide new information on the calibration of the sensors.
24. The group recommended studies to quantify the benefits of dual polarisation channels on conical scanning microwave radiometers for sounding channels which have significant surface contributions to assess if enhanced discrimination of surface effects is possible over the conventional cross-track scanning measurements.
25. It was recognised that high spectral resolution imaging radiometers on geostationary platforms are likely to be an important part of the future global observing system. It was recommended that a demonstration mission be conducted in the near future. GIFTS is the best current option for such a mission.
26. The group was concerned that critical climate monitoring instruments have been removed from NPOESS, specifically the loss of CrIS/ATMS in the 0530 orbit plane, removal of the limb instrument for ozone monitoring, and the Earth Radiation Budget sensors. Removal of CrIS/ATMS in the 0530 orbit seriously affects the monitoring of the diurnal cycle. The removal of ERBS breaks the climate series of a 30 year continuous climate sensor time series.

1.3 FUTURE PLANS

Immediately following the ITSC-XV meeting the process for the election of the new ITWG Co-Chairs began and new Co-Chairs were elected by December 2006. This ensures that following the success of the ITSC-XV meeting in October 2006 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 CIMSS and the email list server maintained by WMO.

In particular, more information suitable for education and training will be incorporated onto the Web site. A second workshop on radiative transfer modelling of the surface is planned to take place during 2008. Plans are being formulated for the next International Direct Broadcast Conference (date/time to be confirmed). EUMETSAT and CNES are hosting a workshop on the use of IASI data in Autumn 2007 which will build on the ITWG sponsored advanced sounder workshops. The links with international bodies such as the IRC, WMO and CGMS will be maintained and a report of this meeting will be made to forthcoming IRC and CGMS meetings.

In addition to this ITSC-XV Working Group Report, a Proceedings for ITSC-XV from the papers submitted will be provided to attendees and other interested persons on CD-ROM. The oral and poster presentations from ITSC-XV are already available as pdf files which can be downloaded from the ITWG Web site. The next meeting of the ITWG is planned for Spring 2008. Topics of interest will include 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 new 91 level dataset is available.

Action RTSP-2

Paul van Delst to ask Yong Han (STAR/JCSDA) to provide COSPAR profile set information to the RTSP-WG Chairs.

Action RTSP-3

Paul van Delst to inquire on the availability of the IASI balloon instrument ISRF data. This information should become available from CNES (T. Phulpin, <http://smc.cnes.fr/IASI>).

Action RTSP-4

Tom Kleespies and Paul van Delst will provide most relevant links on RTSP-WG Web page related to MetOp instruments and data as they become available.

Action RTSP-5

Tom Kleespies will post the AMSU-B RFI information to the group.

Action RTSP-6

Marco Matricardi will advertise an ECMWF technical memo on LBL model spectral differences when published.

Action RTSP-7

Paul van Delst will gather information on level-to-layer conversion methodologies (including any units conversion) and software and distribute to RTSP-WG members for consideration. TL and AD modules to be included.

Action RTSP-8

Yves Rochon and Louis Garand to provide the code of the proposed new vertical interpolator: forward interpolator and mapping of Jacobians from the fast RT layering to the NWP vertical coordinates (TL/AD/Gradient). A link will be put on the RTSP-WG Website to the code (pending approval from Canadian authorities).

Recommendation RTSP-1 to fast RT developers

Perform relative comparison between models for cloudy calculations. Evaluate the accuracy of cloudy radiance models with respect to speed and complexity (e.g., how many streams are needed). Additionally perform an absolute comparison between models and measured radiances.

Action RTSP-9

Paul van Delst will distribute information to RTSP-WG members on the availability of optical property databases. More specifically documentation on the optical property databases used within the CRTM will be provided.

Action RTSP-10

Fuzhong Weng will investigate how to better assess the PC-RTM adjoint performance.

Action RTSP-11

Paul van Delst and Fuzhong Weng will investigate making the Zeeman model of Yong Han available to ITSC community.

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, CRTM teams) should be reported before the next conference.

Recommendation RTSP-3 to NWP centers involved in hyperspectral radiance assimilation

Document the methodologies used to speed up the hyperspectral radiance assimilation. Post that information on their monitoring Web site which is accessible to other centers. Speed estimates for standard radiance volumes should also be provided in future intercomparisons.

Recommendation RTSP-4 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-12

Ben Ruston to update information on the archival and documentation of sources of emissivity information in the IR and MW on a centralised site (pending NWP-SAF proposal).

Action RTSP-13

Ben Ruston to investigate the interest for global comparisons of land skin temperature in both the NWP and retrieval communities.

Recommendation RTSP-5 to Co-Chairs of the second meeting on surface property modeling

Plan the Second Workshop on Remote Sensing and Modeling of Surface Properties for the spring of 2008 (avoiding interference with ITSC-XVI). Encourage LSM investigators to attend to discuss requirements for inputs to surface emissivity models. Also encourage experts in radiometric property modeling to attend.

Action RTSP-14

Paul van Delst to investigate the feasibility of incorporating the PROSPECT emissivity model in the CRTM.

Action RTSP-15

Lihang Zhou to provide link to AIRS Science Team meeting presentations of interest on the subject of emissivity retrieval methodology and validation.

Action RTSP-16

Louis Garand to provide a report on surface emissivity definition for radiance assimilation at NWP centers.

Action RTSP-17

Louis Garand to investigate the availability of the LMD surface emissivity database at 1 x 1 degree resolution providing high spectral resolution spectra suitable for AIRS and IASI applications.

Action RTSP-18

Ben Ruston to provide link to soil type database for emissivity modeling.

Action RTSP-19

Banghua Yan to provide information on current JCSDA research and future publications on snow emissivity estimates.

Action RTSP-20

Paul van Delst to provide report on comparison of compact OPTRAN and RTTOV gas absorption model in CRTM.

Action RTSP-21

Fiona Hilton to provide link to Una O’Keefe’s report on the intercomparison between RTTOV (just cloud absorption) and DOTLRT (Discrete Ordinate Tangent-Linear Radiative Transfer) models.

Action RTSP-22

Stefan Buehler to provide information on datasets for cloudy/scattering RT model input.

Recommendation RTSP-6 to RTTOV and CRTM developers

Compare RTTOV and CRTM cloudy/scattering calculations in both the IR and MW.

Action RTSP-23

Nicole Jacquinet (with colleague R. Armante) to provide links to validation datasets used at LMD for AIRS and IASI and general information on Thorpex, Eaquate and IASI balloon experiments.

Action RTSP-24

Fiona Hilton to contact Jon Taylor about access to the Eaquate dataset on the <http://badc.nerc.ac.uk> Web site and report back to the RTSP-WG.

TOVS/ATOVS IN CLIMATE

Action Climate-1

ITWG members led by John Bates – to activate the ITWG Climate WG Web site to provide a clearing house for datasets, current activities and plans for climate.

Action Climate-2

Links to assessment Web sites and references of climatologies should be added to the ITWG climate Web site (C. Stubenrauch, J. Bates, A. Kaifel).

Recommendation Climate-1 to Space Agencies

Space Agencies should ensure archival of all level 0 data along with any metadata for future use by the climate research and monitoring community.

Recommendation Climate-2 to Space Agencies

Satellite data archives must ensure the collection, retention, and provide access to complete metadata compatible with international standards (e.g., includes reference, context, provenance, and integrity information).

Recommendation Climate-3 to agencies

Communication channels within agencies and the international community relating to operational data reception and processing should incorporate climate requirements within an integrated GOS for NWP and climate. In turn the ITWG climate community must endeavour to tap into the appropriate information streams both locally and internationally to ensure that this happens.

Action Climate-3

John Bates to add to ITWG climate group Web page and act as an international focus for the provision of information regarding current and future developments to the satellite component of the GOS, and their implications. In particular to make available information relating to the status of the NPOESS project as and when publicly available.

Action Climate-4

The group members are asked to provide available information on future plans of satellite agencies and/or past actions helping in the interpretation of data streams to the Web page (e.g., known useful links

to Web pages or putting the information on a news page). This will need regular updates and monitoring by the group (e.g., adding information on performed satellite changes after the planned event).

Recommendation Climate-4 to reanalysis groups

Reanalysis groups should seek to work with the operational satellite climate centres on the optimal calibration and reprocessing of archived data sets. They also should send back to the relative operational centre any metadata obtained during or after the reanalysis.

Recommendation Climate-5 to WMO

ITWG strongly supports WMO for the continued efforts to develop GSICS for climate.

Recommendation Climate-6 to NESDIS

ITWG strongly supports NESDIS for the continued efforts to develop the GCOS Atmospheric Reference Observation Network (GARON) for climate with the primary objective of creating long term records of same-same critical upper air measurements and associated error characteristics to support their continuing integration in climate applications and research.

Action Climate-5

Tony Reale to collect existing data to quantify the impact and requirement for spatial and temporal coincidence of radiosonde, satellite and ground truth in-situ observations to inform GARON network operating principles.

Action Climate-6

ITWG to support pending programs to collect coincident satellite and radiosonde observations at ARM sites currently proposed for Aqua-AIRS (SGP, NGA and TWP; Revercomb and Tobin) and ATOVS (SGP; Reale and Lescht). Also to support analysis to quantify the requirement for spatial and temporal coincidence of radiosonde, satellite and ground truth observations in the development of GARON network operating principles. (Revercomb, Tobin, Reale, Lescht).

Action Climate-7

ITWG Radiative Transfer WG to provide updated knowledge on instrument characteristics Web links on the ITWG Web site.

Action Climate-8

ITWG Climate Group to post any information on satellite data reprocessing and sensor metadata updates on the ITWG Web site.

Recommendation Climate-7 to reprocessing and reanalysis centres

Provide reanalysed or reprocessed satellite data together with their metadata to the original satellite agency archiving centre.

Recommendation Climate-8 to Satellite Agencies and to GCOS

Ensure frequency continuity of microwave channels so that new instruments can be easily merged with MSU and AMSU data records.

Recommendation Climate-9 to Satellite Agencies and to GCOS

Strive for extended satellites overlap periods, for at least three years, by extension of missions beyond their nominal lifetime.

Recommendation Climate-10 to JAXA

The GCOM-W (Global Change Observation Mission-Winds) project should be pursued as a successor for AMSR-E data.

Recommendation Climate-11 from John Bates to IPO through Mitch Goldberg

The needs of the climate monitoring community for a continuous time series of sensors is to be taken into account in the planning of future satellites. The concerns of the Working Group regarding the IPO plans for NPOESS should be addressed to NOAA.

Recommendation Climate-12 to IPO

OMPS limb sounding capabilities should be made available on NPP and NPOESS.

Recommendation Climate-13 to space agencies

Future operational missions should carry high precision instruments for monitoring of climate critical gases (e.g., CH₄, CO and CO₂) and aerosols.

Recommendation Climate-14 to satellite instrument providers/space agencies and to GCOS

Work on inter-calibration and the definition of a (common) reference needs to be coordinated. The climate-user community needs access to all information concerning calibration and inter-calibration of the different sensors, both within a satellite series of a single provider and for the different polar orbiting systems.

Recommendation Climate-15 to space agencies and to GCOS

ITWG suggest all space agencies consider spacecraft maneuvers to investigate sensor calibration at some stage in the life of the spacecraft.

Action Climate-9

ITWG to thank NESDIS for the NOAA-14 pitch test and suggest this be done at some stage during the lifetime of current platforms (e.g., NOAA-15 to 18).

Recommendation Climate-16 to EPS NRT users (National Meteorological Services)

Prepare for the generation of IASI sub-sampled datasets (spectral, spatial, temporal) suitable for the use in climate monitoring studies from the IASI NRT data streams, and generate local archives hosting these subsets for further use.

Action Climate-10

ITWG members to circulate NRT planned IASI processing activities for climate (e.g., M. McCarthy for Met Office plans).

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

Recommendation DA/NWP-1 to satellite agencies

The Working Group feels that the notification of users about significant changes to current and future observation systems has not been sufficient. For example, information concerning the turning on of the RADCAL instrument on the DMSP F-15 satellite was not communicated quickly enough to the users to react. Also the cancellation of the HES instrument was not widely advertised. Early communication of these decisions is necessary for planning and preparation by the NWP community

Action DA/NWP-1

All members of the Working Group to examine the mail list for missing e-mail addresses. Steve English to maintain and update the e-mail list.

Action DA/NWP-2

NWP WG Co-Chairs to ask developers of software packages (e.g., JCSDA and NWPSAF) to announce new software releases on the ITWG mailing list.

Action DA/NWP-3 (open from ITSC-XIV)

Tony McNally to provide information from the ITWG NWP survey on the ITWG NWP group Web pages and if possible to allow updating as operational systems change.

Action DA/NWP-4

Walter Wolf to email content and format of MODIS BUFR dataset to ITWG NWP mailing list for comment.

Action DA/NWP-5

Walter Wolf to provide AIRS MODIS dataset and MODIS BUFR dataset as soon as possible on NOAA server.

Action DA/NWP-6

NWP centres to evaluate both MODIS datasets.

Recommendation DA/NWP-2 to SSMIS user community

The WG encourages development and implementation of a single SSMIS data correction and selection method.

Action DA/NWP-7

NRL, Met Office and NESDIS to participate in and report the results of unification of operational SSMIS processing, calibration (including corrections applied going from antenna temperatures to brightness temperatures) and distribution by April 2007.

Action DA/NWP-8

Nancy Baker to report on DMSP-F17 cal/val and data distribution plans.

Recommendation DA/NWP-3 to science community (also AS-6)

The group encourages research into investigating some of the theoretical benefits of a combined microwave imager sounder (for example, it may help with assimilation over difficult emissivity surfaces) relative to the conventional cross-track scanning sounders.

Recommendation DA/NWP-4 to NWPSAF and JCSDA.

Continue on going collaboration on RT development and report on progress to ITWG.

Action DA/NWP-9

NWP WG Co-Chairs to ask Roger Saunders and Paul van Delst to circulate report to NWP WG mailing list and to present at next ITSC.

Recommendation DA/NWP-5 to WMO

Continue to support fast delivery initiatives (e.g., RARS), extending this where possible (e.g., Hawaii). However, the 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.

Action DA/NWP-10

NWP WG Co-Chairs to bring recommendation DA/NWP-5 to the attention of WMO.

Recommendation DA/NWP-6 to IPO

The short operational delivery time of NPOESS data to NWP centres is an extremely attractive component of the system design. The group would like to ensure that this component be retained in the restructuring of the NPOESS program.

Action DA/NWP-11

John Derber to ask JCSDA and NESDIS to present recommendation DA/NWP-6 to IPO.

Recommendation DA/NWP-7 to all satellite agencies

Operational NWP centres 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-12

John Derber and Stephen English to ask ITWG Co-Chairs to ensure recommendation DA/NWP-7 is conveyed to all satellite agencies and operational NWP centres via appropriate international bodies (e.g., CGMS).

Recommendation DA/NWP-8 to space agencies

A three orbit system (ideally equally separated) of microwave and IR polar orbiting instruments has been shown to produce positive impact over a two orbit system. The group recommends consideration of a three orbit system containing state of the art microwave and IR sounders in each orbit.

Action DA/NWP-13

NWP WG Co-Chairs to pass recommendation DA/NWP-8 to WMO and space agencies.

Action DA/NWP-14 (open action from ITSC-XIV)

John LeMarshall to ensure establishment of the NPP non-GTS data distribution policy for countries outside the United States and report to the WG.

Action DA/NWP-15

Thomas Auligné and Tony McNally to propose a method for communicating a subset of the monitoring for IASI and set up a system for producing a Web-based display of participating centres results. The proposal will be sent to WG members for suggestions and approval through the NWP WG mailing list.

Recommendation DA/NWP-9 to satellite agencies and WMO

The WG encourages research and operational satellite agencies to work together towards developing the next generation of operational satellites.

Action DA/NWP-16

NWP WG Co-Chairs to pass recommendation DA/NWP-9 to WMO and space agencies.

Action DA/NWP-17

John Derber and Stephen English to ask ITWG Co-Chairs to ensure recommendation DA/NWP-9 is conveyed to all satellite agencies via appropriate international bodies (e.g., CGMS).

Recommendation DA/NWP-10 to satellite agencies and WMO

The geostationary orbit is ideal for observing the rapidly changing components of the atmospheric fields. The WG recommends the development of a demonstration system observing with high spectral resolution IR and/or microwave instruments. Ideally if both missions are possible the microwave and IR instruments should observe the same portion of the atmosphere at the same time.

Action DA/NWP-18

NWP WG Co-Chairs to pass recommendation DA/NWP-10 to WMO and space agencies.

Recommendation DA/NWP-11 to satellite agencies and WMO

Conical microwave imagers have a well established role in NWP which the WG wished to continue. The WG expressed concern that there could be a loss of continuity in microwave imagery in the NPOESS era.

Action DA/NWP-19

NWP WG Co-Chairs to pass recommendation DA/NWP-11 to WMO and space agencies.

Recommendation DA/NWP-12 to satellite agencies and NWP centres

The WG would like to encourage the development of an international effort directed towards improving the observing system design. The EUCOS (EUMETNET Composite Observing System) is an example. OSSEs are one tool that can be used for the observing system design problem; however, they must be done very carefully to ensure that they are unbiased and properly estimate the impact of new observing systems.

Action DA/NWP-20

John Derber will distribute an initial template for OSSE experiments to the WG for comment and enhancement.

Action DA/NWP-21

NWP WG to continue to update the NWP WG Web page with assistance of Leanne Avila.

Action DA/NWP-22

NWP WG Co-Chairs to review the status of the actions and recommendations in April 2007 and at regular intervals before ITSC-XVI and email a status report to WG members and ITWG Co-Chairs.

Action DA/NWP-23

NWP WG Co-Chairs to solicit ideas through NWP WG mailing list for WG topics 1 month prior to ITSC-XVI.

ADVANCED SOUNDER WORKING GROUP REPORT

Recommendation AS-1 to the space agencies

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 recommended that a demonstration mission be conducted in the near future. GIFTS is the best current option for such a mission.

Recommendation AS-2 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 should be communicated from the users (i.e., NWP, RT modellers, climate researchers) to the data providers.

Recommendation AS-3 to the space agencies

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 and ARIES airborne sensors, and upper air reference networks need to be added to complementary data sources, such as NWP, in order to validate the radiances and derived products to the very high accuracy and precision specified by the users.

Recommendation AS-4 to EUMETSAT/CNES

Cal/Val efforts for IASI should focus on establishing the in-orbit performance in order that early lessons can be learned for pre-flight testing of future interferometer sounders.

Recommendation AS-5 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.

Recommendation AS-6 to the science community (also DA/NWP-3)

The group encourages research into investigating some of the theoretical benefits of a combined microwave imager sounder (for example it may help with assimilation over difficult emissivity surfaces) relative to the conventional cross-track scanning sounders.

Recommendation AS-7 to the ITWG (also SSSP-4)

It is recommended that trade-off studies be performed to determine the optimal field of view size for the CrIS, considering existing detector noise performance and the desire to increase the density of cloud free sounding observations as a result of decreasing the field of view size. As a first step, a comparison of the yield of MetOp-1 HIRS/4 clear air data versus NOAA 17 HIRS/3 data should be conducted.

Action AS-1 to whoever performs the above study

Once results are available, this item should be brought before the SOAT and/or JCSDA, to determine if a recommendation to the IPO is justified (i.e., to reduce the CrIS FOV size of 14 km to 10 km or less).

Recommendation AS-8 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-9 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-2

Bjorn Lambrigtsen to make a draft table summarising the requirements for microwave sounding systems.

Recommendation AS-10 to the space Agencies

The WMO IGEOLAB concept should be supported.

Recommendation AS-11 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-12 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 transmission and archiving of satellite data be lossless.

Recommendation AS-13 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-14 to the space agencies

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

Recommendation AS-15 to the space agencies

ITWG strongly recommends that certain elements of future operational satellite systems (e.g., the data processing, algorithm and product development system, the evaluation and validation, and the training and outreach programmes), should be led by government agencies. It is also recommended that the users of the satellite system play a key role in the definition of the characteristics of this system.

INTERNATIONAL ISSUES AND FUTURE SYSTEMS

Recommendation II/FS-1 to WMO Space Programme

The WMO Space Programme with CGMS assistance, should continue to promote the implementation of a globally coordinated system of RARS encouraging the development of the South-American and Asia-Pacific RARS and also ensuring coverage over Africa. To extend the coverage over Africa, Gough and Marion Islands, Pretoria and Reunion HRPT stations should be considered. Honolulu and Tahiti HRPT stations should be considered to enlarge Asia-Pacific RARS coverage over the Western Pacific.

Action II/FS-1

WMO Space Programme to enhance user information about RARS through the WMO RARS Web site.

Recommendation II/FS-2 to HRPT station operators

RARS stations to upgrade HRPT stations in order to allow IASI data retransmission.

Recommendation II/FS-3 to space agencies

Space agencies explore the possibility of flying an upgraded AVHRR-like sensor with a water vapour channel centred near 6.7 microns on future polar satellites in order to ensure the continuity of good quality polar atmospheric motion vectors beyond Terra and Aqua.

Recommendation II/FS-4 to satellite agencies

Satellite agencies operating environmental polar satellites to provide or continue to provide a DB 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.

Action II/FS-2

ITWG Webmaster to expand the ITWG education Web page by linking to the international education program developer's sites and by encouraging these developers to use the ITWG education page as part of their resources and curriculum. Also to use the resources of the ITWG to help disseminate information to the international community about the education opportunities available.

Recommendation II/FS-5 to ITWG Co-Chairs

The ITSC-XV Working Group Report Executive Summary should encourage the satellite operators and product developers to financially support a strong education program, both within their region and internationally.

Action II/FS-3

ITWG members who are education material developers and providers (P. Antonelli, K. Strabala, EUMETSAT, etc.) to contact WMO Space Programme Department and the other international agencies to pursue the possibility of a certification for education programs.

Recommendation II/FS-6 to ITWG Co-Chairs

The ITSC-XV Working Group Report Executive Summary should encourage the organization of a workshop to bring together the scientists who are involved in environmental remote sensing education and outreach programs to present their past and present activities and to co-ordinate future initiatives.

Recommendation II/FS-7 to NOAA and DOD

NOAA and DOD consider options to fund reinstatement of sensors removed from NPOESS based on assessment by US and International users.

Action II/FS-4

M. Goldberg to NPOESS Joint Agency Requirements Group (JARG) to request the assessment of a microwave imager only solution as replacement for the CMIS, and replace the loss of soundings with ATMS in the 0530 orbit plane.

Action II/FS-5

M. Goldberg to IPO to assess cost savings of adding ATMS and/or CrIS in the 05:30 orbit in case of an early failure of either IASI/AMSU (10:00 orbit) or CrIS/ATMS (13:30 orbit). Cost assessment should include savings due to delaying a new launch for a single instrument failure as well as cost benefits for ensuring likelihood of having three sounders in different orbits.

Recommendation II/FS-8 to IPO and NASA

Consider including CERES on NPP instead of NPOESS-C1.

Action II/FS-6

Pete Wilczynski to provide a schedule (timetable) of availability of data format(s) for NPP/NPOESS real time Low Rate Data (LRD) & High Rate Data (HRD) as soon as practical.

Recommendation II/FS-9 to all space agencies

Provide expected formats of level 1b and level 2 datasets at least one year prior to launch. Establish Web sites to provide detailed information on instruments, schedule, products and formats.

Recommendation II/FS-10 to NWP and Climate Modelling Centres

Studies should continue to be conducted to 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 II/FS-11 to Space Agencies

Future passive sensors should be designed to detect potential anomalies, corrupt data or interference in order to report to national Administrations and international organisations in frequency management for further action. As a matter of urgency, the frequency bands which should be considered are the following:

1400-1427 MHz	10.6-10.7 GHz	18.6-18.8 GHz	23.6-24 GHz	31.3-31.5 GHz
36-37 GHz	50.2-50.4 GHz	52.6-54.25 GHz.		

Action II/FS-7

Jean Pla to provide a list of existing documents addressing the use of microwave passive bands; and to produce additional documents if necessary on related topics and to contribute to the update or improvement of those existing documents with a view to disseminate corresponding information to administrations and international organizations dealing with frequency management.

Action II/FS-8

Jean Pla to update the ITWG Web site dealing with frequency protection (see <http://cimss.ssec.wisc.edu/itwg/groups/frequency/>)

SATELLITE SOUNDER SCIENCE AND PRODUCTS

Action SSSP-1

L. Lavanant and L. Avila to

- Continue the search and solicitation of inputs for the HRPT area of the SSSP Web site using the existing survey and HRPT site list.
- Set up a tabular format to summarize HRPT sites and available information.
- Set up a mailing list of participating HRPT sites.

Action SSSP-2

L. Lavanant, M. Dumont, D. Griersmith, D. Lee, N. Atkinson to update the existing EARS Web page to include information on the RARS network.

Recommendation SSSP-1 to EUMETSAT and NOAA/NESDIS

A capability to routinely retain and provide retrospective access to selected portions of raw and pre-processed observations from “operational” satellites by operational centres and selected EARS / RARS facilities should be pursued.

Action SSSP-3

SSSP Co-Chairs to develop and forward above recommendation to NOAA and EUMETSAT and EARS / RARS facilitators.

Action SSSP-4

SSSP Co-Chairs to develop a dedicated SSSP Web site area as central location for storing and accessing such observations arising from Recommendation SSSP-1.

Action SSSP-5

SSSP Co-Chairs, H. Bloom, A. Huang, N. Atkinson, D. Chaohua to request information from space agencies on processing packages for direct broadcast data and facilitate the creation of links to the information via the SSSP Web site.

Action SSSP-6

A. Kaifel, P. Schlüssel, N. Atkinson, R. Saunders to

- Determine the current status of planned instrument co-registration onboard MetOp and planned NPP and NPOESS satellites.
- Define requirements for additional instrument co-registration.
- Encourage processing package providers (EUMETSAT, CIMSS) to incorporate available co-registration procedures.
- Provide information and status on SSSP Web site.

Recommendation SSSP-2 to CNES and EUMETSAT

Satellite agencies are requested to provide available status information for MetOp IASI level-1 data, including during the 8-month commissioning phase (CNES) and also for AVHRR, AMSU, MHS, HIRS, ASCAT, GRAS and available level-2 products (EUMETSAT).

Recommendation SSSP-3 to NOAA/IPO and NSMC

Satellite agencies are requested to provide information on the status of preparations for NPP, NPOESS and FY-3 platforms.

Action SSSP-7

SSSP Co-Chairs

- Forward the above recommendations to satellite agencies and provide links to the information on the SSSP Web site.

- Include links to MetOp operational daily monitoring reports of level-1 including ASCAT and GRAS (for example from ECMWF, UKMO, NOAA and Meteo-France) after the commissioning phase.

Action SSSP-8

H. Bloom, D. Chaohua, N. Atkinson, A. Huang, SSSP Co-Chairs,

- Report on the strategy of ensuring local/global coherence for IMAPP (Aqua)
- Report on the strategy for NPP, FY-3 and NPOESS local/global coherence through contacts with national agencies and direct readout package developers responsible for software and data output data formats.
- Provide status and the information on the SSSP Web site.

Action SSSP-9

Tony Reale, Peter Schlüssel, Thomas King

- Report on the availability of processed data and products from NOAA and EUMETSAT.
- Recommend the agencies coordinate their efforts of data dissemination and validation.
- Advertise how to access MetOp global operational products and to put the information on the SSSP Web site including a tabular summary describing available products, data formats, metadata and software for reading data files.
- Put information on the SSSP Web site on disseminated product validation.

Action SSSP-10

Tom Kleespies, Cheng-Zhi Zou, Nigel Atkinson, Roger Saunders

- Identify source information on instrument performance characteristics for HIRS, MSU, SSU, AMSU-A, AMSU-B (including RFI) and MHS (including RFI).
- Provide access to available historical and current (in real-time) SNO data and associated corrections (metadata); and predicted (future) SNO points for selected instruments. (Note: at this time there are historical SNO points and derived inter-satellite adjustments for HIRS and MSU on a CD (perhaps only for MSU). Information on future SNO points and capability to inquire per sounder etc. are likely not routinely available but would be beneficial.)

Recommendation SSSP-4 to NOAA, CIMSS and EUMETSAT (also AS-7)

These agencies are encouraged to investigate the impact of the 10 km vs. 17 km field of view with respect to improved cloud detection and cloud clearing.

Action SSSP-11 to SSSP Co-Chairs

- Forward Recommendation SSSP-4 to respective NOAA and CIMSS scientists to investigate the impact of the higher resolution (10 km) HIRS on cloud detection and sounding products.
- Forward Recommendation SSSP-4 to EUMETSAT scientists to quantify the impact of higher resolution HIRS with coincident IASI data on MetOp.

Action SSSP-12

Co-Chairs, Walter Wolf, all WG members

- Investigate and report on opportunities and feasibility of further developing the validation areas.
- Coordinate the expansion of the designated “Validation” topic area of the SSSP Web site to provide an efficient validation tool.

Action SSSP-13

SSSP Co-Chairs, all SSSP WG members

- Solicit willing SSSP WG members to take the responsibility of selected product areas in the SSSP site.
- Solicit willing SSSP WG members to undertake a review of the overall site layout and specific topic areas and in conjunction with the Co-Chairs and Webmaster to oversee modifications.
- Activate SSSP WG mailing list to facilitate these activities and overall member interaction.

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), Tom Kleespies, Shawn Turner, Stefan Buehler, Marco Matricardi, Nicole Jacquinet, Lihang Zhou, Banghua Yan, Martin Stengel, Jose Antonio Aravequia, Rodrigo Augusto F. de Souza, Fiona Hilton, Pascal Brunel, Benjamin Ruston, Fuzhong Weng, Adam Dybbroe

The group focused on the issues related to atmospheric radiative transfer (RT) and surface property (SP) models which are relevant for radiance assimilation as well as atmospheric and surface retrievals from infrared and microwave sounder or imager data. At ITSC-XV, the group first reviewed the actions from ITSC-XIV. The main accomplishments related to these actions were:

- a) Completion of the AIRS Radiative Transfer inter-comparison with a journal article to appear in JGR.
- b) A first workshop on surface property modeling was held in Paris, France (June 2006). Presentations are available from a link posted on the ITWG Web site.
- c) A special issue is to appear in the Journal of Atmospheric Science in early 2007 consisting of a series of papers summarizing the progress on the modeling of radiation in cloud/precipitating atmospheres.
- d) A new vertical interpolator with good Jacobian mapping characteristics between NWP and RT vertical coordinates has been developed. Code will be made available to the community.
- e) Steady progress was reported at ITSC-XV on the development of new RT capabilities within the RTTOV and CRTM fast RT models.
- f) A major update of the structure and contents of the RTSP-WG portion of the ITWG Web site. This included detailed information on fast and LBL models, links to surface emissivity databases, spectroscopic databases, instrument characteristics, information on adjoint coding etc.

The new action items listed below are to be completed by April 1, 2007.

2.1.1 Profile datasets

Marco Matricardi reported that a new 91 level dataset, including trace gases, to be used for training RTTOV will be available next year.

Action RTSP-1

Marco Matricardi to announce to the RTSP-WG when the new 91 level dataset is available.

The COSPAR (Committee on Space Research) dataset with upper level profile data is now available.

Action RTSP-2

Paul van Delst to ask Yong Han (STAR/JCSDA) to provide COSPAR profile set information to the RTSP-WG Chairs.

2.1.2 Instrument characteristics

The IASI balloon instrument SRF information was advertised to the group.

Action RTSP-3

Paul van Delst to inquire on the availability of the IASI balloon instrument ISRF data. This information should become available from CNES (T. Phulpin, <http://smc.cnes.fr/IASI>).

The characteristics of the MetOp suite of instruments was discussed. General and specific information is available from:

http://www.eumetsat.int/Home/Main/What_We_Do/Satellites/EUMETSAT_Polar_System/Space_Segments/index.htm?l=en

Action RTSP-4

Tom Kleespies and Paul van Delst will provide most relevant links on RTSP-WG Web page related to MetOp instruments and data as they become available.

The history of the AMSU-B RFI coefficients in the on-line user guide was reviewed.

Action RTSP-5

Tom Kleespies will post the AMSU-B RFI information to the group.

2.1.3 Line by Line (LBL) modeling

There is a need to identify the spectral regions (or channels) where LBL model or spectroscopy differences would be of the greatest concern to fast RT model users.

Action RTSP-6

Marco Matricardi will advertise an ECMWF technical memo on LBL model spectral differences when published.

A unique spectral response function shape for all IASI channels can be used. This function will be made available on the RTSP-WG site. This is part of RTSP-4.

2.1.4 Fast RT modeling

The issue of level or layer input to fast RT models was discussed by the group.

Action RTSP-7

Paul van Delst will gather information on level-to-layer conversion methodologies (including any units conversion) and software and distribute to RTSP-WG members for consideration. TL and AD modules to be included.

Concerning vertical profile interpolator software and its TL and AD, new methodology and software have been developed to solve the “blind level” problem, i.e. using all input levels to generate an output. There was a presentation made at ITSC-XV on this topic. A paper should appear next year in QJRMS.

Action RTSP-8:

Yves Rochon and Louis Garand to provide the code of the proposed new vertical interpolator: forward interpolator and mapping of Jacobians from the fast RT layering to the NWP vertical coordinates (TL/AD/Gradient). A link will be put on the RTSP-WG Web site to the code (pending approval from Canadian authorities).

The issue of the accuracy of cloudy radiance modeling was raised. Future inter-comparisons of RT models should involve cloudy atmospheres. Input data for models is not easily obtainable as there are measurements of radiances, but no associated microphysics, or measurements of microphysics but no radiances. Fiona Hilton will survey the <http://badc.nerc.ac.uk> site to determine what measured cloudy model input data (e.g., particle size, water content) and associated measured radiances are available. Similarly, Ben Ruston will contact the IPWG at NRL to identify the availability of observed cloud microphysical parameters.

Recommendation RTSP-1 to fast RT developers

Perform relative comparison between models for cloudy calculations. Evaluate the accuracy of cloudy radiance models with respect to speed and complexity (e.g., how many streams are needed). Additionally perform an absolute comparison between models and measured radiances.

Regarding the databases of particle shapes used to derive cloudy optical properties, and the associated software they will be very useful for the recommendation RTSP-1.

Action RTSP-9

Paul van Delst will distribute information to RTSP-WG members on the availability of optical property databases. More specifically documentation on the optical property databases used within the CRTM will be provided.

For the new Principal Component RTMs the question of how to fairly compare the adjoint of a PC RTM with “traditional” models was discussed. This issue was raised in the Saunders *et al.* (2006) AIRS RT model inter-comparison paper.

Action RTSP-10

Fuzhong Weng will investigate how to better assess the PC-RTM adjoint performance.

There is now consensus that the Zeeman effect at microwave frequencies for channels which have weighting functions that peak in the upper stratosphere or mesosphere should be accounted for.

Action RTSP-11

Paul van Delst and Fuzhong Weng will investigate making the Zeeman model of Yong Han available to ITSC community.

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, CRTM teams) should be reported before the next conference.

Improving the speed of fast RT models is important. How do we make them faster? Options are the model parameterisation, the code structure, parallelisation issues (OpenMP/MPI), hardware issues, or combinations thereof that could be improved.

Recommendation RTSP-3 to NWP centers involved in hyperspectral radiance assimilation

Document the methodologies used to speed up the hyperspectral radiance assimilation. Post that information on their monitoring Web site which is accessible to other centers. Speed estimates for standard radiance volumes should also be provided in future intercomparisons.

It was reported that fast model developers are now considering extending their models to the Visible/Near Infrared part of the spectrum.

Recommendation RTSP-4 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.

2.1.5 Surface property modeling

A discussion on the surface property modeling led to the following actions and recommendations.

Action RTSP-12

Ben Ruston to update information on the archival and documentation of sources of emissivity information in the IR and MW on a centralised site (pending NWP-SAF proposal).

Action RTSP-13

Ben Ruston to investigate the interest for global comparisons of land skin temperature in both the NWP and retrieval communities.

Recommendation RTSP-5 to Co-Chairs of the second meeting on surface property modeling

Plan the Second Workshop on Remote Sensing and Modeling of Surface Properties for the spring of 2008 (avoiding interference with ITSC-XVI). Encourage LSM investigators to attend to discuss requirements for inputs to surface emissivity models. Also encourage experts in radiometric property modeling to attend.

Action RTSP-14

Paul van Delst to investigate the feasibility of incorporating the PROSPECT emissivity model in the CRTM.

Bob Knuteson (SSEC/UW-Madison) and the ARM group have done an intercomparison of global surface emissivity maps retrieved from AIRS and SEVIRI data. They generally agree well but over desert there are disagreements. The RTSP-WG group should have access to these kind of studies.

Action RTSP-15

Lihang Zhou to provide link to AIRS Science Team meeting presentations of interest on the subject of emissivity retrieval methodology and validation.

Information on how NWP centers define surface emissivity for the purpose of radiance assimilation is of interest to this group.

Action RTSP-16

Louis Garand to provide a report on surface emissivity definition for radiance assimilation at NWP centers.

Action RTSP-17

Louis Garand to investigate the availability of the LMD surface emissivity database at 1 x 1 degree resolution providing high spectral resolution spectra suitable for AIRS and IASI applications.

Action RTSP-18

Ben Ruston to provide link to soil type database for emissivity modeling.

Snow emissivity estimates are not yet accurate. Eric Wood (Princeton) is working on the snow emissivity problem through JCSDA (intercomparison of three models with CRTM code).

Action RTSP-19

Banghua Yan to provide information on current JCSDA research and future publications on snow emissivity estimates.

2.1.6 Model intercomparisons

Action RTSP-20

Paul van Delst to provide report on comparison of compact OPTRAN and RTTOV gas absorption model in CRTM.

Fast RT cloudy/scattering model comparisons were discussed. There is an NWP-SAF project to compare RTTOV against a reference. Also, details regarding the model inputs for these comparisons still need to be worked out, e.g., conversion of model inputs dominates the error in the comparisons.

Action RTSP-21

Fiona Hilton to provide link to Una O'Keefe's report on the intercomparison between RTTOV (just cloud absorption) and DOTLRT (Discrete Ordinate Tangent-Linear Radiative Transfer) models.

Action RTSP-22

Stefan Buehler to provide information on datasets for cloudy/scattering RT model input.

Recommendation RTSP-6 to RTTOV and CRTM developers

Compare RTTOV and CRTM cloudy/scattering calculations in both the IR and MW.

2.1.7 Validation datasets

Nicole Jacquinet provided an update on the availability of observational datasets for line-by-line (LBL) model validation. However, there are issues with some of these datasets, e.g.

- Access can be difficult.
- Description of the conditions of observations (e.g., ozone, CO, mixing ratio, clear/cloudy situation) and description of instrumental characteristics (e.g., ISRF, S/N ratio) are sometimes insufficiently documented.
- Atmospheric conditions do not extend to very humid atmospheres to validate the formulation of the continua for example.

More information on upcoming experiments would facilitate communication with campaign PIs to address the above issues where appropriate.

Action RTSP-23

Nicole Jacquinet (with colleague R. Armante) to provide links to validation datasets used at LMD for AIRS and IASI and general information on Thorpex, Eaquate and IASI balloon experiments.

Action RTSP-24

Fiona Hilton to contact Jon Taylor about access to the Eaquate dataset on the <http://badc.nerc.ac.uk> Web site and report back to the RTSP-WG.

2.2 TOVS/ATOVS IN CLIMATE

Working Group members: John Bates (Co-Chair), Claudia Stubenrauch (Co-Chair), Mitch Goldberg, Anton Kaifel, Graeme Kelly, Bożena Lapeta, Mark McCarthy, Tony Reale, Masami Sakamoto, Peter Schlüssel, Nathalie Selbach, Cheng-Zhi Zou

2.2.1 Quality of existing climate records

The record length of TOVS/ATOVS now exceeds 27 years and the quality and number of climate products continues to grow. A sign of the success of these efforts, and the commitment to the importance of climate studies to society is that there are now efforts emerging to support the routine, operational production of Climate Data Records (CDRs) at several different centers.

Definitions:

- A CDR is a time series of sufficient length, consistency, and continuity to determine climate variability and change.
- Fundamental CDRs (FCDRs) are sensor data (e.g., calibrated radiances, brightness temperatures, radar backscatter) that have been improved and quality controlled over time, together with the ancillary data used to calibrate them.
- Thematic CDRs (TCDRs) are geophysical variables derived from the FCDRs, specific to various disciplines, and often generated by blending satellite observations, in-situ data, and model output.

The Global Climate Observing system (GCOS) has attempted to define requirements for CDRs by establishing a sub-set of essential climate variables in its report¹ for the ocean, atmosphere, and land. As a result, the ITWG Climate WG report should give a more complete set of references to datasets (including reprocessing), reanalyses, current activities and ongoing plans and assessments, hosted on a Web site.

Action Climate-1

ITWG members led by John Bates – to activate the ITWG Climate WG Web site to provide a clearing house for datasets, current activities and plans for climate.

2.2.1.1 Assessments of climatologies

In the last years many efforts have been undertaken to produce climate records on different variables, like radiation, temperature, precipitation, cloud properties, aerosols and trace gases. Within the framework of IPCC and of GEWEX, assessments have been established to evaluate the quality of these datasets. The GEWEX precipitation assessment will be finalized by the end of 2006. GEWEX surface radiation budget, cloud and aerosol assessments are in progress.

Action Climate-2

Links to assessment Web sites and references of climatologies should be added to the ITWG climate Web site (C. Stubenrauch, J. Bates, A. Kaifel).

2.2.2 Plans and challenges for climate observations from satellites and relations to operational centers

2.2.2.1 Climate Operational Processing

Detecting climate change, understanding and attributing change to specific climate processes, and projecting climate impacts on the Earth system requires, among other capabilities, a long-term (many decades) consistent and comprehensive observing system. Many climate trends are small and can only be

¹ National Research Council, 2004: Climate Data Records from Environmental Satellites. National Academy Press, Washington, D. C., 150.

distinguished from short-term variability through careful analysis of long time series. Short data records or long gaps in the records can make such detection and analysis much more uncertain and costly. Projecting climate trends and impacts requires a comprehensive suite of measurements ranging from physical variables such as sea surface temperature, wind stress and water vapor to biogeochemical variables such as oceanic chlorophyll and land cover. To confidently detect small climate shifts requires instrument accuracy and stability better than generally required for weather research. While research-driven missions have revealed many of the important science issues, helped define observing requirements, and tested new technology, sustaining these observing systems without gaps is an essential component of understanding, monitoring, and predicting climate variability and change.

Recommendation Climate-1 to Space Agencies

Space Agencies should ensure archival of all level 0 data along with any metadata for future use by the climate research and monitoring community.

Recommendation Climate-2 to Space Agencies

Satellite data archives must ensure the collection, retention, and provide access to complete metadata compatible with international standards (e.g., includes reference, context, provenance, and integrity information).

2.2.2.2 Relations with operational centers

The satellite component of the Global Observing System (GOS) is an invaluable resource for climate. For the purposes of climate monitoring it is vital to provide strong constraints on the GOS to ensure stability and continuity of methods such that the uncertainty in the long-term data record is smaller than the subtle climate signatures to be detected. Considerable effort has gone into the calibration of historical satellite data for the generation of climate data records, but climate monitoring activities are also strongly dependent upon the near-real time processing of data and future developments to the GOS. Therefore, it is imperative that the GOS reflects the operational requirements of both NWP and climate. The climate user community requires timely information regarding proposed operational changes to satellite programs and data processing, and in turn it must communicate its requirements clearly in response to any such proposals.

A recent example with the end of life of NOAA-14 has made it clear that any future changes to the operational processing should be on the ITWG climate Web site.

Recommendation Climate-3 to agencies

Communication channels within agencies and the international community relating to operational data reception and processing should incorporate climate requirements within an integrated GOS for NWP and climate. In turn the ITWG climate community must endeavour to tap into the appropriate information streams both locally and internationally to ensure that this happens.

Action Climate-3

John Bates to add to ITWG climate group Web page and act as an international focus for the provision of information regarding current and future developments to the satellite component of the GOS, and their implications. In particular to make available information relating to the status of the NPOESS project as and when publicly available.

Action Climate-4

The group members are asked to provide available information on future plans of satellite agencies and/or past actions helping in the interpretation of data streams to the Web page (e.g., known useful links to Web pages or putting the information on a news page). This will need regular updates and monitoring by the group (e.g., adding information on performed satellite changes after the planned event).

2.2.2.3 Reanalysis activities

It is important that the ITWG climate Web site contains details of all reanalysis efforts including documentation of any reprocessing of satellite data used and any problems with these datasets.

Recommendation Climate-4 to reanalysis groups

Reanalysis groups should seek to work with the operational satellite climate centres on the optimal calibration and reprocessing of archived data sets. They also should send back to the relative operational centre any metadata obtained during or after the reanalysis.

2.2.3 Use of ancillary data in climate studies

2.2.3.1 Improved Accuracy and Calibration of Remote Sensing Measurements

In order to achieve improved calibration, the ITWG strongly recommends that satellite agencies support the new WMO Global Space based Inter-calibration System (GSICS) to improve the use of space-based global observations for weather, climate and environmental applications through operational inter-calibration of the space component of the World Weather Watch (WWW)'s GOS and GEOSS. The ITWG recommends research and operational satellite agencies to establish reference measurements in space, as well as on ground and in air that will enable absolute inter-calibration (e.g., a spectrally resolving infrared radiometer). This inter-calibration system would quantitatively relate the radiances from different sensors viewing the same target to allow consistent measurements to be taken over the globe by all elements of the space-based component of the World Weather Watch's Global Observing System. In addition, it would provide the ability to retrospectively re-calibrate archived satellite data using the operational inter-calibration system in order to make satellite data archives worthy for climate studies.

Recommendation Climate-5 to WMO

ITWG strongly supports WMO for the continued efforts to develop GSICS for climate.

2.2.3.2 In situ networks

Under the auspices of the Atmospheric Observations Panel for Climate (AOPC) Working Group on upper-air reference observations a report has been produced that outlines the scientific justification, principles, and station requirements for a GCOS Atmospheric Reference Observation Network (GARON) for climate. This is the result of two international workshops organised by GCOS and NOAA. Continued work in this area will be led by the AOPC Working Group and incorporate the wider community and WMO in order to implement such a network.

The complexity and magnitude of this undertaking is acknowledged, and the importance of such a program to standardize (normalize) the long-term records of evolving satellite and ground data platforms cannot be overstated. Critical areas include emphasis on the importance of providing observations which are "synchronized" with operational polar satellite overpass, and sufficient protocols to collectively manage the compilation of observations at each globally distributed GARON site.

Recommendation Climate-6 to NESDIS

ITWG strongly supports NESDIS for the continued efforts to develop the GCOS Atmospheric Reference Observation Network (GARON) for climate with the primary objective of creating long term records of same-same critical upper air measurements and associated error characteristics to support their continuing integration in climate applications and research.

Action Climate-5

Tony Reale to collect existing data to quantify the impact and requirement for spatial and temporal coincidence of radiosonde, satellite and ground truth in-situ observations to inform GARON network operating principles.

Action Climate-6

ITWG to support pending programs to collect coincident satellite and radiosonde observations at ARM sites currently proposed for Aqua-AIRS (SGP, NGA and TWP; Revercomb and Tobin) and ATOVS (SGP; Reale and Lescht). Also to support analysis to quantify the requirement for spatial and temporal coincidence of radiosonde, satellite and ground truth observations in the development of GARON network operating principles. (Revercomb, Tobin, Reale, Lescht).

2.2.4 Requirements for climate observations from satellites

2.2.4.1 Characterization of past instruments

The recent re-analyses from ECMWF and JMA, using radiance assimilation, have identified that many similar instruments on different spacecraft often have very different biases. This is partly due to uncertainties in channel frequency and spectral response. The Climate Working Group stresses the continuing need to update knowledge of the instrument characteristics and make use of satellite nadir cross-calibration and re-analysis radiance bias corrections. There is also a need to keep this information available on the ITWG Web or links from there.

Action Climate-7

ITWG Radiative Transfer WG to provide updated knowledge on instrument characteristics Web links on the ITWG Web site.

Various groups are reprocessing and cleaning up various satellite data records and derived products. If possible the datasets together with their metadata should be provided to the original archiving centres.

Action Climate-8

ITWG Climate Group to post any information on satellite data reprocessing and sensor metadata updates on the ITWG Web site.

Recommendation Climate-7 to reprocessing and reanalysis centres

Provide reanalysed or reprocessed satellite data together with their metadata to the original satellite agency archiving centre.

Major problems identified in MSU and AMSU climate studies were related to uncertainties due to merging data records from different satellites and diurnal cycle effects. Substantial progress has been made in this area by characterisation of inter-satellite biases with the help of cross-calibration of satellite nadir observations (SNO) time series. SNO based inter-calibration algorithms have been developed and result in well-merged and well inter-calibrated MSU level 1b records for climate applications, including trend analyses and data assimilation into reanalyses. Past experience has shown that extended overlaps (up to three years) are beneficial for the cross-calibration. Remaining problems involve the merge of MSU and AMSU time series, the short overlap between subsequent satellite missions (e.g., NOAA-9 and NOAA-10), and diurnal cycle effects in the sun-synchronous time series.

Recommendation Climate-8 to Satellite Agencies and to GCOS

Ensure frequency continuity of microwave channels so that new instruments can be easily merged with MSU and AMSU data records.

Recommendation Climate-9 to Satellite Agencies and to GCOS

Strive for extended satellites overlap periods, for at least three years, by extension of missions beyond their nominal lifetime.

2.2.4.2 Continuation of Current Sensors

Consistent observations from conically scanning microwave radiometers SSM/I and AMSR-E have a critical impact on water cycle analyses and research. A continuation of those missions is very desirable.

Recommendation Climate-10 to JAXA

The GCOM-W (Global Change Observation Mission-Winds) project should be pursued as a successor for AMSR-E data.

2.2.4.3 Recommendations for future sensors

The current plans for NPOESS and the available sensors onboard the satellite were discussed. The continuous availability of certain sensors/channels being of importance for climate monitoring is critical for the generation of a homogeneous climate data set based on radiances and/or retrieved products. Changes in the frequencies or even missing sensor types onboard future satellites will affect the quality of the retrieved data sets or even result in gaps in time series. The Working Group expressed its concerns on the impact of current plans for the NPOESS satellites on CDRs. A potential change in the configuration of the satellite will strongly affect the ongoing efforts of the climate community to build up a long-term satellite-based climate monitoring dataset.

Recommendation Climate-11 from John Bates to IPO through Mitch Goldberg

The needs of the climate monitoring community for a continuous time series of sensors is to be taken into account in the planning of future satellites. The concerns of the Working Group regarding the IPO plans for NPOESS should be addressed to NOAA.

Instruments measuring ozone, trace gases and aerosols are required to be maintained in space for climate. At present and in the past these types are mostly on research satellites.

Recommendation Climate-12 to IPO

OMPS limb sounding capabilities should be made available on NPP and NPOESS.

Recommendation Climate-13 to space agencies

Future operational missions should carry high precision instruments for monitoring of climate critical gases (e.g., CH₄, CO and CO₂) and aerosols.

2.2.4.4 Calibration

The topic of inter-calibration of different satellites has been discussed previously during ITSC-XIV. The inter-calibration of different satellites is of importance for the generation of a homogeneous fundamental climate data record. Work needs to be done on the inter-calibration of different satellite platforms onboard the same satellite series (e.g., the NOAA series). In the light of the planned launch of the first EPS satellite having similar (or partially the same) sensors as the NOAA satellites, it also becomes important for the climate community to get information on the inter-calibration of the two polar-orbiting systems.

Recommendation Climate-14 to satellite instrument providers/space agencies and to GCOS

Work on inter-calibration and the definition of a (common) reference needs to be coordinated. The climate-user community needs access to all information concerning calibration and inter-calibration of the different sensors, both within a satellite series of a single provider and for the different polar orbiting systems.

The recent pitch maneuver of NOAA-14 has provided the climate community with a better description of the MSU antenna pattern. This enables more accurate sensor calibration which is very important to obtain good data for climate studies.

Recommendation Climate-15 to space agencies and to GCOS

ITWG suggest all space agencies consider spacecraft maneuver to investigate sensor calibration at some stage in the life of the spacecraft.

Action Climate-9

ITWG to thank NESDIS for the NOAA-14 pitch test and suggest this be done at some stage during the lifetime of current platforms (e.g., NOAA-15 to 18).

Climate Studies: IASI data

Hyper-spectral sounding data from the Infrared Atmospheric Sounding Interferometer (IASI) will become operationally available in 2007. IASI will provide well calibrated radiance spectra being well suited for the use in climate monitoring activities. These activities have to be well prepared, preferably before the end of the commissioning phase. One issue will be the huge data volume, of which transfer from the central archive might be a bottleneck for any reprocessing. Therefore, it would be beneficial to generate any climate data records directly from a sub-sample of the near-real-time (NRT) distribution of the IASI data for local storage and further access to such subsets. To facilitate full exploitation of the NRT products for climate studies it is necessary to provide them in a form that is compatible with the needs of climate monitoring.

Recommendation Climate-16 to EPS NRT users (National Meteorological Services)

Prepare for the generation of IASI sub-sampled datasets (spectral, spatial, temporal) suitable for the use in climate monitoring studies from the IASI NRT data streams, and generate local archives hosting these subsets for further use.

Action Climate-10

ITWG members to circulate NRT planned IASI processing activities for climate (e.g., M. McCarthy for Met Office plans).

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

Working Group members: Steve English (Co-Chair) and John Derber (Co-Chair), Sid Boukabara, David Anselmo, Niels Bormann, Denis Blumstein, Nadia Fourrie, Thomas Auligné, Tony McNally, Nancy Baker, Chris Tingwell, Brett Candy, Kozo Okamoto, Roger Randriamampianina, Dezsó Devenyi, Godelieve Deblonde, Walter Wolf, Per Dahlgren, Dirceu Herdies

2.3.1 Introduction

There were many substantive presentations at this meeting that indicated very positive results using satellite data from different instruments. The trend towards the use of level 1b sounder and imager radiances has continued with almost all centres now using or preparing to use radiances. OSEs presented at this meeting demonstrate that satellite data has an extremely important impact on weather forecasting and promising new results suggest the potential for future enhancements in the use of satellite sounder and imager data. The microwave and infrared sounding data continues to have a very large impact and it is important that future instruments as a baseline maintain, and if cost effective improve upon, the quality of AMSU and AIRS.

Since the last meeting most operational centres are now assimilating AIRS data, and several of the centres are working intensively on SSMIS data. Substantial effort has been directed towards correcting and/or flagging incorrect SSMIS data resulting from instrument problems. Use of the flagged/corrected SSMIS has given a small positive impact in the Southern Hemisphere and as a result the data has been implemented operationally at the Met Office. However, results in the Northern Hemisphere have not been as good. Further correction/screening of the data appears to be necessary.

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 5 years.

At this ITSC meeting, there were several presentations by groups describing their development and enhancement of radiance bias correction schemes. There was an increase in the number of centres using or working towards use of variational bias correction. We believe that much of this development has been spurred by the ECMWF bias correction workshop last year. The group is supportive of the efforts directed towards this important problem.

2.3.2 Evaluation and use of TOVS/ATOVS in Data Assimilation/NWP

The use of satellite data remains very dependent on the monitoring and evaluation procedures for the satellite data. Prior to the use of the data, it is important to diagnose the significant biases between background and radiances which still remain. After implementation, monitoring is necessary to ensure that changes to the data or data assimilation system do not adversely affect the results. Many difficulties have been diagnosed and resolved by monitoring procedures. As more and more centres get involved in radiance data assimilation, better coordination of the monitoring procedures and more documentation, particularly on the bias correction method should be exchanged between the various data assimilation groups. The group continues to encourage the development and documentation of monitoring procedures as part of any centre's analysis procedure and to post monitoring results and documentation on their external Web site.

The group acknowledged the continued excellent support to users of AIRS data. The very detailed information distributed and the response to users when possible anomalies are spotted has been very helpful. The group would like to see support, similar to that provided for AIRS, for other current and future missions.

Recommendation DA/NWP-1 to satellite agencies

The Working Group feels that the notification of users about significant changes to current and future observation systems has not been sufficient. For example, information concerning the turning on of the RADCAL instrument on the DMSP F-15 satellite was not communicated quickly enough to the users to react. Also the cancellation of the HES instrument was not widely advertised. Early communication of these decisions is necessary for planning and preparation by the NWP community

The Working Group noted that a new email list server has been established for exchange of information on ATOVS data quality issues and also discussion of other topics relevant to the NWP WG. The address is itwg_nwp@metoffice.gov.uk and the administrator for the list is Stephen English.

Action DA/NWP-1

All members of the Working Group to examine the mail list for missing e-mail addresses. Steve English to maintain and update the e-mail list.

Action DA/NWP-2

NWP WG Co-Chairs to ask developers of software packages (e.g., JCSDA and NWPSAF) to announce new software releases on the ITWG mailing list.

The results of the ITWG survey presented at this meeting and reproduced in the Table 2.3-1 below, indicate that the NWP community still has an operational requirement for NOAA/NESDIS ATOVS data processing from instrument counts to calibrated radiances, preprocessed radiances and through to retrieved products. The group again wished to recognize the effort of Tony McNally (ECMWF) for coordinating the survey and to all centres that responded.

Table 2.3-1. Use of satellite data in operational NWP (ITWG survey of systems at 01/10/06)

<i>Institute</i>	Retrievals In Global NWP	Retrievals in Regional NWP	Radiances in Global NWP	Radiances in Regional NWP	external WWW DATA MON
Australia	NESDIS	NESDIS	YES-PP (1DVAR)	YES-PP (1DVAR)	
Canada (CMC)			YES – 1C (4DVAR)	YES – 1C (3DVAR)	YES (p-w)
ECMWF			YES – 1C (4DVAR)		YES
France			YES – 1C (4DVAR)	YES – 1C (3DVAR)	YES (p-w)
Germany			YES – PP (1DVAR)		YES
Hungary				YES – 1C (3DVAR)	
<i>India</i>	<i>NESDIS</i>				
Japan		NESDIS/JMA	YES – 1C (4DVAR)		
Korea			<i>YES – PP (3DVAR)</i>		
Spain				<i>YES – 1C (3DVAR)</i>	
Sweden				YES – 1C (3DVAR)	YES
UK			YES – 1C (4DVAR)	YES – 1C (4DVAR)	YES
USA (NCEP)			YES – 1C (3D SSI)	YES – 1C (3D GSI)	YES
USA (NRL)	NESDIS	NESDIS	YES – 1C (3DVAR)		YES

Notes

1) In the above table “1C” means that calibrated but unprocessed radiances are used. “PP” means processed radiances from NESDIS are used.

2) There is still a very limited use of tropospheric data (radiances or retrievals) over land and ice. This is true for both microwave and infrared.

3) *Where both the use of radiances and retrievals are used this generally means that some part of the retrievals (such as above the model top) are used to improve the usage of the radiances.*

4) *The responses from each NWP centre have provided much more information than is presented here and will be made available in full to all interested parties (hopefully on the ITWG Web site).*

5) *Responses in italics represent a carry over from the previous survey since no response was received prior to this meeting.*

Action DA/NWP-3 (open from ITSC-XIV)

Tony McNally to provide information from the ITWG NWP survey on the ITWG NWP group Web pages and if possible to allow updating as operational systems change.

2.3.3 Evaluation and use of other sounding instruments in NWP

The group agreed NESDIS should be congratulated for the past activity in providing AIRS data and be encouraged to continue with the current activity to provide clear fields of view in thinned data sets available to the operational community. The group discussed options for improved exploitation of AIRS, including new datasets. It was agreed that coordination was necessary in switching from the existing operational dataset to new datasets and that more evaluation of products using MODIS for cloud detection was required. There are two datasets using MODIS data to support use of AIRS:

1. The AIRS-MODIS dataset is an AIRS spatially thinned dataset where MODIS has been used to select the field of view most likely to be cloud-free. Its format is identical to the existing AIRS warmest field of view and AIRS central field of view datasets.

2. The MODIS BUFR dataset has products derived from MODIS on each AIRS field of view e.g., standard deviation of MODIS 11micron brightness temperature.

It was also noted that more work is required on developing and testing methods which aim to allow the full spectral information to be used efficiently.

Action DA/NWP-4

Walter Wolf to email content and format of MODIS BUFR dataset to ITWG NWP mailing list for comment.

Action DA/NWP-5

Walter Wolf to provide AIRS MODIS dataset and MODIS BUFR dataset as soon as possible on NOAA server.

Action DA/NWP-6

NWP centres to evaluate both MODIS datasets.

The group welcomed the on-going effort on correcting SSMIS data streams but noted that at present there are several different versions with different anomaly correction methods. Bill Bell (Met Office) will visit NRL in spring 2007 with a goal of developing a single agreed best processing method.

Recommendation DA/NWP-2 to SSMIS user community

The WG encourages development and implementation of a single SSMIS data correction and selection method.

Action DA/NWP-7

NRL, Met Office and NESDIS to participate in and report the results of unification of operational SSMIS processing, calibration (including corrections applied going from antenna temperatures to brightness temperatures) and distribution by April 2007.

Action DA/NWP-8

Nancy Baker to report on DMSP-F17 cal/val and data distribution plans.

Recommendation DA/NWP-3 to science community (also AS-6)

The group encourages research into investigating some of the theoretical benefits of a combined microwave imager sounder (for example, it may help with assimilation over difficult emissivity surfaces) relative to the conventional cross-track scanning sounders.

2.3.4 Forward modelling

The WG welcomed the work towards integrating RTTOV into the CRTM. This will allow good comparisons between the two systems and enhancement of both.

Recommendation DA/NWP-4 to NWPSAF and JCSDA.

Continue on going collaboration on RT development and report on progress to ITWG.

Action DA/NWP-9

NWP WG Co-Chairs to ask Roger Saunders and Paul van Delst to circulate report to NWP WG mailing list and to present at next ITSC.

Surface emissivity estimation remains an important problem and the activities in this area at the JCSDA and the NWPSAF are also welcomed.

2.3.5 Observing systems and real time access to data

As the use of satellite data matures, the design of observing systems, availability of data, procedures for introducing new data sources and how the data is delivered continue to be major sources of concern for operational NWP centres. The group recognizes that the inclusion of NWP early on in the preparation for AIRS data was a positive step, and encourages future satellite programs to have similar plans. For the SSMIS data the operational NWP community was not included in the early stages of the evaluation, although a productive level of cooperation was achieved at a later stage of the cal/val process.

It has been an ongoing concern of the group that a significant portion of the observations arrive too late for complete inclusion in the data assimilation systems. The operational centres are under pressure to shorten the delivery times of their forecasts to the users and thus are shortening their cut-off times for data delivery. Also, a significant increase in the use of satellite data in limited area models has been noted. These limited area systems often have shorter time requirements than global systems. Two encouraging advances have been noted. The significant improvement in the expected delivery time for the NPOESS satellites (20-30min) and the creation of the RARS (e.g., EARS, SA-RARS, AP-RARS) system should both allow a significant improvement in the availability of data. The creation of the RARS system has been particularly innovative in providing a low cost system to significantly reduce delivery times of the data. The NWPSAF currently monitors consistency of EARS data compared to NESDIS global 1B data. Similar monitoring will be desirable for the SA-RARS and AP-RARS data.

Recommendation DA/NWP-5 to WMO

Continue to support fast delivery initiatives (e.g., RARS), extending this where possible (e.g. Hawaii). However, the 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.

Action DA/NWP-10

NWP WG Co-Chairs to bring recommendation DA/NWP-5 to the attention of WMO.

Recommendation DA/NWP-6 to IPO

The short operational delivery time of NPOESS data to NWP centres is an extremely attractive component of the system design. The group would like to ensure that this component be retained in the restructuring of the NPOESS program.

Action DA/NWP-11

John Derber to ask JCSDA and NESDIS to present recommendation DA/NWP-6 to IPO.

The use of research satellites in operational NWP centres has been increasing. The group strongly welcomed the inclusion of research satellites in the global observing system as a very positive step forward. The availability of research data (e.g., the high spectral resolution data from AIRS) has allowed the NWP centres to develop techniques to use the data more quickly and allowing the monitoring components of the system to feed back to the instrument scientists. However, the group noted there continues to be development of satellite programs with limited or no real time access to the data.

The managers of new satellites and satellite programs have often been reluctant to allow outside users to access the data until it has been completely proven. However, NWP centres often have access to data, algorithms and monitoring capabilities which are unavailable to the satellite programs. This makes the NWP centres ideal partners in the initial evaluation process and allows them to begin early development of the infrastructure necessary to use the data.

Recommendation DA/NWP-7 to all satellite agencies

Operational NWP centres 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-12

John Derber and Stephen English to ask ITWG Co-Chairs to ensure recommendation DA/NWP-7 is conveyed to all satellite agencies and operational NWP centres via appropriate international bodies (e.g., CGMS).

The group welcomed the continuation of the “TOVS” heritage through future missions. The group reaffirmed the statement from past meetings that the positive impact of this data on NWP will be largest if satellite agencies choose complementary overpass times which optimize the data coverage.

Recommendation DA/NWP-8 to space agencies

A three orbit system (ideally equally separated) of microwave and IR polar orbiting instruments has been shown to produce positive impact over a two orbit system. The group recommends consideration of a three orbit system containing state of the art microwave and IR sounders in each orbit.

Action DA/NWP-13

NWP WG Co-Chairs to pass recommendation DA/NWP-8 to WMO and space agencies.

The WG discussed data distribution for NPP and MetOp products and welcomed the developments for direct broadcast data for both satellites. Whilst the policy for GTS products is clear, the group needs more information on the policy for distribution of non-GTS products. The international distribution policy for the NPP satellite is currently unspecified.

Action DA/NWP-14 (open action from ITSC-XIV)

John LeMarshall to ensure establishment of the NPP non-GTS data distribution policy for countries outside the United States and report to the WG.

The WG considered it important that NWP centres have a system which easily allows comparison of monitoring results from various centres. Thomas Auligné has proposed and circulated a monitoring strategy for IASI to various NWP centres. Currently, several centres have agreed to adopt this strategy.

Action DA/NWP-15

Thomas Auligné and Tony McNally to propose a method for communicating a subset of the monitoring for IASI and set up a system for producing a Web-based display of participating centres results. The proposal will be sent to WG members for suggestions and approval through the NWP WG mailing list.

2.3.6 Other data assimilation issues

The geostationary orbit is useful for observing rapidly changing features of the atmosphere. The HES IR sounder has recently been cancelled on the GOES-R platform.

Recommendation DA/NWP-9 to satellite agencies and WMO

The WG encourages research and operational satellite agencies to work together towards developing the next generation of operational satellites.

Action DA/NWP-16

NWP WG Co-Chairs to pass recommendation DA/NWP-9 to WMO and space agencies.

Action DA/NWP-17

John Derber and Stephen English to ask ITWG Co-Chairs to ensure recommendation DA/NWP-9 is conveyed to all satellite agencies via appropriate international bodies (e.g., CGMS).

Recommendation DA/NWP-10 to satellite agencies and WMO

The geostationary orbit is ideal for observing the rapidly changing components of the atmospheric fields. The WG recommends the development of a demonstration system observing with high spectral resolution IR and/or microwave instruments. Ideally if both missions are possible the microwave and IR instruments should observe the same portion of the atmosphere at the same time.

Action DA/NWP-18

NWP WG Co-Chairs to pass recommendation DA/NWP-10 to WMO and space agencies.

Recommendation DA/NWP-11 to satellite agencies and WMO

Conical microwave imagers have a well established role in NWP which the WG wished to continue. The WG expressed concern that there could be a loss of continuity in microwave imagery in the NPOESS era.

Action DA/NWP-19

NWP WG Co-Chairs to pass recommendation DA/NWP-11 to WMO and space agencies.

Observing system design is the key to having a well observed atmosphere for use in NWP. Many of the decisions concerning the observing system are often made with little or no scientific evidence. This design information is extremely important for agencies to make cost-effective well thought out decisions.

Recommendation DA/NWP-12 to satellite agencies and NWP centres

The WG would like to encourage the development of an international effort directed towards improving the observing system design. The EUCOS (EUMETNET Composite Observing System) is an example. OSSEs are one tool that can be used for the observing system design problem; however, they must be done very carefully to ensure that they are unbiased and properly estimate the impact of new observing systems.

Action DA/NWP-20

John Derber will distribute an initial template for OSSE experiments to the WG for comment and enhancement.

2.3.7 ITWG NWP WG administration issues

The WG expressed a strong desire to provide a useful Web page under ITWG. The Working Group notes the excellent work of Leanne Avila in the establishment of the Web page.

Action DA/NWP-21

NWP WG to continue to update the NWP WG Web page with assistance of Leanne Avila.

Action DA/NWP-22

NWP WG Co-Chairs to review the status of the actions and recommendations in April 2007 and at regular intervals before ITSC-XVI and email a status report to WG members and ITWG Co-Chairs.

Action DA/NWP-23

NWP WG Co-Chairs to solicit ideas through NWP WG mailing list for WG topics 1 month prior to ITSC-XVI.

2.4 ADVANCED SOUNDER WORKING GROUP REPORT

Working Group members: Andrew Collard (Co-Chair), Allen Huang (Co-Chair), Bill Smith (Co-Chair), Paolo Antonelli, Alain Beaulne, Bill Campbell, Dong Chaohua, Zhaohui Cheng, David Crain, Mitch Goldberg, Sylvain Heilliette, Sara Hörnquist, Thomas King, Bjorn Lambrigtsen, Allen Larar, Jun Li, Yann Michel, Ed Pavelin, Eric Péquignot, Nikita Pougatchev, Filomena Romano, Stephen Tjemkes, Alexander Uspensky, Banghua Yan, 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 regarding to instrument specification, performance, data processing, and utilization. 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 expressed disappointment in the cancelling of the HES geostationary advanced infrared sounder. It was noted that the operational status of the instrument resulted in extremely conservative estimates of the cost of the ground segment which in turn resulted in the project being much more expensive than a research mission would be. It was also noted that these concerns were specific to the GOES-R project and should not be interpreted as pertinent to the development of the advanced IR sounder on MTG and FY-4. It was agreed that a research mission is required to demonstrate the utility of a geostationary advanced infrared sounder and that the existing GIFTS instrument would be a good candidate to be flown in the near future.

Recommendation AS-1 to the space agencies

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 recommended that a demonstration mission be conducted in the near future. GIFTS is the best current option for such a 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 a 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-2 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 should be communicated from the users (i.e., NWP, RT modellers, climate researchers) to the data providers.

The group noted that a variety of differing and complementary data sources are required for full validation of advanced sounders. The identification and correction of contamination in the SSMIS radiances based on NWP comparisons and a detailed knowledge of the spacecraft’s orientation while in orbit was noted. 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-3 to the space agencies

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 and ARIES airborne

sensors, and upper air reference networks need to be added to complementary data sources, such as NWP, in order to validate the radiances and derived products to the very high accuracy and precision specified by the users.

The validation of the calibration and impressive stability of AIRS instrument was noted. Cal/Val efforts for IASI should similarly concentrate on establishing the in-flight performance of the instrument to a similar degree of accuracy.

Recommendation AS-4 to EUMETSAT/CNES

Cal/Val efforts for IASI should focus on establishing the in-orbit performance in order that early lessons can be learned for pre-flight testing of future interferometer sounders.

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 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-5 to the science community

The utility of applying the SNO (Simultaneous Nadir Observation) technique for an equatorial (inclination $<20^\circ$ degrees) 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.

2.4.3 Research on the benefits of dual polarisation on microwave conical scanners

The group noted the potential benefits of dual polarisation in the surface sounding channels of SSMIS. The use of these data should be investigated and the conclusions be considered when designing future microwave sounder systems. This led to a recommendation also picked up by the DA/NWP group.

Recommendation AS-6 to the science community (also DA/NWP-3)

The group encourages research into investigating some of the theoretical benefits of a combined microwave imager sounder (for example it may help with assimilation over difficult emissivity surfaces) relative to the conventional cross-track scanning sounders.

2.4.4 Sounder Field-of-View issue

At ITSC-XIV, considerable discussion was held discussing the impact of the spatial resolution for the CrIS instrument being poorer than that of the current HIRS/4. It was pointed out that there was never an intent to make the CrIS horizontal resolution poorer than the existing HIRS horizontal resolution (i.e., 10 km). Previously, it was recommended that the sounding yield and accuracy of the HIRS/4 be compared with that achieved with the lower spatial resolution (17 km) HIRS/3 instrument. This task was not completed because of optical element motion induced noise on the NOAA-18 HIRS/4. It was suggested that the HIRS/4 on MetOp-1 could be used instead and this change was made to the recommendation. An action was added, requiring the results of any study to be brought before the SOAT (the IPO Sounder Operational Algorithm Team). A related recommendation (SSSP-4) and action (SSSP-11) is made in the SSSP report (section 2.6).

Recommendation AS-7 to the ITWG (also SSSP-4)

It is recommended that trade-off studies be performed to determine the optimal field of view size for the CrIS, considering existing detector noise performance and the desire to increase the density of cloud free sounding observations as a result of decreasing the field of view size. As a

first step, a comparison of the yield of MetOp-1 HIRS/4 clear air data versus NOAA 17 HIRS/3 data should be conducted.

Action AS-1 to whoever performs the above study

Once results are available, this item should be brought before the SOAT and/or JCSDA, to determine if a recommendation to the IPO is justified (i.e., to reduce the CrIS FOV size of 14 km to 10 km or less).

2.4.5 Objectives and Desirable System Requirements of Advanced IR 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.

2.4.5.1 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	100	-	-	-	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/Emis. & 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 Vapor Flux Trop. Wind Profiles ⁶
1590-2000	1.2	H ₂ O, T _s , Cld	2,1	15	1,2	15	5	Water Vapor Flux Trop. Wind Profiles ⁶
2000-2200	0.6	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: δn (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., $2 \times \delta\nu$).

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.

Recommendation AS-8 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.

2.4.6 New Initiatives for Geostationary Sounding

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-9 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-2

Bjorn Lambrigtsen to make a draft table summarising the requirements for microwave sounding systems.

2.4.7 International Geostationary Laboratory

The IGEOLab initiative to promote international cooperation to place and test advanced sounders (e.g., GIFTS and MW) in geostationary orbit was also noted. This initiative should be supported.

Recommendation AS-10 to the space Agencies

The WMO IGEOLAB concept should be supported.

2.4.8 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 Principle 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, quality control, cloud detection and monitoring.

Recommendation AS-11 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.

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 data 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 and transmission of data, the compression scheme should be lossless. Datasets with lossy compression can be distributed if they are identified as such.

Recommendation AS-12 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 transmission and archiving of satellite data be lossless.

2.4.9 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-13 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.

2.4.10 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-14 to the space agencies

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

2.4.11 Move to Single Contractor’s Responsibility for Satellite Sounder Systems

Historically, environmental satellite systems have been developed by a partnership of government (NASA, NOAA, and EUMESAT, 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 the single contractor approach adopted by the NPOESS program, and is currently considered by NOAA for the development of the GOES-R system and any other future operational satellite systems, would tilt the resource balance so that it would undermine the ability of government to provide continuity into the future and would place much of the science community under the financial control of industry, inhibiting the science community from acting as an objective, commercially neutral, body in the development and application of future satellite systems.

Recommendation AS-15 to the space agencies

ITWG strongly recommends that certain elements of future operational satellite systems (e.g., the data processing, algorithm and product development system, the evaluation and validation, and the training and outreach programmes), should be led by government agencies. It is also recommended that the users of the satellite system play a key role in the definition of the characteristics of this system.

2.5 INTERNATIONAL ISSUES AND FUTURE SYSTEMS

Working Group members: Mitch Goldberg (Chair), Tom Ahtor, Roger Saunders, Anthony Rea, Jian Liu, Marie Dumont, Kathy Strabala, Hal Bloom, Thierry Phulpin, Peter Wilczynski, Carmine Serio, Paolo Antonelli, Jean Pla

2.5.1 Regional ATOVS Retransmission Service

The Working Group noted the considerable progress made with the Regional ATOVS Retransmission Service (RARS) since the last conference. The Asia-Pacific RARS is now putting ATOVS data from Australia, Japan, China, and Korea on to the GTS providing more timely data to the NWP centres. At least one NWP centre is already assimilating ATOVS from this new source and several others are preparing to do so. The South American RARS is being set up with data becoming available in 2007. Contacts have been made with African stations to set up an African RARS but commitments need to be clarified. The group also noted the need to possibly upgrade HRPT stations to receive the MetOp IASI broadcast.

Recommendation II/FS-1 to WMO Space Programme

The WMO Space Programme with CGMS assistance, should continue to promote the implementation of a globally coordinated system of RARS encouraging the development of the South-American and Asia-Pacific RARS and also ensuring coverage over Africa. To extend the coverage over Africa, Gough and Marion Islands, Pretoria and Reunion HRPT stations should be considered. Honolulu and Tahiti HRPT stations should be considered to enlarge Asia-Pacific RARS coverage over the Western Pacific.

Action II/FS-1

WMO Space Programme to enhance user information about RARS through the WMO RARS Web site.

Recommendation II/FS-2 to HRPT station operators

RARS stations to upgrade HRPT stations in order to allow IASI data retransmission.

2.5.2 Addition of water vapour channel to polar imager

As noted at ITSC-XIV the lack of a water vapour channel on VIIRS will seriously affect the height assignment of the polar atmospheric motion vectors (AMVs) that have been shown to be an important data source for NWP forecasts. Recognizing the high costs of modifying the VIIRS, the group considered the possibility of proposing an AVHRR-like sensor with a water vapour channel to fly on future satellites.

Recommendation II/FS-3 to space agencies

Space agencies explore the possibility of flying an upgraded AVHRR-like sensor with a water vapour channel centred near 6.7 microns on future polar satellites in order to ensure the continuity of good quality polar atmospheric motion vectors beyond Terra and Aqua.

2.5.3 Direct Broadcast

The success of environmental satellite direct broadcast (DB) has enabled users worldwide to acquire and process data for their region in real time. These DB software packages allow users to decode the raw data signal to calibrated, navigated radiances (Level 1B), and in many cases to create various products (Level 2) for environmental monitoring/evaluation, resources management/planning and weather/hazard forecasting. DB software developed through the ITWG include the ITPP for TOVS, and AAPP/IAPP for ATOVS. NASA has funded the IMAPP software package for the EOS program, including training workshops to educate users of the data and software. There are ongoing plans to support DB capabilities for MetOp IASI (AAPPv6), NPP/NPOESS (IPOPP creation) and FY-3. The Working Group also noted the success of the

Benevento, Italy, DB conference and encouraged the agencies to continue to support these valuable meetings.

Recommendation II/FS-4 to satellite agencies

Satellite agencies operating environmental polar satellites to provide or continue to provide a DB 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.

2.5.4 International Education Programs

There are several agencies and university groups that have developed international education programs in remote sensing and applications of environmental satellite data. Examples include the Virtual Laboratory, EUMETSAT and the University of Wisconsin-Madison CIMSS. To make potential users more aware of the opportunities and to enable coordination between education material developers, it was felt that the ITWG should assist as follows:

Action II/FS-2

ITWG Webmaster to expand the ITWG education Web page by linking to the international education program developer's sites and by encouraging these developers to use the ITWG education page as part of their resources and curriculum. Also to use the resources of the ITWG to help disseminate information to the international community about the education opportunities available.

The group discussed the importance of these education programs in training the next generation of scientists emphasizing the need for creating opportunities for students in developing countries. Also, the need for follow up to the training courses is very important to continue to engage the young scientists.

Recommendation II/FS-5 to ITWG Co-Chairs

The ITSC-XV Working Group Report Executive Summary should encourage the satellite operators and product developers to financially support a strong education program, both within their region and internationally.

The group also discussed the possibility of obtaining certification for their workshops or course materials from key agencies (e.g., WMO, NASA, NOAA, EUMETSAT). Such certification may help to secure funding for further development and presentation of course materials. This certification may also help to enable students to participate in these programs and receive credit from their agencies or universities.

Action II/FS-3

ITWG members who are education material developers and providers (P. Antonelli, K. Strabala, EUMETSAT, etc.) to contact WMO Space Programme Department and the other international agencies to pursue the possibility of a certification for education programs.

The group discussed the benefits of gathering together, for an international workshop, the scientists who are involved in education and outreach. The possibility of sharing information and experiences is a crucial first step to optimize the educational effort at an international level.

Recommendation II/FS-6 to ITWG Co-Chairs

The ITSC-XV Working Group Report Executive Summary should encourage the organization of a workshop to bring together the scientists who are involved in environmental remote sensing education and outreach programs to present their past and present activities and to co-ordinate future initiatives.

2.5.5 NPOESS

The group is concerned that because of the recent descope of the NPOESS payload, critical climate monitoring instruments have been removed. Specifically we are concerned that the loss of CrIS/ATMS in the 0530 orbit plane, removal of the limb instrument for ozone monitoring, and the Earth Radiation Budget sensor on future NPOESS orbits. Removal of CrIS/ATMS in the 0530 orbit seriously affects the diurnal cycle of the vertical temperature and moisture and affects climate monitoring. Removal of the ozone limb sensor degrades the resolution of the ozone profile, and the removal of ERBS from NPOESS breaks the climate series of a 30 year continuous climate sensor time series.

Recommendation II/FS-7 to NOAA and DOD

NOAA and DOD consider options to fund reinstatement of sensors removed from NPOESS based on assessment by US and International users.

Results presented at ITSC-XV have shown that the use of conical MW radiances in NWP models have positive impacts that are similar but not better than cross-track MW instruments. Based on this information conical sounding on a CMIS like instrument are not essential and can complicate the overall sensor design in terms of the overall cost and technical complexity. The existing NPOESS CrIMSS suite, the MetOp IASI/AMSU/MHS, and an additional early morning ATMS will provide the required sounding coverage that currently exists.

Action II/FS-4

M. Goldberg to NPOESS Joint Agency Requirements Group (JARG) to request the assessment of a microwave imager only solution as replacement for the CMIS, and replace the loss of soundings with ATMS in the 0530 orbit plane.

NWP impact studies have shown the importance of two sounders in different orbital planes and still additional impacts from sounders in a third orbit. Since new satellite systems have fewer satellites with longer life, the impact of a failure is greatly reduced with a full complement of sounders (IR & MW) in three orbital planes. Launch of a new NPOESS satellite due to a loss of a single critical instrument (e.g., CrIS) can be delayed if a back-up exists in the 05:30 orbit.

Action II/FS-5

M. Goldberg to IPO to assess cost savings of adding ATMS and/or CrIS in the 05:30 orbit in case of an early failure of either IASI/AMSU (10:00 orbit) or CrIS/ATMS (13:30 orbit). Cost assessment should include savings due to delaying a new launch for a single instrument failure as well as cost benefits for ensuring likelihood of having three sounders in different orbits.

There is a risk of a gap in the CERES long-term record. This is a very important Earth Radiation Budget (ERB) dataset of climate quality.

Recommendation II/FS-8 to IPO and NASA

Consider including CERES on NPP instead of NPOESS-C1.

Documentation and distribution of NPOESS product formats well before launch is critical for both users and data reception equipment manufacturers in order to prepare for the new data. Without early delivery, a substantial delay will occur in the utilization of these high quality advanced observations and products.

Action II/FS-6

Pete Wilczynski to provide a schedule (timetable) of availability of data format(s) for NPP/NPOESS real time Low Rate Data (LRD) & High Rate Data (HRD) as soon as practical.

2.5.6 Other International Satellite Systems

Early access to data formats of other international satellite systems is critical for user readiness.

Recommendation II/FS-9 to all space agencies

**Provide expected formats of level 1b and level 2 datasets at least one year prior to launch.
Establish Web sites to provide detailed information on instruments, schedule, products and formats.**

2.5.7 Frequency Protection

The International Telecommunication Union, Radiocommunication sector (ITU-R) plays a vital role in the management of the radio-frequency spectrum and satellite orbits. These frequencies are finite natural resources which are increasingly in demand from a large number of services such as fixed, mobile, broadcasting, amateur, space research, meteorology, global positioning systems, environmental monitoring and communication services. ITU-R has allocated frequency bands to the passive Earth Exploration Satellite Service, EESS, for the purpose of sounding the atmosphere and surface.

The frequency bands listed in Radio Regulation (RR) N° 5.340 are unique natural resources that need to be fully protected and therefore all emissions in these bands are prohibited. Any limitation of the operation of passive sensors conducted in the satellite passive bands, especially those covered by article N° 5.340 (“All emissions are prohibited”) would degrade the sensitivity of those sensors.

Experience has shown that some non exclusive EESS (passive) bands shared with other non passive services are facing high interference levels from the emissions of systems of active services in some parts of the world. Unwanted emissions from active services operating in adjacent bands may cause unacceptable interference to the EESS (passive) bands. Existing ITU-R recommendations provide performance and interference criteria for satellite passive remote sensing giving radiometric resolution and maximum interference levels. These are used in all sharing analyses with other services. Any degradation of radiometric resolution will disrupt numerical weather prediction (NWP) forecasts and climate models.

Generally the impact of radio frequency interference, RFI, within satellite passive bands is not precisely known, especially within ITU-R. In the frequency bands detailed in Recommendation II/FS-11, the question is: if the RFI is such that the interference thresholds are exceeded, what are the consequences in terms of reliability of the weather forecasting, climatology and monitoring of the environment? What happens if, for example, some EESS satellite pixels are corrupted due to non-natural emissions at 24 or 50 GHz?

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.

Another issue is the impact of missing data, due to high levels of interference. As the data are known to be bad over the same area of the globe, they are systematically deleted from the dataset to be used.

Recommendation II/FS-10 to NWP and Climate Modelling Centres

Studies should continue to be conducted to 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 II/FS-11 to Space Agencies

Future passive sensors should be designed to detect potential anomalies, corrupt data or interference in order to report to national Administrations and international organisations in frequency management for further action. As a matter of urgency, the frequency bands which should be considered are the following:

**1400-1427 MHz 10.6-10.7 GHz 18.6-18.8 GHz 23.6-24 GHz 31.3-31.5 GHz
36-37 GHz 50.2-50.4 GHz 52.6-54.25 GHz.**

There are a number of documents addressing the usage of the microwave frequency passive bands, their scientific interest, the retrieved parameters and the technical characteristics of the corresponding passive

radiometers. These documents are available from the International Telecommunication Union, radiocommunication sector (ITU-R), WMO and other organizations. The ITU-R has adopted recommendations providing performance and interference criteria for satellite passive remote sensing (i.e., radiometric resolution and maximum interference level).

Action II/FS-7

Jean Pla to provide a list of existing documents addressing the use of microwave passive bands; and to produce additional documents if necessary on related topics and to contribute to the update or improvement of those existing documents with a view to disseminate corresponding information to administrations and international organizations dealing with frequency management.

Action II/FS-8

Jean Pla to update the ITWG Web site dealing with frequency protection (see <http://cimss.ssec.wisc.edu/itwg/groups/frequency/>)

2.6 SATELLITE SOUNDER SCIENCE AND PRODUCTS

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

Working Group members: Tony Reale (Co-Chair), Lydie Lavanant (Co-Chair), Tom Ahtor, Nigel Atkinson, Leanne Avila, Sid Boukabara, Dong Chaohua, Izabela Dyras, Marie Dumont, Anton Kaifel, Thomas King, Bozena Lapeta, Thierry Phulpin, Nikita Pougatchev, Elisabetta Ricciardelli, Filomena Romano, Devendra Singh, Roger Saunders, Peter Schlüssel, Rodrigo de Souza, Fuzhong Weng, Walter Wolf, Lihang Zhou, Alexander Uspensky

2.6.1 Introduction

The Working Group 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 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.edu/itwg/sssp>

The following report summarizes the topics of discussion, recommendations and action from the SSSP Working Group meetings held at ITSC-XV.

2.6.2 Information on HRPT sites

A directory of HRPT facilities that are actively receiving, ingesting, processing and archiving polar satellite data was set up on the SSSP Web site. This was recognized as a useful tool to promote interaction among ground stations and within ITWG-SSSP activities. HRPT sites are searched and solicited (see HRPT survey on Web site) and feedback and updated information received from several sites. Most recently, responses from a number of Russian sites (universities, research institutes...) and from the Chinese national meteorological institute have been collected.

A revision of the HRPT topic area format will be made to provide tabular listings of the subsets of identified sites and associated inputs received, including the satellites, instrument data, processing packages, associated measurements and products, validation, distribution and site links.

It was also agreed to set up an HRPT mailing list to facilitate the circulation of information between SSSP and HRPT sites and among HRPT sites.

Action SSSP-1

L. Lavanant and L. Avila to

- Continue the search and solicitation of inputs for the HRPT area of the SSSP Web site using the existing survey and HRPT site list.
- Set up a tabular format to summarize HRPT sites and available information.
- Set up a mailing list of participating HRPT sites.

2.6.3 HRPT network (EARS, RARS) information

The SSSP Web site includes information on the EARS (EUMETSAT ATOVS Retransmission Service) HRPT network. Since the last update, more HRPT sites (Lannion, Gilmore Creek...) and data retransmission (AVHRR...) capabilities have been added to the service. In parallel, the Asia-Pacific RARS (Regional ATOVS Retransmission Service) for the South Hemisphere is under development. The goal is improved access to real-time (polar) satellite observations on a regional and global scale.

Action SSSP-2

L. Lavanant, M. Dumont, D. Griersmith, D. Lee, N. Atkinson to update the existing EARS Web page to include information on the RARS network.

2.6.4 Access to HRPT raw data and processing packages for direct broadcast data

The capability to routinely obtain a limited sample (selected orbit or orbit segment) of raw (1a and 1b formats) and pre-processed (1c and 1d formats) observations as available from operational centres (NESDIS, EUMETSAT) and HRPT sites (EARS, RARS) in either 1a, 1b, 1c or 1d would be a valuable contribution for training exercises. Observations of immediate interest would include HIRS, AMSU-A and AMSU-B (also MHS), followed by AVHRR and IASI.

Recommendation SSSP-1 to EUMETSAT and NOAA/NESDIS

A capability to routinely retain and provide retrospective access to selected portions of raw and pre-processed observations from “operational” satellites by operational centres and selected EARS / RARS facilities should be pursued.

Action SSSP-3

SSSP Co-Chairs to develop and forward above recommendation to NOAA and EUMETSAT and EARS / RARS facilitators.

Action SSSP-4

SSSP Co-Chairs to develop a dedicated SSSP Web site area as central location for storing and accessing such observations arising from Recommendation SSSP-1.

2.6.5 Information on processing packages for direct broadcast data

Software packages to ingest and process HRPT data from existing and planned satellites are needed by the user community to create navigated, calibrated datasets. The current AAPP software allows for the processing of locally received MetOp observations up to level-1d for IASI, HIRS, AMSU and MHS and up to level-1b for AVHRR. The International MODIS/AIRS Processing Package (IMAPP) provides ground stations the capability to ingest direct broadcast data from Aqua and produce calibrated and geo-located AIRS/AMSU/HSB radiances (and selected AIRS level-2 products).

Current plans for introducing CrIS and VIIRS (from planned NPP satellites) into AAPP need to be clarified. Plans to make local processing systems from the Chinese FY-3 satellites available to the user community also needs to be clarified. Updated information as available shall be appended to the SSSP Web site.

Action SSSP-5

SSSP Co-Chairs, H. Bloom, A. Huang, N. Atkinson, D. Chaohua to request information from space agencies on processing packages for direct broadcast data and facilitate the creation of links to the information via the SSSP Web site.

2.6.6 Instruments co-registration procedures

Procedures for co-registering the GOME and AVHRR observations with IASI data on MetOp need to be developed and made available, either inside the AAPP package (as it is done for AVHRR to HIRS) or through an independent route.

The status of planned co-registration procedures for instruments onboard future NPP and NPOESS satellites also needs to be clarified.

Action SSSP-6

A. Kaifel, P. Schlüssel, N. Atkinson, R. Saunders to

- **Determine the current status of planned instrument co-registration onboard MetOp and planned NPP and NPOESS satellites.**
- **Define requirements for additional instrument co-registration.**
- **Encourage processing package providers (EUMETSAT, CIMSS) to incorporate available co-registration procedures.**
- **Provide information and status on SSSP Web site.**

2.6.7 Current and future instrument status

The SSSP Web site currently provides operational polar satellite instrument health status for the suite of NOAA and EOS AIRS instruments via ‘Satellite Health Status’ and ‘Level-1 Instrument Monitoring Reports’ areas of the SSSP Web site. Similar information is needed for all the MetOp instruments and in particular during the planned 8-month Cal/Val commissioning phase for IASI.

Similarly, access to information on the status of preparations for near term future satellites, for example NPP, FY-3 and NPOESS is also needed to facilitate timely planning for the processing of these data.

Recommendation SSSP-2 to CNES and EUMETSAT

Satellite agencies are requested to provide available status information for MetOp IASI level-1 data, including during the 8-month commissioning phase (CNES) and also for AVHRR, AMSU, MHS, HIRS, ASCAT, GRAS and available level-2 products (EUMETSAT).

Recommendation SSSP-3 to NOAA/IPO and NSMC

Satellite agencies are requested to provide information on the status of preparations for NPP, NPOESS and FY-3 platforms.

Action SSSP-7

SSSP Co-Chairs

- **Forward the above recommendations to satellite agencies and provide links to the information on the SSSP Web site.**
- **Include links to MetOp operational daily monitoring reports of level-1 including ASCAT and GRAS (for example from ECMWF, UKMO, NOAA and Meteo-France) after the commissioning phase.**

2.6.8 Consistency between local and global packages

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 data 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 NPP, FY-3 and NPOESS processing systems.

Action SSSP-8

H. Bloom, D. Chaohua, N. Atkinson, A. Huang, SSSP Co-Chairs,

- **Report on the strategy of ensuring local/global coherence for IMAPP (Aqua)**
- **Report on the strategy for NPP, FY-3 and NPOESS local/global coherence through contacts with national agencies and direct readout package developers responsible for software and data output data formats.**
- **Provide status and the information on the SSSP Web site.**

2.6.9 ATOVS and IASI global data products from MetOp

Access to operational global MetOp data, initially for ATOVS and later for ATOVS + IASI observations, in near-real time and retrospectively, is processed by the respective operational satellite agencies (EUMETSAT and NOAA). This includes all stages of product generation for products such as atmospheric profiles, surface and cloud parameters, precipitation and trace gas concentrations. Consistent validation and comparison of the processed data and product combinations from the respective agencies should be coordinated and made available to international users and researchers (e.g., via the SSSP Web site).

Action SSSP-9

Tony Reale, Peter Schlüssel, Thomas King

- **Report on the availability of processed data and products from NOAA and EUMETSAT.**
- **Recommend the agencies coordinate their efforts of data dissemination and validation.**
- **Advertise how to access MetOp global operational products and to put the information on the SSSP Web site including a tabular summary describing available products, data formats, metadata and software for reading data files.**
- **Put information on the SSSP Web site on disseminated product validation.**

2.6.10 TOVS and ATOVS instrument performance

There is a need for climate activities for the recovery and documentation of available metadata records with respect to TOVS/ATOVS instruments concerning, spectral response, antenna pattern, format (i.e., 1b-level) changes, calibration corrections and systematic calibrated measurement bias, metadata. This was also noted under section 2.2.4.1 in the Climate WG.

Action SSSP-10

Tom Kleespies, Cheng-Zhi Zou, Nigel Atkinson, Roger Saunders

- **Identify source information on instrument performance characteristics for HIRS, MSU, SSU, AMSU-A, AMSU-B (including RFI) and MHS (including RFI).**
- **Provide access to available historical and current (in real-time) SNO data and associated corrections (metadata); and predicted (future) SNO points for selected instruments.**
(Note: at this time there are historical SNO points and derived inter-satellite adjustments for HIRS and MSU on a CD (perhaps only for MSU). Information on future SNO points and capability to inquire per sounder etc. are likely not routinely available but would be beneficial.)

2.6.11 Impact of HIRS sounder fov size

The ITWG was a strong proponent of decreasing the field of view of HIRS from 17 km to 10 km, 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 10 km 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 infra-red data from IASI. Unfortunately, direct comparison against the lower resolution (17 km) 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).

Recommendation SSSP-4 to NOAA, CIMSS and EUMETSAT (also AS-7)

These agencies are encouraged to investigate the impact of the 10 km vs. 17 km field of view with respect to improved cloud detection and cloud clearing.

Action SSSP-11 to SSSP Co-Chairs

- **Forward Recommendation SSSP-4 to respective NOAA and CIMSS scientists to investigate the impact of the higher resolution (10 km) HIRS on cloud detection and sounding products.**
- **Forward Recommendation SSSP-4 to EUMETSAT scientists to quantify the impact of higher resolution HIRS with coincident IASI data on MetOp.**

2.6.12 Access to validation datasets

A number of available, pending and new ideas to support user requirements for data validation were identified as candidates for inclusion in the data validation topic area of the SSSP Web site.

It was generally 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, CIMSS and EUMETSAT, would provide users with important information to validate and tune their respective scientific algorithms and applications which utilize these observations.

The SSSP Web site recently deployed a utility (see Cal /Val area) which allows users to interrogate individual collocations of such observations over an approximately one week period, in conjunction with the NOAA polar satellite operation. Procedures to routinely update these datasets and improve the user access are planned.

Validation systems to compile longer-term and expanded multi-platform validation datasets, including observations from Aqua, GOES and emerging COSMIC observations are either available or in the planning stages at NOAA.

SSSP WG discussions also led to a validation strategy, designed mainly for HRPT users, to designate a number of global target areas (mainly in the vicinity of WMO and research data facilities such as ARM and BSRN and national observatories) for which useful data describing the surface information, cloud classification (including cloud nephelyses), ambient weather (temperature, moisture, precipitation) could be routinely collected in addition to the more routinely available satellite data and products (from global centres and EARS / RARS). Such datasets would be limited to a rolling (i.e. 30-day) period and also archived to facilitate retrospective analysis later.

Numerous cross validation datasets comparing specific products for existing (and past) operational and research satellite and ground sensors also exist across the operational and research community landscape (e.g., Vonder Haar and Forsythe comparisons of NVAP versus AIRS and ATOVS for TPW). Coordination is needed to identify suitable studies which can be accessed as a source of ongoing and / or historical validation information for users.

Action SSSP-12

Co-Chairs, Walter Wolf, all WG members

- **Investigate and report on opportunities and feasibility of further developing the validation areas.**
- **Coordinate the expansion of the designated “Validation” topic area of the SSSP Web site to provide an efficient validation tool.**

2.6.13 SSSP product inputs and site review

Information on scientific products as reported on the SSSP Web site have not increased much over the past two years and in some cases the existing sites no longer exist or have not been updated for several years. A letter soliciting new inputs was forwarded prior to ITSC-XV, requesting inputs from participants who have not yet registered their work, with minimal response. It was recognized during the Working Group meeting that perhaps a better way to increase product inputs would be for willing WG members to search the internet within their domain of expertise and verify that the information on the site is updated (verify / update existing links) and actively pursue new contributions.

The need for SSSP Web site review was also discussed and it was similarly recognized that a review of the site might again be more efficient if willing WG members can verify in their domain of competence that the specific topic areas of the site are efficiently structured and cohesive within the overall site structure.

Finally, it was agreed that the circulation of information between members would be facilitated through a mailing list comprised of all identified SSSP WG members, representatives of HRPT sites, ITWG representatives of the space agencies and others willing to contribute.

Action SSSP-13

SSSP Co-Chairs, all SSSP WG members

- **Solicit willing SSSP WG members to take the responsibility of selected product areas in the SSSP site.**
- **Solicit willing SSSP WG members to undertake a review of the overall site layout and specific topic areas and in conjunction with the Co-Chairs and Webmaster to oversee modifications.**
- **Activate SSSP WG mailing list to facilitate these activities and overall member interaction.**

3. TECHNICAL SUB-GROUP REPORTS

3.1 ATOVS AND AVHRR PROCESSING PACKAGE (AAPP)

For a detailed report on AAPP status, see presentation 5.1 (N. Atkinson).

AAPP version 5 was released in July 2005, shortly after ITSC-XIV and the launch of NOAA-18. Since then there have been a number of minor updates, mainly bug fixes.

Most of the development effort has concentrated on version 6, supporting MetOp. Version 6.1 was released on 12th October 2006. To mitigate the MetOp-A launch delays, AAPP v6 was released before the launch of MetOp-A, and therefore before it had been tested on live MetOp data. Thanks are due to the various beta testers who provided feedback. The NWP SAF will issue updates as required during MetOp-A commissioning.

For MetOp direct readout processing, the interface to AAPP v6 is at EPS Level 0 (as defined by EUMETSAT). Users are advised to ensure that their HRPT stations are upgraded to deliver this format. AAPP v6 can also ingest the BUFR format data that EUMETSAT will be distributing.

Several AAPP users had requested that the NWP SAF consider updating the AAPP build system that is used in versions 1 to 5. Given that new modules are in any case required for the MetOp processing, a new build system was therefore introduced in v6. It is hoped that this system is more flexible and easier to use than the old.

The IASI Level 1 processor is called OPS-LRS (Operation Software – Local Reception Station). It is a self-contained module and is delivered as an optional component of AAPP v6.

During the next phase of development, work will start on the ingest and pre-processing modules for data from ATMS, CrIS and VIIRS instruments on NPP. AAPP will not process the direct-readout data stream directly, but will be able to ingest level 1 radiances from the International Polar Orbiter Processing Package (IPOPP), being developed jointly by IPO, NASA and the University of Wisconsin-Madison. There is an urgent need for IPO to release details of the instrument data formats as soon as possible.

3.2 INTERNATIONAL ATOVS PROCESSING PACKAGE (IAPP)

There are at present two versions of IAPP running routinely at CIMSS:

Version 2.1 is the current public release, and is available for download from the SSEC anonymous ftp server. It is capable of processing data from NOAA-15 through NOAA-18. Note that NOAA-17 can be handled only prior to the failure of AMSU-A1 in October 2003. This package is used for daily operational processing of NOAA-16.

Version 3.0 is undergoing development. It will have the capability to process data from NOAA-18 and subsequent spacecraft carrying “second-generation” ATOVS, consisting of HIRS-4, AMSU-A, and MHS, such as MetOp. This package is used for daily operational processing of NOAA-18.

When Version 2.1, which for the first time provided Linux support for IAPP, was first released, there was a lot of interest. Unfortunately, many users experienced problems – and frustration – in compiling and linking, especially in regard to the required netCDF software. To address these issues, an “open binary” subdirectory was set up on the ftp server – to accompany the “Open Source” – containing the libraries and executables that produced a working system on the CIMSS Linux system. A number of users have reported success in utilizing those files.

Because two of the three ATOVS instruments changed with NOAA-18, and the new suite will be flown on several future spacecraft, this was considered an appropriate occasion to make some evolutionary changes to IAPP, resulting in Version 3.0:

- To accommodate the variance in spacecraft names, rather than just numbers, the portion of the program interface relating to spacecraft identification was modified. The internal “bookkeeping” engendered by this change is invisible to the user.
- The regression first guess procedure originally involved eight files and eight subroutines, to handle for different instrument combinations and the presence or absence of supporting surface observations. Through a fairly simple coding change in the off-line coefficient generation software, it was possible to reduce the number of subroutines to four (there are still eight files).
- The new version (3.0) will be released after testing with live MetOp data.

Feedback from both established and potential/beginning users is always welcome! Requests for assistance with installation and/or running problems are addressed as rapidly as resources permit (see Web site at <http://cimss.ssec.wisc.edu/opsats/polar/iapp/IAPP.html>).

3.3 INTERNATIONAL MODIS/AIRS PROCESSING PACKAGE (IMAPP)

The International Moderate Resolution Imaging Spectroradiometer/Atmospheric Infrared Sounder (MODIS/AIRS) Processing Package (IMAPP) has been providing EOS Terra and Aqua direct broadcast users with the capability to calibrate and navigate locally received satellite data since 2000. This NASA funded software package has expanded to include a number of environmental data products of significant regional interest and is freely distributed to end users by the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison. IMAPP can be downloaded via anonymous ftp at <http://cimss.ssec.wisc.edu/~gumley/IMAPP/>.

The current package now contains collection 5 software which will create MODIS products including:

- calibrated/navigated radiances,
- cloud mask, cloud top properties,
- cloud phase,
- retrievals of atmospheric profiles,
- total precipitable water vapor,
- aerosol optical depth,
- sea surface temperature, and a
- near-infrared technique to determine atmospheric water vapor.

In addition, the package also includes AIRS sounder suite calibration and navigation software for the AIRS and AMSU instruments. Two complementary techniques for generating temperature and moisture profiles from the AIRS Sounder suite have now been added, one using a physical based algorithm and the other a clear sky only statistical algorithm at single AIRS pixel resolution. Finally, AMSR-E calibration and navigation software is available along with science production software for generating rain rate and soil moisture.

Future enhancements to IMAPP will include a new way to execute the software, automatically retrieving all required dynamic ancillary data, as well as an updated distribution Web page. Other future additions include:

- AMSR-E sea surface temperatures and snow/water equivalent software,
- AMSU liquid water path software,
- AIRS/MODIS collocation software and combined products,

and the transition to the next generation of direct broadcast software, the International Polar Orbiter Processing Package (IPOPP), will begin and encompass a broad array of instruments and platforms from NPP/NPOESS VIIRS and CrIS to MetOp IASI.

Beyond the EOS direct broadcast software development, distribution, and user support, the IMAPP team at CIMSS/UW also has conducted training workshops to educate software users in general remote sensing principles, sensor characteristics, data processing techniques, processing algorithms, product applications, and real time utilities. IMAPP workshops conducted so far were at:

- 2004 – Nanjing, China
- 2004 – Perth, Australia
- 2005 – Taipei, Taiwan
- 2005 – Beijing, China
- 2006 – Andenes, Norway
- 2006 – Pretoria, South Africa

The CIMSS/UW IMAPP and IPOPP team will continue its effort in supporting ITWG and global direct broadcast users in the form of:

- Developing and distributing production software (Level 1 and level 2 data and products),
- Providing processing scripts and cluster processing expertise,
- Developing and providing visualization tools, and
- Conducting tutorials and workshops for many more years to come.

3.4 FAST RADIATIVE TRANSFER MODEL (RTTOV)

The development of the RTTOV fast radiative transfer model — part of the EUMETSAT-sponsored NWP-SAF activities — is continuing since the release of RTTOV-8 in November 2004. Around 180 users worldwide have received the new version. For your free copy, visit the URL below and click on 'software requests' in the right panel. A few bugs have been detected in the code and the fixes to these are available together with all the documentation from the RTTOV Web site at:

<http://www.metoffice.gov.uk/research/interproj/nwpsaf/rtm/>.

Since ITSC-XIV the RTTOV_SCATT code has been rewritten and released as part of the updated model RTTOV-87. Work is ongoing to make the code more efficient on vector machines. Both RTTOV-7 and RTTOV-8 participated in the AIRS radiative transfer comparison exercise which is reported as a paper in this conference proceedings.

New coefficient files are now available both for RTTOV-7 and RTTOV-8 from the Web site which currently are:

- MetOp (n.b. satellite id=2)
 - IASI
 - HIRS
 - AMSU-A
 - MHS
 - AVHRR
- MSG-2 SEVIRI
- GOES-12 sounder
- MeghaTropiques
 - Saphir
 - Madras

Work is now proceeding on the development of RTTOV-9 due for release in the Spring of 2007. The major enhancements are:

- Inclusion of multiple scattering for cloudy and aerosol radiance calculations
- Linear in tau mean path values
- Zenith angle dependence of path
- Include reflected solar for SWIR
- More active trace gases CO, CH₄, N₂O,
- Further optimisation of predictors
- Minor improvements to RTTOV_SCATT (new Mie tables)
- Change interface to allow profile input on user levels
- Change interface to avoid need to specify polarisation index

Most of these changes are described in more detail in the talk by M. Matricardi given at this conference. It is planned to make the science changes optional so that RTTOV-9 is backward compatible and be able to reproduce the results of RTTOV-8 if required.

If you would like to be informed about RTTOV developments, bugs in the code, and new coefficient files you can join an RTTOV email list by sending an email to: nwpsaf@metoffice.gov.uk and requesting to be added to the list.

3.5 COMMUNITY RADIATIVE TRANSFER MODEL (CRTM)

Gas Absorption

Currently CompactOPTRAN, a polychromatic algorithm, is used for all sensors. Work is underway to allow the integration of different gas absorption algorithms (e.g. OPTRANv7, SARTA, RTTOV) simultaneously. The methodology to allow this is still being tested and will require a minor change in the CRTM User Interface.

Initial work on the integration of the RTTOV gas absorption algorithm into the CRTM was undertaken by Roger Saunders (Met Office) during a visit to the JCSDA in April-May 2006. Completion of the initial integration of RTTOV in the CRTM extended from the forward model to the tangent-linear (TL), adjoint (AD), and K-matrix (KM) models during a visit by Paul van Delst (CIMSS/EMC/JCSDA) to the Met Office in Aug-Sep 2006. Details of the results of this work are available as NWP-SAF Visiting Scientist Reports.

OSS (Optimal Spectral Sampling), a monochromatic algorithm, has been integrated into an earlier version of the CRTM. This code is still being tested.

Cloud Scattering

The initial cloud scattering module of the CRTM produces optical parameters for six different cloud types: water, ice, rain, snow, graupel, and hail. The optical parameters are interpolated from a lookup table (LUT) based on effective radius and water amount. This module is currently being tested for continuity across the LUT hinge points, and consistency between the forward, tangent-linear (TL), and adjoint (AD) models. that are used in the scattering radiative transfer.

Aerosol Scattering

The code to provide the optical parameters for aerosol scattering is still under review and has not been integrated into the CRTM. This code performs similarly to the cloud scatter module in that it uses a LUT to provide the optical parameters. Seven aerosol types are included in the table: dust, sea salt, dry organic carbon (OC), wet OC, dry black carbon (BC), wet black carbon, and sulphates.

Surface Optics

The surface optics portion of the CRTM has infrared (IR) and microwave (MW) models for the four basic surface types: land, water, snow, and ice. Each basic surface type has within it categories of allowable subtypes. The non-water IR surface models are rudimentary and are placeholders for further development. The integration of the CIMSS/SSEC IR land surface emissivity database into the CRTM SfcOptics module is underway. The inclusion of IR land surface emissivity models is being investigated.

Radiative Transfer

The current radiative transfer solver in the CRTM is the NESDIS advanced doubling-adding module. The UW-SOI is also available and is still being tested in the CRTM.

3.6 FREQUENCY MANAGEMENT

This technical Working Group met during ITSC-XV. Jean Pla (CNES) has taken over the leadership of the group from Guy Rochard. A comprehensive presentation was given on the latest status regarding microwave frequency protection for passive sounders during the ITSC-XV conference and a paper containing detailed information is available in the conference proceedings. During the Conference, the following issues have been discussed.

- Several examples of radio frequency interference on passive sounder data have been presented at 6 and 10.6 GHz.
- Review of two agenda items for the next World Radio Conference to be held in October 2007.
- Study the impact on meteorological forecast and climate modeling of having corrupted measurements within the field of view of a passive radiometer.

Examples of RFI

One example especially deals with the sharing situation within the band 10.60-10.68 GHz: it was shown that large degradation due to interference is experienced over **Japan, UK and Italy**. It is to be noted that only one form of interference (horizontal polarization emissions) is shown, and fails to demonstrate how extensive undetectable interference is. However it is reasonable to assume that in regions of extensive detectable RFI there are likely to be larger areas of undetectable interference. Therefore, detectable interference at high levels is a symptom of a problem, but absence of detectable RFI does not imply that there is not a problem. This situation illustrates that the problem is real and growing given that such signatures were not detectable a few years ago.

Another dramatic example is the interference situation experienced by space borne passive sensors in 6-7 GHz. This band is very useful for monitoring soil moisture, sea surface temperature and sea surface wind speed. According to observations made by JAXA at 6.9 GHz (350 MHz bandwidth), the AMSR (Advanced Microwave Scanning Radiometer) mounted on the ADEOS-II, and the AMSR-E mounted on the AQUA, it was noticed that this band is highly polluted in most of the countries and corresponding observations are becoming more and more difficult due to the very high level of interference. Moreover, it appears that this interference seems to increase year by year.

The next World Radio Conference (WRC)

The next World Radio Conference which will be held in October-November 2007 (WRC-07) contains two agenda items (1.2 and 1.20) dealing with passive services. Agenda item 1.2 deals 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 deals with out of band emissions since the frequency bands under consideration are exclusive (1400-1427 MHz, 23.6-24 GHz, 31.3-31.5 GHz, 50.2-50.4 GHz and 52.6-52.8 GHz). A solution which is preferred by the space and meteorological agencies is the inclusion of limits in terms of power or radiated power of active services within the frequency bands of passive services in the regulations.

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 is 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. The most appropriate method in order to better protect the shared passive band at 10.6 and 36 GHz is to introduce within the Radio Regulations a single entry emission limit taking into account the results of the compatibility analysis. Those limits would be non-retroactive for the terrestrial active systems notified or brought into use before WRC-07 (the exact date corresponding to this concept will have to be decided by WRC-07).

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 that fall within the EESS (passive) allocations (Radio Regulation (RR) numbers **1.144-1.146** and Appendix 3), thus presenting a risk that unwanted emissions could cause unacceptable interference to EESS (passive) measurements.

Prior to WRC-03, ITU-R conducted studies between the EESS (passive) and active services in certain adjacent or nearby bands. WRC-03 did not reach any agreement and decided to further the studies for specified pairs of frequency allocations EESS (passive) and active services. Preliminary calculations have shown that low levels of interference received at the input of the passive sensors may degrade passive sensor operations according to the thresholds contained in Recommendation ITU-R S.1029-2.

Concerning the band pairs under investigation for agenda item 1.20, it is to be noted that only **5.340** bands are considered for this agenda item, since these bands are in principle protected from in-band emissions (except for the automotive short range radars which have been unfortunately authorized in some countries). It is assumed that due to their status provided by **5.340** (« All emissions are prohibited »), those bands are able to receive RFI from services in operation in adjacent bands only: those kinds of RFI are also known under the name of unwanted emissions (composed of spurious emissions and of out of band emissions).

For each band pair as mentioned in ITU-R Resolution 438, the Conference may decide a method to satisfy the Agenda Item. The main objective is to ensure equitable burden sharing for achieving compatibility between active and passive services. It is to be noted that the Conference may decide that, for a given band pair, no regulatory measures are required. The method which is preferable is to propose for each band pair a mandatory power limit for unwanted emissions from a single transmitter of a specified service in an adjacent or nearby band.

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

Generally the impact of RFI or wrong measurements derived from non-natural or man-made transmissions within satellite passive bands is not precisely known, especially within ITU-R

One 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 at 24 or 50 GHz? It is now becoming urgent to get a good *quantitative* explanation of the various levels of degradation. It is still possible to keep arguing that it is not easy to derive this kind of information since complex algorithms are needed to model the atmosphere which is known to be unpredictable in nature. However, Space and Meteorological Agencies have to bring evidence to the regulation 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.

Another issue is the impact of missing data, due to high level of interference. As the data are known to be bad over the same area of the globe, they are systematically deleted from the dataset to be used. What are the consequences if data are lost? It is recommended that 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 modeling.

ITSC-XV AGENDA

Tuesday 3 October 2006

15:00-19:00 Registration

Wednesday 4 October 2006

8:00 Registration (continues until 15:00)

8:30-9:00 Welcome
Co-Chairs Tom Achtor, Roger Saunders
Vincenzo Cuomo, IMAA
Paolo Pagano, Italian Air Force

Local Arrangements
Filomena Romano

IRC Science Council Briefing
Tom Achtor

Review of Agenda
Co-Chairs

9:00-10:00

Session 1: Radiative Transfer

Chair: Stephen Tjemkes

- | | | |
|-----|------------------|--|
| 1.1 | Marco Matricardi | Recent advances in the science of RTTOV |
| 1.2 | Fuzhong Weng | Advances in Radiative Transfer Modeling in Support of
Satellite Data Assimilation |
| 1.3 | Raymond Armante | Recent Validations of infrared and microwave forward models
at LMD |
| 1.4 | Roger Saunders | A Comparison of AIRS Radiative Transfer models |

10:00-10:30 BREAK

10:30-11:30

Session 1 (continued)

- | | | |
|-----|--------------------------------|--|
| 1.5 | Carmine Serio | Validation of the forward/inverse physical scheme ϕ -IASI with
NAST-I and IMG data |
| 1.6 | Fuzhong Weng
(for Yong Han) | A Fast Radiative Transfer Model for SSMIS Upper-air
Sounding Channels Affected by Zeeman Splitting and Its
Application for Temperature Retrieval |
| 1.7 | Ed Westwater | Clear-Air Forward Microwave and Millimeterwave Radiative
Transfer Models for Arctic Conditions |
| 1.8 | Nicole Jacquinet | GEISA/IASI-03: Data Quality Evaluation Through
Comparisons with other Public Database Archives |

11:30-12:00

Session 2: Surface Studies

Chair: Ben Ruston

- | | | |
|-----|--------------------------------------|---|
| 2.1 | Eric Pequignot | Infrared continental surface emissivity spectra retrieved from
hyperspectral sensors. Application to AIRS observations |
| 2.2 | Allen Huang
(for Robert Knuteson) | Land Surface Temperature and Infrared Emissivity at High
Latitudes from Advanced Infrared Sounder Observations |

12:00-13:30 Lunch (Plus Poster Session Preparation)

13:30-14:00

Session 3: Cloud Studies

Chair: Claudia Stubenrauch

- 3.1 Allen Huang
(for Hong Zhang)
- 3.2 Filomena Romano

Global Analysis and Characterization of AIRS/MODIS Cloud-Clearing
Analysis of day- and night-time Arctic clouds by means of hyperspectral infrared and ground-based observations

14:00-14:30

Session 4: Climate Studies

Chair: Vincenzo Cuomo

- 4.1 John Bates
- 4.2 Masami Sakamoto

NOAA's archive, access, and assessment of satellite data for climate applications
A follow-up study of the TOVS application for the Japanese Climatic Reanalysis: JRA-25

14:30-15:00 BREAK

15:00-16:00

Session 4 (continued)

- 4.3 Mark McCarthy
- 4.4 Claudia Stubenrauch
- 4.5 Tony Reale
- 4.6 Cheng-Zhi Zou

Met Office plans for the development of a climate data record from HIRS and IASI
Assessment of global cloud climatologies from satellite observations
Vicarious Satellite Monitoring / Validation and Pending Reference Networks
Recalibration of Microwave Sounding Unit for Climate Studies Using Simultaneous Nadir Overpasses

17:00-18:30 Poster Session A

18:30 Icebreaker

Thursday 5 October 2006

8:30-9:45

Session 5: Guy Rochard Session on DB Software, Education and MW Frequency Protection

Chair: Roger Saunders and Tom Achtor

- 5.1 Nigel Atkinson
- 5.2 Allen Huang
- 5.3 Frode Dinessen
- 5.4 Jean Pla
- 5.5 Paolo Antonelli

AAPP status report and experiences with processing METOP data
Status Update of IMAPP and IPOPP – The End-to-End Processing Package for EOS and future Polar Orbiting Satellite Systems
Integration of 3party processing packages in a satellite reception system
Passive Microwave Protection: Impact of Active Services on Satellite Passive Observations
Fostering a new generation of Remote Sensing Scientists

9:45-10:15 BREAK

10:15-11:30

Session 6: Preprocessing and Calibration

Chair: Allen Huang

- | | | |
|-----|---|--|
| 6.1 | Tom Kleespies | Results from the NOAA-14 Microwave Sounding Unit Pitch Test |
| 6.2 | Banghua Yan | Recalibration of SSM/I/S for Weather and Climate Studies |
| 6.3 | Bjorn Lambrigtsen
(for Hartmut Aumann) | AIRS observations of Dome Concordia in Antarctica and comparison with Automated Weather Stations (AWS) during 2005 |
| 6.4 | Allen Larar | Satellite Infrared Radiance Validation Using the NAST-Interferometer |
| 6.5 | Dong Chaohua | Plan of Calibration and Validation of FY-3 Instruments and Products |

11:30-13:00 Lunch (Plus poster session preparation)

13:00-14:30 Poster Session B

14:30-16:45 ITSC-14 Action Items presented by ITSC-14 WG Chairs Moderators: Tom Achtor/
Roger Saunders

- Radiative Transfer and Surface Property Modeling (Louis Garand)
 - 1st Workshop on Remote Sensing and Modeling of Surface Properties (Ben Ruston)
- ATOVS/TOVS in Climate Studies (John Bates)
- ATOVS/TOVS in NWP (Steve English)
- Advanced Infrared Sounders (Allen Huang)
- International Issues and Future Systems (Tom Achtor and Roger Saunders)
- Satellite Sounder Science and Products (Tony Reale)

Technical Sub-Group Reports

- ATOVS DB Packages
- Update on Radiative Transfer Packages (RTTOV, CRTM)
- Frequency Protection

16:45-17:00 Working Group Formation

Chairs: Roger Saunders and Tom Achtor

Evening free (Bus available to go to Maratea)

Friday 6 October 2006

8:30-10:00

Session 7: Operational Use of ATOVS

Chair: Niels Bormann

- | | | |
|-----|-----------------|--|
| 7.1 | Nancy Baker | Satellite Assimilation Activities for the NRL Atmospheric Variational Data Assimilation (NAVDAS) and NAVDAS-AR (Accelerated Representer) Systems |
| 7.2 | Benjamin Ruston | Assimilation of AIRS data at NRL |
| 7.3 | Tony McNally | The assimilation of satellite data at ECMWF: Operational status and research plans |
| 7.4 | Kozo Okamoto | Use of satellite radiances in the global assimilation system at JMA |
| 7.5 | Antonio Vocino | Assimilation of ATOVS retrievals and AMSU-A radiances at the Italian Weather Service: current status and perspectives |
| 7.6 | Louis Garand | Operational implementation of AIRS and SSM/I assimilation at MSC |

10:00-10:30 BREAK

10:30-11:00

Session 7 (continued)

- 7.7 Brett Candy Current and Future Use of Microwave Sounding Data in the Met Office Global NWP Model
- 7.8 Fiona Hilton Current status and future plans for the use of AIRS and IASI data at the Met Office

11:00-12:30

Session 8: Developments in use of ATOVS in NWP **Chair: Steve English**

- 8.1 Graeme Kelly The relative contributions of the various space observing systems to the ECMWF forecast system
- 8.2 Chris Tingwell Assimilation of Level-1D ATOVS Radiances in Australian Regional and Mesoscale Data Assimilation and Prediction Systems
- 8.3 Thomas Auligne Bias correction of satellite radiances at ECMWF
- 8.4 William Campbell Pre-operational testing and results from direct assimilation of the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave Imager Sounder (SSMIS)
- 8.5 Niels Bormann Assimilation and monitoring of SSMIS, AMSR-E, and TMI data at ECMWF
- 8.6 Jishan Xue
(for Wei Han) Bias Correction of AMSU in GRAPES Global and Regional Models

12:30-14:00 Lunch

14:00-15:15

Session 8 (continued)

- 8.7 Roger Randriamampianina Estimation of satellite observations bias correction for limited area models
- 8.8 Godelieve Deblonde One-dimensional variational assimilation of SSM/I observations in Rainy Atmospheres at MSC
- 8.9 Nadia Fourrie Towards assimilation of cloudy radiances
- 8.10 John Derber The use of hyperspectral infrared radiances in numerical weather prediction
(for John LeMarshall)
- 8.11 Andrew Collard The use of AIRS Reconstructed Radiances in NWP and Preparations for IASI

15:15-15:45 BREAK

15:45-16:30

Session 9: International Issues

Chair: Carmine Serio

- 9.1 Luigi De Leonibus The EUMETSAT Satellite Application Facility on support to Operational Hydrology and Water Management (H-SAF)
- 9.2 Jian Liu Space based Global Observing System Requirements for Satellite Sounders
- 9.3 Mitch Goldberg Global Space-based InterCalibration System (GSICS)
- 9.4 Marie DuMont A global Network of Regional ATOVS Retransmission Services (RARS)

Evening free (Bus available to go to Sapri)

Saturday 7 October 2006

Working Groups

9am-11am (or as arranged by WG Chairs)

2pm Depart for Coach tour of local area

Group Dinner in Castle (at end of tour)

Sunday 8 October 2006

Working Groups

6-8pm (or as arranged by WG Chairs)

Monday 9 October 2006

8:30-9:30

Session 10: Agency Status Reports

Chair: Dong Chaohua

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|------|----------------------------------|--------------|
| 10.1 | Peter Schlüssel for Dieter Klaes | EUMETSAT |
| 10.2 | Mitch Goldberg | NOAA Report |
| 10.3 | Dong Chaohua | China |
| 10.4 | Alexander Uspensky | Russia |
| 10.5 | Devendra Singh | India |
| 10.6 | Kozo Okamoto | JMA and JAXA |

9:30-10:00

Session 11: Products from ATOVS

Chair: Bill Smith

- | | | |
|------|----------------------------------|---|
| 11.1 | Devendra Singh | Validation and inter comparisons of profiles from ATOVS and AIRS data over India and it surrounding regions |
| 11.2 | Tony Reale
(for A. K. Sharma) | Updates on Operational Processing for NOAA/NESDIS Sounding Data Products and Services |

10:00-10:30 BREAK

10:30-12:30

Session 11: Products from ATOVS (continued)

- | | | |
|-------|---------------------|--|
| 11.3 | Nikita Pougatchev | Assessment of Atmospheric Profile Retrieved from Satellite: Theory and Case Study |
| 11.4 | Anton Kaifel | Neural Network based Ozone Profile Retrieval Using Combined UV/VIS and IR Satellite Data |
| 11.5 | Alexander Uspensky | Retrieval of Atmospheric Trace Gases Variability with Satellite Advanced IR sounders |
| 11.6 | Sid Ahmed Boukabara | Introducing NOAA's Microwave Integrated Retrieval System (MIRS) |
| 11.7 | Silvia Puca | Refinement and operation implementation of a rain rate algorithm based AMSU/MHS and raingauges data over the H-SAF |
| 11.8 | Bormin Huang | Linear form of the radiative transfer equation revisited |
| 11.9 | Yves Rochon | Jacobian mapping between vertical coordinate systems in variational assimilation |
| 11.10 | Ralf Bennartz | Progress in modeling efforts related to radiance assimilation of clouds and precipitation |

12:30-14:00 Lunch

14:00-14:45

Session 12: METOP Development

Chair: Peter Schlüssel

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|------|-----------------|--|
| 12.1 | Denis Blumstein | IASI in-flight calibration and preliminary results |
| 12.2 | Thierry Phulpin | Use of IASI data for tropospheric trace gas retrieval |
| 12.3 | Thomas King | Development of the IASI Near Real-Time Operational Product Processing System |

14:45-15:15

Session 13: Future Sensors

Chair: Mitch Goldberg

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|------|------------------|--|
| 13.1 | Peter Wilczynski | NPOESS - A Restructured Program |
| 13.2 | Hal Bloom | Recent Updates to the NPOESS Space Segment and Sensor Manifest |

15:15-15:45 BREAK

15:45-16:45

Session 13 (continued)

- | | | |
|------|------------------------------------|--|
| 13.3 | Bill Smith | Geostationary Imaging Fourier Transform Spectrometer: New Technology for Atmospheric Temperature, Moisture, Chemistry, & Winds |
| 13.4 | Jun Li | GOES Infrared Sounders – the future perspective from the current applications |
| 13.5 | Ed Westwater
(for Al Gasiewski) | Geostationary Passive Microwave Observation System Simulation Experiments for Hydrometric Tracking |
| 13.6 | Bjorn Lambrigtsen | GeoSTAR |

16:45-19:00 BREAK (Working Group Meetings to finish reports if needed)

19:00 Conference Banquet

Tuesday 10 October 2006

- 8:30-9:30 Working Group reports and actions summary
- Radiative Transfer and Surface Property Modeling
 - ATOVS/TOVS in Climate Studies
 - ATOVS/TOVS in NWP

9:30-10:00 BREAK

- 10:00-11:00 Working Group reports and actions summary (continued)
- Advanced Infrared Sounders
 - International Issues and Future Systems
 - Satellite Sounder Science and Products

11:00-12:00 Future meetings, election and other events relevant to ITWG
Plans for next meeting and closing remarks

Co-Chairs Tom Achtor,
Roger Saunders

12:00-13:00 Lunch

Two Buses to Naples Airport: Noon and 2pm

Poster Session A: Wednesday

- A01 David Anselmo:** Detailed impact evaluation of AIRS and SSM/I assimilation
- A02 Alain Beaulne:** Detailed impact evaluation of AIRS and SSM/I assimilation
- A03 Steve English:** Assimilation of cloudy AMSU-A radiances in 4D-var
- A04 Steve English:** Assimilation of near surface sounding radiances
- A05 Alan Geer:** Assimilation of cloud and precipitation affected microwave radiances at ECMWF
- A06 Yann Michel:** Automated tracking of dry intrusions on satellite water vapour imagery and model output for data assimilation
- A07 Martin Stengel:** 1DVAR studies with SEVIRI data and the HIRLAM model
- A08 Elisabetta Ricciardelli:** Physical and statistical approach for MSG cloud identification
- A09 Stephen Tjemkes:** Performance analysis of MTG-IRS
- A10 Tom Kleespies:** Relative Information Content of the Advanced Technology Microwave Sounder, and the Advanced Microwave Sounding Unit and the Microwave Humidity Sounder Suite
- A11 Tom Kleespies:** The Use of Google Earth in Meteorological Satellite Visualization
- A12 Steven Swadley:** Calibration Anomalies and Radiance Assimilation Correction Strategies for the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave Imager Sounder (SSMIS)
- A13 cancelled**
- A14 Tom Achtor:** SSEC/CIMSS Participation in the NPP PEATE Program
- A15 Kathleen Strabala:** Polar Orbiting Satellite Direct Broadcast Activities at the University of Wisconsin-Madison
- A16 Luigi De Leonibus:** HYDROLOGY SATELLITE APPLICATION FACILITY (H-SAF): a distributed element of the EUMETSAT Application Ground Segment
- A17 Zhaohui Cheng:** The use of principal component analysis in processing simulated IASI data
- A18 Per Dahlgren:** Direct assimilation of AMSU-B radiances in the HIRLAM 3DVAR analysis
- A19 Dezso Devenyi:** Satellite products in the Rapid Update Cycle and plans for the Rapid Refresh
- A20 Nathalie Selbach:** Comparison of ATOVS, CHAMP and ground based humidity estimates on different spatiotemporal scales
- A21 Xu Liu:** Application of a Principal Component-based Radiative Transfer Model to NAST-I data Retrievals
- A22 Niels Bormann:** Assimilation of limb radiances from MIPAS at ECMWF using 1d and 2d radiative transfer models
- A23 David Shawn Turner:** A Fast Forward Model for the Stratospheric Wind Interferometer For Transport studies
- A24 Domenico Cimini:** On the role of surface emissivity in polar night-time cloud detection
- A25 Teodosio Lacava:** Monitoring space-time soil wetness variations by a multi-temporal microwave satellite records analysis
- A26 Nadia Fourrie:** Status of ATOVS-like and SSM/I data in the operational assimilation system at Météo-France and perspectives towards the use of microwave surface sensitive channels over land
- A27 Izabela Dyras/Bozena Lapeta:** Homogenization of the total ozone amount series derived from NOAA/TOVS data
- A28 Stefan Buehler:** CIWSIR: A Proposed ESA Mission to Measure Cloud Ice Water Path
- A29 Anthony Rea:** Current and Future Plans for Satellite Data Reception and Utilisation at the Australian Bureau of Meteorology

Poster Session B: Thursday

- B01 Bjorn Lambrigtsen:** Climate Research With the Atmospheric Infrared Sounder
- B02 Lydie Lavanant:** AVHRR operational cloud masks intercomparison
- B03 Brett Candy:** Improvements to Use of Satellite Sounding Data in Met Office Regional Models
- B04 cancelled**
- B05 Sylvain Heilliette:** Variational estimation of cloud parameters with a view towards cloudy radiance assimilation. Application to AIRS observations
- B06 Ed Pavelin:** Plans for the assimilation of cloud-affected infrared soundings at the Met Office
- B07 Dirceu Herdies (for Luiz Fernando Sapucci):** The Inclusion of Integrated Water Vapor Estimates from AIRS/AMSU and SSM/I Sensors into PSAS Data Assimilation System in the CPTEC
- B08 moved to talk 8.2**
- B09 Rodrigo Souza:** First Results from the Use of the Aqua Sounding System in the CPTEC Global Data Assimilation/Forecast System
- B10 Rodrigo Souza:** Performance of the AIRS/AMSU and MODIS Soundings over Natal/Brazil using collocated sondes: SHADOZ campaign 2004-2005
- B11 John Palmer:** Standard back-propagation artificial neural networks for cloud liquid water path retrieval from AMSU-B data
- B12 Thierry Phulpin:** SIFTI : a new generation FTIR spectrometer for the Tropospheric composition and Air Quality (TRAQ) mission
- B13 Peter Schlüssel:** Impact of thermal inhomogeneity on IASI spectral response and its correction
- B14 Jishan Xue (for Wei Han):** Satellite Data Assimilation in Tropical Cyclone Forecasts
- B15 Tom Achtor:** ITWG Overview
- B16 Leanne Avila:** The ITWG Web Site: How to Create a Useful Forum for the Community
- B17 Lihang Zhou:** An Integrated Web-based Visualization System for Monitoring and Validation of the Products from Hyper-spectral Instruments
- B18 Walter Wolf:** Distribution of Hyperspectral Radiances to Numerical Weather Prediction Centers
- B19 Paul van Delst (for Yong Han):** JCSDA Community Radiative Transfer Mode (CRTM) version 1 and development prospects
- B20 Raymond Armante:** The status of the 4A (Automatized Atmospheric Absorption Atlas) forward model
- B21 cancelled**
- B22 cancelled**
- B23 Dan Zhou:** Surface emissivity retrieved from AIRS
- B24 Claudia Stubenrauch:** Cloud properties from AIRS
- B25 José Aravéquia:** Observation operator and estimation of uncertainty in the assimilation of AIRS radiances using ensemble Kalman Filter

ITSC-XV ABSTRACTS

SESSION 1

1.1: Recent advances in the science of RTTOV

Presenter: Marco Matricardi

Marco Matricardi
ECMWF

A number of significant scientific changes have been made to the RTTOV fast radiative transfer model. A major new feature of RTTOV is the inclusion of a parameterization of multiple scattering that is performed by scaling the optical depths by a factor derived by including the backward scattering in the emission of a layer and in the transmission between levels. The introduction of multiple scattering allows RTTOV to simulate AIRS and IASI radiances in presence of eleven different types of aerosol components, five different types of water clouds and 30 different types of ice clouds. In RTTOV, ice clouds can be assumed to be composed either of randomly oriented hexagonal ice crystals or ice aggregate. RTTOV can now simulate IASI and AIRS radiances which include CO, CH₄, N₂O and CO₂ as profile variables and a solar term to evaluate the solar radiance reflected by a land or a wind roughened water surface. For a land surface, the reflecting surface is treated as a perfect diffuser following the Lambert law whereas for a full-gravity-capillary wave water surface the bidirectional reflectivity of the surface is computed explicitly for any geometry using a wave model to evaluate the variance of the wave slope. The treatment of the angular dependence of the optical depths has also been improved by introducing an altitude dependent value of the local zenith angle that takes into account the curvature of the Earth and its surrounding atmosphere. To improve the accuracy of the radiance computation in presence of optically thick layers, RTTOV features a new parameterization of the Planck function based on the linear in tau assumption that the source function throughout the layer is linear with the optical depth of the layer. Finally, to solve the radiative transfer for an atmosphere partially covered by clouds, RTTOV uses a scheme (stream method) that divides the field of view into a number of homogeneous columns, each column containing either cloud-free layers or totally cloudy layers. Each column is assigned a fractional coverage and the number of columns is determined by the cloud overlapping assumption (maximum-random overlap in RTTOV) and the number of layers the atmosphere is divided into. The total radiance is then obtained as the sum of the radiances for the single columns weighted by the column fractional coverage. It is planned that these upgrades are included in the next release of RTTOV, RTTOV-9.

1.2: Advances in Radiative Transfer Modeling in Support of Satellite Data Assimilation

Presenter: Fuzhong Weng

Fuzhong Weng
NOAA/NESDIS/Office of Research and Applications

The development of fast and accurate radiative transfer models for clear atmospheric conditions has enabled the direct assimilation of clear sky radiances from satellites in numerical weather prediction models. Currently, many fast models also handle the scattering and emission processes that dominate cloud and precipitation. Some analytic Jacobian schemes, crucial components for satellite data assimilation, have also been developed. For the operational data assimilation system, distinct features from each radiative transfer model may ultimately be combined in the more refined versions of the scattering radiative transfer by taking the advantages of speed and accuracy relative to benchmark solutions, storage efficiency for coefficients, inclusion of Jacobian, and potential developments for future instruments.

Major impediments in assimilating satellite radiances are several folds. Since scattering by precipitation and clouds is a function of particle size which is not currently predicted or diagnosed in most NWP models, there remain large uncertainties in computing cloudy radiances. The spatial inhomogeneity of clouds and precipitation demands complex, time consuming techniques such as three-dimension Monte Carlo modeling for computing scattering. Uncertainties in surface radiometric property modeling remain large in many geographical regions, particularly over desert and sea ice covered conditions. There are few comprehensive data sets for fully assessing the accuracies and performances of simulated radiances under these circumstances.

1.3: Recent Validations of infrared and microwave forward models at LMD

Presenter: Raymond Armante

R. Armante, V. Cappelle, N.A. Scott, N. Jacquinet, A. Chédin
Laboratoire de Météorologie Dynamique, Ecole Polytechnique

To be successfully performed and understood, applications based on high spectral infrared sounders as well as microwave radiometers observations require rapid and accurate forward radiative transfer models. Accordingly, these models have to be regularly validated against auxiliary data, and, in particular, against collocated satellite-radiosonde observations.

Such models have been designed and maintained at LMD from the original line-by-line and layer-by-layer STRANSAC and 4A models to the hyper-fast 3R_N based on a neural network approach. These models are involved in our applications, from the processing of TOVS to the processing of hyper spectral sounders e.g. AIRS/AMSU/Aqua and IASI/AMSU/Metop. For example, more than three years of AIRS/AMSU have already been processed.

Line by line model discrepancies or inaccuracy may find their origin in several sources: spectroscopic line parameters, minor gases cross section (temperature dependence), missing absorber, line coupling formulation including temperature dependence, exploration of the line wings, modeling of the continua, discretization in pressure and in frequency, etc.

Here, we report on recent extensive validations performed in under several conditions of observations (downwelling, upwelling, limb) and for several types of instruments (radiometers, interferometers). Results will be presented and analyzed for campaigns as Thorpex, Eaquate, IASI balloon experiment, etc. Retroactions towards the spectroscopic database GEISA (line parameters, CFC's and aerosol description) will be also discussed.

1.4: A Comparison of AIRS Radiative Transfer models

Presenter: Roger Saunders

Roger Saunders¹, P. Rayer¹, A. von Engeln², N. Bormann³, S. Hannon⁴, S. Heilliette⁵, Xu Liu⁶, F. Miskolczi⁶, Y. Han⁷, G. Masiello⁸, J-L Moncet⁹, V. Sherlock¹⁰, D.S. Turner¹¹, Gennady Uymin⁹

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Under the auspices of the ITWG an AIRS radiative transfer model comparison was proposed and undertaken. Results from 14 line-by-line and fast parameterized infrared models were submitted for comparison. Several aspects of the models were compared. Firstly the forward model calculations for all 2378 AIRS channels for 52 diverse atmospheric profiles and one tropical Pacific profile coincident with AIRS data were computed for three local zenith viewing angles: nadir, 45 and 60 degrees. Secondly, for

a subset of the models and only 20 AIRS channels, the layer to space transmittances were provided. Finally for some models the Jacobians with respect to temperature, water vapor and ozone were also computed. For the forward model calculations most models agree to within 0.02K when compared to a reference line-by-line model averaged over 49 profiles with the exception of a few spectral regions. When compared with AIRS observations however the mean differences increase to 0.2K and for a few models even greater differences are seen. The transmittance differences highlighted regions of the spectrum where the spectroscopy of the models differ, particularly in the carbon dioxide absorption bands at 667cm⁻¹ and 2386cm⁻¹. For the Jacobians all models have some profiles/channels that do not fit the reference well. The model differences only increase slightly for off nadir viewing angles for both forward and Jacobian calculations.

1.5: Validation of the forward/inverse physical scheme ϕ -IASI with NAST-I and IMG data

Presenter: Carmine Serio

A. Carissimo¹, G. Grieco¹, G. Masiello², C. Serio^{1,2}, V. Cuomo²

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²Istituto di Metodologie di Analisi Ambientale del CNR, IMAA/CNR

The package ϕ -IASI is a line-by-line radiative transfer model designed for fast computation of spectral radiance and its derivatives (Jacobian) with respect to a given set of geophysical parameters. It represents a compromise between the accuracy of the exact line-by-line radiative model and the fastness of the hyper-fast radiative transfer model. This compromise is achieved by means of a look-up table of pre-computed pressure dependent monochromatic optical depths and an interpolation procedure. The optical depth look-up-table take into account also effects depending on the gas concentration, such as the line self-broadening of the water vapor. The added capability of radiance derivatives computation gives to ϕ -IASI the flexibility to be used also for the inversion process of geophysical parameters. This is done through a Newton-Raphson scheme in which the Radiative Transfer Equation is step-linearized by Taylor expansion.

ϕ -IASI has been developed to meet the spectral range of the IASI (Infrared Atmospheric Sounding Interferometer). The European IASI instrument covers the spectral range between 3.6 and 15.5 micron with a spectral resolution of 0.25 cm⁻¹ and it will be launched on board of MetOp satellite on 2005. The same spectral range is covered by the NAST-I Fourier Transform

Spectrometer (NPOESS Aircraft Sounder Testbed Interferometer). NAST-I flies on board on the NASA ER-2 stratospheric airplane and the Proteus, and has a spectral resolution quite similar to that of IASI.

σ -IASI has been adapted to NAST-I and the paper shows and discusses examples of radiance inversion for Temperature, water vapor and ozone. Examples from CAMEX-3 and EAQUATE experiments will be shown. In addition, ozone retrieval from IMG radiance is discussed and compared to TOMS/ADEOS columnar ozone. The analysis provides a quality check of the ϕ -IASI forward/inverse capability and allowed us to assess the retrieval accuracy for temperature, water vapor obtained by high spectral resolution infrared observations.

1.6: A Fast Radiative Transfer Model for SSMIS Upper-air Sounding Channels Affected by Zeeman Splitting and Its Application for Temperature Retrieval

Presenter: Fuzhong Weng (for Yong Han)

Yong Han¹, Quanhua Liu², Fuzhong Weng¹, and Paul van Delst³

¹ NOAA/NESDIS/Center for Satellite Applications and Research, Camp Springs, MD

² QSS Group, Inc.

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A fast radiative transfer model has been developed at the US Joint Center for Satellite Data Assimilation (JCSDA) as part of the community radiative transfer model (CRTM) for the SSMIS upper-air sounding channels affected by the O₂ Zeeman splitting. It is a regression-based model, trained with the Rosenkranz line-by-line model that takes the Zeeman effects into account and a set of atmospheric profiles. The model's inputs include atmospheric pressure and temperature profiles, the Earth's magnetic field strength and the cosine angle between the magnetic field and wave propagation direction. Its outputs include brightness temperatures and brightness temperature Jacobians with respect to the atmospheric temperatures for SSMIS channels 19 – 24. In this presentation we will show the performance of the model against that of the line-by-line model and the SSMIS measurements. We will also show the characteristics of the upper-air sounding channels such as the dependence of the brightness temperatures and the weighting functions on geographic location due to the variations of the Earth's magnetic field and the angle between the field and the wave propagation direction. Finally, we will discuss the model's applications for upper-air temperature retrievals.

1.7: Clear-Air Forward Microwave and Millimeterwave Radiative Transfer Models for Arctic Conditions

Presenter: Ed Westwater

E. R. Westwater¹, D. Cimini², V. Mattioli³, A. Gasiewski¹, M. Klein¹, and V. Leuski¹

¹Department of Electrical and Computer Engineering/CIRES, University of Colorado at Boulder, USA

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Forward models of atmospheric emission in the clear air are important for remote sensing, both in clear and cloudy conditions, and from ground- or space-based platforms. Based on the results of a ground-based radiometric experiment that was conducted at Barrow, Alaska, during March-April, 2004, several absorption models were evaluated. The experiment comprised of upward-looking radiometers from 22.235 to 400 GHz, and involved three systems. The first two were the Microwave Radiometer (MWR) and the Microwave Radiometer Profiler (MWRP) manufactured by Radiometrics Corporation, Inc. (USA) and operated by the Atmospheric Radiation Measurements (ARM) program. These radiometers operated from 22.235 to 58.8 GHz. The third system, the Ground-based Scanning Radiometer (GSR), was developed and operated by NOAA/Physical Science Division, and measured radiances from 50 to 400 GHz. In addition to the microwave and millimeterwave radiometers, cloud lidars, cloud radars, and infrared radiometers, were also operated to provide information on clouds. To provide a base to develop radiative transfer models as well as derived products, several sets of radiosondes were launched. First, at the "Great White", the location of all of the remote sensors, once-a-day Vaisala RS-90 radiosondes were launched. In the city of Barrow, less than 5 km away, RS90 radiosondes were launched four-times per day, and the NOAA National Weather Service also launched VIZ radiosondes twice-a-day at synoptic times. Finally, eight dual-radiosonde launches were made using co-located "Snow White", RS90, and VIZ-type sensors. A good variety of cold weather conditions were encountered during the experiment with surface temperatures ranging from -40 °C to -4 °C and Precipitable Water Vapor from 0.8 to 15 mm.

Brightness temperatures from five different absorption models will be compared with the well-calibrated radiometric measurements. These models include the 1987 and 1993 models of H. J. Liebe, the 1998 and 2003 models of P. W. Rosenkranz, and a recent modification of the 2003 Rosenkranz model that was published by J. C. Liljegren et al. (2005). In addition to

the discussions of the differences and accuracies of the five models, we also will show the lack of sensitivity of the NWS radiosondes to water vapor in the upper troposphere and lower stratosphere (Mattioli et al. 2006). This lack of sensitivity is demonstrated both by comparisons with the other radiosonde types, and with the radiance observations themselves. Since the NOAA/NWS Barrow observations form a part of the U. S. climate base, we discuss the implications of these results for satellite validation in the Arctic.

1.8: GEISA/IASI-03: Data Quality Evaluation Through Comparisons with other Public Database Archives

Presenter: Nicole Jacquinet

*N. Jacquinet, N. A. Scott, A. Chédin, R. Armante
Laboratoire de Météorologie Dynamique, Ecole Polytechnique*

The GEISA (Gestion et Etude des Informations Spectroscopiques Atmosphériques; Management and Study of Atmospheric Spectroscopic Information database) has been updated in 2003/2004.

The performances of new atmospheric sounders like AIRS (Advanced InfraRed Sounder), in the USA, and IASI (Infrared Atmospheric Sounder Interferometer) in Europe, which have a better vertical resolution and accuracy, compared to the presently existing satellite infrared vertical sounders, is directly related to the quality of the spectroscopic parameters of the optically active gases. For these instruments, the so-called GEISA /IASI spectroscopic sub-database has been elaborated from the general GEISA spectroscopic database system, with a continuous update from new spectroscopic parameters, when available. The specific purpose of this effort is to assess the capability of measurement by the IASI instrument, within the designated goals of ISSWG (IASI Sounding Science Working Group), in the frame of the CNES (Centre National d'Etudes Spatiales, France) /EUMETSAT (European organization for the exploitation of METeorological SATellites) European Polar System (EPS) preparation. The assessment is done by simulating either high-resolution radiance spectra or experimental data, or both, as the situation demands.

The purpose of this presentation is to show some selected results of critical comparisons, in terms of spectroscopic line parameter archives (i.e.: HITRAN or MIPAS databases). All the archived spectroscopic data of GEISA and GEISA/IASI can be handled through a user-friendly associated management software, which is posted on the ARA/LMD group Web site at: <http://ara.lmd.polytechnique.fr>

SESSION 2

2.1: Infrared continental surface emissivity spectra retrieved from hyperspectral sensors: Application to AIRS observations

Presenter: E. Péquignot

*E. Péquignot, A. Chédin, N. A. Scott
Laboratoire de Météorologie Dynamique (LMD),
Institut Pierre-Simon Laplace, Ecole Polytechnique*

Continental surface infrared emissivity strongly depends on the wavelength and on the type of the surface. For example, in the reststrahlen spectral band of quartz around 8-10 μm , emissivity values as low as 0.6 may be observed, particularly over Sahara desert. Surface temperature and emissivity spectra are variables essential for greatly improving models of the earth surface-atmosphere interaction, retrievals of meteorological profiles as well as cloud and aerosol characteristics from infrared vertical sounders. In this paper, Atmospheric InfraRed Sounder (AIRS) satellite observations (aboard the NASA/AQUA platform) are interpreted in terms of monthly mean surface skin temperature and emissivity spectra. The difficulty of the interpretation of window channel radiances in terms of surface emissivity and temperature is accounted for by using directly the radiative transfer equation. For each AIRS observation, an estimation of the atmospheric temperature and water vapor profiles is performed using a proximity recognition scheme within the Thermodynamic Initial Guess Retrieval (TIGR) climatological library of about 2300 representative atmospheric situations. With this information, all terms of the radiative equation are calculated independently by using the 4A line-by-line radiative transfer model. Then surface temperature is evaluated by using a single AIRS channel (at 12.183 μm) characterized by an almost constant emissivity with respect to soil type. Emissivity spectrum is then calculated for all atmospheric windows (transmittance greater than 0.3). The overall infrared emissivity spectrum at 0.05 μm resolution is finally derived through a combination of high spectral resolution laboratory measurements of selected materials (ASTER and MODIS emissivity spectra libraries). Three years of AIRS observations (from April 2003 to March 2006) between 30°S and 30°N have been processed and interpreted in terms of monthly mean surface skin temperature and emissivity spectra from 3.7 to 14.0 μm at a spatial resolution of 1°x1°. To estimate the quality of our multi-spectral method, retrievals are compared with the Moderate Resolution Imaging Spectroradiometer (MODIS, also flying aboard the NASA/AQUA platform) monthly mean L3 products and with the CIMSS/SSEC University of Wisconsin global infrared land surface emissivity database. Infrared emissivity spectra estimation by the multi-spectral method is fast, simple, robust and

adaptable to all hyperspectral infrared sensors (AIRS/IASI). It can easily be implemented within the assimilation scheme of numerical models.

2.2: Land Surface Temperature and Infrared Emissivity at High Latitudes from Advanced Infrared Sounder Observations

Presenter: Allen Huang (for Robert Knuteson)

*Robert O. Knuteson, Henry E. Revercomb, and David C. Tobin
University of Wisconsin-Madison*

In preparation for the routine NWP assimilation of operational advanced infrared sounder data (IASI on MetOp and CrIS on NPOESS) over high latitude land regions of the globe, we present a methodology to determine land surface temperature from clear fields of view. The method is demonstrated using NASA AIRS and MODIS data over snow covered land and sea ice. MODIS data collocated within AIRS fields of view are used to estimate the uniformity of the scene. Also the derived surface emissivity derived from AIRS is compared to theoretical expectations of snow emissivity by Dozier. A clear filter is applied to the AIRS data which uses both the MODIS sub-pixel uniformity and consistency with the expected snow emissivity within certain limits. A surface temperature is derived from these clear AIRS pixels using one or more estimation methods. Preliminary validation is provided from ground truth measurements from the U.S. Atmospheric Radiation Measurement North Slope of Alaska (ARM NSA) site and selected surface radiation sites in other locations. A time series is also provided of derived surface temperatures for the Greenland ice sheet to illustrate the time continuity and sampling of these high latitude observations from polar orbiting satellites.

SESSION 3

3.1: Global Analysis and Characterization of AIRS/MODIS Cloud-Clearing

Presenter: Allen Huang (for Hong Zhang)

*Hong Zhang, Allen Hung-Lung Huang, Jun Li, Kevin Baggett, Erik Olson, and Chian-Yi Liu
Cooperative Institute for Meteorological Satellite Studies, Space Science and Engineering Center,
University of Wisconsin - Madison*

The Atmospheric Infrared Sounder (AIRS) and MODerate-Resolution Imaging Spectroradiometer (MODIS) on board the EOS Aqua spacecraft measure the upwelling infrared radiance used for numerous remote sensing and climate related applications. AIRS provides high spectral resolution infrared radiances while MODIS provides collocated high spatial

resolution radiances at sixteen broad infrared bands. An optimal algorithm for cloud-clearing has been developed for AIRS cloudy soundings at the University of Wisconsin-Madison where the concurrent AIRS and MODIS data has been used to verify this algorithm. A global analysis study and characterization of the AIRS cloud-clearing, the global bias and the standard deviation between AIRS cloud-cleared brightness temperature and the nearby clear brightness temperature are analyzed, and their potential for numerical weather prediction and cloudy sounding applications are studied.

3.2: Analysis of day- and night-time Arctic clouds by means of hyperspectral infrared and ground-based observations

Presenter: Filomena Romano

*F. Romano, D. Cimini, E. Ricciardelli, and V. Cuomo
Institute of Methodologies for Environmental Analysis
(IMAA) National Research Council (CNR)*

The detection of polar clouds with satellite passive observations presents several difficulties. In fact, 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. These characteristics impact in different ways the ability of cloud detection. 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.

Several techniques are available to detect polar clouds based on visible and infrared observations. However, single and bi-spectral threshold methods are sometimes inappropriate due to large variability of surface emissivity and cloud conditions. More recently, the availability of multi- and hyper-spectral observations (e.g. MODIS, AIRS) 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 few clear and cloudy case studies collected in the Arctic winter during an intensive operational period. Ground-based active and passive measurements are used to constrain simulations of satellite data, which are then compared to real observations to investigate the advantages and limitations of different cloud detection techniques. In conclusion, the additional information content associated with the new hyperspectral sensor IASI will be discussed.

SESSION 4

4.1: NOAA's archive, access, and assessment of satellite data for climate applications

Presenter: John Bates

*John Bates
NOAA NCDC*

NOAA's National Climatic Data Center (NCDC) is the U.S. Agency records center for weather and climate data. The mission of NCDC is to provide stewardship and access to the Nation's resource of global climate and weather related data and information, and assess and monitor climate variation and change. As such, NCDC archives all of NOAA's polar orbiting data, selected instruments from the DMSP satellites, and all data from NOAA's geostationary satellites. Stewardship efforts are underway to 'rescue' some of these data sets to ensure their quality. These data can be accessed through the Comprehensive Large-Array data Stewardship System (CLASS) which is under continuing development for the data center. Finally, NOAA's Scientific Data Stewardship Project has been established to produce long-term climate data records to apply to the NCDC mission of assessing and monitoring climate variation and change.

4.2: A follow-up study of the TOVS application for the Japanese Climatic Reanalysis: JRA-25

Presenter: Masami Sakamoto

*Masami Sakamoto, Kozo Okamoto, and Yoshito Yoshizaki
Japan Meteorological Agency*

Japan Meteorological Agency (JMA) and the Central Research Institute of Electric Power Industry (CRIEPI) achieved a 26 year climatic reanalysis: JRA-25. This climatic reanalysis was achieved on the basis of the numerical prediction and data assimilation techniques of JMA and computational resources of CRIEPI. Since JMA had never experienced an assimilation of equivalent Temperature of BlackBody (TBB) of TOVS on board TIROS-N to NOAA-14 operationally, JRA-25 developed and adopted an assimilation scheme for level-1d data for HIRS and MSU, and level-1c for SSU. The result of the assimilation of TOVS shows some interesting features; stable and consistent expressions in the troposphere, but unstable behaviors in the stratosphere in comparison with other reanalyses.

As a follow up study of JRA-25, TOVS observation was compared with climatic reanalyses: JRA-25, ERA-40, ERA-15, and NCEP / NCAR. This comparison provides much information on reanalyses qualities and TOVS observation qualities. And it

shows that apparently newer reanalyses: JRA-25 and ERA-40 show good agreements with TOVS observations. The comparison and examinations on reanalyses reveal how reanalyses differ and what brought these differences.

According to the results of this follow-up study, the authors have been thinking about an ideal strategy for a coming next generation climatic reanalysis and how to cope with an assimilation of satellite sounding observations: TOVS / ATOVS and their predecessor VTRP. One of the keys to a successful application might be an exact assimilation of the sounding observations with zero-bias from the background, combined with Global Climate Model (GCM) improvement, which aims at a GCM that can describe climatic trends and events. These concepts seem very common to operational NWP for seasonal forecasts, but they still are very challenging as for a climatic reanalysis.

4.3: Met Office plans for the development of a climate data record from HIRS and IASI

Presenter: Mark McCarthy

*Mark McCarthy, Simon Tett, Roger Saunders, Nigel Atkinson, Karsten Fennig
Met Office*

The Infra-red Atmospheric Sounding Interferometer (IASI) has a commitment to at least 15 years of continuous observation. The global coverage, good absolute calibration, well defined spectral response, and commitment to a long mission supports the use of IASI for climate monitoring. It will also provide unprecedented vertical (1km) resolution. Furthermore the high spectral resolution makes it feasible to match channels of the High resolution Infra-red Sounder (HIRS, 1979-2015) instruments, which can provide an important first step in the homogenisation of the historical data. As the Met Office will receive IASI data in near-real-time we will process them and merge with the historical infra-red record, to generate a near-real-time climate data record monitoring the free-atmosphere temperature and humidity.

In this presentation we will outline our plans for the homogenisation of the HIRS record back to 1979 and the processing of the near-real-time IASI climate product. Climate signals are small, and in order to adequately span structural uncertainty it is important that homogenization of data sets is a continually evolving process. Therefore this work will complement and build upon existing and planned datasets developed elsewhere, and will necessarily require close collaboration internationally. Our ultimate aim for this extensive observational resource is to place stronger constraints on climate feedbacks and sensitivity.

4.4: Assessment of global cloud climatologies from satellite observations

Presenter: Claudia Stubenrauch

C. J. Stubenrauch (+ GEWEX cloud assessment group)

Laboratoire de Météorologie Dynamique (LMD)

Only satellite observations are capable to give a continuous survey of the state of the atmosphere over the whole globe. At present, long time-series (twenty years) of measured radiances are available from IR-VIS imagers and of vertical sounders. Second generation instruments with improved spatial and spectral resolution take data since the second millennium. A GEWEX activity is to assess the quality and reliability of available global cloud data sets for climate studies. Among these are ISCCP, TOVS Path-A, TOVS Path-B and UW-HIRS. Climatological averages of cloud properties, their regional, seasonal and diurnal variations as well as time series are compared.

4.5: Vicarious Satellite Monitoring / Validation and Pending Reference Networks

Presenter: Tony Reale

*Tony Reale
NOAA/NESDIS/STAR*

NOAA/NESDIS plans for a unified approach for NOAA (and METOP) operational satellite data monitoring and validation against an expanding suite of ground and space based observations are presented. Candidate collocated observations and data collection / management strategies are outline along with proposed analytical techniques using currently available observations and planned observations from National Polar Orbiting Environmental Satellite System (NPOESS) Preparatory Project (NPP) and NPOESS. Synergy with emerging GCOS Reference Upper Air Network requirements from the most recent Workshop held in May 2006 is addressed.

4.6: Recalibration of Microwave Sounding Unit for Climate Studies Using Simultaneous Nadir Overpasses

Presenter: Cheng-Zhi Zou

*Cheng-Zhi Zou
NOAA/NESDIS/STAR*

The measurements from Microwave Sounding Unit (MSU) onboard different NOAA polar-orbiting satellites have been extensively used for detecting atmospheric temperature trend during the last several

decades. However, temperature trends derived from these measurements are under significant debate, mostly caused by calibration errors. This study recalibrates the MSU Channel 2 observations at level 0 using the post-launch simultaneous nadir overpass (SNO) matchups and then provides a well-merged new MSU 1b dataset for climate studies. The calibration algorithm consists of a dominant linear response of the MSU raw counts to the Earth-view radiance plus a smaller quadratic term. Uncertainties are represented by a constant offset and errors in the coefficient for the nonlinear quadratic term. A SNO matchup dataset for nadir pixels with criteria of simultaneity of less than 100 seconds and within a ground distance of 111 km is generated for all overlaps of NOAA satellites. The simultaneous nature of these matchups eliminates the impact of orbital drifts on the calibration. A radiance error model for the SNO pairs is developed and then used to determine the offsets and nonlinear coefficients through regressions of the SNO matchups. It is found that the SNO matchups can accurately determine the differences of the offsets as well as the nonlinear coefficients between satellite pairs, thus providing a strong constraint to link calibration coefficients of different satellites together. However, SNO matchups alone cannot determine the absolute values of the coefficients because there is a high degree of colinearity between satellite SNO observations. Absolute values of calibration coefficients are obtained through sensitivity experiments, in which the percentage of variance in the brightness temperature difference time series that can be explained by the warm target temperatures of overlapping satellites is a function of the calibration coefficient. By minimizing these percentages of variance for overlapping observations, a new set of calibration coefficients is obtained from the SNO regressions. These new coefficients are significantly different from the pre-launch calibration values, but they result in bias-free SNO matchups and near-zero contaminations by the warm target temperatures in terms of the calibrated brightness temperature.

Applying the new calibration coefficients to the Level 0 MSU observations, a well-merged MSU pentad dataset is generated for climate trend studies. To avoid errors caused by small SNO samplings between NOAA 10 and 9, observations only from and after NOAA 10 are used. In addition, only ocean averages are investigated so that diurnal cycle effect can be ignored. The global ocean-averaged intersatellite biases for the pentad dataset are between 0.05 to 0.1 K, which is an order of magnitude smaller than that obtained when using the unadjusted calibration algorithm. The ocean-only anomaly trend for the combined MSU channel 2 brightness temperature is found to be 0.198 K decade⁻¹ during 1987-2003.

SESSION 5

5.1: AAPP status report and experiences with processing METOP data

Presenter: Nigel Atkinson

Nigel Atkinson¹, Pascal Brunel², Philippe Marguinaud² and Tiphaine Laborot²

¹*Met Office*

²*Meteo-France*

Version 6 of the ATOVS and AVHRR Preprocessing Package (AAPP) has been prepared in order to process direct readout, regional and global data from METOP. The package is due to be released as soon as it has been validated with METOP-A direct readout data - which should be in September 2006. The talk will describe the structure of AAPP v6 and the initial experiences with running it on live METOP data.

AAPP v6 comprises three main components - (1) the "core" AAPP (providing the functionality of previous versions of AAPP), (2) a set of tools for handling the METOP data formats, and (3) the IASI level 0 to level 1c processor OPS-LRS (Operational Software - Local Reception Station).

The OPS-LRS is an optional component, based on the OPS software originally provided to EUMETSAT by CNES. Since the last ITSC a set of top-level perl scripts has been added; these scripts automatically start OPS, prepare work orders based on supplied level 0 data, run OPS and generally simplify the operation of the software.

The core AAPP has been enhanced to process IASI level 1c data, with various options including mapping AMSU to IASI, spectral thinning (Principal Components and/or channel selection) and spatial thinning. As well as additional functionality, the AAPP v6 code has been restructured with a more modern, simplified build system, removing the previous reliance on "imake".

METOP-A is due to be launched on 17th July 2006, with AHRPT data being available about one week later. The reception systems at Exeter (UK) and Lannion (France) are planning to receive these early transmissions, and the data will be used to validate AAPP v6. The talk will report on the experiences with processing METOP data.

Finally the talk will look forward to subsequent developments including extension of AAPP to accept data from NPP (to be launched in 2009). This will require the ability to ingest products from the IPOPP software being developed by NASA and the University of Wisconsin.

5.2: Status Update of IMAPP and IPOPP – The End-to-End Processing Package for EOS and future Polar Orbiting Satellite Systems

Presenter: Allen Huang

*Hung-Lung Huang, Liam Gumley, Kathleen Strabala, Jun Li, Jun Huang, and Elisabeth Weisz
Cooperative Institute for Meteorological Satellite Studies
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The International Moderate Resolution Imaging Spectroradiometer / Atmospheric Infrared Sounder (MODIS/AIRS) Processing Package (IMAPP) provides users with an EOS satellite Terra and Aqua direct broadcast system the capability to calibrate and navigate locally received satellite data and, from these data, to create environmental data products of significant regional interest. This software development effort is funded by NASA and is freely distributed to end users by the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison. So far, more than 120 direct broadcast stations are using IMAPP for their daily routine direct broadcast processing from the raw data to the generation of end products and information.

While CIMSS is currently seeking funding to maintain and update IMAPP and to continue to support direct broadcast users, planning for the NPOESS and its Preparatory Project (NPP) is well underway. The processing package for NPP/NPOESS will be built on the foundation laid by IMAPP and the data processing element provided by the NPOESS prime contractor, working closely with NASA's Direct Readout Laboratory (DRL). In addition, the proposed International Polar Orbiter Processing Package (IPOPP) will also be extended to include the processing of METOP data. The IPOPP METOP component effort is to leverage EUMETSAT NWP Satellite Application Facility (SAF) located at UK Met office and its Meteo France partner. These SAF team members are jointly developing a new version of AAPP (ATOVS and AVHRR Pre-Processing Package) to allow users to perform level 1 processing on the direct broadcast data for AMSU, MHS, HIRS, AVHRR and IASI (i.e. generate calibrated, geolocated radiances or brightness temperatures). Within IPOPP, specified level 2 retrieval algorithms to individually and/or synergistically process AMSU, MHS, AVHRR and IASI data to produce atmospheric products will also be developed and distributed.

In summary, in this paper we will highlight the current status and future prospects for IMAPP and its successor, IPOPP. Specifically, we shall address the role these software packages play in bringing to the international polar orbiting direct broadcast community the considerable capabilities of EOS of

NASA, METOP of EUMETSAT, and, into the future, NPP/NPOESS of NOAA and its partners.

5.3: Integration of 3party processing packages in a satellite reception system

Presenter: Frode Dinessen

*Frode Dinessen
Kongsberg Spacetec*

The recent development in satellite data reception systems have made available a multitude of free processing packages for various processing levels. Satellite owners and operators often promote the use of their data by distributing processing software either directly or through cooperating research institutes and universities.

Software packages such as IMAPP for TERRA/AQUA, SeaDAS for SEAWIFS/TERRA/AQUA, AAPP for NOAA/METOP are well known to the community for low-level processing of the science data from the given satellites. In addition we have software packages such as IAPP, ICI and MODIS-DB algorithms implementations for higher level processing.

The benefits of this policy are many; rapid on-site processing, more cost effective systems, and common calibration and interpretation guides promote the cooperation between satellite data users and facilitates further research for application specific algorithms.

The shortcomings of these sw packages are the often cumbersome operations. Several independent systems are needed for antenna scheduling and tracking, for data reception, for level 0 processing and for higher level processing.

We will in these paper present methods utilizing freely available software packages in combination with a flexible monitoring and control system capable of integrating all units into an autonomous ground station for reception, processing and distribution of data.

The core of these methods is a Station Control System (SCS) which provides external interface, logistics services and scheduling capabilities. A graphical user interface (GUI) against the SCS fully exploits all its possibilities. Through its interface the SCS can be monitored and controlled remotely by multiple monitoring systems.

The software packages are controlled by the SCS through an interface script that starts the application, deliver the parameters and handle the output. All software packages can be run independent but the SCS is also equipped with a high-level flexible instruction language to control the work flow. The instruction language specifies a chain of commands (jobs) to be

executed by the system according to a set of rules. In this way output from one application can be used to trigger execution of a subsequent application.

Logistic information written by the software packages to the standard output are translated by the interfacing script and sent to the SCS for monitoring.

Auxiliary data needed by software packages are handled by a rolling archive mechanism. The rolling archive is set up in such a way that old files are automatically deleted once a defined maximum disk quota is used.

5.4: Passive microwave protection: impact of active services on satellite passive observations

Presenter: Jean Pla

*Jean Pla
Centre National d'Etudes Spatiales*

The microwave passive frequency bands that are essential for the retrieval of physical parameters such as 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 next World Radio Conference which will be held in November 2007 (WRC-07) contain two agenda items (1.2 and 1.20) dealing with passive services. Agenda item 1.2 deals 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 deals with out of band emissions since the frequency bands under consideration are exclusive (1400-1427 MHz, 23.6-24 GHz, 31.3-31.5 GHz and 50.2-50.4 GHz).

The paper will provide a description of physical and mathematical tools to solve the two agenda items, as well as a description of regulatory solutions currently envisaged. In particular, one solution which has the preference of the space and meteorological agencies is the inclusion of limits in terms of power or radiated power of active services within the frequency bands of passive services within RR. One basic question that needs to be clearly answered is the following: 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? For instance, what are the consequences on the weather forecast if some EESS satellite pixels are corrupted with wrong data due to non-natural emissions at 24 or 50 GHz? This essential issue will be developed with some examples, possible answers and future workplan.

5.5: Fostering a new generation of Remote Sensing Scientists

Presenter: Paolo Antonelli

Paolo Antonelli¹, Leanne Avila¹, Steve Dutcher¹, Liam Gumley¹, Allen Huang¹, Jean Phillips¹, Tom Rink¹, Kathy Strabala¹, and Paul Menzel²

¹ University of Wisconsin-Madison

² NOAA/NESDIS

While 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 particular many of SSEC's recent training efforts have focused on national and international researchers interested in theoretical and operational aspects of remote sensing.

SSEC and CIMSS have hosted workshops for the last three years that bring both young and more experienced scientists together to discuss new data, techniques and results. They have also given weeklong remote sensing seminars that provide a broader and more fundamental perspective to experienced and new researchers and to the graduate students around the world. These seminars often include lectures on

- Radiation and the radiative transfer equation,
- Remote sensing of the Earth surface and its atmosphere,
- Instrument considerations,
- Algorithms for detecting and estimating water vapor, cloud, and aerosol properties,
- Current and future remote sensing capabilities.

The lectures are supplemented with laboratory exercises that emphasize investigation of high spatial resolution visible and infrared data (from MODIS and MSG) and high spectral resolution infrared data (from AIRS and the Scanning HIS).

In the last five years, from China to South Africa to New York City, SSEC and CIMSS scientists have brought greater understanding of the technology, the applications, and the benefits of remote sensing measurements of our Earth, to more than 400 students. Through these efforts SSEC provides a solid

contribution in fostering a new generation of scientists, who will help to carry our work forward in a team-oriented fashion.

SESSION 6

6.1: Results from the NOAA-14 Microwave Sounding Unit Pitch Test

Presenter: Thomas Kleespies

Thomas J. Kleespies

NOAA/NESDIS

The Microwave Sounding Unit has been flown on NOAA spacecraft since 1979. It has been used by a number of teams to attempt to determine decadal trends of atmospheric temperature, often with conflicting results. While a great deal of innovation has gone into refined post-launch calibration, considerable uncertainty remains, especially regarding asymmetry of the radiances. NOAA plans to perform a pitch test in which the satellite remains in an inertial drift for one orbit. This will permit all of the instruments to view the relatively flat cosmic background while in normal scanning mode, and thus resolve any questions about possible asymmetries. This paper will describe the results of this test.

6.2: Recalibration of SSM/I/S for Weather and Climate Studies

Presenter: Banghua Yan

Banghua Yan¹ and Fuzhong Weng²

¹QSS Group Inc.

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In the past two decades, many advanced satellite sensors were tasked with improving measurements of the Earth's atmosphere, clouds, and surface to enable enhancements in weather prediction, climate monitoring capability. For example, Special Sensor Microwave Imager (SSM/I) on board the Defense Meteorological Satellite Program (DMSP) satellites provides measurements of the cloud liquid water path, total precipitable water content, and various surface parameters. From 1987 to present, a 19 year length of the SSM/I record throughout satellite series from F-8 to F-15 has been constructed. On October 18, 2003, a more advanced instrument, the Special Sensor Microwave Imager Sounder (SSM/I/S) was successfully launched on board F-16. SSM/I/S measures the Earth's radiation from 19 to 183 GHz and presumably provides improved atmospheric temperature and water vapor sounding. Thus, a 19 year length of the SSM/I/S record is able to be utilized for diagnosing the climate trend of global atmospheric and surface properties.

However, a reliable calibration of SSM/I/S measurements is still critical in monitoring long-term of climate trend and maximizing operational and research utility of such data. This study will address some of the challenges associated with recalibrating SSM/I/S measurements of Temperature Data Records (TDR) and Sensor Data Records (SDR). In SSM/I measurements, the characteristics of the warm load temperature/counts and cold counts from sensor to sensor are first studies to detect and remove any anomalies in calibration targets. The non-linearity coefficients in the SSM/I radiometers response functions (calibration equations) on board from F-8 to F-15 satellites are further derived at TDR level from post-launch simultaneous conical overpass (SCO) observations between two satellites. In SSM/I/S measurements, the main reflector from the SSMIS antenna subsystem emits some additional radiation and contaminates the earth scene signals. In addition, the warm calibration target is intruded by direct solar radiation and other stray lights, which produces anomalous calibration counts in several latitudinal zones. These contamination sources result in anomalies in SSMIS TDR and SDR radiances. A new methodology has been developed to recalibrate the SSM/I/S measurements at the TDR level, including the predictions of the reflector temperature and emissivity, and of the calibration count anomalies. Therefore, the recalibrated SSM/I/S data through NOAA processing is of improved quality for operational applications in weather and climate models.

6.3: AIRS observations of Dome Concordia in Antarctica and comparison with Automated Weather Stations (AWS) during 2005

Presenter: Bjorn Lambrigtsen (for Hartmut H. Aumann)

*Hartmut Aumann
Jet Propulsion Laboratory, California Institute of Technology*

In preparation for the international polar year we have started the analysis of 4 years of AIRS data taken within a 50 km radius of Dome C. In the following paper we present results from data taken between 27 January 2005 and 15 November 2005, when surface temperature data were available from two Automatic Weather Stations. The AIRS calibration has already been established at the 200 mK level absolute and with better than 16 mK/year stability. The readings from the two AWS agree with 0.5 K bias and 1 K stdev during the winter season, but differ by more than 3 K and almost 3 K stdev during the summer season. One of the two stations agrees consistently better with the AIRS measurements than the other, but even there we see a 1.7 K cold bias during both seasons. Since the bias relative to AIRS is wind speed dependent, getting considerable colder at wind speeds below 3 m/s, we

conclude that we see the gradient between the temperature measured by the AWS at 3 meter above the surface and the surface skin temperature measured by AIRS.

AIRS, a hyperspectral infrared sounder on the EOS Aqua in polar sun synchronous orbit, has returned 3 million spectra of the upwelling radiance each day since September 2002.

6.4: Satellite Infrared Radiance Validation Using the NAST-Interferometer

Presenter: Allen Larar

Allen M. Larar¹, Daniel K. Zhou¹, William L. Smith^{2,3}, and Xu Liu¹

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²*Hampton University, Hampton, VA*

³*University of Wisconsin, Space Science and Engineering Center, Madison, WI*

Advanced satellite sensors are tasked with improving measurements of the Earth's atmosphere, clouds, and surface to enable enhancements in weather prediction, climate monitoring capability, and environmental change detection. Measurement system validation is critical to achieving this goal and maximizing research and operational utility of resultant data. This study will address some of the challenges associated with validating infrared radiances, while exploiting the benefits obtained from coincident high spectral/spatial resolution observations from the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Airborne Sounder Testbed-Interferometer (NAST-I) during recent field campaigns. Methodology employed herein for Aqua AIRS radiance validation will be applied to corresponding Metop IASI data when available.

6.5: Plan of Calibration and Validation of FY-3 Instruments and Products

Presenter: Dong Chaohua

DONG Chaohua¹, YANG Jun¹, LU Naimeng¹, ZHANG Wenjian², LIU Yujie¹, YANG Zhongdong¹, CAI Bin¹

¹*National Satellite Meteorological Center*

²*Department of Observation and Telecommunication, China Meteorological Administration*

Launch of FY-3A, the first satellite in the new series of Chinese polar-orbiting meteorological satellites, is planned for 2007. Development for the final product of the spacecraft is going on. FY-3A will carry 11 instruments, namely, VIRR, IRAS, MWTS, MWHS, MERSI, MWRI, ERM, SIM, SBUS, TOU, SEM. Except for the 10-channel VIRR (visible and infrared

radiometer) the rest instruments, whose spectral bands cover violet, visible, near-infrared, infrared, and microwave, are all newly developed and to be mounted on FY-3 for the first time. These instruments will be used to detect clouds, radiation, atmosphere, land and ocean.

The purpose of calibration (CAL) and validation (VAL) of FY-3 instruments and products is twofold: to maintain the best performance and precision of the instruments during the satellite operation; to provide users with the precision range of the satellite's products after finishing the in-orbit test. They mainly include 1) pre-launch calibration in the laboratory; 2) post-launch validation when satellite is in the orbit. By in-orbit validation we indicate the synchronous measurement on the ground and the inter-calibration between similar instruments on different satellites; and, 3) physical parameters – the products converted from the calibrated measurements onto else geographic location. In order to finish the work above, it's needed to get supporting algorithms and data-base, and independent methods as well.

The paper gives the characteristics of FY-3A instruments and main products, briefly introduces the instruments' laboratory calibration and aero-flight test, plan for vicarious calibration and inter-calibration of the instruments in operation.

SESSION 7

7.1: Satellite Assimilation Activities for the NRL Atmospheric Variational Data Assimilation (NAVDAS) and NAVDAS-AR (Accelerated Representer) Systems

Presenter: Nancy Baker

Nancy L. Baker¹, Clay Blankenship¹, William F. Campbell¹, Rolf Langland¹, Benjamin Ruston¹, Liang Xu¹, Tom Rosmond², Steven D. Swadley³

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The U.S. Navy's three-dimensional variational analysis system NAVDAS became operational at Fleet Numerical Meteorology and Oceanography Center (FNMOC) on October 1, 2003, paving the way for the direct assimilation of satellite radiances with the U.S. Navy's global² and mesoscale³ numerical weather

² Navy Operational Global Atmospheric Prediction System (NOGAPS)

³ COAMPS® is a registered trademark of the Naval Research Laboratory

prediction models. AMSU-A radiance assimilation, which became operational at FNMOC on June 9, 2004, significantly improved the forecast skill: the two- to five-day forecast skill at 500 hPa increased by 3-10 hours in the Northern Hemisphere and by 12-20 hrs in the Southern Hemisphere, compared to ATOVS retrieval control runs. Data thinning, channel selection, quality control and bias correction methods will be presented, along with results from assimilation tests.

Current research goals include increasing the number of AMSU-A observations that are assimilated. To this end, we are developing estimates of microwave surface emissivity over land. A combination of statistics from a 1D-Var retrieval and the NESDIS Microwave Emissivity Model provide emissivity estimates over bare and vegetated land, ice and snow. In addition, the JCSDA Community Radiative Transfer Model (CRTM) is being implemented to eliminate our dependence on ATOVS retrievals for the background above the model top. Alternative bias correction methods are also being tested, in order to reduce the bias correction related errors in the model polar stratosphere.

An adjoint-based method monitors in near real-time the impact of atmospheric observations assimilated in the operational NAVDAS on the short-range NWP forecast error. The technique uses adjoint versions of NAVDAS and NOGAPS and has been developed and tested at NRL-Monterey over the last several years. This technique has proven valuable for identify observing system issues relevant to the NAVDAS operational data assimilation, and several specific examples will be presented.

NAVDAS-AR (Accelerated Representer), an observation space 4D-VAR algorithm, is being developed and tested, along with its adjoint. The NAVDAS-AR adjoint will allow the temporal aspects of the satellite observation impact to be evaluated. Preliminary comparisons between NAVDAS and NAVDAS-AR forecast impact and adjoint-based observation impact monitoring will be presented.

Ongoing SSMI/S and AIRS assimilation research will be discussed in separate presentations. This talk will conclude with a brief summary of other related NRL assimilation research for ozone, GPS, aerosols, and future sensors.

7.2: Assimilation of AIRS data at NRL

Presenter: Benjamin Ruston

Benjamin Ruston, Nancy Baker, Bill Campbell, and Clay Blankenship
NRL

The assimilation of the AIRS and co-located AMSU sensors into the NRL NAVDAS system has been undergoing pre-operational testing. This testing uses the 5 minute granules of the 324 channel subset of AIRS data with the 15 AMSU-A channels. The data is from the central AIRS spot in a 3 x 3 scan array. Radiative transfer calculations have been performed using the JCSDA community radiative transfer model framework. This work began by testing 14 AIRS channels from the 324 channel subset along with the AMSU channels. The impact of the various AIRS channels on the NWP forecast error was assessed using adjoint-based procedures. Testing progressed from using channels with no surface sensitivity (judged by the Jacobian to surface temperature) to those channels exhibiting surface sensitivity. When surface sensitive channels were used, a 1DVAR preprocessor obtained the land surface temperature and spectral emissivity which was passed to the 3DVAR system. We will present methodologies including observation errors used, quality control and cloud clearing methodology, as well as results such as the forecast model error reduction and observed-minus-background departures.

7.3: The assimilation of satellite data at ECMWF: Operational status and research plans

Presenter: Tony McNally

*Tony McNally
ECMWF*

An overview of the current ECMWF 4D-Var assimilation system is presented and the evolution of some of the key elements related to satellite data is described. In particular it will be shown that a wide variety of satellite measurements are now used with some considerable synergy between different observing systems. Steps being taken to handle the ever increasing volume and diversity of satellite data will be described. Some important areas of development will also be presented, in particular the use of cloud affected infrared radiances and rain affected microwave radiances. Finally, wider applications of the NWP satellite data assimilation system to environmental monitoring activities (e.g. GEMS) will be illustrated.

7.4: Use of satellite radiances in the global assimilation system at JMA

Presenter: Kozo Okamoto

*Kozo Okamoto, Hiromi Owada, Yoshiaki Sato and
Toshiyuki Ishibashi
Japan Meteorological Agency*

Recently JMA has been extensively developing satellite data assimilation in the operational global

4D-Var system. Radiance data of AMSU-A and -B and microwave radiometers (MWRs) of SSM/I, AMSR-E and TMI are operationally used. Clear sky radiances (CSRs) of MTSAT-1R water vapor channel and AIRS radiances will be operationally used within 2006.

AMSU-A radiance assimilation with revised QC procedures and reduced observation errors improves forecast scores. Initially adding MWR radiances did not generate sufficiently favorable forecast impacts due to moisture impacts inconsistent with existing bias-corrected AMSU-B radiances. A variational bias correction scheme, instead of a constant air-mass bias correction scheme, adjusts bias correction coefficients to make all available radiance data, conventional data and background consistent. The assimilation of less cloud-affected radiance from MWRs reduces typhoon track forecast errors and improves precipitation forecast.

7.5: Assimilation of ATOVS retrievals and AMSU-A radiances at the Italian Weather Service: current status and perspectives

Presenter : Antonio Vocino

*Massimo Bonavita, Lucio Torrisi, and Antonio Vocino
CNMCA*

Since 2003 a variational assimilation system has been running at National Center for Aeronautic Meteorology and Climatology (CNMCA) of the Italian Air Force Weather Service in order to provide accurate and timely initial conditions for CNMCA operational NWP models (Bonavita and Torrisi, 2005). The objective analysis component currently ingests a variety of observation types, both of synoptic and a-synoptic nature: TEMP, PILOT, SYNOP, SHIP, BUOY, AMDAR, AIREP, AMV, WIND PROF, QUIKSCAT and ERS2 winds. The start of the EUMETSAT ATOVS Retransmission Service has given us the opportunity to receive sounder data from the NOAA polar orbiters' constellation within the time limits imposed by the operational schedule of our data assimilation system. Two different strategies for incorporating satellite sounding data have been investigated. In the first one temperature retrieved profiles were generated from a selection of HIRS and AMSUA-B channels using the IASI 1D-VAR software available from EUMETSAT NWP SAF. These retrievals were then ingested from the objective analysis as pseudo-TEMP observations on standard pressure levels. The second approach has been to directly ingest the level1C AMSU-A radiances in the variational assimilation system, making use of the RTTOV fast radiative transfer model and its tangent linear component. The relative merits of the two strategies are discussed in light of current results and future application to hyper-spectral interferometers.

7.6: Operational implementation of AIRS and SSM/I assimilation at MSC

Presenter: Louis Garand

*L. Garand, M. Buehner, G. Deblonde, A. Beaulne, D. Anselmo, J. Halle, N. Wagneur
Meteorological Service of Canada*

The operational assimilation of about 100 AIRS channels and 7 SSM/I channels is foreseen for early 2007. This will be done in the context of the new GEM-meso forecast model with horizontal resolution of 35 km and 58 vertical levels. In addition the background and observation errors statistics were revised following a Monte Carlo approach instead of the NMC method. Other aspects include the use of RTTOV-8, an improved vertical interpolator, and automated bias correction. Assimilation cycles in 3D-FGAT mode and later full 4D-var mode are planned. The presentation will focus on main results of the combined package and some results on the separate impact of the various components.

7.7: Current and Future Use of Microwave Sounding Data in the Met Office Global NWP Model

Presenter: Brett Candy

*Brett Candy, William Bell, Steve English, Fiona Hilton & Michael Thurlow
Met Office*

Since the last ITSC several developments have increased the amount of microwave sounding data that is used in the global model. We will review these developments which include, the introduction of NOAA18 AMSU data and the increased use of sounding data across the assimilation time window. The SSMIS instrument combines, for the first time sounding and imagery capabilities and its initial impact will be presented. Since the failure of the AMSU-A instrument onboard NOAA17 in 2003 data from this satellite has not been used. However its midday overpass time is not covered by other NOAA satellites and so the reintroduction of NOAA17 HIRS data will also be discussed.

Central to the preprocessing of sounding data at the met office is the 1D-Var retrieval technique. Its use will be outlined with particular reference to the role it can play in determining atmospheric variables such as surface skin temperature and cloud properties, with are then used in the full assimilation as fixed constraints. These are of particular importance if we are to make more use of channel information in challenging situations, such as radiances strongly affected by clouds and low level channels over land.

7.8: Current status and future plans for the use of AIRS and IASI data at the Met Office

Presenter: Fiona Hilton

*Fiona Hilton, James Cameron, Stephen English, Ed Pavelin, TR Sreerekha
Met Office*

At the Met Office we are now assimilating the AIRS Warmest Field of View dataset in both the Global and North Atlantic and European (NAE) models. Current work is focussed on improving the coverage of observations assimilated, to include observations over land and channels above cloud. Preparations for assimilation of IASI data are progressing; the status of the project will be discussed and plans for monitoring the early data presented.

SESSION 8

8.1: The relative contributions of the various space observing systems to the ECMWF forecast system

Presenter: Graeme Kelly

*Graeme Kelly and Jean-Noel Thepaut
ECMWF*

The study was sponsored on behalf of EUMETSAT to evaluate the impact of the space component of the Global Observing System (GOS) through Observing System Experiments. In this study the relative contributions of the various space observing systems have been assessed within the context of the ECMWF data assimilation system.

It is inspiring to see that all the space base sensors contribute in a positive way to the overall improvement of the ECMWF forecast system. Sensors like AMSUA, AIRS and HIRS are clearly very important. In addition the humidity analysis requires AMSUB (also MHS), GEO CSRs and SSMI. SCATT clearly impacts on the surface wind in the Southern Hemisphere and finally the impact of AMVs and MODIS winds is clearly demonstrated.

8.2: Assimilation of Level-1D ATOVS Radiances in Australian Regional and Mesoscale Data Assimilation and Prediction Systems

Presenter: Chris Tingwell

*C. Tingwell, M. Chattopadhyay, C. Vincent, B. Harris, P. Steinle and W. Bourke
Bureau of Meteorology Research Centre*

Recent work developing and testing 60 level (L60) configurations of the Australian Bureau of

Meteorology's Global Assimilation and Prediction System (GASP) and Limited Area Assimilation and Prediction System (LAPS) has progressed to the point where these systems are nearing operational trial and implementation. The L60 configuration facilitates the assimilation of ATOVS radiance data, whether received from overseas centres or locally via direct readout, processed to 1D level data via the AAPP package. The positive impact on forecast skill in the LAPS system from the use of these 1D data in trials conducted to date has been considerable.

Recently we have begun trialing a limited area 10km meso-scale assimilation and prediction system. The meso-scale system employs the same L60 vertical configuration as LAPS - in which it nests - and also assimilates level 1D ATOVS radiances, with radiance bias predictors inherited from the nesting system. The focus of the work with this system has so far been on low level wind forecasts; a major potential application lies in the production of more accurate wind forecasts for the burgeoning Australian wind energy sector. Results to date suggest that the forecast skill of this system will exceed that of the Bureau of Meteorology's current operational mesoscale prediction system.

8.3: Bias correction of satellite radiances at ECMWF

Presenter: Thomas Auligne

*Thomas Auligne, Tony McNally, Dick Dee, Graeme Kelly
ECMWF*

Biases in satellite observations are of particular concern as they have the potential, if uncorrected, to damage the Numerical Weather Prediction (NWP) system globally in a very short space of time.

The number of instruments and channels that are monitored and assimilated in NWP centres has increased dramatically. Therefore adaptive bias correction methods, where the bias is updated automatically for each assimilation cycle, are very appealing.

In order to detect failing observations and remove them prior to the analysis, the data needs to pass a quality control (QC). The interaction between the bias correction and the QC is highlighted. In particular when an adaptive bias correction is used, a feedback process can occur. The mechanism of this feedback is studied and methods to reduce it are proposed.

The variational bias correction (VarBC) is an adaptive bias correction that updates the bias inside the analysis. It has been implemented in the ECMWF 4D-Var assimilation system (D.De) and its robustness has been tested.

The VarBC has demonstrated some skill to discriminate between observation bias and systematic NWP model error. This property is exploited to select objectively the predictors that are used to model the observation bias in a linear regression.

The status and choices for the bias correction within the ERA reanalysis are also addressed.

8.4: Pre-Operational Testing and Results from Direct Assimilation of the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave Imager Sounder (SSMIS)

Presenter: William Campbell

William F. Campbell¹, Nancy Baker¹, Clay Blankenship¹, Benjamin Ruston¹, Steven D. Swadley², and William Bell³

¹*Marine Meteorology Division, Naval Research Laboratory*

²*METOC Consulting, Naval Research Laboratory*

³*Satellite Radiance Assimilation Group, Met Office*

On October 18th, 2003, the Defense Meteorological Satellite Program (DMSP) successfully launched a satellite with the first Special Sensor Microwave Imager Sounder (SSMIS) instrument aboard. The SSMIS is a conically scanning passive microwave radiometer that includes seven temperature sounding channels peaking below 30 Km, and seven peaking between 30Km and 80 Km. Two calibration anomalies were discovered, and must be corrected before the radiance data can meet the stringent requirements of NWP data assimilation systems. The first was due to nonzero reflector emission contaminating the scene temperatures. At both the Met Office and the Naval Research Laboratory (NRL), a reflector emissivity correction is performed in a similar fashion. The second was due to a solar intrusion onto the warm load calibration target. At NRL, Fourier filtering is used to correct the gain; at the Met Office, the contaminated data is flagged and not used. Calibration mitigation will be discussed in detail in a separate presentation.

At both centers, several similar pre-operational tests have been performed. Control runs consisting of the current operational system (4DVar + 3 Advanced Microwave Sounding Units (AMSU) + Atmospheric Infrared Sounder (AIRS) + Global Positioning System Radio Occultation (GPSRO) at the Met Office; 3DVar + 3 AMSU at NRL) set the baseline performance. In the first experiment, data from SSMIS channels sensitive to the tropospheric and stratospheric temperature are added to the operational systems, and evaluated after one month of assimilation. In the second month-long experiment, the data from NOAA-15 AMSU-A is removed from the system, and replaced by SSMIS. This scenario is a risk-reduction

test, and will tell us whether SSMIS can substitute for a failed AMSU instrument. Performance of the SSMIS instrument may prove crucial to NWP efforts, given the gap between the expected end of life of the NOAA operational satellites and the launch of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) and NPOESS Preparatory Project (NPP) satellite systems. Detailed descriptions and forecast impacts of these experiments will be presented.

8.5: Assimilation and monitoring of SSMIS, AMSR-E, and TMI data at ECMWF

Presenter: Niels Bormann

*Niels Bormann, Graeme Kelly, and Peter Bauer
ECMWF*

The status of monitoring and assimilation experiments with clear-sky radiances from SSMIS, AMSR-E, and TMI is presented. SSMIS combines channels similar to AMSU-A, AMSU-B, and SSMI, with a three-channel mesospheric sounder in one conically scanning instrument, whereas AMSR-E and TMI are microwave imagers similar to SSMI. After SSMIS, AMSR-E is particularly attractive for future assimilation as EOS Aqua's orbit provides coverage in areas which are currently not covered by SSMI onboard the DMSP satellites.

The quality of the data is assessed by comparisons against model equivalents. For SSMIS, the mapped dataset prepared by the Met. Office is used. This dataset includes corrections for various instrument anomalies (such as solar intrusions and thermal emissions from the main reflector) and additional quality control flags. Departure statistics appear relatively stable for the tropospheric and stratospheric sounding channels on SSMIS. AMSR-E and TMI currently show relatively large biases, especially for the lower-frequency channels at 6.925 and 10.65 GHz which are additional to the SSMI channels on these sensors. These biases may be due to deficiencies in the surface emissivity modelling at these frequencies.

Assimilation experiments with suitable channels from the new sensors will also be discussed.

8.6: Bias Correction of AMSU in GRAPES Global and Regional Models

Presenter: Jishan Xue (for Wei Han)

*Wei Han¹, Jishan Xue¹, Zhiquan Liu^{2,3}
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In the traditional framework of variational assimilation, the NWP model forecasts and observations are all assumed to have normal and unbiased distributions. Nevertheless, departures between the operational observations and the equivalent from the NWP model first-guess (innovations or first-guess departures) show systematic errors. In operational assimilation of satellite data, bias correction is one of the key elements.

For initial implementation, a bias correction scheme based on simple linear regression (Harris and Kelly, 2001) is adopted in GRAPES global and regional model. The scheme is based on a separation of the biases into scan-angle dependent which is a function of latitude as well as scan position and state dependent components which is expressed as a linear combination of a set of state-dependent predictors. The predictor coefficients for the state-dependent component of the bias are obtained by linear regression. Since November 2005, CMA has been pre-operationally using global ATOVS (on board NOAA-15, -16, -17, -18) 11b raw data from the National Oceanic and Atmospheric Administration (NOAA) / National Environmental Satellite and Data Information Service (NESDIS). The first-guess departures of AMSU are analyzed and the bias correction scheme, the predictors in the bias model, the estimation method of the predictor coefficients are all re-examined in GRAPES global and regional models respectively. The results and comparisons will be given in this presentation.

8.7: Estimation of satellite observations bias correction for limited area models

Presenter: Roger Randriamampianina

*Roger Randriamampianina
Hungarian Meteorological Service*

Assimilation of satellite radiances requires systematic bias correction. Biases are mainly from instrument characteristics, inaccuracies of the radiative transfer model and of the assimilating model and also in the observation preprocessing. Accurate bias correction methods have been worked out for the assimilation of satellite radiances in global models. Bias correction computed with global models comprises synoptic situations and different seasonal conditions (summer and winter hemispheres).

Question arises when estimating the bias correction for a limited area model (LAM) regarding the period of computation to have the "most representative" bias characteristics. Our previous study showed that bias correction characteristics estimated using the global model cannot guaranty stable positive impact in a LAM.

This paper investigates the impact of different predictors and different periods in the computation of the bias correction characteristics for a LAM assimilation system.

8.8: One-dimensional variational assimilation of SSM/I observations in Rainy Atmospheres at MSC

Presenter: Presenter: Godelieve Deblonde

*G. Deblonde, J.-F. Mahfouf, B. Bilodeau and D. Anselmo
Environment Canada*

Currently, satellite radiances in the Canadian Meteorological Centre operational data assimilation system are only assimilated in clear skies. A two-step method, developed at the European Centre for Medium Range Weather Forecasts, is considered to assimilate Special Sensor Microwave/Imager (SSM/I) observations in rainy atmospheres. The first step consists of a one-dimensional variational (1D-Var) assimilation method. Model temperature and humidity profiles are adjusted by assimilating either SSM/I brightness temperatures (Tb) or retrieved surface rain rates (derived from SSM/I Tb). In the second step, 1D-Var column integrated water vapor analyses are assimilated in 4D-Var. At the Meteorological Service of Canada, such a 1D-Var assimilation system has been developed. Model profiles are obtained from a research version of the Global Environmental Multi-Scale model. Several issues raised while developing the 1D-Var system are addressed. The impact of the size of the observation error is studied when Tb is assimilated. For two case studies, analyses are derived when either surface rain rate or Tb is assimilated. Differences in the analyzed fields between these configurations are discussed and shortcomings of each approach are identified. Results of sensitivity studies are also provided. First the impact of observation error correlation between channels is investigated. Second, the size of the background temperature error is varied to assess its impact on the analyzed column integrated water vapor. Thirdly, the importance of each moist physical scheme is investigated. Finally, the portability of moist physical schemes specifically developed for data assimilation is discussed.

8.9: Towards assimilation of cloudy radiances

Presenter: Nadia Fourrié

*N. Fourrié¹, M. Dahoui², and F. Rabier³
¹ CNRS
² Moroccan Meteorological Service
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We are attempting to assimilate AIRS cloudy radiances inside the 4D-Var assimilation scheme of the global

french model ARPEGE. Two approaches are used: the first one is based on a combination of a diagnostic cloud scheme together with the radiative transfer model RTTOVCLD to simulate AIRS cloudy radiances. With this diagnostic cloud scheme, only large scale processes are taken into account. Therefore, situations dominated by convection, are discarded. Linearity and accuracy requirements for the observation operator reduce significantly the number of AIRS channels suitable for use in 4D-Var. The second approach makes use of the cloud top pressure and the cloud cover derived from the CO2-slicing technique. In a first stage, CO2-slicing outputs are directly used by RTTOV to simulate the cloud-affected spectrum. In a second stage, CO2-slicing outputs are adjusted by a prior 1D-Var before being used by RTTOV.

Preliminary experiments have been conducted in a simplified framework over only a ten day period. The number of channels from cloudy pixels assimilated in the 4D-Var is weak and larger with the CO2-slicing approach than the diagnostic approach and the reference experiment. The impact of the assimilation of cloudy radiances is neutral over the assimilation of the observations, except for AMSU-B data in the case of the CO2-slicing approach. In that latter case, more AMSU-B observations are assimilated than in the reference experiment. A very slight and non-significant impact on the forecast is found for the first approach. With a slightly more positive impact, results with the second approach are encouraging. The positive impact is more pronounced with the prior adjustment by the 1D-Var of cloud parameters. Results are thus significantly but weakly improved in the southern hemisphere. Finally, some points to be studied in the near future will be presented.

8.10: The Use of Hyperspectral infrared radiances in numerical weather prediction

Presenter: John Derber (for John Le Marshall)

*J. Le Marshall¹, J. Jung¹, T. Zapotocny¹, W.L. Smith², J. Derber¹, R. Treadon¹, S. Lord¹, M. Goldberg¹ and W. Wolf¹
¹NASA, NOAA and DoD Joint Center for Satellite Data Assimilation (JCSDA)
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In 2002, the Atmospheric Infrared Sounder (AIRS), the first of the hyperspectral sounders able to provide real time data for operational and research meteorology was launched. Several of these new generation advanced sounders will subsequently be launched as part of an upgrade to the current Global Observing System. These instruments include the US Cross-track Infrared Sounder (CrIS) and Hyperspectral Environmental Suite (HES), as well as the European Infrared Atmospheric Sounding Interferometer (IASA). Demonstration of the benefits of

hyperspectral data on Numerical Weather Prediction (NWP) has been a high priority. Observing System Experiments (OSSEs) designed to examine effective methods to use hyperspectral radiances in NWP are summarized here. Experiments showing the benefit of using hyperspectral radiance data, available in real-time from the AIRS instrument are reviewed. Effective methods of data thinning and noise reduction are noted. The importance of the spatial resolution of the data used is documented. The importance of channel selection for NWP is also discussed. Note is made of the current use of variable hyperspectral emissivity over the entire globe and a number of methods being used to detect cloud in hyperspectral fields of view. Finally, note is also made of the benefits to be gained by the enhanced use of hyperspectral data in NWP and some discussion is provided on desirable observation characteristics for infrared sounders and their efficient application to NWP.

8.11: The use of AIRS Reconstructed Radiances in NWP and Preparations for IASI

Presenter: Andrew Collard

*A. Collard and A. McNally
ECMWF*

AIRS is currently assimilated at ECMWF and provides significant positive forecast impact. Out of the 2378 AIRS channels, 324 are delivered to NWP centres in near-real time, of which a maximum of 150 are assimilated.

The efficient representation of the information in the AIRS observations may be achieved through the use of a principal component noise smoother where the observations are reconstructed from the principal components corresponding to the largest variance in the data (and therefore assumed to be the components containing atmospheric signal rather than noise). Reconstructed radiances are produced routinely in near real time at NOAA/NESDIS from the 200 leading principal components of the full AIRS spectrum and are supplied to NWP centres in the same 324 channel set as the unsmoothed radiances. As the 324 supplied reconstructed radiances contain information from the entire spectrum, the information content of this subset of channels is increased.

A number of experiments have been performed comparing the impact of the assimilation of reconstructed radiances with the unsmoothed radiances. The effect of noise smoothing can be seen through inspection of the first-guess departure statistics. Some improvement in the model's fit to radiosondes is seen, but the change in forecast performance relative to the (already positive) operational AIRS configuration is small. Experiments aimed at more aggressively exploiting the AIRS reconstructed radiances are discussed.

Experience with AIRS, including those designed to exploit compressed versions of the AIRS data such as reconstructed radiances, is invaluable in determining the strategy for the assimilation of IASI radiances. The strategy for assimilation IASI data at ECMWF is discussed, including data pre-processing and cloud/aerosol detection.

SESSION 9

9.1: The EUMETSAT Satellite Application Facility on support to Operational Hydrology and Water Management (H-SAF)

Presenter: Luigi De Leonibus

Bizzarro Bizzarri¹, Luigi De Leonibus² and Roberto Sorani³

¹CNR

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In recent years, the interest of the hydrological community for using satellite data has rapidly increased. This is a consequence of improved satellite data quality, and improved performance of hydrological models including their capability to assimilate observational data. As a consequence, scientific demonstration works and operationally-oriented initiatives are proliferating. One of these is the *EUMETSAT Satellite Application Facility on support to operational hydrology and water management (H-SAF)*. It was established by the EUMETSAT Council in July 2005 and the Development phase started on 1st September 2005.

H-SAF membership includes 11 EUMETSAT member or cooperating States (Austria, Belgium, Finland, France, Germany, Hungary, Italy, Poland, Romania, Slovakia and Turkey) and ECMWF. The Italian Meteorological Service serves as Host Institute. In several Countries the activity is run by more institutes, of either operational or scientific nature. Partners of the Italian Meteorological Service are: the Department of Civil Protection (DPC) and the CNR Institute of Atmosphere and Climate Sciences (ISAC).

Since the earliest discussions that finally led to the establishment of H-SAF, the interest for new satellite products focused on:

- precipitation rate and cumulate precipitation, including liquid/solid discrimination;
- soil moisture in the surface layer and possibly in the roots region;
- snow parameters such as effective cover, wet/dry discrimination, water equivalent.

The key element for the feasibility of generating these products with the required quality is the current or

expected availability of highly-performing satellite instruments, such as: SEVIRI on Meteosat; AVHRR/3, AMSU-A and AMSU-B/MHS on Metop and NOAA; SSM/I and SSMIS on DMSP; ASCAT on Metop; and others, including some embarked on satellites of R&D nature such as AMSR-E and MODIS on EOS-Aqua, and TMI, PR and LIS on TRMM. Instruments will be used, that will have a long-term operational future either in their current configuration or as evolutions, e.g. VIIRS, CMIS and ATMS on NPOESS to replace AVHRR/3, MODIS, SSM/I, SSMIS and AMSU. The suite of currently available instruments and processing methods will allow early start of pre-operational product generation. Progressive availability of improved instruments and processing methods will enable progressive improvement of products quality in the course of the 5-year Development phase.

While progressing with the products generation activity, a hydrological validation programme will have to demonstrate the cost effectiveness of the novel data so as to support the case for a follow-on Operational phase. The ingredients of the hydrological validation programme will be:

- development of techniques to up/downscale the information for use at basin level;
- merging satellite and conventional data, and assimilation in hydrological models;
- assessment of the benefit of the new satellite data on the performance of operational hydrological models on the basis of actual experimentation on selected test sites.

Whereas the product generation activity will be performed by meteorological services supported by scientific institutes specialised in remote sensing, the hydrological validation programme will be performed by hydrometeorological services, hydrological scientific institutes and operational units of Civil Defence.

Cooperation with other SAF's is envisaged and although time de-phasing between H-SAF and others SAFs, efforts to tune some activities with SAF operations starting in 2007 will be pursued.

HSAF has also strong interest in the activities of other international groups like as ITSC, which carries on studies on applications of atmospheric sounding and related issues, focusing mainly on generation of geophysical parameters with emphasis on the potential of MW water vapour absorbing channel in precipitation retrieval.

9.2: Space based Global Observing System Requirements for Satellite Sounders

Presenter: Jian Liu

Jian Liu

Space Programme, World Meteorological Organization

Satellite sounders play an important role in space based global observing system. Satellite sounders can offer more valuable information, especially detailed information on temperature, humidity, wind, cloud and precipitation. Advanced geostationary imager-sounders (e.g. GIFTS) offer wind profile information in cloud-free areas through tracking of highly resolved features in water vapour channels. Polar satellites provide information on temperature and tropospheric humidity with global coverage, good horizontal resolution and acceptable accuracy. However, vertical resolution is currently marginal. Until recently performance in cloudy areas was poor, but the new microwave measurements from AMSU offer substantial improvements. Geostationary infrared soundings (GOES) are also helping to expand coverage in some regions by making measurements hourly and thus creating more opportunities for finding cloud-free areas. Vertical resolution will be substantially improved in cloud-free areas with the launch of high-resolution infrared sounders planned for METOP, NPOESS and EOS-Aqua. Polar orbiting satellites have microwave sounders that can penetrate clouds (the Advanced Microwave Sounding Unit-AMSU). They give information on cloud liquid water, cloud ice, and precipitation. All these information have been proved to be positive impact on NWP and climate research. This paper reviewed the requirements from space agencies and WMO (user) for satellite sounders.

The Implementation Plan (IP) for the Evolution of the GOS was updated by ET-ODRRGOS at its meeting 12-16 July 2004 and, following minor revision by ICT at its meeting 6-10 September 2004, was endorsed by CBS-XIII in February 2005. This version of the updated IP for the space-based component of the GOS was reviewed by the ET-EGOS and ET-SAT in a joint session on 7 December 2005. Among these recommendations, some are related with sounders as follow:

- **GEO Sounders** - All meteorological geostationary satellites should be equipped with hyper-spectral infrared sensors for frequent temperature/humidity sounding as well as tracer wind profiling with adequately high resolution (horizontal, vertical and time). WMO Space Programme is continuing pursuit of a GIFTS demonstration on IGeoLab with space agencies.
- **LEO data timeliness** - More timely data are needed to improve utilization, especially in NWP. Improved communication and processing systems should be explored to meet the timeliness requirements in some

applications areas (e.g. Regional and Global NWP). The successful EUMETSAT ATOVS Retransmission Service (EARS) has been renamed the EUMETSAT Advanced Retransmission Service and will carry AVHRR and ASCAT products in addition to ATOVS. EARS ATOVS data are now available with a delay of less than 30 minutes; the data are used operationally at some NWP centres and planned at others. WMO Space Programme is planning, with Members and CGMS, the development of Advanced Dissemination Methods (ADMs) and an Integrated Global Data Dissemination Service (IGDDS).

- **RO-Sounders** - The opportunities for a constellation of radio occultation sounders should be explored and operational implementation planned. International sharing of ground support network systems (necessary for accurate positioning in real time) should be achieved to minimize development and running costs.
- **Limb Sounders** - Temperature profiles in the higher stratosphere from already planned missions oriented to atmospheric chemistry exploiting limb sounders should be made operationally available for environmental monitoring.

9.3: The Global Space-based InterCalibration System (GSICS)

Presenter: Mitch Goldberg

*Mitch Goldberg
NOAA/NESDIS
Center for Satellite Applications and Research (STAR)*

Requirements for more accurate information products from operational environmental satellites are rapidly growing. As numerical weather prediction models become more reliable, their appetite for more accurate data input steadily increases. As the requirements for monitoring global climate become clearer – temperature changes as tiny as a few tenths of a degree per decade, ozone trends as small as 1% per decade – the measurements become more demanding. Calibration ties a satellite instrument's readings to physical quantities such as units of radiant energy. Intercalibration of instruments achieves comparability of measurements from different instruments. To deliver the more accurate observations needed by modern day weather forecasting and to permit early detection of climate change, it is vital that satellite instrument calibration is of the highest quality and that a capability exists to intercalibrate the satellite sensors. This is the motivating force for the establishment of the

Global Space-Based Inter-Calibration System (GSICS).

The concept and strategy for a Global Space-based Inter-calibration System were submitted by WMO and endorsed by the Coordination Group of Meteorological Satellites (CGMS) at its 33rd meeting (CGMS-XXXIII) held in Tokyo, Japan, on 1-4 November 2005. The goal is to achieve operational inter-calibration of the space component of the World Weather Watch's Global Observing System (WWW's GOS) that addresses the climate, weather forecasting and other environmental needs of WMO Members.

This Implementation Plan describes the components of GSICS, the roles of participating agencies, a timetable for implementing the program, and coordination with other international programs.

The GSICS consists of a GSICS Executive Panel, GSICS Coordination Centre (GCC), and GSICS Processing and Research Centers (GPRCs). GSICS also includes critical calibration support segments (CSS). Some CSS are performed directly by GSICS participating agencies while others are performed by external contributing entities.

The GSICS Executive Panel, to be established by the WMO, will be responsible for Monitoring and Evaluation of GSICS and will conduct annual progress reviews of the program. To assist in the coordination, planning and implementation of the research and data management activities of GSICS, the WMO will also form a GSICS Research Working Group and a GSICS Data Working Group.

The GSICS Coordination Centre (GCC) will be co-located with one of the participating GPRCs (TBD). The GCC will coordinate the specifications for collocated data requirements (satellite-to-satellite, satellite-to-reference sites), specifications on collocation criteria, sampling frequency, formats, reporting times, methodology for instrument intercomparisons, and archiving and access of collocated data. The GCC will transmit satellite collocation times and locations to satellite operators, it will receive intercalibration results and reports from satellite agencies and reference sites and will maintain a central archive for the intercalibration collocations. All data will be accessible by the GPRCs. A GSICS Processing and Research Center (GPRC) will be located at each operational satellite agency. The GPRC will have access to all data collected by the GCC. The GPRCs will conduct instrument calibration and validation activities, which includes pre-launch characterization. Each GPRC will focus on calibration activities based on priorities established by their respective satellite agencies. Inter-satellite calibration will use collocated satellite observations and overlapping satellite records to achieve comparability

of sensors on different satellites. Pre-launch characterization and calibration will engage the national standard laboratories of participating countries to insure that pre-launch calibrations are traceable to the accepted international standards. Each GPRC will also support research activities in the framework of the distributed research component of GSICS, coordinated by the GSICS Research Working Group (GRWG)

The GSICS Calibration Support Segments (CSS) will be carried out by participating satellite agencies, national standards laboratories, major NWP centers, and national research laboratories. CSS activities are:

- **Earth-based reference sites**, such as stable desert areas, long-term specially equipped ground sites, and special field campaigns, will be used to monitor satellite instrument performance.
- **Extra-terrestrial calibration sources**, such as the sun, the moon, and the stars, will provide stable calibration targets for on-orbit monitoring of instrument calibration
- **Model simulations** will allow comparisons of radiances computed from NWP analyses of atmospheric conditions with those observed by satellite instruments
- **Benchmark measurements** of the highest accuracy by special satellite and ground-based instruments will help nail down satellite instrument calibrations

WMO, CGMS, satellite agencies, national standards institutes, national data centers, major NWP centers, and national research laboratories will carry out the GSICS.

The WMO will organize a number of implementation planning activities – including obtaining commitment from participating agencies - that will culminate with the first GSICS Annual Operating Plan in March 2007 and the initiation of GSICS operations in April 2007.

Successful implementation of GSICS will result in substantial benefits to the ultimate user communities of operational environmental satellite observations – the weather and climate communities – in the form of more accurate weather forecasts and reliable climate monitoring.

9.4: A Global Network of Regional ATOVS Retransmission

Presenter: Marie Dumont

Marie Dumont¹, Anders Soerensen², Jérôme Lafeuille¹
¹WMO
²EUMETSAT

No abstract.

SESSION 10

10.1: EUMETSAT Plans

Presenter: Peter Schlüssel (for Dieter Klaes)

Dieter Klaes
EUMETSAT

The paper will give an overview on the status of EUMETSAT satellite programmes, which include the geostationary programmes MTP, MSG and the new Polar System EPS with the Metop satellites. A focus will be on EPS and possibly some first results will be shown. At the time of the conference we'll be in full commissioning. Additionally a short mention of the optional and future programmes will be made.

SESSION 11

11.1: Validation and inter comparisons of profiles from ATOVS and AIRS data over India and its surrounding regions

Presenter: Devendra Singh

Devendra Singh
Department of Science and Technology, India

Inversion Coupled with Imager (ICI3) scheme is used to retrieve vertical temperature and moisture profiles from ATOVS onboard NOAA-16 polar-orbiting satellite. In the present study, an attempt has been made to validate and intercompare the profiles retrieved from ATOVS and that of AIRS. The rms and bias were computed using NCEP reanalysis data for both ATOVS and AIRS profiles for the month of January and August 2004. The differences in temperature and moisture profiles are found to be more over land about 3K and 3gm/kg in lower atmosphere compared to that of middle and upper atmosphere, where the differences are less than 2k and 2gm/kg respectively. Regarding the comparisons of ATOVS and AIRS profiles, it has been observed that in general the temperature and moisture profiles are comparable. However, the best agreements have been observed over oceanic region in both the seasons.

11.2: Updates on Operational Processing for NOAA/NESDIS Sounding Data Products and Services

Presenter: Tony Reale (for A.K. Sharma)

A.K. Sharma
NOAA/NESDIS

For more than two decades the National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services (NOAA/NESDIS) has been 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. 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. Sounding Data Products are generated from the advanced TIROS Operational Vertical Sounder (ATOVS), and Meteorological Operational Satellite (MetOp-1) and MetOp-2. The ATOVS onboard NOAA-15, NOAA-16, and NOAA-17 consists of three instruments, Advanced Microwave Sounding Units (AMSU), AMSU-A and AMSU-B, and a High-resolution Infrared Radiation Sounders (HIRS) instrument. Currently sounding products have been generated from NOAA-15, 16 and 18 satellites. NOAA-17 sounding products processing was terminated in late October 2003, when AMSU-A instrument failed. 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. This presentation will include the discussion on the improvements of the data quality, pipeline processing and distribution via DDS, and user timeliness requirements envisioned from the upcoming 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 ATOVS and Infrared Atmospheric Sounding Interferometer* (*IASI) data products from the upcoming NOAA satellites and the European Organization for the Exploitation of Meteorological (EUMSAT) satellites, MetOp-1 and MetOp-2 will also be discussed.

11.3: Assessment of Atmospheric Profile Retrieved from Satellite: Theory and Case Study

Presenter: Nikita Pougatchev

N. S. Pougatchev¹, G. E. Bingham¹, S. V. Kireev², D. C. Tobin³

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A linear mathematical error model for the assessment of accuracy and precision of atmospheric profile retrievals (Environmental Data Records - EDR) is

presented. The EDR Assessment Model (EDRAM) provides theoretical basis and practical tool for assessment of actual performance of the remote sensing satellite system while in orbit by comparing its measurements to some relevant data sets.

The satellite retrieved profile and the profile used for comparison are generally taken at different time and space. Moreover, they sample the atmosphere differently, i.e. they have different vertical resolution. All the above mentioned factors cause apparent difference between the compared entities. To make the assessment of the EDR accurate, the EDRAM accounts for those factors allowing one to separate them from possible bias (accuracy) and noise (precision) of the satellite system.

To account for time and space difference, the EDRAM uses statistical characteristics (mean value, covariance and correlation) of the ensembles of true atmospheric states on which the satellite system and the system used for comparison perform the measurements. To reconcile the difference in vertical resolution the averaging kernel formalism is implemented.

For the case study the model has been applied to a limited set of radiosonde temperature profiles taken over the ARM Southern Great Plain site and simulated AIRS retrievals. It has been demonstrated how unaccounted temperature difference/error between compared profiles depends on time interval separating them. In particular study, for two sets of profiles (107 profiles each) separated by less than six hours the mean unaccounted error is within 0.3 ± 0.2 K.

The EDRAM can be used for assessment and interpretation of the validation results when the above mentioned sources of discrepancies are significant, as well as for referencing the satellite EDRs from instruments such as CrIMS, IASI, and AIRS to other data sets for the use as Earth System or Climate Data Records (ESDRs or CDRs).

11.4: Neural Network based Ozone Profile Retrieval Using Combined UV/VIS and IR Satellite Data

Presenter: Anton Kaifel

Anton K. Kaifel¹, Martin D. Felder², Jasmine Kaptur¹

¹Center for Solar Energy and Hydrogen Research

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The Neural Network Ozone Retrieval System (NNORSY) was developed during the last years for total ozone and ozone profile retrieval from UV/VIS spectra (ERS2-GOME) and total ozone column retrieval from IR satellite data (NOAA-TOVS). Information content of UV/VIS satellite data for tropospheric ozone profile retrieval is very low for

nadir satellite instruments (e.g. GOME) restricting the use of resulting products for environmental and air quality monitoring. Recent studies and assessments within the ESA project CAPACITY (<http://www.knmi.nl/capacity>) referring to future Operational Atmospheric Chemistry Monitoring Missions proves that for air quality assessment with a combined retrieval using UV-VIS and IR nadir viewing satellite instruments significant improvements in data quality and accuracy can be achieved. With the upcoming launch of MetOp-1 satellite including GOME-2 and IASI instrument first time UV/VIS and IR soundings will be available on one satellite platform.

In preparation of the application of combined one step ozone profile retrievals with NNORSY, a study was undertaken combining ERS2-GOME and TOVS NOAA-14 satellite data in order to show the feasibility and capabilities of this new approach. Advantage of neural network technique for this approach is that no RTM models for the different spectral regions are necessary and that the neural networks are able to exploit the full information content of both spectral regions in order to improve the accuracy of resulting ozone profile retrievals. For training of neural networks WOUDC and SHADOZ ozone sonde measurements as well as satellite ozone profile data from SAGE, HALOE and POAM are used. After training and testing of neural networks multi-year GOME/TOVS data are processed yielding global ozone profile product with improved accuracy compared to GOME retrievals only. Comparisons with independent ground truth data will be presented as well, showing the improvements of the combination of UV/VIS and IR spectral data especially in the troposphere.

11.5: Retrieval of Atmospheric Trace Gases Variability with Satellite Advanced IR sounders

Presenter: Alexander Uspensky

A. B. Uspensky¹, A. N. Trotsenko², A.V. Kukharsky¹

¹ SRC Planeta, Roshydromet

² RRC Kurchatov Institute

The space-borne IR-sounders on board current or future environmental satellites (AIRS/Aqua, IASI/MetOp, CrIS/NPOESS, IRFS/Meteor) should provide high spectral resolution (0.5-1.0 cm⁻¹) radiance measurements of continuous or quasi-continuous coverage from 3.7 (5.0) to 15.5 m. The outgoing radiance spectra measured by these sounders can reveal valuable information about tropospheric variations of trace gases, namely CH₄, N₂O, CO. Besides, some capabilities should exist for detecting variations of atmospheric carbon dioxide. This presentation summarizes the performance characteristics of approaches developed for retrieval of

CH₄, N₂O, CO, and CO₂ columnar amounts (CAs). The retrieval procedure for the above first three trace gas CAs from IASI data is based upon the physical inversion method using limited number of the IASI spectral channels (4, 3, and 5 for the cases of CH₄, N₂O and CO, respectively). The first guess estimates are provided on the basis of the zonally and seasonally averaged data. Furthermore the retrieval methods exploit the preceding IASI-based retrievals for the temperature and humidity profiles, and the surface temperature, which are considered as the interfering factors of relevant inverse problems. As follows from the verification retrieval experiments with synthetic clear-sky IASI data, the retrieval accuracy (in terms of relative r.m.s. errors) for the columnar amounts of CH₄, N₂O, and CO accounts for 3-5, 6-8, and 8-10 per cent respectively. The capabilities and limitations to monitor atmospheric CO₂ variations with advanced IR-sounders have been also investigated. With respect to AIRS/Aqua measurements the sensitivity studies have been performed and a set of the most informative channels has been selected for carbon dioxide CA retrieval. Moreover the studies have been focused on the construction of CO₂-dedicated AIRS super-channels (linear combination of pre-selected individual channels) in order to separate the effects of temperature profile and carbon dioxide variations. The original method to retrieve CO₂ CA has been developed and tested based on application empirical and synthetic regression; a signal in AIRS super-channel is treated as predictor variable. The validation exercise carried out with actual AIRS data for the area of boreal forests (Western Siberia, Novosibirsk region) and for several dates of year 2003 demonstrates that the retrieval of the CO₂ CA is really possible. The retrieved CA values are consistent with seasonal variations of CO₂ concentration derived from in-situ airborne observations. The regression estimates of CO₂ columns appear to be suitable for utilization as first guess in more general AIRS data inversion scheme.

11.6: Introducing NOAA's Microwave Integrated Retrieval System (MIRS)

Presenter: S-A. Boukabara

S-A. Boukabara¹, F. Weng², R. Ferraro², L. Zhao², Q. Liu³, B. Yan³, A. Li³, W. Chen³, N. Sun¹, H. Meng³, T. Kleespies², C. Kongoli³, Y. Han², P. Van Delst⁴, J. Zhao³ and C. Dean³

¹IMSG Inc. at NOAA/NESDIS

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³QSS Group Inc.

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We introduce a microwave 1D-VAR algorithm, MIRS (Microwave Integrated Retrieval System) used to simultaneously retrieve surface parameters and atmospheric profiles in all-weather conditions over a

multitude of surface backgrounds. The MIRS is in its final development and validation stage and will become operational at NOAA in the near future. The final outputs of the algorithm depend on the sensor being processed and could include the humidity and temperature profiles, the cloud and precipitation profiles, the ground skin temperature and the surface emissivity spectrum. Natural by-products of these outputs include the total precipitable water (TPW), the vertically-integrated cloud liquid water amount (CLW), rain water path (RWP) as well as the ice water path (IWP). To permit a stable inversion, the retrieval is performed in reduced space for the atmospheric profiles including the cloud and precipitation parameters, and for the surface emissivity spectrum. This is achieved by performing an Eigenvalue decomposition of the covariance matrix. The forward operator used by MIRS is a version of the Community Radiative Transfer Model (CRTM), based on a two-stream approximation for the modeling of multiple scattering effects of clouds and precipitation. The algorithm is routinely applied to data from the NOAA-18 satellite with its two microwave sounders AMSU and MHS. It is also applied to DMSP-F16 SSMI/S and Coriolis-WINDSAT data. It is also ready to process data from the soon to be launched METOP satellite. General validation of the model outputs is presented by comparing the results of the retrieval to a number of sources considered as references: radiosondes, airborne GPS-dropsondes, ARM-based uplooking measurements, Global Data Assimilation System (GDAS) global analyses and heritage products from the Microwave Surface and Precipitation Products System (MSPPS) which have been thoroughly validated in the past. A special attention will be given to the retrieval in cloudy and highly precipitating conditions (hurricanes) because it represents a major added value of this system compared to existing ones.

11.7: Refinement and operation implementation of a rain rate algorithm based AMSU/MHS and raingauges data over the H-SAF

Presenter: Silvia Puca

S. Puca¹, F. Zauli², P. Antonelli³

¹ *Dipartimento della Protezione Civile Italiana*

² *Centro Nazionale di Meteorologia e Climatologia dell'Aeronautica militare*

³ *Cooperative Institute for Meteorological Satellite Studies*

Within the Hydrology Satellite Application Facility (H-SAF) project, supported by EUMETSAT, the Italian Department of Civil Protection and the Meteorological Service of the Italian Air Force have initiated a collaboration with the Space Science and Engineering Center of the University of Wisconsin - Madison, for the refinement and implementation of a

pre-existing precipitation estimation algorithm based on the AMSU/MHS and raingauges data. The effort will be carried over through the establishment of Visiting Scientist programme. The existing algorithm, developed at the University of Wisconsin – Madison, is based on the use of the 89 and 150 GHz channels of AMSU, and, in its original formulation, it has been calibrated by NEXRAD data. Our project aims to evaluate the performances of this two-channels method on the H-SAF area (Europe) using raingauges data for different cloud type deduced by the SEVIRI channels. The statistical analysis of the performances will be based on the requirements of the H-SAF hydrologists community. The validation will also lead to the determination of new thresholds for each cloud type in order to fine-tune the algorithm over the region of interest. A system of neural networks will also be used for the reconstruction of the non-linear part of the relationship between the rain rate derived for each different cloud type and the observed raingauges data.

11.8: Linear Form of the Radiative Transfer Equation Revisited

Presenter: Bormin Huang

Bormin Huang

SSEC/CIMSS, University of Wisconsin-Madison

A linear form of the radiative transfer equation (RTE) for the simultaneous retrieval of temperature and absorbing constituent profiles from radiance spectra was derived in the classic paper by Smith et al. (1991). The derivation started with the RTE difference between the true and initial radiance spectra. It is shown here that there exists the dual representation of this RTE difference, and the resulting dual linear form of the RTE appears more general than the original linear form.

11.9: Jacobian mapping between vertical coordinate systems in variational assimilation

Presenter: Yves J. Rochon

Y. J. Rochon, L. Garand, D. S. Turner, and S. Polavarapu

Atmospheric Science and Technology Directorate, Environment Canada

In atmospheric data assimilation, radiances measured by remote sensing instruments form a significant component of the observation network. Radiance assimilation involves fast radiative transfer models (RTM) which project profiles provided by forecast models onto the observation space for direct comparison with the measurements. One of the features typically characterizing fast RTMs is the use of a fixed vertical coordinate. In the absence of a fast

RTM for calculating radiances directly using the levels of the forecast model, an interpolation of forecast profiles to the RTM coordinate is necessary. In data assimilation, the mapping of the Jacobians of the observations from the radiative transfer model coordinate to the forecast model coordinate is therefore also necessary. This mapping of Jacobians is accomplished through the adjoint of the forecast profile interpolator. As shown here, the nearest neighbour log-linear interpolator commonly used operationally can lead to incorrect mapping of Jacobians and can potentially lead to incorrect assimilation. This problem has been previously masked in part through the smoothing effect of forecast error vertical correlations on the analysis increments. To solve this problem, an alternative interpolator relying on piecewise log-linear weighted averaging over the layers is proposed. One of two investigated variants of this interpolator is found to satisfy design guidelines stipulated for ensuring acceptable Jacobian mappings.

11.10: Progress in modeling efforts related to radiance assimilation of clouds and precipitation

Presenter: Ralf Bennartz

Ralf Bennartz¹, Christopher O'Dell¹, Mark Kulie¹, Min-Jeong Kim², and Peter Bauer³

¹University of Wisconsin, Madison, Wisconsin, USA

²NOAA/NESDIS

³ECMWF, Reading, UK

We will report on the progress we made in radiative transfer forward modeling and algorithm development related to microwave radiance assimilation under cloudy or precipitating conditions.

Firstly, an update will be given on the status of the successive order of interaction (SOI) fast forward and adjoint radiative transfer model that has been developed in a project supported by the Joint Center for Satellite Data Assimilation (JCSDA). The model has now been implemented into the community radiative transfer model (CRTM) and is currently undergoing testing.

Secondly, a new scattering database for non-spherical particles within the framework of the SOI model will be discussed and example comparisons between observed and simulated AMSU-A/B brightness temperatures will be shown. The results indicate that the scattering database is capable of accurately simulating both the angular as well as the frequency dependence of scattering at microwave frequencies between 23 GHz and 190 GHz.

Thirdly, a new computationally effective cloud overlap scheme for the microwave has been developed. This scheme allows to simulate radiative transfer within a

variational assimilation context under cloudy and precipitating situations. It has been tested at ECMWF against global passive microwave observations and has been found to reduce biases between model and observations over the scheme that is currently implemented operationally at ECMWF.

SESSION 12

12.1: IASI in-flight calibration and preliminary results

Presenter: Denis Blumstein

Denis Blumstein¹, C. Buil¹, T. Phulpin¹, R. Jortoft¹, F. Bernard¹, T. Carlier¹, G. Chalon¹, G. Ponce¹, I.

Gaudel¹, B. Tournier², F. Cayla³

¹CNES

²Noveltis

³SISCLE

The Infrared Atmospheric Sounding Interferometer (IASI) is a key element of the payload embarked on METOP series of European meteorological polar-orbit satellites. IASI will provide very accurate data about the atmosphere, land and oceans for application to weather predictions and climate studies. IASI measurements will allow to derive 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 region and an associated infrared imager operating in the 10.3-12.5 μm region. 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 AVHRR imager onboard METOP.

The first IASI Model will fly on Metop A whose launch is planned for the 17th of July 2006. This paper presents the first results obtained during the beginning of the in-flight calibration of the instrument. The in-flight calibration phase is performed under the lead of the IASI TEC (CNES Toulouse) in close cooperation with EUMETSAT and with the collaboration of many contributors (METEO FRANCE, LPMA, ECMWF, UK MetOffice, etc.). The plans for the remaining part of the calibration will also be presented.

12.2: Use of IASI data for tropospheric trace gas retrieval

Presenter: Thierry Phulpin

Thierry Phulpin¹, Cathy Clerbaux², Piet Coheur³, Solene Turquety⁴, and Claude Camy Peyrer⁵

¹CNES

²IPSL/SA

³ULB

⁴IPSL/SA

⁵LPMAA

IASI, the Infrared Atmospheric Sounding Interferometer, has been launched on MetOp-A on 17 July 2006. Two additional flight models are ready to be flown on the MetOp series, ensuring hopefully a suite of very consistent high quality data up to 2020. If IASI is firstly devoted to operational Meteorology, its spectral range and its spectral resolution are such that it will also permit to retrieve ozone profiles, column of carbon monoxide, methane and nitrous oxide. The algorithms to retrieve these products have been tested on simulated data obtained either from other sensors like IMG, Mopitt or IASI balloon. First studies have also been undertaken to combine IASI and GOME data to improve ozone profiles. It is showed that the number of DOFS increase then from 3 to 5. The tools to assimilate IASI CO have also been developed. An illustration of the a priori global field of Co used as a priori is shown. Additional species like HNO₃ or SO₂ are also expected.

12.3: Development of the IASI Near Real-Time Operational Product Processing System

Presenter: Thomas King

T. King¹, Z. Cheng¹, H. Sun¹, W. Zhou¹, P. Keehn¹, L. Zhou¹, W. Wolf¹, C. Barner², and M. Goldberg²

¹QSS Group Inc.

²NOAA/NESDIS/STAR

The NOAA/NESDIS/STAR IASI product processing system is being tested and prepared for delivery to operations. This system will ingest near-real time IASI level 1C data from EUMETSAT as well as AVHRR, AMSU-A and MHS orbital data from NOAA/NESDIS/OSDPD. These data will be used to produce spatial and spectral subsets of the IASI level 1C radiances and NOAA unique products such as principal components, reconstructed radiances, cloud-cleared radiances and trace gas profiles. These data will be made available in BUFR and netCDF format to NWP (Numerical Weather Prediction) centers in the United States through the NOAA/NESDIS/ESPC data distribution server. The system also produces a set of gridded and binary data sets which are used internally for near-real time monitoring, product validation, and reprocessing. The EUMETSAT level 1C and NOAA unique products will be archived to NOAA/NESDIS/CLASS. In preparation for the ingestion of the actual data, a simulation system is currently providing pseudo

near-real time IASI, AMSU-A, and MHS data for system testing and code refinement. This will speed the transition of the system into near real-time operations when the actual data are made available.

SESSION 13

13.1: NPOESS - A Restructured Program

Presenters: Peter A. Wilczynski

*Peter A. Wilczynski and Colonel Dan Stockton
NOAA – NPOESS Program Executive Office*

During the last decade, the two U.S. civilian and military systems, POES and DMSP, have evolved to use a somewhat similar spacecraft bus, but have different instrument suites. Many government studies had been conducted to assess the value of converging the two systems into a single system. Most studies recommended retaining the separate systems. A 1993 tri-agency study by DoD, NOAA, and NASA recommended that a single converged system should replace the current separate systems.

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. Accessibility to data is a key feature of the NPOESS mission.

In 2005, the NPOESS program sustained numerous technical problems. These problems resulted in significant impacts to the overall mission content and schedule. Mandated U.S. Congressional and senior NOAA, NASA and Air Force oversight has resulted in a restructured NPOESS program, as announced on June 5, 2006. This paper and presentation will explain all the changes to the NPOESS program. It will explain the impacts to operational and research data users, including direct readout users. A detailed review of the mission by orbit will be provided as well as current sensor status updates. This will also include sensors (such as CMIS) that have been de-manifested from early NPOESS flights. Although, NPP is minimally affected by the NPOESS restructure, an NPP status update will be provided for completeness. Schedule and planned NPP/NPOESS implementation will be discussed as part of the paper.

13.2: Recent Updates to the NPOESS Space Segment and Sensor Manifest

Presenter: Hal Bloom

*Hal Bloom
NOAA/NESDIS*

The National Polar Orbiting Operational Satellite System (NPOESS) is the next generation US weather satellite system. NPOESS is a combination of the US Department of Defense Meteorological Satellite Program (DMSP) and the US Department of Commerce Polar Orbiting Environmental System (POES). NPOESS is a transition from 1970's technology to state of the art technology. Along the way, we solved numerous technical challenges trying to make the new technology feasible for space remote sensing applications. The paper will detail the issues that the program faced and the lessons learned. This presentation will be focused on two distinct parts within the space segment; part I the major development sensors with an early look at test data, and part II; the NPOESS spacecraft. The sensors discussed in this paper are the Visible Infrared Imaging Radiometer Suite (VIIRS), Advanced Technology Microwave Sounder (ATMS), Cross Track Infrared Sounder (CrIS), and Conical Microwave Imager Sounder (CMIS) and Ozone Mapping and Profiler Suite (OMPS). VIIRS, follow-on to MODIS collects visible and infrared radiometric data of the Earth's atmosphere, ocean, and land surfaces. CrIS in conjunction with ATMS is follow-on to AIRS/AMSU provides global observations of temperature and moisture profiles at high temporal resolution. CMIS, follow-on to AMSR/SSMIS/WINDSAT collects global microwave radiometry and sounding data to produce microwave imagery and other meteorological and oceanographic data. OMPS follow-on to TOMS/SBUV collects total and profile ozone products. Finally, part two of the presentation will discuss aspects of the common NPOESS spacecraft and subsystems.

13.3: Advanced Geostationary Satellite Infrared Sounding Sensor Requirements

Presenter: William L. Smith

William L. Smith Sr.^{1,2}, Allen H-L Huang², Jun Li², Daniel K. Zhou³, Stanislav Kireev¹, and John LeMarshall⁴

¹ Hampton University

² University of Wisconsin – Madison

³ NASA Langley Research Center

⁴ Joint Center for Satellite Data Assimilation

The environmental measurement objectives of advanced geostationary satellite infrared sounding sensors are considered. The sensor requirements,

needed to achieve the environmental measurement objectives, are defined in terms of horizontal resolution, horizontal coverage, temporal resolution, spectral resolution, spectral coverage, field-of-view co-registration, spectral radiance noise, absolute radiometric accuracy, and the need, and requirements for, a built-in or co-registered imager. Results from airborne NAST spectral radiance measurements, polar orbiting AIRS and MODIS radiance observations, and simulated Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) radiance data, are used to support the sensor requirements defined in this presentation.

13.4: GOES Infrared Sounders – the future perspective from the current applications

Presenter: Jun Li

Jun Li¹, Timothy J. Schmit², and W. Paul Menzel², James J. Gurka³

¹ Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison

² Center for Satellite Applications and Research, NOAA/NESDIS

³ Office of System Development, NOAA/NESDIS

Since 1994 a new generation of Geostationary Operational Environmental Satellite (GOES) Sounders (from GOES-8 to GOES-13) has been measuring broad band radiances in 18 infrared (IR) spectral bands, ranging from approximately 3.7 μ m – 14.7 μ m. These data have been used to provide atmospheric and cloud products for meteorological applications on an hourly basis over North America and adjacent oceanic regions. The products include clear-sky radiances, atmospheric temperature and moisture profiles, total precipitable water, cloud-top pressure, water-vapor tracked winds, etc. Products are generated operationally by NOAA/NESDIS in Washington, D.C. Some Sounder products, including total column ozone, are also produced at the Cooperative Institute for Meteorological Satellite Studies at the University of Wisconsin-Madison. Applications of those products include: nowcasting and forecasting of weather events, assimilation of cloud products into regional numerical forecast models, and monitoring of temperature and moisture changes in the pre-convective periods.

The increased spectral, temporal and spatial resolutions of the Hyperspectral Environmental Suite (HES) on the GOES-R and beyond will provide a substantial increase in the quantity and quality of the products. The HES IR portion is hyperspectral sounder instrument suite with two threshold tasks. HES will provide high-spectral resolution Hemispheric Disk Soundings (DS) and Severe Weather Mesoscale (SW/M) soundings. HES DS provides better than 10 km spatial resolution from 3.7 μ m to 15.4 μ m with a one-hour refresh rate of the full disk, 62° local zenith

angle. SW/M will cover a 1000 x 1000 km square in less than 5 minutes, at approximately 5 km spatial resolution for IR. The GOES-R HES will be a flexible instrument that can provide hourly coverage of the near full disk, or provide more frequent coverage of smaller areas. The latter will be used when there is the potential for explosive development of severe thunderstorms, hurricanes, or severe winter storms. It can also be used over areas where the numerical forecast models have low confidence (targeted observations). IR data from the HES will be used for: 1) providing an accurate, hourly three-dimensional picture of atmospheric temperature and water vapor; 2) tracking atmospheric motions by discriminating more levels of motion and assigning heights more accurately; 3) possibly distinguishing between ice and water cloud and identifying cloud microphysical properties; 4) providing a 5 km field of view (FOV) for better viewing between clouds and cloud edges; 5) providing accurate land and sea surface temperatures and IR surface emissivities; 6) distinguishing atmospheric constituents with improved certainty, including dust, volcanic ash and ozone; and 7) detecting clear-sky low-level atmospheric inversions. The HES-IR will be able to provide higher spectral resolution observations (on the order of 1 cm^{-1} , compared to 20 cm^{-1} on today's broadband GOES sounder).

Aspects of improvement of HES over current GOES Sounder includes: spatial coverage, vertical moisture information, nowcasting, numerical weather prediction, clouds, winds, dust/aerosols, trace gases, climate, ocean/land. With the improved spectral resolution, an improved surface emissivity can also be estimated. Current and future applications of GOES Sounder and HES are demonstrated and compared in this talk by using the current satellite and aircraft measurements as well as simulated data.

13.5: Geostationary Passive Microwave Observation System Simulation Experiments for Hydrometric Tracking

Presenter: Ed Westwater (for Al Gasiewski)

Albin J. Gasiewski¹, Bob L. Weber¹, Alexander G. Voronovich², and Jian-Wen Bao²

¹ *University of Colorado, Center for Environmental Technology*

² *NOAA Earth System Research Laboratory*

A hydrometric tracking algorithm using two (real and synthetic aperture) sensor concepts is being developed within the framework of radiance assimilation into a numerical weather prediction model (MM5) in order to evaluate the relative performance of those sensor concepts in precipitation forecasting. The real aperture concept is a submillimeter-wave geosynchronous microwave (GEM) sounder and imager reflector

antenna. The synthetic aperture concept is the JPL GeoSTAR Y-shaped array of antenna and receiver elements. The hydrometric tracking algorithm uses simulated GEM and GeoSTAR sensor observation simulation (SOS) data.

The current GEM concept is based on a ~2 meter steerable Cassegrain reflector antenna and fast-scanning subreflector. The low-mass scanning subreflector provides a means of high-resolution imaging of ~200 km wide swaths on a regional basis, while the main reflector's momentum-compensated steering mechanism provides the ability to scan the swath over the Earth's disk. A total of up to 44 channels within the AMSU-A (50-57 GHz) and AMSU-B (183.310 GHz) bands and near the 118.750-GHz O₂ line, the 340 GHz transmission window, the 380.197 GHz water vapor line, and the 424.763 GHz O₂ line are considered in the baseline system design. The subsatellite spatial resolution at the highest frequency channel is ~12 km after beam deconvolution.

Aperture synthesis would use a Y-shaped array of antenna and receiver elements along with several tens of thousands of one-bit digital correlators to synthesize a full-disk image of the Earth's brightness temperature. The system would require no moving components to provide ~25 km subsatellite spatial resolution at 183 GHz, but impose tradeoffs in sensitivity, spectral coverage, calibration accuracy, and spaceborne hardware complexity. The JPL GeoSTAR concept is based on implementing this technique at the two primary AMSU bands (50-57 and 183 GHz), with possible inclusion of the 89 GHz AMSU window channel.

In order to assess the operational capabilities of each of these systems for forecasting applications a set of observation system simulation experiments (OSSEs) using the two concepts are being conducted. The assessment requires that the simulated data be considered in the context of the intended operational application, specifically, for NOAA forecasting requirements. In this talk we present the status of the OSSE effort with a focus on forward radiative transfer modeling studies of upwelling radiation fields from a simulated landfalling hurricane. A 2D-var scheme for locking the precipitation state variables of a numerical weather prediction model onto simulated geostationary satellite brightness imagery will be presented.

13.6: GeoSTAR

Presenter: Bjorn Lambrigtsen

B. Lambrigtsen¹, T. Gaier¹, A. Tanner¹, P. Kangaslahti¹, S. Brown¹, C. Ruf², and J. Piepmeier³

¹JPL

²U. Michigan

³NASA/GSFC

The Geostationary Synthetic Thinned Aperture Radiometer, GeoSTAR, is a new concept for a microwave atmospheric sounder intended for geostationary satellites such as the GOES weather satellites operated by NOAA. A small but fully functional prototype has recently been developed at the Jet Propulsion Laboratory to demonstrate the feasibility of using aperture synthesis in lieu of the large solid parabolic dish antenna that is required with the conventional approach. Spatial resolution requirements dictate such a large aperture in GEO that the conventional approach has not been feasible, and it is only now - with the GeoSTAR approach - that a GEO microwave sounder can be contemplated. Others have proposed GEO microwave radiometers that would operate at sub-millimeter wavelengths to circumvent the large-aperture problem, but GeoSTAR is the only viable approach that can provide full sounding capabilities equal to or exceeding those of the AMSU systems now operating on LEO weather satellites and which have had tremendous impact on numerical weather forecasting. GeoSTAR will satisfy a number of important measurement objectives, many of them identified by NOAA as unmet needs in their GOES-R pre-planned product improvements (P3I) lists and others by NASA in their research roadmaps and as discussed in a white paper submitted to the NRC Decadal Survey. The performance of the prototype has been outstanding, and this proof of concept represents a major breakthrough in remote sensing capabilities. The GeoSTAR concept is now at a stage of development where an infusion into space systems can be initiated - either on a NASA sponsored research mission or on a NOAA sponsored operational mission. GeoSTAR is an ideal candidate for a joint "research to operations" mission, and that may be the most likely scenario. Additional GeoSTAR related technology development and other risk reduction activities are under way, and a GeoSTAR mission is feasible in the GOES-R/S time frame, 2014-2016.

POSTER SESSION A: WEDNESDAY

A01: Detailed impact evaluation of AIRS and SSM/I assimilation

Presenter: David Anselmo

*D. Anselmo, A. Beaulne, L. Garand, G. Deblonde, J. Halle, N. Wagneur
Meteorological Service of Canada*

The assimilation of 100 AIRS channels and 7 SSM/I channels is foreseen for early 2007 in the new MSC model configuration with 58 levels and 35 km resolution. A positive impact from both data sources was demonstrated in the previous configuration at coarser resolution. Most recent impact results in assimilation cycles are shown in terms of classical measures such as anomaly correlation or verification against radiosondes, but perhaps more interestingly in terms of changes to the "climate" of the model, notably large scale changes in temporally averaged temperature and moisture (level or integrated) fields. Some specific sensitivity studies are also presented such as comparing the assimilation in nonlinear and tangent-linear modes. The level of synergy between the two data types will be investigated. The poster complements the more general oral presentation.

A02: Detailed impact evaluation of AIRS and SSM/I assimilation

Presenter: Alain Beaulne

*A. Beaulne, D. Anselmo, L. Garand, G. Deblonde, J. Halle, N. Wagneur
Meteorological Service of Canada*

The assimilation of 100 AIRS channels and 7 SSM/I channels is foreseen for early 2007 in the new MSC model configuration with 58 levels and 35 km resolution. A positive impact from both data sources was demonstrated in the previous configuration at coarser resolution. Most recent impact results in assimilation cycles are shown in terms of classical measures such as anomaly correlation or verification against radiosondes, but perhaps more interestingly in terms of changes to the "climate" of the model, notably large scale changes in temporally averaged temperature and moisture (level or integrated) fields. Some specific sensitivity studies are also presented such as comparing the assimilation in nonlinear and tangent-linear modes. The level of synergy between the two data types will be investigated. The poster complements the more general oral presentation.

A03: Assimilation of cloudy AMSU-A radiances in 4D-var

Presenter: Stephen English

*Stephen English and Una O'Keeffe
Met Office, UK*

The assimilation of cloud-affected satellite microwave radiances within Numerical Weather Prediction systems will allow a significant increase in the observational information used to constrain forecast models. In particular, the 23 GHz and 31 GHz microwave window channels of the AMSU-A instrument contain much information on cloud liquid water which is currently not fully exploited. Work at the Met Office has studied the effect of allowing the gradient of the observations with respect to cloud liquid water to influence the analysis through innovations in cloudy radiances, using the RTTOV radiative transfer model and an incremental cloud liquid water operator in the variational data assimilation. In this way, AMSU-A radiances at 23 GHz and 31 GHz are now being assimilated in all cloudy situations (except in heavy precipitation, detected using the scattering index method) at the Met Office pre-operationally. This poster will present results of both clear air and cloudy radiance assimilation trials at these frequencies.

A04: Assimilation of near surface sounding radiances

Presenter: Stephen English

*Stephen English and TR Sreerekha
Met Office, UK*

The assimilation of sounding radiances with peak contribution close to the earth's surface has proven very difficult with only limited success at NWP centres. This is largely due to difficulties in handling cloud effects and specifying surface temperature accurately enough. For both applications it is usually necessary to have independent prior information on land surface emissivity: simply analysing emissivity from the measurements is not an adequate solution. In order to gain a deeper understanding of the effect of different assumptions about emissivity a number of experiments have been run with simulated and real data and the results of these will be presented.

A05: Assimilation of cloud and precipitation affected microwave radiances at ECMWF

Presenter: Alan Geer

*Alan Geer, Peter Bauer, Philippe Lopez, Deborah Salmond and Sabatino Di Michele
ECMWF*

Cloud and precipitation affected radiances from SSM/I have been assimilated operationally at ECMWF since June 2005, using a two-step approach. A 1D variational (1D-Var) retrieval produces a total column water vapour amount that is then assimilated in the main 4D-Var analysis. The 1D-Var observation operator contains simplified large-scale and convective cloud schemes as well as microwave radiative transfer. This paper summarises the operational system, describes the impact of the 1D+4D-Var assimilation, and examines test cases and problem areas. In particular, in the southern winter, the northward intrusion of Antarctic polar maritime air produces areas of scattered convection with the precipitation column being dominated snow rather than rain. In these cases the 1D-Var retrieval of SSM/I radiances produces poor results. The latest version of the system produces better forecasts by excluding them.

A06: Automated tracking of dry intrusions on satellite water vapour imagery and model output for data assimilation

Presenter: Yann Michel

*Y. Michel¹, F. Bouttier²
¹ CNRM/GMAP/OBS Meteo France
² CNRM/GMAP/D Meteo France*

Despite steady improvements in numerical weather prediction in recent years, some cyclogenetic events are still associated with poor forecast quality. Their mechanism has been fairly well explained at a theoretical level, and forecasters are able to interpret water vapour imagery from geostationary satellite in a conceptual way using potential vorticity thinking. A satellite image processing technique has been developed for the identification and tracking of upper tropospheric features related to midlatitude synoptic scale cyclogenesis. Persistent warm radiance features are detected on water vapour images using an adaptive thresholding technique, tracked using cross-correlation of successive images and speed estimation, and then screened using both image-based and model-based criteria, taking in account that the relationship only holds in the vicinity of a jet streak. The aim is the automatic characterisation of dynamical tropopause anomalies and dry intrusions of stratospheric air into the upper troposphere. On a selected sample of events, the resulting trajectories prove to be very consistent with the subjective identification of cyclogenesis events on imagery. In accordance with potential vorticity theory, the detected warm features are correlated with positive anomalies of potential vorticity. This identification technique can also be applied to synthetic water vapour imagery produced by a radiative transfer model. The comparison of the cells in the two imageries provides some guidance for the specification of pseudo-observations of potential vorticity, which aims to be included in a variational

assimilation system. A potential vorticity operator based on a simplified form of Ertel Potential Vorticity has been previously implemented in the 4D variational assimilation of French model ARPEGE with its tangent and adjoint versions. The next step will be to automatically specify pseudo-observations of potential vorticity following the tracking algorithm, and to include them into the 4D-Var assimilation system.

A07: 1DVAR studies with SEVIRI data and the HIRLAM model

Presenter: Martin Stengel (SMHI)

*Martin Stengel, Per Dahlgren
SMHI*

Potential use of SEVIRI data in the HIRLAM model VAR analysis is being investigated at SMHI. Initially, we test the performance of SEVIRI IR-channels simulations using RTTOV for clear sky cases. These simulations are being done utilizing the HIRLAM model output to set up the atmospheric conditions. Using these results, long-term bias-monitoring of SEVIRI measurements and HIRLAM model equivalents in observation space can be performed and are presented. Thereby, deficiencies in the radiative transfer calculations and shortcomings of the NWP model can be identified and characterized.

Furthermore, preliminary studies addressing the possible utilisation of SEVIRI clear sky IR radiances within HIRLAM VAR analysis system are examined. These studies are being done including achievements of a 1D-VAR code that analyses HIRLAM profiles and SEVIRI data. Therewith obtained results as well as a discussion about possible data thinning of the utilized satellite measurements are shown within this presentation.

A08: Physical and statistical approach for MSG cloud identification

Presenter: Elisabetta Ricciardelli

*E. Ricciardelli, F. Romano, and V. Cuomo
Istituto di Metodologie per l'Analisi Ambientale,
IMAA/CNR*

Cloud detection is essential to retrieve accurate atmospheric parameter such as temperature and water vapour from satellite data.

A statistical and physical approach have been developed for MSG (Meteosat Second Generation) in order to improve cloud identification for very thin clouds and very low clouds. Low clouds and fog are difficult to detect in the infrared when their

temperatures are nearly the same as the nearby Earth surfaces.

The statistical algorithm is a pattern recognition technique that uses textural and spectral features estimated in boxes 3x3. The spectral features used in this analysis are the grey level maxima, minima, mean and the ratio between maxima and minima. The textural features include the contrast, the entropy, the mean, the angular second moment in four directions and the Roberts Gradient. The algorithm was trained on the basis of MSG images collected for different seasons and different regions.

The physical approach based on dynamic threshold tests does not require any ancillary data. The two algorithm run independently, if the algorithms do not agree a cost function is applied in order to decide the final FOV flag.

MSG cloud mask has been validated against MODIS cloud mask and compared with the SAFNWC cloud mask.

A09: Performance analysis of MTG-IRS

Presenter: Stephen Tjemkes

*Stephen Tjemkes, Jochen Grandell and Rolf Stuhlmann
EUMETSAT*

In 2001 EUMETSAT consulted end users regarding requirements for product and services for their operational meteorological applications in the time frame 2015 – 2025. From an analysis of these requirements by remote sensing experts five candidate missions were identified as part of Meteosat Third Generation Geostationary Satellite System. One of which is an infrared sounder the so-called MTG-IRS.

As a result of industrial analysis and trade-off studies by external experts, a set of observational requirements for the MTG-IRS has been prepared which will be used for the Phase A industrial studies.

During the proposed poster presentation these requirements will be presented together with results of information content analysis and retrieval simulations.

A10: Relative Information Content of the Advanced Technology Microwave Sounder, and the Advanced Microwave Sounding Unit and the Microwave Humidity Sounder Suite

Presenter: Thomas Kleespies

*Thomas J. Kleespies
NOAA/NESDIS*

There is considerable concern in the numerical weather prediction (NWP) community that the Advanced Technology Microwave Sounder (ATMS) is merely being built to the noise specifications of the Advanced Sounding Unit (AMSU) and the Microwave Humidity Sounder (MHS). In fact, the AMSU/MHS have greatly exceeded specification, and the NWP community worries that the ATMS would be a step backwards. The International TOVS Study Conference-XIV Working Group on The Use of TOVS/ATOVS Data in Data Assimilation/Numerical Weather Prediction noted [1]: "The WG is concerned that the instrument specification for ATMS channel noise exceeds current AMSU performance and that the choice of polarizations may not be optimal for sounding the lower troposphere. The WG were keen to do more scientific studies to provide good evidence for the impact of different choices in microwave sounder design on microwave sounder impact in NWP. When these studies are complete, the WG will be in a stronger position to formulate a recommendation to satellite agencies concerning future microwave sounding missions. Action: Tom Kleespies to repeat Kleespies & Watts [2] MHS study for ATMS compared to AMSU-A." The purpose of this paper is to document the initial results of this study.

A11: The Use of Google Earth in Meteorological Satellite Visualization

Presenter: Thomas Kleespies

*Thomas J. Kleespies
NOAA/NESDIS/STAR*

Google Earth is an innovative free browser that permits an explorer or scientist to view a vast collection of aircraft and satellite imagery of the Earth. Like any browser, Google Earth can be programmed by a using markup language, in this case the Keyhole Markup Language (KML). KML permits a user to specify place marks and identifying points on the earth, script tours of selected sites on the earth, and to place image overlays on the earth and the screen. A very powerful feature is the ability to create polygons at altitude which can be extruded to the surface, and even three dimensional structures. All of these can be published to the Web as long as the user has the Google Earth server software. I have explored several environmental satellite applications of Google Earth which include: verification of the Amazon rainforest as a microwave vicarious calibration source, visualization of AMSU inhomogeneous footprints over land and coastlines, visualization of three dimensional atmospheric structure by vertically stacked AMSU fields of view, and animation of hurricane Katrina imagery as viewed from arbitrary perspectives. These and other applications will be shown in this paper. If high speed internet is available at the conference site, I

will also give demonstrations of Google Earth in action.

A12: Calibration Anomalies and Radiance Assimilation Correction Strategies for the Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave Imager Sounder (SSMIS)

Presenter: Steven Swadley

*Steven D. Swadley¹, Nancy Baker², Clay Blankenship², William Campbell², Gene Poe², Benjamin Ruston², David Kunkee³, Donald Boucher³, and William Bell⁴
¹METOC Consulting, Naval Research Laboratory
²Marine Meteorology Division, Naval Research Laboratory
³The Aerospace Corporation
⁴Satellite Radiance Assimilation Group, Met Office*

The Defense Meteorological Satellite Program (DMSP) launched the first in a series of five spacecraft carrying Special Sensor Microwave Imager Sounders (SSMIS) on October 18, 2003. The SSMIS is a 24 channel conically scanning microwave radiometer, with frequencies ranging from 19 to 183 GHz. During the comprehensive SSMIS Calibration and Validation (Cal/Val) efforts, unexpected calibration anomalies were discovered in the radiometric data. 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. Data assimilation systems for numerical weather prediction typically demand less than 0.4 K uncertainty in the 50-60 GHz oxygen absorption channels, and require that such observed biases be removed prior to assimilation.

The solar intrusion anomaly is readily evident in the time series of the individual channel radiometer gains. This anomaly can result in as much a 1.5 K peak depression in the observed scene temperatures near the center of the intrusion period. 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).

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. The maximum reflector emission anomaly occurs just after the spacecraft emerges from earth and/or spacecraft shadow, and the reflector face is directly illuminated by the sun. A reflector emission bias correction, based on the time rate of change of the observed SSMIS reflector arm temperature, is used to obtain a emission corrected scene temperature in each channel. Detailed

descriptions and application results using these SSMIS calibration mitigation strategies will be presented.

A13: cancelled

A14: SSEC/CIMSS Participation in the NPP PEATE Program

Presenter: Tom Achtor

*Liam Gumley, Hank Revercomb, Bryan Baum, Paolo Antonelli, Steve Dutcher, Scott Mindock, Robert Holz and Tom Achtor
Space Science and Engineering Center, University of Wisconsin-Madison*

The NPOESS Preparatory Project (NPP) mission scheduled to launch in 2009 will provide a first look at a new generation of products from U.S. operational polar orbiting Earth observing satellites. Production of Sensor Data Record (SDR) and Environmental Data Record (EDR) products will be accomplished by the Interface Data Processing Segment (IDPS) of the NPOESS Ground System. The NASA NPP Science Team has been tasked with evaluation of the operational products from the IDPS within a facility known as the Science Data Segment (SDS). Within the SDS, NASA has established five Product and Evaluation and Test Elements (PEATEs) to enable the NPP Science Team to efficiently and effectively evaluate the operational SDRs and EDRs from NPP. The PEATEs are organized into categories including Atmosphere, Land, Ocean, Ozone and Sounder. The Atmosphere PEATE has been established within SSEC/CIMSS.

The Atmosphere PEATE will enable the NPP Science Team to: (a) assess the impact of on-orbit instrument performance on SDRs and subsequently on Atmosphere EDRs; (b) evaluate the quality of Atmosphere EDRs at sensor resolution over a wide range of spatial and temporal conditions; (c) validate Atmosphere EDRs against ground-based and satellite-based measurements; (d) develop improved Atmosphere EDR algorithms; and (e) evaluate the climate quality of the Atmosphere EDRs. Computing resources will be provided by a cluster of Linux servers, and the system will be designed to allow global SDR and EDR product generation at more than 100 times real-time processing speed, enabling one month of data to be processed in one day. This will allow the NPP Science Team to rapidly assess the impact of calibration and science algorithm changes on climatologically significant subsets of the NPP data record.

The project has begun with the design and development of a 1st generation computing system that will enable a demonstration of the data processing

capability. The demonstration will use NASA EOS MODIS and AIRS data and science team algorithms as a testbed to evaluate the processing capability to fulfill requirements for NPP. The Atmosphere PEATE has also begun evaluating the NPOESS contractor algorithm for atmosphere and cloud products from NPP, and has also established a calibration/validation facility for automated comparison of NPP and precursor products against satellite and ground based data.

A15: Polar Orbiting Satellite Direct Broadcast Activities at the University of Wisconsin-Madison

Presenter: Kathleen Strabala

*Kathleen Strabala, Liam Gumley, H. L. Huang, Elisabeth Weisz, Jun Huang
Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison*

The direct broadcast facility for acquiring and processing Aqua and Terra EOS downlinked data located at the University of Wisconsin-Madison is now being used for a wide ranging set of purposes. It is being used in support of the International MODIS and AIRS Processing Package (IMAPP), an effort to provide direct broadcast data users software to calibrate, geolocate and generate science products from Aqua and Terra data. The number of products is increasing and now includes AMSR-E rain rate, AIRS Level 2 retrievals as well as MODIS cloud mask, cloud top properties, atmospheric profiles, aerosol optical depth, sea surface temperatures and near-infrared water vapor. These IMAPP products generated in near real-time are being imported into the US National Weather Service AWIPS system to assist forecasters in now casting. The products are also being used to provide Sea Surface Temperatures for high resolution model initialization at the Florida Institute of Technology, as well as to assist researchers in turtle migration studies in and around the Delaware Bay. True color MODIS images in TIF format are being produced in near real-time and used by NOAA's Coastwatch Program to support environmental science, decision making, and supporting research of the Great Lakes. MODIS aerosol and cloud products are being used as part of the Infusing Satellite Data into Environmental Applications (IDEA) program, whose goal is an effort to improve air quality assessment, management, and prediction by infusing satellite measurements (from NASA) into analyses (by EPA and NOAA) for public benefit. The aerosol optical depth product is used to initialize the trajectory forecast model, which is timely enough to be useful for forecasters. AIRS retrievals are being used to simulate future GOES bandwidths. The high spectral resolution data can be convolved using proposed ABI spectral response functions to create ABI like channels. This will be useful in determining the best spectral range

needed to meet ABI goals. Finally, global interest in MODIS and AIRS data has led to MODIS/AIRS radiative transfer workshops being held in China, Australia, Taiwan, Norway and South Africa. Here students learn more about the MODIS and AIRS instruments, algorithms and products. Future workshop sites planned include Argentina and India.

A16: HYDROLOGY SATELLITE APPLICATION FACILITY (H-SAF): a distributed element of the EUMETSAT Application Ground Segment

Presenter : Luigi De Leonibus

Bizzarro Bizzarri¹, Luigi De Leonibus² and Roberto Sorani³

¹CNR

²USAM

³DPC

In recent years, the interest of the hydrological community for using satellite data has rapidly increased. This is a consequence of improved satellite data quality, and improved performance of hydrological models including their capability to assimilate observational data. As a consequence, scientific demonstration works and operationally-oriented initiatives are proliferating. One of these is the *EUMETSAT Satellite Application Facility on support to operational hydrology and water management (H-SAF)*. It was established by the EUMETSAT Council in July 2005 and the Development phase started on 1st September 2005. H-SAF membership includes 11 EUMETSAT member or cooperating States (Austria, Belgium, Finland, France, Germany, Hungary, Italy, Poland, Romania, Slovakia and Turkey) and ECMWF. The Italian Meteorological Service serves as Host Institute. In several Countries the activity is run by more institutes, of either operational or scientific nature. Partners of the Italian Meteorological Service are: the Department of Civil Protection (DPC) and the CNR Institute of Atmosphere and Climate Sciences (ISAC).

Since the earliest discussions that finally led to the establishment of H-SAF, the interest for new satellite products focused on:

- precipitation rate and cumulate precipitation, including liquid/solid discrimination;
- soil moisture in the surface layer and possibly in the roots region;
- snow parameters such as effective cover, wet/dry discrimination, water equivalent.

The key element for the feasibility of generating these products with the required quality is the current or expected availability of highly-performing satellite instruments, such as: SEVIRI on Meteosat; AVHRR/3,

AMSU-A and AMSU-B/MHS on Metop and NOAA; SSM/I and SSMIS on DMSP; ASCAT on Metop; and others, including some embarked on satellites of R&D nature such as AMSR-E and MODIS on EOS-Aqua, and TMI, PR and LIS on TRMM. Instruments will be used, that will have a long-term operational future either in their current configuration or as evolutions, e.g. VIIRS, CMIS and ATMS on NPOESS to replace AVHRR/3, MODIS, SSM/I, SSMIS and AMSU. The suite of currently available instruments and processing methods will allow early start of pre-operational product generation. Progressive availability of improved instruments and processing methods will enable progressive improvement of products quality in the course of the 5-year Development phase.

While progressing with the products generation activity, a hydrological validation programme will have to demonstrate the cost effectiveness of the novel data so as to support the case for a follow-on Operational phase. The ingredients of the hydrological validation programme will be:

- development of techniques to up/downscale the information for use at basin level;
- merging satellite and conventional data, and assimilation in hydrological models;
- assessment of the benefit of the new satellite data on the performance of operational hydrological models on the basis of actual experimentation on selected test sites.

Whereas the product generation activity will be performed by meteorological services supported by scientific institutes specialised in remote sensing, the hydrological validation programme will be performed by hydrometeorological services, hydrological scientific institutes and operational units of Civil Defence.

Cooperation with other SAF's is envisaged and although time de-phasing between H-SAF and others SAFs, efforts to tune some activities with SAF operations starting in 2007 will be pursued.

HSAF has also strong interest in the activities of other international groups like as ITSC, which carries on studies on applications of atmospheric sounding and related issues, focusing mainly on generation of geophysical parameters with emphasis on the potential of MW water vapour absorbing channel in precipitation retrieval.

A17: The use of principal component analysis in processing simulated IASI data

Presenter: Zhaohui Cheng

Zhaohui Cheng¹, Lihang Zhou¹, Walter Wolf¹, Thomas King¹, Haibing Sun¹, Chris Barnett², and Mitch Goldberg²

¹QSS Group, Inc, Lanham, MD 20706

²Center for Satellite Applications and Research, NESDIS/NOAA

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. Currently NOAA/NESDIS/STAR uses PCA to process the simulated IASI data for the data monitoring, quality control, and regression retrievals of geophysical parameters such as atmospheric temperature, moisture, ozone, surface temperature and surface emissivity.

Eigenvectors have been computed for all 8461 IASI channels as well as the three IASI bands. For each eigenvector set, 200 principal components (PCs) and the corresponding reconstruction scores are computed. Reconstructed radiances are produced using the computed PCs and eigenvectors. Large reconstruction errors can be used to identify the suspicious channel/band. A Web page was built to monitor these reconstruction errors in both near real-time and offline.

The regression retrieval for IASI is the same algorithm that is used for AIRS. The STAR approach is based on the use of PCA to reduce the data in fewer components that still retain most of the variability of the information of the original data (Goldberg et al., 2003). 85 principal components are used to solve for atmospheric temperature, moisture, ozone, surface temperature and surface emissivity for simulated IASI data. A clear field of view detection algorithm is being developed to select the best regression retrievals with good global distribution.

In the presentation we will present the above applications and display the results of the regression retrieval based on the NOAA/NESDIS/STAR IASI near real-time simulation system.

A18: Direct assimilation of AMSU-B radiances in the HIRLAM 3DVAR analysis

Presenter: Per Dahlgren

Per Dahlgren
SMHI

Radiances from the humidity sensor AMSU-B have been assimilated for one month, January 2005, in the HIRLAM model 3DVAR analysis. The results, and impact on the forecasts will be presented and discussed on the poster. Compared to radio-sondes, the added humidity information changes the moisture and wind-field on the short forecast ranges, 0-6 hours. In the 36-48 hour forecasts, a small positive impact on temperature and geopotential is also seen. We also

wish to present how the data is processed in terms of quality control, bias-correction etc.

Potential for better impact of AMSU-B data will also be discussed briefly. Single obs experiments with a modified moisture balance and humidity variable will be done at SMHI and presented on this poster.

A19: Satellite products in the Rapid Update Cycle and plans for the Rapid Refresh

Presenter: Dezso Devenyi

*Dezso Devenyi**, Stanley G. Benjamin, Thomas W. Schlatter*, Stephen S. Weygandt
NOAA-Research, Earth System Research Laboratory,
Global Systems Division (ESRL/GSD)
* also affiliated with the University of Colorado,
Cooperative Institute for Research in Environmental
Sciences

The Rapid Update Cycle (RUC) is an hourly data assimilation and short range numerical forecast system run operationally at the National Centers for Environmental Prediction (NCEP) since 1994. The concept of rapid updating means that every hour a new analysis and several short range forecasts are performed using observations collected during the previous hour. Because the process is repeated every hour with fresh data, there is a high demand to incorporate as many observations as possible into the analysis. Therefore the RUC uses a large variety of data in its three-dimensional variational analysis (3DVAR) scheme, including, among others, satellite products: GOES/NESDIS precipitable water, cloud-top pressure and temperature, cloud drift winds, and SSM/I precipitable water. It will be demonstrated how these measurements are used in wind, moisture, and cloud analyses within the RUC. Based on the success of the RUC over the contiguous United States has prompted us to extend its geographical coverage and at the same time to introduce a new generation of RUC called the Rapid Refresh (RR). The new domain will be about four times larger than the present one and will extend hourly assimilation and short-range forecasting to Alaska, Canada, and to the Western Atlantic. RR will also use one of the Weather Research and Forecasting (WRF) model cores for its numerical prediction, and Gridpoint Statistical Interpolation (GSI) as its variational analysis scheme.

GSI is already adopted at ESRL/GSD, and its development continues in close cooperation with the Environmental Modeling Center, one of the National Centers for Environmental Prediction. Because much of the enlarged domain for the Rapid Refresh is much less densely covered by observations than the contiguous United States, direct assimilation of satellite radiances, a capability of the GSI, will have a

big impact on the analysis. Preliminary results from RR experiments will be presented at the conference.

A20: Comparison of ATOVS, CHAMP and ground based humidity estimates on different spatiotemporal scales

Presenter: Nathalie Selbach

J. Schulz¹, R. Lindau², N. Selbach¹, K.-B. Lauritsen³, H. Gleisner³

¹ *Deutscher Wetterdienst, Germany*

² *Meteorological Institute, University of Bonn, Germany*

³ *Danish Meteorological Institute, Copenhagen, Denmark*

This presentation shows the results of a joint visiting scientist activity of the GRAS Satellite Application Facility (GRAS-SAF) and the Satellite Application Facility on Climate Monitoring (CM-SAF). The main objective of this study is to investigate the potential role of GRAS data within the humidity product suite of the CM-SAF. The GRAS-SAF developed retrieval schemes to derive temperature and humidity profiles from Global Positioning System radio-occultation measurements that will be obtained by the GRAS instrument on the EPS platform. GRAS data is expected to improve on the traditional sounder products in the upper troposphere and lower stratosphere as well as under rainy conditions. Although the spatiotemporal sampling of the GRAS instrument is not as good as of other imagers or sounders GRAS data can be used to construct a single source climate product.

The CM-SAF produces a suite of humidity products that contains single source estimates of total and layered precipitable water as well as temperature and relative humidity mean values for thick layers. In its operational version 2 CM-SAF provides estimates from the ATOVS system from NOAA polar satellites employing NOAA's library search algorithm to derive temperature and mixing ratio profiles. Version 3, operational at the end of the Initial Operations Phase, will see an extension to a global product employing the IAPP retrieval package. Within this version optimal merging is used for data sharing the same algorithm and a priori information, i.e., ATOVS data from different NOAA platforms will be merged among themselves.

Within this presentation we will discuss a comprehensive intercomparison of CHAMP, ATOVS, and ground based temperature and mixing ratio profiles. This is to better understand systematic differences between radio occultation and atmospheric sounder estimates. The understanding of the systematic differences is considered to be a prerequisite for the application of merging algorithms to data from

different instruments. ATOVS and CHAMP data are also used to construct monthly, and seasonal maps of integrated water vapour that are analysed w.r.t. the different representation of spatial and temporal variability in the data sets. From this analysis it might be deduced on what spatiotemporal scales the individual estimates are best usable for the purpose of climate monitoring.

A21: Application of a Principal Component-based Radiative Transfer Model to NAST-I data Retrievals

Presenter: Xu Liu

Xu Liu¹, William L. Smith², Daniel K. Zhou¹, and Allen M. Larar¹

¹ *NASA Langley Research Center*

² *Hampton University*

The Principal Component-based Radiative Transfer Model (PCRTM) was developed for super fast retrievals of atmospheric temperature and moisture profiles from hyperspectral remote sensors. The NPOESS Airborne Sounder Testbed Interferometer (NAST-I) is an instrument with 8632 spectral channels. A large amount of time is needed to model all the channel radiances of the NAST-I instrument using channel-based radiative transfer models. The PCRTM on the other hand calculates the principal component scores of the NAST-I radiance, which has much smaller dimension relative to the original channel radiances. The parameterization of the PCRTM model is derived from properties of PC scores and instrument line shape functions. It is physical and accurate. The inversion algorithm is based on a non-linear Levenberg-Marquardt method with climatology covariance and a priori information as constraints. The new physical inversion algorithm has been successfully applied to the NAST-I data. It uses all NAST-I channels for atmospheric temperature and moisture profile retrievals. The results are compared with collocated radiosondes and Lidar measurements.

A22: Assimilation of limb radiances from MIPAS at ECMWF using 1d and 2d radiative transfer models

Presenter: Niels Bormann

*Niels Bormann, Sean Healy, Mats Hamrud
ECMWF*

We discuss assimilation experiments with direct assimilation of emitted infrared limb radiances from MIPAS with a 1-dimensional radiative transfer model that assumes local horizontal homogeneity, and with a 2-dimensional observation operator that takes into account horizontal gradients in the atmosphere. The

results are also contrasted against results from the assimilation of MIPAS retrievals of temperature, humidity, and ozone.

The assimilation of MIPAS data leads to considerable differences in the mean stratospheric analyses of temperature, humidity, and ozone. For instance, the assimilation leads to considerable moistening of the stratosphere and temperature modifications which have an oscillatory structure in the vertical. Both of these aspects are supported by independent data. The radiance and the retrieval assimilation lead to fairly similar results, but the ozone analyses for the retrieval assimilation compare better with independent data over the tropics and Antarctica.

The use of a 2-dimensional observation operator for the radiance assimilation adds only a small benefit to the assimilation compared to using a 1-dimensional observation operator in our experiments. The results show that the 2-dimensional operator correctly takes into account the effect of tangent point drift, is capable of extracting a limited amount of horizontal structure from a single MIPAS scan, and leads to smaller First Guess departures for lower tangent altitudes and more strongly absorbing channels. As a result, humidity and ozone increments from a 2-dimensional operator are smaller in the lower stratosphere and upper troposphere in areas where considerable horizontal gradients prevail. Forecasts of humidity and ozone also appear improved in these areas.

A23: A Fast Forward Model for the Stratospheric Wind Interferometer for Transport Studies

Presenters: D.S. Turner and Yves J. Rochon

D.S. Turner¹, Yves J. Rochon¹, Ian C. McDade² and Peyman Rahnama²

¹ *Atmospheric Science and Technology Directorate, Environment Canada*

² *York University*

The Stratospheric Wind Interferometer for Transport studies (SWIFT) is a Canadian satellite instrument designed to measure stratospheric winds and ozone in the 20-40km region. SWIFT is a field-widened imaging system similar, in principle, to the WINDII (WIND Imaging Interferometer) instrument but will operate in the infrared rather than the visible.

An overview of the current instrument design is described, followed by a description of a preliminary fast forward model to compute limb radiances for the Michelson interferometer imaging system of SWIFT. The model is a derivative of the Fast Line-by-Line Radiative Transfer model. This model, with the addition of a gradient model, will be initially tested in retrieval mode with the aim of eventual use by the Canadian data assimilation system.

This paper will briefly describe the SWIFT instrument to be flown on the Canadian Space Agency's Chinook Mission in late 2010 followed by a description of the fast forward model.

A24: On the role of surface emissivity in polar night-time cloud detection

Presenter: Domenico Cimini

*D. Cimini, F. Romano, E. Ricciardelli, and V. Cuomo
Institute of Methodologies for Environmental Analysis
(IMAA) National Research Council (CNR)*

Clouds play a key role on the radiation budget of the Earth. However, several sources of uncertainties affect the ability to detect cloud presence from passive satellite measurements, especially during winter time in the polar regions. In fact, due to little visible and thermal contrast between clouds and surface, frequent occurrence of temperature inversion, and relatively low optical thickness, the detection of polar cloud is not trivial. During winter, techniques based on differential reflectance (e.g. using 1.6 mm channel) are not usable because of scarcity of sunlight. Therefore, an approach relying on infrared observations only must be used. A variety of threshold methods based on multi- and hyper-spectral observations have been proposed with encouraging results, although problems still exists with thin clouds and weak inversions.

As such, uncertainties related to surface emissivity may play an important role, since spectral emissivity for ice/snow surfaces may differ significantly depending upon microphysical properties. In particular cases, the spectral emissivity of ice/snow surfaces may resemble cloud signatures when observed by satellite, and could potentially confuse detection techniques relying on thresholds. Thus, the effect of realistic ice/snow emissivity spectra on simulated radiances will be shown, with an emphasis on the impact of such an uncertainty on the performances of currently available polar night-time cloud detection techniques. Finally, the implications associated with multispectral (MODIS) and hyperspectral (AIRS, IASI) observations will be discussed.

A25: Monitoring space-time soil wetness variations by a multi-temporal microwave satellite records analysis

Presenter: Teodosio Lacava

T. Lacava¹, E. V. Di Leo¹, N. Pergola¹, and V. Tramutoli²

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² *Dip. di Ingegneria e Fisica dell'Ambiente, Università della Basilicata*

In the last few years, remote sensing observations have become a useful tool for providing hydrological information, including the quantification of the main physical characteristics of the catchment, such as topography and land use, and of its variables, like soil moisture or snow cover. Moreover, satellite data have also been largely used in the framework of hydro-meteorological risk mitigation.

Recently, an innovative Soil Wetness Variation Index (SWVI) has been proposed, using data acquired by the microwave radiometer AMSU (Advanced Microwave Sounding Unit) which flies aboard NOAA (National Oceanic and Atmospheric Administration) satellites.

The proposed index, developed by a multi-temporal analysis of AMSU records, seems able to reduce the problems related to vegetation and/or roughness effects. Such an approach has been tested, with promising results, on the analysis of some flooding events which occurred in Europe in the past.

In this poster preliminary results obtained in the analysis of the flooding event which occurred in Europe during April 2006 are presented. Results obtained seem to confirm the reliability of the proposed approach verifying its sensitivity in the identification of pre-precipitations soil conditions, particularly useful for warning system purposes, as well as for monitoring space-time dynamic of the considered event.

A26: Status of ATOVS-like and SSM/I data in the operational assimilation system at Météo-France and perspectives towards the use of microwave surface sensitive channels over land

Presenter: Nadia Fourrié

Elisabeth Gérard¹, Fatima Karbou¹, Florence Rabier¹, and Zahra Sahlaoui²

¹*Météo-France/CNRM/GMAP*

²*Maroc-Météo*

The operational global model at Météo-France benefits now from the assimilation of AMSUA, AMSUB and HIRS data on board NOAA15, NOAA16, NOAA17, NOAA18 and AQUA satellites, but all three instruments are not used on each platform. A review of the conditions of use of ATOVS channels (blacklist) will be presented.

Under evaluation in the pre-operational suite at the time of the abstract writing, the assimilation of SSM/I radiances in clear sky over sea should be operational at the time of the conference as a positive impact of those data has been revealed in research experiments. The impact of those data on the first guess and analysis

fields will be presented as well as on the forecast scores.

If AMSUA and AMSUB raw radiances are operationally assimilated over ocean in many NWP systems, their assimilation over land is still limited to the least surface sensitive channels. As for SSM/I radiances, they are never used over land. Efforts are performed at Météo-France to use AMSUA, AMSUB and SSM/I channels over land when the surface is reliably described with one of the three surface schemes developed at Météo-France, where (scheme 1) the emissivity is derived from an atlas obtained over 15 days prior to the assimilation period; (scheme 2) the emissivity is dynamically derived from the first channel of each instrument; (scheme 3) the emissivity is derived from the atlas as in scheme 1 and the skin temperature is dynamically computed from the first channel of each instrument. Encouraging results obtained from these schemes on observation departure from first guess, analysis field and forecast performances will be presented.

A27: Homogenization of the total ozone amount series derived from NOAA/TOVS data

Presenter: Bozena Lapeta/Izabela Dyras

B.Lapeta¹, I.Dyras¹, Z.Ustrnul²

¹*Institute of Meteorology and Water Management, Poland*

²*University of Silesia, Poland*

Total ozone amount has been operationally derived from NOAA/TOVS data in Satellite Research Department of Institute of Meteorology and Water Management since 1993. For this period, total ozone amount has been daily calculated for the area covering Central Europe. Such a relatively long series is unusually valuable for trend analysis. However, such an application requires a series to be fully homogenous and of good quality. Meanwhile, during 13 year period of the ozone retrieval from satellite data, both software and instruments were several times. Simultaneously, there are some gaps in series caused by the lack of satellite data.

In the paper, the total ozone amount series is presented as well as the steps undertaken for its homogenization. The analysis was performed for monthly mean values using the ground total ozone measurements from Belsk (21E; 51N) in Poland. The well known in climatology homogeneity SNHT test was applied. The achieved results are presented and discussed.

A28: CIWSIR: A Proposed ESA Mission to Measure Cloud Ice Water Path

Presenter: Stefan Buehler

*S. A. Buehler, on behalf of the CIWSIR Science Team
Lulea Technical University*

Ice clouds play an important role in Earth's radiation balance. In spite of this, our current knowledge of the global statistics of Cloud Ice Water Path (IWP) is astonishingly poor. For example, the different climate models in the IPCC AR4 archive show discrepancies in zonal mean IWP of a factor of 10.

CIWSIR is a new satellite mission that has been proposed in the last ESA call for Earth Explorer Missions. It uses passive radiometric measurements in the sub-millimeter wave spectral range, a spectral range that has so far not been used for meteorological satellite measurements. The advantage of these wavelengths for cloud ice measurements is that the radiation can penetrate the clouds, while still interacting strongly with the cloud ice particles. This allows IWP retrieval with approximately 20-30% accuracy for IWP, according to retrieval simulations. The use of simultaneous infrared data can improve the accuracy to approximately 10-20%.

The presentation focuses on the scientific background of the mission, the mission characteristics, and the expected performance.

A29: Current and Future Plans for Satellite Data Reception and Utilisation at the Australian Bureau of Meteorology

Presenter: Anthony Rea

*Anthony G Rea, David C Griersmith, Ian F Grant
Observations and Engineering Branch, Australian
Bureau of Meteorology*

The Bureau of Meteorology (Bureau) continues to acquire data with national coverage from the polar orbiting NOAA satellites, distributing both imagery and derived products from the AVHRR and the ATOVS sensor suite for atmospheric sounding. The Bureau is currently rolling out a network of X-band receiving stations to complement the existing Australian stations in preparation for the new generation of sensors on the NPP, NPOESS and METOP satellites.

The Bureau also directly receives data from MTSAT-1R and Fengyun-2C, both of which are used in operations, and for the generation of derived products such as atmospheric motion vectors and daily insolation.

There is a global trend toward rapid exchange of regional data for assimilation into numerical weather forecasting systems. The Bureau has been an early participant in the Regional ATOVS Retransmission Service (RARS) which enables routine rapid exchange

over the internet of ATOVS atmospheric sounding information between centres in the Asia-Pacific region. The European forerunner of RARS, EARS, has expanded to include other datasets, and to include regional dissemination by satellite broadcast, and such enhancements are being considered for RARS.

This paper will describe the current reception network and processing systems for both polar-orbiting and geostationary satellites and summarise the work being done to ensure the Bureau receives the satellite data it needs in the medium to long term. A description of the Bureau's involvement in the RARS network will also be presented.

POSTER SESSION B: THURSDAY

B01: Climate Research With the Atmospheric Infrared Sounder

Presenter: Bjorn Lambrigtsen

*B. Lambrigtsen, M. Chahine, T. Pagano, E. Fetzer, B.
Tian
JPL*

The Atmospheric Infrared Sounder (AIRS) was launched in 2002, along with two companion microwave sounders. This AIRS sounding suite is the most advanced atmospheric sounding system to date, with measurement accuracies far surpassing those of current operational weather satellites. From its sun synchronous polar orbit, the AIRS system provides more than 300,000 all-weather soundings covering more than 90% of the globe every 24 hours. As the "retrieval" system used to derive atmospheric and other parameters from the observations is being optimized and those parameters characterized and validated, usage of the AIRS data - which is available to anybody through the archive system operated by NASA - is spreading throughout the atmospheric and climate research community. An ongoing validation effort has confirmed that the system is very accurate and stable and is close to meeting the goal of providing global temperature soundings with an accuracy of 1 K per 1-km layer and water vapor soundings with an accuracy of 20% throughout the troposphere - surpassing the accuracy of radiosondes. This unprecedented data set is already being used for operational weather prediction in a number of countries, with significant positive impact on forecast accuracy and range, and is enabling a number of investigations that were previously not possible or used to shed new light on current issues in atmospheric and climate research. In addition to the basic soundings related to the hydrologic cycle, AIRS also measures a number of trace gases - the latest such product being the global distribution of carbon dioxide. We discuss some examples of recent research with AIRS data and present some thoughts on a future follow-on system.

B02: AVHRR operational cloud masks intercomparison

Presenter: Lydie Lavanant

Adam Dybbroe¹, Andrew Heidinger², Lydie Lavanant³

¹SMHI

²NOAA NESDIS

³Meteo-France

METOP-A is due to be launched on 17th July 2006 and will carry an AVHRR imager onboard. With almost 30 years of continuous global coverage data from the same instrument, and more to come, the AVHRR provides unique possibilities for cloud climate studies. Global AVHRR 1km cloud cover analysis is also a key input for other AVHRR applications like sea surface temperature (SST) analysis and will also serve as a first guess for HIRS and IASI sounding profile retrievals.

This paper focuses on the intercomparison on a global scale of three operational AVHRR cloud masks:

- CLAVR-x is the NOAA AVHRR Operational Cloud Processing System and has been validated by comparing their derived SST products to those from microwave sensors and by comparing their results to in-situ measurements (pyranometers, surface based radar..) and to cloud products from other imagers (MODIS, SEVIRI).
- MAIA is operational at Meteo-France. It has strongly inherited from the NWCSAF/MSG Cloud Mask. It will be the operational mask for the O&SISAF global Metop SST production and is implemented in the NWPSAF AAPP package. It has been validated over Europe by comparing their derived SST products to in-situ Buoys SST, and by comparing their results to interactive land and sea classified targets.
- The PPS cloudmask is developed in the frame of the NWCSAF. It is operational at six European Met Services including the O&SISAF HL center and the CMSAF for cloud parameters at high latitudes. Recently the scope of the NWCSAF/PPS has been widened to the global scale. It has been validated over Europe by comparing results to interactive classified targets, and using a large database of European Synop reports.

This intercomparison is based on global land/sea data collected and classified by experienced nephanalysts. It attempts to demonstrate and improve when necessary the accuracy of the different algorithms in all conditions. The purpose is to enlarge our confidence in their operational production.

B03: Improvements to Use of Satellite Sounding Data in Met Office Regional Models

Presenter: Brett Candy

Brett Candy and Steve English

Met Office

During the past year the forecast performance of the North Atlantic and European (NAE) configuration of the Unified Model has improved very significantly. The first impact studies of satellite sounding data in this model will be presented, including the introduction of NOAA-18 and the first use of AIRS. The generation of bias correction coefficients for regional models has always been a difficult procedure and we will present comparisons of several different methodologies. Finally improvements to boundary layer moisture from AMSU-B channels will be shown, including issues with thin stratocumulus cloud layers.

B04: cancelled

B05: Variational estimation of cloud parameters with a view towards cloudy radiance assimilation: Application to AIRS observations

Presenter: Sylvain Heilliette

Sylvain Heilliette, Louis Garand, Alain Beaulne,

Nicolas Wagneur

Environnement Canada

A variational estimation procedure for the retrieval of effective cloud top height and emissivity is proposed. The method is based on a cloud emissivity model which accounts for the frequency dependence of cloud absorption and scattering, and possible mixed phased situations. The method is applied to real AIRS observations, using 61 channels mostly sensitive to temperature. A 6-h forecast serves as background field, and remains fixed. The problem of infrared cloudy radiance assimilation is approached by assuming that the atmospheric and cloud contributions to observed radiances can be well modelled if the effective cloud parameters are known precisely. Under these conditions, the assimilation of cloudy radiances appears feasible over a broad range of situations defined by the cloud parameters. Examples of 1D-var assimilation are shown, using 100 AIRS channels, this time including humidity channels and allowing the atmospheric state to vary. A comparison of the resulting temperature and water vapor increments with spatially and temporally coincident radiosondes is performed.

B06: Plans for the assimilation of cloud-affected infrared soundings at the Met Office

Presenter: Ed Pavelin

*Ed Pavelin and Stephen English
Met Office, U.K.*

Infrared soundings from AIRS have been assimilated at the Met Office for a number of years, and the assimilation of IASI data is expected to begin in 2007. A large majority of measurements from such advanced infrared sounders are affected by cloud, and these soundings are currently rejected by the data assimilation system. This is mainly due to the lack of useful a-priori information on the cloud properties in the satellite field of view. A new technique is being developed to allow the assimilation of infrared soundings above cloud, using cloud parameters retrieved by 1D-Var analysis. Cloud top pressure and effective cloud fraction are retrieved simultaneously with temperature and humidity profiles, and these cloud parameters are used as inputs to the forward model in 4D-Var. The retrieved cloud top pressure is also used to restrict the choice of assimilated channels by excluding those channels with significant sensitivity below the cloud top. The results of a 1D-Var simulation study show that considerable temperature and humidity information is gained above the cloud top using this technique.

B07: The Inclusion of Integrated Water Vapor Estimates from AIRS/AMSU and SSM/I Sensors into PSAS Data Assimilation System in the CPTEC

Presenter: Dirceu Herdies (for Luiz Fernando Sapucci)

*Luiz Fernando Sapucci, Rodrigo Augusto F. de Souza, Sérgio Henrique S. Ferreira, José Antônio Aravéquia, Rita Valéria Andreoli, Dirceu Luis Herdies
Centro de Previsão de Tempo e Estudos Climáticos (CPTEC)
Instituto Nacional de Pesquisas Espaciais (INPE)*

The atmospheric water vapor plays a crucial role in the atmospheric processes and its distribution is associated with cloud concentration and rainfall. The inclusion of Integrated Water Vapor (IWV) estimates into Numeric Weather Prediction (NWP) improves the vertical structure of the humidity and consequently contributes to obtain a more realistic atmospheric state. Nowadays, remote sensing data is the most important source of humidity, which provides information with good horizontal resolution and global coverage. However, the assimilation of the IWV values from humidity sounding satellites not has been explored in the CPTEC NWP model. This study investigates the impact of using IWV estimate from Atmospheric InfraRed Sounder/Advanced Microwave Sounding Unit (AIRS/AMSU) and Special Sensor Microwave/Imager (SSM/I) as additional sources of moisture information in the CPTEC data assimilation

system (PSAS: Physical-space Statistical Analysis System). In order to characterize this impact were carried out different cyclic processes using Atmospheric Global Circulation Model CPTEC/COLA with and without the inclusion of these data. In the analysis of results is considered the improvement in the forecast of the specific humidity, geopotential height and wind field in different areas: North Hemisphere (0° to 90°N), South Hemisphere (0° to 90°S), Tropical Region (20°N to 20°S) and special attention is given to South of America regions. The preliminary analysis of the results shown that the impact of inclusion IWV from AIRS/AMSU and SSM/I is significant to regions where the density of conventional information is lower, as South Hemisphere and South of America regions. In these areas, the inclusion the IWV values improved the prediction of specific humidity in 850 and 700 hPa, the geopotential height in 500 and 250 hPa and wind components in 250 hPa.

B08: moved to talk 8.2

B09: Performance of the AIRS/AMSU and MODIS Soundings over Natal/Brazil Using Collocated Sondes : SHADOZ Campaign 2004-2005

Presenter: Rodrigo Souza

*Rodrigo Augusto Ferreira de Souza, Juan Carlos Ceballos, Jurandir Ventura Rodrigues
Instituto Nacional de Pesquisas Espaciais (INPE),
Centro de Previsão de Tempo e Estudos Climáticos (CPTEC),
Divisão de Satélites e Sistemas Ambientais (DSA)*

The purpose of this work was to analyze the performance of the AIRS/AQUA sounding system (physical-statistical retrieval code) and of the MODIS/AQUA (statistical retrieval code) to recover atmospheric profiles of temperature and moisture over Natal (northeast region of Brazil) during the SHADOZ (Southern Hemisphere Additional OZonesondes) campaign along 2004 and 2005. The atmospheric profiles retrieved by both inversion models were compared with the collocated radiosonde data ("ground truth") of the campaign, considering satellite retrievals within a 100 km radius around the sounding site. The bias and the root mean square error (RMS) of deviations were assessed for the whole available data of the campaign. The results showed that temperature profiles retrieved from AIRS/AQUA has a bias lower than 1K for pressure levels below 500 hPa, while the MODIS profiles has a bias about -2K, near the ground level. In the troposphere the AIRS soundings showed lower root mean square error (about 1.5K) compared with MODIS retrievals (until 3.5K near the ground level) for all pressure levels below 200 hPa.

Concerning moisture profiles, the results showed that MODIS and AIRS/AMSU profiles have bias about -2 to -4 g/kg for pressure levels below 800 hPa, respectively. In addition, both of them had similar RMS in the troposphere reaching 2 g/kg near the ground level.

B10: First Results from the Use of the Aqua Sounding System in the CPTEC Global Data Assimilation/Forecast System

Presenter: Rodrigo Souza

Rita Valéria Andreoli, Rodrigo Augusto Ferreira de Souza, Sérgio Henrique S. Ferreira, Luiz Fernando Sapucci, Dirceu Luis Herdies, José Antônio Aravéquia, João G. F. de Mattos
Instituto Nacional de Pesquisas Espaciais (INPE), Centro de Previsão de Tempo e Estudos Climáticos (CPTEC)

The Center for Weather Forecasting and Climate Studies of the National Institute for Space Research (CPTEC/INPE) is responsible for producing weather forecast in Brazil. The key issue for numerical prediction is related to provide good estimation of the initial conditions for the Numerical Weather Prediction Model. Nowadays, remote sensing data have become the predominant source of information. The CPTEC operationally uses information from ATVOS/NOAA system to supply such vertical profiles and more recently has been implemented the AQUA sounding system (AIRS/AMSU). Experiments using these data have been conducting to evaluate its impact on weather analysis and forecasting. In these experiments, AIRS/AMSU retrievals were assimilated in different forms using the Physical-space Statistical Analysis System (PSAS) data assimilation system. The spectral Atmospheric Global Circulation Model CPTEC/COLA was used to generate the first guess and state predict to 5 days. The PSAS analysis requires that temperature profiles observations need to be converted to geopotential height profiles, using the hydrostatic relation, and “anchoring” the profile with either the background surface pressure. In the present study two experiments was done. The first experiment considers the first guess height field for the anchoring of the height profile, therefore, the lowest height value, which would be exactly the first guess is not included in the observation vector. The second experiment considers that anchoring is independent of the first guess, and the height of surface is included in the observation vector. The results from the initial experiments with AQUA data indicate significant improvements in forecast skill over the Southern hemisphere and improvement over the Northern hemisphere, most notably for the second experiment, compared with the experiment without AIRS/AMSU data, indicating the potential of AQUA sounding

system to improve operational forecast skill at CPTEC/INPE.

B11: Standard back-propagation artificial neural networks for cloud liquid water path retrieval from AMSU-B data

Presenter: J. M. Palmer

J. M. Palmer, D. Cimini, F. Romano, and V. Cuomo
Institute of Methodologies for Environmental Analysis (IMAA) National Research Council (CNR)

Artificial neural networks (ANNs) have many variants, which can have very different behaviours. The success of ANNs to produce good results for a wide variety of problems when little is known about the search space has lead them to become of interest to many scientific disciplines. Ideally if a problem is tested for the first time with an ANN methodology then this methodology should be standard. However this may be problematic for a number of reasons. It is difficult to know the best configuration of parameters for the learning algorithm. Results from individual runs can be irregular. There may be a very large amount of training data making training slow. These problems often cause researches to diverge from the standard back propagation method. This paper introduces a set of techniques to tackle these problems without diverging from the stranded methodology. Moreover these techniques have been developed for a real problem; to derive the cloud liquid water path (LWPC), using the advanced microwave sounding unit B (AMSU-B) microwave brightness temperatures. The vertically integrated cloud liquid water, also known as LWPC plays a key role in the study of global atmospheric water circulation and the evolution of clouds. The ability to derive LWPC accurately and across large areas therefore means better atmospheric models can be built and tested. Simulated AMSU-B and LWPC data is fitted using linear, polynomial and standard ANN methods. The ANN method performed the best and gave an average RMS error for between 0.06 and 0.02 kgm⁻² dependent on the environment. Finally, real AMSU-B data and co-located LWPC data, measured from ground stations, is used to test the ANN model. This is done in two ways; firstly with a network trained with the simulated data, using the real data as a test, and secondly using the real data for both the training and testing phases. Both cases are compared and the results are discussed.

The methodology introduced in this paper include, a variation on the back propagation learning algorithm, a simple data sampling procedure to reduce the size of the data sets and a parameterised activation function which can be used to test a variety of non-standard activation functions.

B12: Use of IASI data for retrieval of tropospheric gases

Presenter: Thierry Phulpin

Thierry Phulpin¹, Cathy Clerbaux², Piet Coheur³, Solene Turquety², and Claude Camy Peyret⁴, and Sébastien Payan⁴

¹CNES

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IASI, the Infrared Atmospheric Sounding Interferometer, has been launched on MetOp-A on 17 July 2006. Two additional flight models are ready to be flown on the following MetOp satellites, ensuring continuity for very consistent high quality data up to 2020. Even though IASI is firstly devoted to operational meteorology i.e. for temperature and humidity profiling, its spectral range and its spectral resolution are such that it will also permit to retrieve ozone profiles, as well as column of carbon monoxide, methane and nitrous oxide. The algorithms to retrieve these products have been tested on simulated data obtained either from other sensors like IMG, Mopitt or IASI-balloon. Initial simulations have also been undertaken to combine IASI and GOME-2 data in order to improve ozone profiles, showing that the number of DOFS is then increasing from 3 to 5. The tools to assimilate IASI CO have also been developed and an illustration of the global field of CO used as a priori will be shown. Additional species like HNO₃ or SO₂ are also expected to be measurable.

B13: Impact of thermal inhomogeneity on IASI spectral response and its correction

Presenter: Peter Schlüssel

*Peter Schlüssel
EUMETSAT*

IASI (Infrared Atmospheric Sounding Interferometer) has relatively large Instantaneous Fields Of View (IFOV), so that the instrument cannot be considered as an ideal interferometer with an optical path aligned along the normal to the moving mirror. The deviation from this normal increases from the centre towards the outer regions of an IFOV, leading to increased path differences. Consequently, the spectral response function varies across the IFOV and the assumption of a constant reference spectral response function causes an errors in the corresponding radiance if the thermal contrast within an IFOV is big. The error can reach 1 K, which is large compared to the radiometric noise. The thermal inhomogeneity within IASI fields of view are routinely measured by the co-located AVHRR (Advanced Very High Resolution Radiometer), thus it is possible to estimate and correct for this effect.

However, the accurate calculation of the corresponding correction requires substantial computing resources. Therefore, a parameterisation is proposed which is practicable and fit for purpose in an operational environment.

B14: Satellite Data Assimilation in Tropical Cyclone Forecasts

Presenter: Jishan Xue (for Wei Han)

*Wei Han, Jishan Xue
Chinese Academy of Meteorological Sciences, China
Meteorological Administration*

All tropical cyclones landing Chinese coast originate in the Western Pacific or the South China Sea where few conventional soundings or surface data are available. With sparse observations over the oceans, it is impossible to define the large scale flow patterns and the inner structure of tropical cyclones, and such inaccurate analyses cause big errors in both numerical prediction and statistical forecasts of tropical cyclones. So the data voids problem is the most serious challenge faced by Chinese Scientists and forecasters in operational centers. The assimilation of satellite observations is likely the best way for solving this data voids problem. Trials of assimilation of AMSU and Geo-AMVs in Tropical cyclone forecasts will be presented in this poster.

B15: ITWG Overview

Presenter: Tom Achtor

*Tom Achtor
Space Science and Engineering Center, University of
Wisconsin-Madison*

Abstract not available.

B16: The ITWG Web Site: How to Create a Useful Forum for the Community

Presenter: Leanne Avila

*Leanne Avila
CIMSS/University of Wisconsin-Madison*

For the past four and a half 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.

B17: An Integrated Web-based Visualization System for Monitoring and Validation of the Products from Hyper-spectral Instruments

Presenter: Lihang Zhou

L. Zhou¹, Z. Cheng¹, X. Liu¹, Walter Wolf¹, T. King¹, S. Qiu¹, C. Barne² and M. Goldberg²
¹*QSS Group Inc, Lanham, MD, USA*
²*NOAA/NESDIS/STAR, 5200 Auth Road, Camp Springs, MD 20746 USA*

A major achievement of NOAA/NESDIS/STAR in recent years has been to operationally process AIRS products and provide them to the NWP centers in near real-time. A very important part of AIRS processing is the monitoring of the instrument performance and the qualities of the products. NOAA/NESDIS/STAR has developed a Web site for displaying and monitoring the various types of AIRS products. The Web site supports quick image browsing as well as an interactive display for selected time, channels/levels, and surface type. Daily plots and time series of the estimated noise versus the AIRS calibration noise are available, as well as the comparisons of the AIRS products with the forecast model outputs are available from the Web site. New features such as displaying and validation of the retrieved AIRS trace gas products, monitoring the SO₂/volcanic eruptions, and the AIRS co-located MODIS products, have been added recently.

Based on our AIRS experience, a full feature, highly interactive Web-based visualization system has been developed for IASI to monitor the data processing and to view the most recent data that has been processed. This Web site will bring the hyper-spectral observations and the products up close to the users. An offline visualization tool has also been developed for global climatology studies (based on GrADS). This tool enables quick displays and analysis of the hyper-spectral global observation data sets and the products. The integrated visualization system will allow us to continuously monitor the hyper-spectral instruments, such as AIRS, IASI, and CrIS, and support the verification and validation efforts of the products from the different satellite platforms.

B18: Distribution of Hyperspectral Radiances to Numerical Weather Prediction Centers

Presenter: Walter Wolf

Walter Wolf¹, T. King¹, L. Zhou¹, Z. Cheng¹, C. Barne² and M. Goldberg²
¹*QSS Group Inc, Lanham, MD, USA*
²*NOAA/NESDIS/STAR, 5200 Auth Road, Camp Springs, MD 20746 USA*

The near real-time AIRS processing and distribution system has been operational at NOAA/NESDIS/STAR since October 2002. The Numerical Weather Prediction (NWP) Centers have been receiving the AIRS radiances that are now operational at a number of these centers. The initial radiances distributed were the center field of view (FOV) of the nine FOVs within a golf ball. Since the NWP centers assimilate clear radiances, this choice of FOV was non-optimal for distribution. To tailor to the needs of the users, the determination of the FOV to distribute was changed to the warmest FOV within a golf ball (using a window channel). This warmest FOV dataset is currently being operationally distributed. A test dataset is being produced that contains the clearest AIRS golf ball FOV by using MODIS data. This dataset may become operational if deemed more suitable than the warmest FOV dataset.

The AIRS near real-time operational system is the baseline for the design and development of the IASI and then CrIS near real-time processing and distribution systems. The IASI system will be distributing subset radiances to the NWP within the United States while the CrIS system will distribute the near real-time radiances to the same customers as AIRS. The products and similarities of all three systems will be discussed and presented.

B19: JCSDA Community Radiative Transfer Mode (CRTM) version 1 and development prospects

Presenter: Paul van Delst (for Yong Han)

Yong Han¹, Paul van Delst², Quanhua Liu³, Fuzhong Weng¹, Banghua Yan³, Russ Treadon⁴, and John Derber⁴

¹*NOAA/NESDIS/Center for Satellite Applications and Research*

²*University of Wisconsin – Madison*

³*QSS Group, Inc.*

⁴*NOAA/NWS/NCEP/Environmental Modeling Center*

Over the past several years, a new community radiative transfer model (CRTM) has been developed at the U.S. Joint Center for Satellite Data Assimilation (JCSDA) with the joint efforts from various research groups and organizations. Since the end of 2005 it has been an essential component of the Gridpoint Statistical Interpolation (GSI) data assimilation system at the

NOAA National Center for Environmental Prediction (NCEP). The current model simulates the microwave (MW) and infrared (IR) radiances observed by instruments on board spacecrafts for a given state of the atmosphere and Earth's surface under all-weather conditions. It also computes radiance sensitivities such as the radiance derivatives with respect to the state variables. It comprises four major modules: Atmospheric gaseous absorption for gaseous transmittance calculations, Cloud scattering and absorption for cloud optical parameters such as mass extinction coefficients and single scattering albedo, Surface optics for emissivity and reflectivity and RT solution for solving radiative transfer equations. In this presentation we will provide an overview of the implementation of the first version of CRTM, which has been completed and integrated into the GSI system. We will also report the ongoing work for the next version.

B20: The status of the 4A (Automatized Atmospheric Absorption Atlas) forward model

Presenter: Raymond Armante

R. Armante¹, C. Pierangelo¹, N.A. Scott¹, A. Chédin¹, L. Chaumat², C. Standfuss², B. Tournier²

¹Laboratoire de Météorologie Dynamique, Ecole Polytechnique

²Noveltis

This presentation is to summarize the status of the 4A fast line-by-line model, including its operational version (4A/OP). Calculating transmittances, jacobians, radiances and fluxes for a given input of atmospheric and surface conditions is required for both research and operational meteorological or climatological studies. Since its original publication (in the early 80's), the 4A model has been widely involved in such studies as the simulation of high spectral resolution radiances and of their sensitivity to surface and atmospheric variables; the selection of the best possible spectral intervals for the retrieval of atmospheric and surface variables; the investigation of the dynamic range of variation of radiances received at the satellite as a function of spectral and atmospheric variables; the modelling of the Earth radiation budget and simulations of atmospheric cooling rates and radiative forcing; the generation of observation fields (among others the mathematical model of the IASI instrument).

According to new research topics, e.g. related to the new generation of vertical sounders (AIRS/Aqua and IASI/Metop) or limb sounders (Mipas, Ace), the 4A model capabilities have been extended to process limb soundings and take scattering and solar component into account. Performances, computation time will be discussed.

B21: cancelled

B22: cancelled

B23: Surface Emissivity Retrieved from AIRS

Presenter: Daniel Zhou

Daniel K. Zhou¹, William L. Smith², Allen M. Larar¹, and Xu Liu¹

¹NASA Langley Research Center

²Hampton University

The surface emissivity affects thermodynamic parameters (e.g., surface skin temperature, atmospheric moisture, and temperature) retrieved from satellite infrared (IR) spectral radiance will be addressed. Simulation analyses and retrieval validations demonstrate that surface emissivity plays an important role in retrieval of surface skin temperature and terrestrial boundary layer (TBL) moisture. A retrieval algorithm has been developed to retrieve surface and atmospheric parameters. This algorithm has been applied to NAST-I and AIRS hyper-spectral data. Results show appropriate surface skin temperature and emissivity retrieval to be critical for atmospheric profile retrievals of temperature, moisture, and chemical species, since satellite observations such as those from AIRS aboard the AQUA satellite, cover a large variety of surface types. AIRS data are used to demonstrate that a large diversity of surface types is captured with this inversion scheme, indicating surface skin temperature and emissivity information is detected by hyper-spectral remote sensors such as AIRS and IASI. Accurate surface and atmospheric properties retrieved from satellite measurements can greatly enhance benefits realized from usage of such data for NWP and other applications.

B24: Cloud properties from AIRS

Presenter: Claudia Stubenrauch

C. J. Stubenrauch, R. Armante, G. Abdelaziz, C. Crevoisier, F. Eddounia, C. Pierangelo, A. Chédin
C.N.R.S.-IPSL Laboratoire de Météorologie Dynamique (LMD), Ecole Polytechnique

We present a cloud retrieval scheme for the AIRS (Advanced InfraRed Sounder) instrument, which is based on the weighted chi2 method using channels around the CO2 absorption band at 15 micron (Stubenrauch et al. 1999). We discuss the influence of channel choice, cloud detection, spatial resolution and of assumed atmospheric profiles on the retrieval of cloud-top pressure and effective emissivity. Results are

compared to results from ISCCP and MODIS, as well as to the cloud climatology of TOVS Path-B.

B25: Observation operator and estimation of uncertainty in the assimilation of AIRS radiances using ensemble Kalman Filter

Presenter: José Aravéquia

José Antonio Aravéquia^{1,2}, Eugenia Kalnay¹, Elana Fertig¹, Hong Li¹, Junjie Liu¹

¹Department of Atmospheric and Oceanic Science, University of Maryland

²Centro de Previsão do Tempo e Estudos Climáticos, Instituto Nacional de Pesquisas Espaciais, (Permanent Affiliation)

In this work we study the uncertainty of 40 ensemble members run using the CRTM forward model to produce radiances from each model state over whole domain to the subset of 324 channels of AIRS. Calculating the weighting function profile and finding the level of its maximum we are able to attribute an atmospheric level for each channel to indicate where the satellite observation will affect the model state in the LETKF analysis. The radiance fields obtained show us where the model uncertainties in the ensemble are and also where the assimilation of AIRS radiances should be more impact on the reduction of forecast error.

1st Workshop on Remote Sensing and Modeling of Surface Properties

Presenter: Benjamin Ruston

Benjamin Ruston¹, Fuzhong Weng², Sid-Ahmed Boukabara³, Catherine Prigent⁴

¹NRL

²NOAA/NESDIS/STAR

³IMSG Inc., NOAA/NESDIS

⁴LERMA/CNRS, Observatoire de Paris

The workshop, an activity of the International TOVS Working Group, sponsored by Observatoire de Paris and the NOAA/NESDIS/Office of Research and Applications was held in Observatoire de Paris, France from June 20-22, 2006. The meeting was well attended by 62 international specialists and scientists, including representatives of the major NWP centers (e.g., NCEP, ECMWF, Met Office, Météo-France, Meteorological Service of Canada, Norwegian Met Institute). The utilization rate of satellite surface-sensitive data over land, sea ice and snow conditions is still very limited and participants in the First International Workshop of Remote Sensing and Modeling of Surface Properties confirmed that accurate surface emissivity estimates are necessary to assimilate surface-sensitive satellite measurements into NWP models. The NWP centers gave an overview of the status of the assimilation of infrared

and microwave surface-sensitive radiances over both ocean and land and presented their plans for the future. Strategies include the use of surface emissivity models as well as the direct estimation of the emissivities from window channel observations. Recent advances in emissivity and reflectivity models were presented. Major problem areas still exist, including the need for input parameters not directly related to the physical variables in the NWP models and difficult to estimate on a global basis. The development of a community surface emissivity modeling framework that can be used by all NWP centers was encouraged. It was recognized that the land surface modeling community needs to be brought more closely into this study. Global and regional data sets of satellite-derived land surface emissivities are now available both in the IR and in the microwave and several were presented. These can provide first guess estimates and statistics for assimilation of close-to-the-surface channels. It was emphasized that efforts should be made to compare these emissivity estimates with model results and in-situ measurements. The key role of the land surface temperature in the surface radiative contribution (in the IR and in the microwave) prompted a call for a global comparison of land surface temperature from satellite and models to better understand the differences and identify those regions of greatest uncertainty. Lastly, in addition to the development of a common emissivity modeling framework, the workshop recommended the archival and documentation of all existing land surface emissivity data bases from IR and microwave wavelengths at a centralized Web site for public access for an efficient intercomparison and evaluation of the modeled, satellite-derived and in-situ emissivity estimates.

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