INTERNATIONAL

TOVS

WORKING GROUP

Sharing ideas, plans and techniques
to study the earth's weather
using space-based observations

A Report on the Fourteenth International TOVS Study Conference

Beijing, China

25-31 May 2005

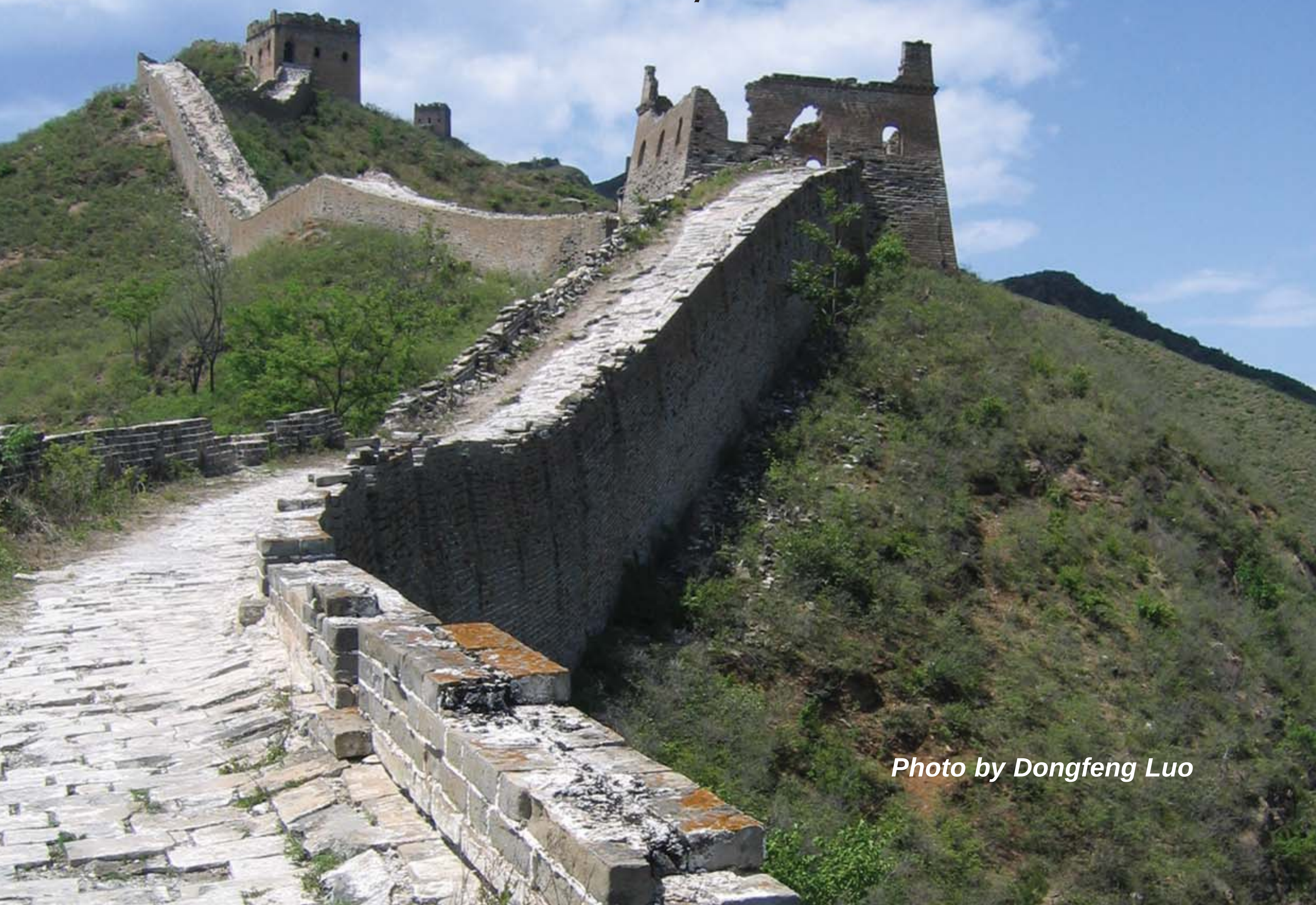

Photo by Dongfeng Luo

A Report on
The Fourteenth International
TOVS Study Conference

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Conference sponsored by:

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Univ. of Wisconsin / SSEC
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FOREWORD

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

The Fourteenth International TOVS Study Conference (ITSC-XIV) was hosted by the National Satellite Meteorological Center (NSMC) in Beijing, China from 25 to 31 May 2005. 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-XIV scientific presentations. The ITWG web site contains electronic versions of the conference presentations and publications (http://cimss.ssec.wisc.edu/itwg/). Together, these documents and web pages reflect the conduct of a highly successful meeting in Beijing. An active and mature community of TOVS and ATOVS data users now exists, and considerable progress and positive results were reported at ITSC-XIV in a number of areas, including many related to the ATOVS system and to the current and impending advanced sounding instruments.

ITSC-XIV was sponsored by industry, government agencies and research centers, including, VCS, CNES, Kongsberg Spacetec AS, the Raytheon Company, the Met Office (U.K.), the University of Wisconsin 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 NSMC, particularly Director General Yang Jun, his international affairs leader, Dongfeng Luo, and Mr. Luo’s excellent staff.

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International TOVS Study Conference – XIV

INTERNATIONAL TOVS WORKING GROUP

Corporate and Agency Sponsors

25 – 31 May 2005

Beijing, China

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ITSC-XIV Poster

THE FOURTEENTH INTERNATIONAL
TOVS STUDY CONFERENCE (ITSC-XIV)
Beijing, China: 25-31 May 2005

International TOVS Working Group (ITWG) Co-Chairs

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Roger Saunders, Met Office, UK

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INTERNATIONAL TOVS WORKING GROUP

The 14th International TOVS Study Conference

第 14 届国际泰罗斯业务垂直探测研讨会

(25–31 May, Beijing, China)

ITSC-XIV Group Photo

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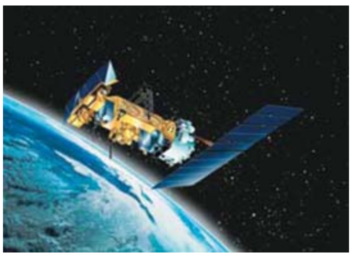

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Fourteenth International TOVS Study Conference, ITSC-XIV, was held on the Chinese Meteorological Administration campus in Beijing, China from 25 - 31 May 2005. One hundred and twenty-five participants attended the Conference and provided scientific contributions. Twenty-two countries, and three international organizations were represented: Australia, Austria, Belgium, Brazil, Canada, China, Denmark, France, Germany, Hungary, India, Italy, Japan, South Korea, New Zealand, Norway, Poland, Portugal, Sweden, Taiwan, the United Kingdom, the United States of America, ECMWF, EUMETSAT and WMO. This was the largest conference to date in terms of total number of presentations and posters. The conference attendees were able to witness images and products from the successful deployment of the new ATOVS instruments on NOAA-18, which had been launched the previous week.

Most of the meeting was occupied with presentations on a range of issues which included:

- ATOVS radiance and retrieval studies
- ATOVS cloud studies
- Climate applications
- Radiative transfer and surface modelling
- Operational use of ATOVS
- Use of ATOVS in NWP
- Direct reception and software packages
- Preparations for METOP and NPOESS
- Future instruments

There were 77 oral and 80 poster presentations during the conference. An effort was made to reduce the number of oral presentations for this conference compared with ITSC-XIII in order to create a less crowded agenda (which can be found starting on page 63).

Working Groups were formed to consider six key areas for the International TOVS Working Group (ITWG), including Radiative Transfer and Surface Property Modelling; Use of TOVS and ATOVS for Climate Studies; Use of TOVS and ATOVS in Numerical Weather Prediction; Advanced Sounders; International Issues and Future Systems; 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 Section 2 of this Report. A summary of the key points are listed below.

During the Conference, a session on Status Reports considered summaries of activities that had taken place since ITSC-XIII. This session also reviewed progress on the Action Items identified by the ITSC-XIII Working Groups. Many of these items formed the basis for further discussion by the Working Groups at ITSC-XIV. Several technical sub groups met during ITSC-XIV to discuss developments and plans concerning specific software packages, shared and in common use in TOVS, ATOVS and Advanced Sounder processing centres. Brief reports on these sub group meetings are recorded in Section 3. Holding the conference in Beijing also allowed the conference participants to learn more about the latest developments in the Chinese meteorological satellite program which is now well advanced after the successful operation of its new generation geostationary satellite, FY-2C.

1.2 SUMMARY OF MAJOR CONCLUSIONS

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

1. Two operational NWP centres are now assimilating radiances from the advanced infrared sounder, AIRS, on the EOS Aqua satellite and getting significant positive forecast impacts even though the radiances assimilated are a small fraction of those available. Work is underway to allow a more complete use of the AIRS data (e.g. more channels especially in the shortwave infrared, more data over land, and possibly cloud cleared radiances).

2. A new AIRS dataset containing the warmest field of view in the AMSU-A footprint instead of the central field of view is about to be made available operationally to NWP centres. Tests at ECMWF suggest this dataset allows more AIRS data to enter the analysis. NOAA are about to provide to NWP centres a dataset which uses MODIS to identify the clearest AIRS fields of view.

3. In addition to AIRS, several centres are also assimilating the Aqua AMSU-A radiances to increase the robustness of their systems to possible loss of data from the NOAA constellation.

4. The number of NWP centres using level 1b ATOVS radiances in their variational assimilation systems continues to grow but there are still some centres that rely on the level 2 retrievals provided by NESDIS.

5. Several NWP centres have started using ATOVS radiances from the EUMETSAT Advanced Retransmission Service, EARS, in order to provide more timely data (within 30 minutes) to their NWP models. This was originally envisaged to be for regional models but global models are also benefiting from the improved timeliness of these data.

6. With the success of EARS the group encouraged further initiatives, now being setup to expand the coverage beyond Europe and North America (e.g. RARS), to be implemented.

7. The group also supported plans by the satellite agencies to reduce the delay in the blind orbits for the global dataset by using ground stations closer to the poles.

8. The assimilation of higher resolution ATOVS data in local area models was presented, (e.g. Met Office, HIRLAM) expanding the exploitation of ATOVS data for NWP.

9. The first data from the Microwave Humidity Sounder (MHS) on NOAA-18 was shown during the conference. Although very similar to AMSU-B there are a few minor differences in the instrument characteristics. NWP centres are planning to assimilate NOAA-18 ATOVS data within a few months of its availability.

10. All satellite agencies should be urged to provide their data to NWP centres as part of the cal/val program. Recent experience with SSMI(S) data has once again shown the value of NWP to help diagnose unforeseen instrument characteristics. It is also important to allocate resources for dedicated cal/val campaigns for new sensors using aircraft to measure both in-situ parameters and co-incident radiance measurements.

11. Preparations for the METOP launch in 2006 are well underway. The offer of NESDIS to provide simulated IASI data to NWP centres will help ensure they are prepared for IASI data soon after METOP launch. Only a subset of IASI channels will be available to NWP centres on the GTS and so activities are underway to define the optimal channel subset for NWP applications.

12. Since the last ITSC a second high spectral resolution sounder workshop was held at Ravello, Italy in May 2004 to allow a more detailed discussion of scientific issues related to advanced sounders. These workshops can educate and train young scientists entering the field. Another workshop is planned before the next ITSC.

13. The community software packages for processing locally received ATOVS data have been upgraded to allow data to be processed from NOAA-18. 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. The issue of maintaining consistency between globally processed ATOVS and locally processed ATOVS was discussed and recommendations were made to ensure this is the case for METOP and equivalent NPP/NPOESS sensors.

15. Community software for processing Terra and Aqua locally received data (i.e. AIRS, AMSU-A, HSB, AMSR-E and MODIS) is available for direct broadcast users. The conference discussed plans to provide similar software for the NPP and NPOESS data.

16. The group noted the development of the Community Radiative Transfer Model at the Joint Centre for Satellite Data Assimilation (JCSDA) and encouraged all radiative transfer (RT) modelers to standardize on the interfaces to their models to make it easier for users to incorporate the RT models into their own applications and to facilitate comparisons.

17. Results from an intercomparison of radiative transfer calculations for AIRS co-coordinated by the group were presented. This study will help to quantify the forward model errors for advanced sounders.

18. It was recommended to set up an ITWG surface property modeling sub group to better co-ordinate developments in infrared and microwave surface modeling. It will report to the RT and surface modeling group but may hold its own meetings.

19. Several radiative transfer models for rain affected microwave radiances have been developed and preliminary experiments demonstrating the assimilation of rain affected radiances have begun. This offers a new source of information from satellite data not yet exploited in NWP.

20. As with previous conferences the group reiterated the importance of using more data over land. There were no major advances reported in the use of infrared radiances over land however promising results were presented for the use of more microwave radiances over land.

21. The group was updated about plans for a reference network of radiosonde stations, with additional surface based measurements to ensure the accuracy of the in situ sounding. This reference network has been proposed to the GCOS group in WMO and is planned to be implemented in the next 5 years. The group supported this proposal for climate monitoring applications.

22. The ITWG hosted the satellite frequency co-ordination group meeting, SFCG-24, in September 2004 in Lannion, France. R. Saunders (ITWG Co-chair) gave a presentation to the meeting on the issues of frequency protection for NWP applications. It was noted the RF interference is now evident in all the AMSR-E low frequency bands in spite of some of them being protected.

23. The Working Group noted that WMO and CGMS have developed the Virtual Laboratory for Training in Satellite Meteorology (VL). The ITWG Members were asked to review and provide guidance for the VL material related to ATOVS. The ITWG will establish an outreach and education focal point to serve as liaison between ITWG and the VL focus group.

24. Access to documents describing NPOESS/NPP ground processing and raw data and sensor data records (content and format) still needs to be established to allow review by members of the group. IPO representatives undertook to ensure early release of these documents.

25. The new 10km field of view on the NOAA-18 HIRS will allow comparisons with the 17km field of view on NOAA-16 HIRS in terms of the yield of cloud free radiances. The effect of this field of view difference should be studied to consider the requirement for the field of view size for the CrIS and other advanced sounders.

26. The ITWG noted there are differences between the AMSU and ATMS sounder specifications and recommended studies are undertaken before ITSC-XV to determine the impact of these differences for users. This will provide guidance for specifications for future microwave sounders.

27. The ITWG recommended the Integrated Program Office (IPO) to consider placing NPP into a 1430 UTC ascending orbit (instead of the planned 1030 UTC descending orbit in order to complement the METOP/IASI with NPP/CrIS and to provide continuity with Aqua/AIRS.

28. The ITWG noted and endorsed studies underway that demonstrate the feasibility of a microwave imager/sounder in geostationary orbit.

1.3 FUTURE PLANS

Following the success of the ITSC-XIV meeting in May 2005 the ITWG will continue to inform the ATOVS community of the latest news and developments through its Web site maintained by the University of Wisconsin and the email list server maintained by WMO. In particular, more information suitable for training will be incorporated on to the Web site. A workshop on high spectral resolution sounders is planned to take place during 2005/6. There will be an International Direct Broadcast Conference in Benevento, Italy in October 2005. The NWP Satellite Application Facility is hosting a workshop on radiance bias correction at ECMWF in November 2005. The AIRS radiative transfer model intercomparison sponsored by ITWG will be published. 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-XIV Working Group Report, the Proceedings for ITSC-XIV from the papers submitted will be provided to attendees and other interested persons on CD-ROM. The oral and poster presentations from ITSC-XIV are already available as pdf files which can be downloaded from the ITWG Web site. The next meeting of the ITWG is planned for Autumn/Winter 2006. Topics of interest will include detailed evaluation of NOAA-18 ATOVS data, initial assessments of METOP data and status of preparations for the NPP launch.

ACTIONS AND RECOMMENDATIONS

WORKING GROUP ON RADIATIVE TRANSFER AND SURFACE PROPERTY MODELING

Action RTSP-1
RTSP-WG Co-Chairs to add revised version of Table 2.1-1 (see page 18) to RTSP-WG Web site. Revisions listed below to be accomplished by 31 August 2005.
1. Roger Saunders to provide the Web link for the trace gas profile set to add to Table 2.1-1
2. Hal Woolf to put CIMSS data sets on the Web and provide updated information for Table 2.1-1
3. Eva Borbas to provide details of her profile dataset. RTSP-WG Co-Chairs to add entry in Table 2.1-1
4. RTSP-WG Co-Chairs to add a column in Table 2.1-1 indicating data sets the RTSP-WG considers to be standard and only include URLs of datasets we endorse.

Action RTSP-2
Fuzhong Weng to inform RTSP-WG when A-train matchup data set is available for RT model validation.

Action RTSP-3
Xu Liu to contact MOZART model group for combined (co-located) temperature, humidity and trace gas profile data sets for independent RT validation and provide RTSP-WG Co-Chairs with details of data set availability (actual and planned).

Action RTSP-4
Nicole Jaquinet-Husson to document observational datasets available for line-by-line (and fast model) validation and details on how to access these data sets if publically available.

Action RTSP-5 (carried forward)
All members of the group to send information on validation datasets to RTSP-WG Co-Chairs who will post this information on the RTSP-WG Web site.

Action RTSP-6
Louis Garand to provide his profile interpolation and associated adjoint/TL code to the group.

Action RTSP-7
Louis Garand to survey NWP centres to establish the profile interpolation and adjoint techniques they use. The goal is to seek the best code to map Jacobians from RTM levels to NWP model levels (this implies an appropriate design of the forward interpolation routine).

Action RTSP-8
Tom Kleespies to co-ordinate with Pascal Brunel and post links to all AVHRR SRFs.

Action RTSP-9
Nicole Jacquinet-Husson to provide the updated IASI SRF dataset to the RTSP-WG as soon as it is available.

Action RTSP-10
Peter Schluessel will be the point of contact for SRFs for ATOVS on METOP.

Action RTSP-11
RTSP-WG Co-Chairs to update RTSP-WG Web page information on AIRS SRF and channel blacklist referred to above.

Action RTSP-12
Rolando Rizzi to contact LbL modelers and invite them to provide a summary of LbL model

development status to RTSP-WG Co-Chairs by September 15, 2005. This summary should include model name, version, code access and licensing details, important technical features (including adjoint or analytical Jacobian capability, treatment of scattering) and literature references.

Action RTSP-13
RTSP-WG Co-Chairs to add a summary of LbL model information on RTSP-WG Web page by 15 December 2005.

Recommendation RTSP-1 to RT modellers
The RTSP-WG recommends that ozone absorption demonstrated to affect the AMSU 183 GHz channels is included in radiative transfer models.

Action RTSP-14
Stephen English will provide results of a study quantifying the impact for AMSU and SSMI radiances to the group.

Recommendation RTSP-2 to spectroscopic database developers
The RTSP-WG urges spectroscopic database developers to adopt a standard and rigorous version control system for spectroscopic databases.

Action RTSP-15
Modellers to provide fast RT model summary including name, version, code access and licensing details, supported instruments, technical features (including FM/TL/AD or analytical Jacobians, scattering properties, variable gases, spectroscopy, training set, generating LbL, vertical discretisation), literature references to RTSP-WG Co-Chairs.

Action RTSP-16
RTSP-WG Co-Chairs to add a summary of fast models to RTSP-WG Web page by 15 December 2005.

Action RTSP-17
Tom Kleespies and Roger Saunders to collect notes on developing and testing tangent linear and adjoing code and post a summary on the ITWG RTSP-WG Web site.

Action RTSP-18
All AIRS RT modellers should facilitate the publication of the intercomparison results without delay.

Recommendation RTSP-3 to RT modellers
The RTSP-WG recommends that future RT model validation studies be undertaken when collocated A-train sensor data sets become available.

Action RTSP-19
A surface property task group of the RTSP-WG to be set up and co-ordinated by Ben Ruston.

Recommendation RTSP-4 to RT modellers
The RTSP-WG recommends standardization of emissivity model interfaces, e.g. within CRTM framework.

Recommendation RTSP-5 to RT modellers
The RTSP-WG recommends studies into the relationship between retrieved IR and MW skin temperatures (and retrieved/modelled emissivities).

Action RTSP-20
F. Weng and R. Bennartz to summarize recent progress on modeling of radiation in cloudy/precipitating

atmospheres (including discussion of the effects of FOV and 3D cloud structure).

Action RTSP-21
RTSP-WG Co-Chairs to review and update RTSP-WG Web pages by 15 December 2005.

WORKING GROUP ON TOVS/ATOVS DATA IN CLIMATE

Action Climate-1
John Bates to provide the ITWG Climate WG with further details of the Climate Data Record (CDR) measurement maturity index and include their feedback in the further development of the index.

Recommendation Climate-1 to agencies/investigators producing climate data records
It is vital to produce multiple independent climate data records for a given atmospheric parameter or satellite instrument to thoroughly understand the effects of methodological choices and better discern the true climate signal. The ITWG endorses the development of criteria to assess the level of capability and maturity of climate data records by defining a set of 'best practices' that would include criteria such as the multiple independent production of CDRs by different groups and their intercomparison.

Recommendation Climate-2 to agencies/investigators producing climate data records
Many CDRs are produced within universities or other science institutions. To provide a continuous treatment and data access of those data sets meeting GCOS climate monitoring requirements, the ITWG climate group recommends continuation of such research efforts as well as the transition of mature products into operational climate activities.

Recommendation Climate-3 to agencies/investigators producing climate data records
ITWG endorses activities that lead to a comprehensive analysis of the existing temporal records either by intercomparison in the framework of the GEWEX Radiation Panel (or its successor, the WCRP Observations and Analysis Program) or their use in applications at operational climate centers.

Action Climate-2
ITWG Co-Chairs to report Recommendations Climate-1-Climate-3 to GEWEX radiation panel and any responses to these Recommendations to the ITWG Climate WG.

Recommendation Climate-4 to WMO Coordinator for satellite observations
Numerous efforts have been made to intercalibrate satellites with each other and against in situ data. Better coordination between relevant agencies and long-term archive and access is required to the various calibration and intercalibration efforts.

Action Climate-3
ITWG Co-Chairs to report Recommendation Climate-4 to WMO and response of WMO to this recommendation.

Recommendation Climate-5 to GCOS/NOAA climate observation requirements WG
ITWG strongly supports the vision of a reference network that consists of multiple instruments to fully characterize the atmospheric column, providing a continuous rigorous ground truth, which would have benefits not just to the climate community. GCOS/NOAA are encouraged to continue to strongly pursue this vision and coordinate with other relevant bodies.

Action Climate-4
Peter Thorne to advertise reports and progress from the GCOS/NOAA workshop series to the ITWG list to permit feedback from the ITWG community to ensure that the needs of the satellite community are incorporated.

Recommendation Climate-6 to reanalysis centers
Reanalyses efforts would greatly benefit from undertaking observing system experiments to understand what input data, particularly the start of different observing systems such as TOVS/ATOVS and hyperspectral sounders, affect the analysis system. This will help future reanalyses mitigate these changes in the observing system and better capture long-term behavior free of biases.

Action Climate-5
ITWG Co-Chairs to report Recommendation Climate-6 to appropriate reanalysis centers and any responses to recommendation to the ITWG Climate WG.

Recommendation Climate-7 to space agencies
Space Agencies should ensure archival of and access to all level 0 data along with any metadata for future use by the climate research and monitoring community.

Recommendation Climate-8 to satellite archive centers
Satellite archive centers must ensure the collection, retention, and accessibility of complete and rich metadata. The rich metadata inventory should include compatibility with international standards for metadata and include reference, context, provenance, and integrity information.

Recommendation Climate-9 to reanalysis groups
Reanalysis groups should seek to work with the new operational satellite climate centers on the optimal calibration and processing of archival data sets.

Recommendation Climate-10 to space agencies
Space Agencies should archive and make easily accessible radiances of all spectral channels available including geographically subsampled data sets.

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

Action DA/NWP-1
Mitch Goldberg to enquire (through NESDIS) if the same level of detailed real time information which has been provided for AIRS can be replicated for other instruments and similarly the response to user enquiries.

Action DA/NWP-2
Mitch Goldberg to provide to the ITWG NWP WG a list identifying the most appropriate contact for instrument problems for each instrument.

Action DA/NWP-3
John Le Marshall with ITWG input to facilitate the establishment of a Web page for instrument status (channel by channel being used where appropriate) and ensure this is linked to the ITWG Web page.

Action DA/NWP-4
John LeMarshall to ask NWP WG members to provide information to him on their current channel usage for each instrument (used now, used in the past, never used) for input to a summary table which he will put on the ITWG Web page.

Action DA/NWP-5
DA/NWP Co-Chairs and Tony McNally to provide information from ITWG NWP survey on ITWG Web page.

Action DA/NWP-6
Stephen English (Met Office) and Andrew Collard (ECMWF) to coordinate with NOAA the change to warmest fov over the US-Exeter link.

Recommendation DA/NWP-1 to ECMWF/Met Office
ECMWF/Met Office to evaluate AIRS "MODIS" product when it becomes available.

Action DA/NWP-7
Thomas Auligné and Stephen English to present recommendation DA/NWP-1 to ECMWF and Met Office for consideration.

Action DA/NWP-8
John LeMarshall to ask JCSDA to review AIRS 324 channel data set in light of full spectral resolution experiments and recommend any promising additions.

Recommendation DA/NWP-2 to NOAA
Add more MODIS cloud information on AIRS FOVS using existing AIRS BUFR tables rather than additional parameters.

Action DA/NWP-9
John LeMarshall to present recommendation DA/NWP-2 to NOAA, providing full details of what is required in consultation with the WG members.

Recommendation DA/NWP-3 to all RT model developers
Where possible use an existing interface (e.g. CRTM, RTTOV) for new models.

Action DA/NWP-10
Stephen English to ask Roger Saunders to communicate recommendation DA/NWP-3 to the wider RT development community.

Recommendation DA/NWP-4 to JCSDA (Paul van Delst) and NWP-SAF (Roger Saunders)
To work towards the same interface for CRTM and RTTOV.

Action DA/NWP-11
Stephen English to present recommendation DA/NWP-4 to the NWP SAF SG.

Action DA/NWP-12
John LeMarshall to present recommendation DA/NWP-4 to the JCSDA SG.

Recommendation DA/NWP-5 to NWP SAF (Stephen English)
To provide information to RTTOV users on sources of emissivity information and emissivity models.

Action DA/NWP-13
Stephen English to discuss with NWP SAF SG whether recommendation DA/NWP-5 can be undertaken by the NWP SAF.

Recommendation DA/NWP-6 to CGMS
Continue to support fast delivery initiatives (EARS, RARS), extending where possible (e.g. Hawaii).

Action DA/NWP-14
Stephen English to communicate recommendation DA/NWP-6 to EUMETSAT and to ask John Eyre to bring it to the attention of WMO and CGMS.

Recommendation DA/NWP-7 to NOAA
To use new global ground stations to mitigate blind orbit problems for NPOESS data.

Action DA/NWP-15
John LeMarshall to present recommendation DA/NWP-7 to NOAA.

Recommendation DA/NWP-8 to all satellite agencies
The assimilation community (all major NWP centres) to be part of the 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-16
John LeMarshall and Stephen English to ask ITWG Co-Chairs to ensure recommendation DA/NWP-8 is conveyed to all satellite agencies via appropriate international bodies (e.g. CGMS).

Recommendation DA/NWP-9 to all satellite agencies
While current operational practice and very considerable benefits are based mainly on the use of microwave data and the longwave and midwave IR components of the hyperspectral frequency range, the potential exists for continued gains to be made through additional application of the shortwave IR component of the spectrum. It is recommended that research addressing the problems of solar contamination and surface emissivity be given enhanced emphasis.

Action DA/NWP-17
Stephen English to ask the IASI Sounding Science WG Co-Chairs to note recommendation DA/NWP-9.

Action DA/NWP-18
Nancy Baker to get detailed instrument actual performance figures for ATMS and to then study the relative performance of AMSU-A and ATMS through experiments in the NRL NWP system. Note: JCSDA also plans an OSSE using ATMS this year.

Action DA/NWP-19
Tom Kleespies to repeat Kleespies & Watts MHS study for ATMS compared to AMSU-A.

Recommendation DA/NWP-10 to IPO
To add a 6.7 micron water vapour channel to VIIRS.

Action DA/NWP-20
John LeMarshall to present recommendation DA/NWP-10 to the IPO JARG.

Action DA/NWP-21
John LeMarshall to establish and report to the WG the NPP and METOP non-GTS data distribution policy for countries outside Europe.

Action DA/NWP-22
Thomas Auligné to propose and then circulate a monitoring strategy for IASI to be adopted by all NWP centres, to allow easy comparison of monitoring between centres.

Action DA/NWP-23
Stephen English to ask NWP WG members to study the proposal by Andrew Collard for IASI GTS products and provide feedback to Andrew Collard by the end of July 2005 (other IASI GTS questions/comments should be fed to Simon Elliot at EUMETSAT).

Recommendation DA/NWP-11 to NWP Centres
NWP centres to provide feedback to NESDIS if NOAA-16 data reception is not acceptable during

NOAA-18 commissioning.

Action DA/NWP-24
Stephen English to inform NWP centres of the expected situation for NOAA-16 to NOAA-18 transition and recommendation 14.11.

Recommendation DA/NWP-12 to EUMETSAT
EUMETSAT to provide NOAA-15, NOAA-16, NOAA-17, and NOAA-18 HRPT data as part of EARS where possible.

Action DA/NWP-25
Stephen English to inform EUMETSAT EARS team of recommendation DA/NWP-12.

Action DA/NWP-26
Graeme Kelly to re-advertise details of ECMWF bias correction workshop to ITWG.

Action DA/NWP-27
Stephen English to re-advertise existence of NWP SAF Web based guidance on bias correction on NWP SAF Web page to ITWG and to pass on positive feedback about the Web page to the NWP SAF SG.

Action DA/NWP-28
Mitch Goldberg to check with CMS (Pascal Brunel) whether NESDIS can provide any information which would allow AAPP processing of HIRS to be even closer to global processing.

Action DA/NWP-29
Stephen English to ask NWP WG members to supply him with information on assumed observation errors for radiance assimilation in order to create a summary Web page for the ITWG NWP WG Web page. This can then be updated as and when necessary.

Action DA/NWP-30
Stephen English to ask NWP WG members to provide him with text (with Web links where appropriate) to describe current techniques used at their centre for estimating observation errors (e.g. Chapnik method).

Action DA/NWP-31
All WG members to submit information on verification methods (including software tools where available) to Brett Candy, who will create a Web page for the NWP WG Web site.

Action DA/NWP-32
Stephen English to get initial information for NWP WG Web page to Leanne Avila.

Action DA/NWP-33
NWP Co-Chairs to review the status of the actions and recommendations in September 2005 and at regular intervals before ITSC-XV and email a status report to WG members and ITWG Co-Chairs.

WORKING GROUP ON ADVANCED SOUNDERS

Recommendation AS-1 to space agencies
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 observations as well as decrease the field of view size. As a first step, a comparison of the yield of NOAA 18 HIRS clear air data versus NOAA 16 HIRS data should be conducted. If the results of these

trade-off studies strongly support a change to the CrIS spatial sampling characteristics, a recommendation would be prepared to take to the Joint Agency Requirements Group.

Recommendation AS-2 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 the minimum radiometric measurement requirements for advanced IR sounders to be carried on future polar and geostationary orbiting satellites.

Recommendation AS-3 to the space agencies
Cal/Val for advanced sounders needs to be an activity which receives sufficient resources. While radiosondes and NWP fields can provide a basic validation, high-altitude airborne sensors, such as those associated with the NAST and ARIES airborne sensors, and upper air reference networks (see Climate WG Report) need to also be included in order to validate the radiances, and derived products, to the very high accuracy, and precision, specified for advanced sounding instruments.

Action AS-1
NWP centers should review the channel selection method proposed at ITSC-XIV to ensure that the channels selected will meet their initial requirements for NWP applications and provide any comments to the ITWG Co-Chairs.

Recommendation AS-4 to advanced sounder research community
The advanced sounder research community needs to consider issues such as: (1) the ability to detect cloud such that the impact of undetected cloud on the observed radiances is less than 0.2K, (2) the correct usage of Principal Components (PCs), (3) effective and efficient quality control (particularly for PCs), (4) the continued development of fast models in super channel or PC space, that are robust, fast and sufficiently accurate, and (5) the quantification of the observational and forward model error covariance matrices.

Recommendation AS-5
It is recommended that relevant organizations conduct studies to identify the functions of microwave sounders, identify users, and develop consensus measurement requirements for future systems. This should be done for LEO as well as GEO sounders. It is recommended that this information be consolidated in a table similar to that presented above for the IR sounder.

Recommendation AS-6
For future microwave sounders, it is recommended that efforts be devoted to improving radiometric sensitivity and horizontal spatial resolution. It is further recommended that scattering models, which will enhance rain rate estimates and enable retrieval of vertically resolved rain, be further developed.

Recommendation AS-7 to space agencies
Microwave sounders should be considered to be flown with future advanced IR sounders, to provide simultaneous observations at the same time and at the same location.

Recommendation AS-8 to space agencies
Future imaging radiometers to be flown with advanced IR sounding instruments should possess lower tropospheric IR sounding channels to support the interpretation and enhanced utilization of advanced IR sounding spectrometer observations obtained for cloudy sky scene conditions.

Recommendation AS-9 to space agencies
A study should be undertaken to determine the impact of horizontal and vertical polarization for future MW sounders, taking into account the impact on "clear sky" information content as well as the ability to detect clouds and precipitation. The goal of this study should be to compare the AMSU and ATMS

systems to determine what is best for future microwave sounders. The study will also inform users what they can expect from the ATMS data.

Recommendation AS-10 to science community
The utility of applying the SNO (Simultaneous Nadir Observation) technique for an equatorial (inclination <20° degrees) LEO platform for the purpose of radiometric cross-calibration should be examined. Optimal orbital parameters (attitude and inclination), as well as sensor type, should be determined so that recommendations for possible sensors on future equatorial satellites can be put forward.

Recommendation AS-11 to space agencies
ITWG strongly recommends that certain elements of future satellite systems (e.g., the data processing, algorithm and product development system, the evaluation and validation, and the training program), be led by government agencies, together with its academic teams, in partnership with industry. It is also recommended that the users of the satellite system play a role in the definition of the characteristics of this system.

Action AS-2
Advanced Sounder WG Co-Chairs to forward recommendations to specified groups by end of 2005.

WORKING GROUP ON INTERNATIONAL ISSUES AND FUTURE SYSTEMS

Recommendation IIFS-1 to research and operational satellite operators
Make data available in a form and browse display similar to that done by NASA on their rapidfire sites (e.g. http://rapidfire.sci.gsfc.nasa.gov/realtime/) that provide access to MODIS and AIRS data. While some providers may have specialized formats, all providers should strive to make their data also available in standard formats (e.g. hdf for images, BUFR for soundings).

Action IIFS-1
ITWG Rapporteur to take Recommendation II-1 forward at CGMS 2005.

Recommendation IIFS-2 to WMO Space Program Office and CGMS
Establish a process for similar data set distribution from other instruments whereby users can formally express their need for such data sets and conduct a dialogue with the data providers on issues of content and format.

Recommendation IIFS-3 to the direct broadcast community
An International Direct Broadcast Working Group should plan meetings like the forthcoming Benevento, Italy meeting on a regular basis to provide a forum for the international direct broadcast users to exchange vital technical planning information regarding achieving access to and maintaining consistency of level 0 and level 1 data. Annual plenary meetings would suffice, however, more frequent sub-groups should be considered. Failure to do so may put at risk the continuity of data access at some NWP centers and synergy within the international user community. All international DB users should plan to be represented at the October workshop.

Action IIFS-2
The ITWG rapporteur to encourage consideration for establishing an IDBWG within CGMS in the near future.

Recommendation IIFS-4 to the WMO Space Program Office
The WMO, with CGMS assistance, should continue to promote the implementation of a globally coordinated system of RARS. The 6th Asia-Pacific Satellite Data Exchange and Utilization (APSDEU-

6) meeting in Seoul in June 2005 will seek to reach agreement on implementation of an Asia-Pacific RARS. The WMO Space Program Office should organize a further global RARS meeting thereafter.

Recommendation IIFS-5 to the WMO Space Program Office
To coordinate the development of backbone reception stations and dissemination nodes, contacts and implementation standards, including quality, formats, and processing software requirements. A Web site should be established as a central reference for all global RARS information.

Recommendation IIFS-6 to CGMS
To continue to provide a forum for discussion and coordination among satellite operators to avoid orbit overlap as much as possible.

Action IIFS-3
ITWG Rapporteur to CGMS to present Recommendation 14.6.

Recommendation IIFS-7 to IPO
To consider placing NPP into a 1430 local time ascending orbit (instead of the planned 1030 descending orbit) in order to complement the pending METOP/IASI with NPP/CrIS and to provide continuity with Aqua/AIRS.

Action IIFS-4
Goldberg to present Recommendation 14.7 to the IPO/JARG.

Recommendation IIFS-8 to NOAA NESDIS
To pursue added support from the new IPO/NESDIS antenna located in Svalbard, Norway to eliminate the blind orbits and hence significantly improve data timeliness for existing polar orbiting international users.

Recommendation IIFS-9 to CGMS
To add discussion of the distribution of development tasks to their agenda in November 2005.

Action IIFS-5
ITWG Rapporteur to CGMS to present Recommendation 14.9.

Recommendation IIFS-10 to ITWG members
To review WMO TD 1267.

Action IIFS-6
ITWG Co-Chairs to seek volunteers to review the WMO TD 1267 who will provide their comments to P. Menzel by end of July 2005.

Recommendation IIFS-11 to the WMO Space Program Office
To organize the production of a WMO Technical Document containing the characteristics, environmental utility, and need for each requested frequency.

Action IIFS-7
(a) ITWG Members to review and provide guidance for VL Materials on VRL Electronic Notebook to help assure updated materials for VRL (Available through WMO Space Program Web site for Virtual Lab and linking to CIRA VRL site). (b) ITWG to establish an outreach and education focal point to serve as liaison between ITWG and VL focus group.

WORKING GROUP ON SATELLITE SOUNDER SCIENCE AND PRODUCTS

Action SSSP-1
Lydie Lavanant to continue HRPT survey and collect data and Leanne Avila to put the information on the ITWG/SSSP Web page.

Recommendation SSSP-1 to space agencies and direct readout package developers
Future NPP, METOP, FY-3 and NPOESS programs should provide data and products in a standard reference format. If not, then global centres should provide an interface routine (i.e., in FORTRAN and/or C languages which converts the data into a reference format such as HDF and/or BUFR). Local packages for direct readout should also use these formats or provide an appropriate interface similar to the global centres.

Action SSSP-2
SSSP Co-Chairs to forward these recommendations to space agencies and identified direct readout package developers.

Recommendation SSSP-2 to NOAA and EUMETSAT
Make available simulated IASI measurements (from NWP) in a routine manner, for example through ftp, to facilitate ITWG user access. It is recommended that such data be archived and accessible through interfaces to define time period and if possible geographic windows (i.e., similar as for ECMWF archived data) to help mange the high volume of these data.

Action SSSP-3
SSSP Co-Chairs to forward this recommendation to NOAA and EUMETSAT.

Recommendation SSSP-3 to space agencies
When defining their global processing systems, space agencies (EUMETSAT, NOAA) should consider the portability and availability of their software on standard platforms (e.g. Linux PCs). This would facilitate comparisons of local and global processed data that would be mutually beneficial to data providers and users alike. These comparisons should be routinely conducted by identified centres (e.g. NWP-SAF), and results made available to all users (i.e., via the SSSP Web site).

Action SSSP-4
SSSP Co-Chairs to forward these recommendations to space agencies and direct readout package developers.

Action SSSP-5
Hal Woolf/A. Reale to include some "global" ATOVS products from IAPP (available from CIMSS) in the cross-validation studies.

Action SSSP-6
The SSSP Co-Chairs shall forward these concerns to appropriate NOAA agencies in an effort to locate sources of information and software concerning the status of available meta-data and processing software for 1b-level TOVS from 1979-2001.

Action SSSP-7
Eva Borbas to provide information on the SSSP Web site under agency planning for RO-GPS. Specifically provide links to respective programs (NASA, UCAR, EUMETSAT) with respect to GPS data, and associated sites where such data and software (i.e., SAF GRAS) are available.

Action SSSP-8
SSSP Co-Chairs to identify contact points for agencies from China and Russia, contact them, gather

information and include them on the SSSP Web site.

Action SSSP-9
SSSP Co-Chairs and their collaborators will write a letter requesting that information on the SSSP Web site be updated and maintained. They will also solicit new inputs (including from non-ITWG members).

Action SSSP-10
The site needs to be reviewed by ITWG members with suggestions, recommendations and in particular areas of concern provided to the SSSP Co-Chairs.

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: V. Sherlock (Co-Chair), L. Garand (Co-Chair) with R. Bennartz, E. Borbas, P. Brunel, D. Cimini, S. English, R. Hess, F. Hilton, N. Jacquinet-Husson, F. Karbou, T. Kleespies, X. Liu, P. Marguinaud, J-L. Moncet, C. Ping, R. Rizzi, G. Rochard, B. Ruston, R. Saunders, P. Schluessel, M. Schwaerz, D.S. Turner, P. Wang, F. Weng, H. Woolf.

This Working Group focuses on the issues related to atmospheric radiative transfer (RT) and surface property (SP) models which are relevant for radiance assimilation and atmospheric and surface retrievals from past, current and planned infrared and microwave sounder data. From now on we refer to this Working Group as **RTSP-WG** (previously RTWG).

Unless noted otherwise, action items are to be completed by 15 September 2005.

2.1.1 Atmospheric profile datasets for Radiative Transfer

Radiative transfer models require a dataset of diverse profiles for training and independent validation.

a) Training datasets

The group is actively using various profiles datasets whose characteristics are summarised in Table 2.1-1. This table was reviewed and a revised version of the table will be placed on the RTSP-WG Web pages.

Action RTSP-1

RTSP-WG Co-Chairs to add revised version of Table 2.1-1 to RTSP-WG Web site. Revisions listed below to be accomplished by 31 August 2005.

1. **Roger Saunders to provide the Web link for the trace gas profile set to add to Table 2.1-1**
2. **Hal Woolf to put CIMSS data sets on the Web and provide updated information for Table 2.1-1**
3. **Eva Borbas to provide details of her profile dataset. RTSP-WG Co-Chairs to add entry in Table 2.1-1**
4. **RTSP-WG Co-Chairs to add a column in Table 2.1-1 indicating data sets the RTSP-WG considers to be standard and only include URLs of datasets we endorse.**

b) Validation datasets

The group indicated willingness to document observational data sets which are available for model validation. If modelers become aware of auxiliary data streams which are missing or documentation which is lacking which limits the exploitation of a given data set, they are requested to raise the problem with the RTSP-WG Co-Chairs.

Action RTSP-2

Fuzhong Weng to inform RTSP-WG when A-train matchup data set is available for RT model validation.

Action RTSP-3

Xu Liu to contact MOZART model group for combined (co-located) temperature, humidity and trace gas profile data sets for independent RT validation and provide RTSP-WG Co-Chairs with details of data set availability (actual and planned).

Diverse Profile dataset	Number of Profiles	Number of Levels	Contact point/Web page
TIGR v3 radiosonde set Sub set from v2	2311 43	40L 43L	http://ara.lmd.polytechnique.fr Marco Matricardi, ECMWF
ECMWF 60L model set Sub set	13495 52	60L 101L	http://www.metoffice.com/research/interproj/nwpsaf/rtm/
ECMWF 50L model set Sub set	13766 117	50L 43L	
UMBC set	49 49	101L 42L	Scott Hannon, UMBC Hal Woolf, CIMSS
NOAA-88 Sub set	8005 32	40L 40L	Larry McMillin, NESDIS
CIMSS	32	40/42/101 L	Hal Woolf, CIMSS
CIMSS Ozone Sub set	380 34	40L 40L/43L	Hal Woolf, CIMSS M. Matricardi for 43L
Trace Gases CH_4,CO,N_2O,CO_2	43	90L	Marco Matricardi, ECMWF http://cimss.ssec.wisc.edu/itwg/groups/rtwg/trace_gases.tar.gz

Table 2.1-1. Summary of diverse profile datasets used to train RT models.

Following a review of ITSC-XIV RTSP-WG recommendation 2.1.3,

Action RTSP-4

Nicole Jaquinet-Husson to document observational datasets available for line-by-line (and fast model) validation and details on how to access these data sets if publically available.

Action RTSP-5 (carried forward)

All members of the group to send information on validation datasets to RTSP-WG Co-Chairs who will post this information on the RTSP-WG Web site.

c) Profile utilities

The RTSP-WG recognizes the importance of standard methods for profile interpolation and integration for RT modeling, and has previously distributed profile interpolation codes. However, associated adjoint (and TL) operators (essential for correct mapping of Jacobians) were not distributed.

Action RTSP-6

Louis Garand to provide his profile interpolation and associated adjoint/TL code to the group.

Action RTSP-7

Louis Garand to survey NWP centres to establish the profile interpolation and adjoint techniques they use. The goal is to seek the best code to map Jacobians from RTM levels to NWP model levels (this implies an appropriate design of the forward interpolation routine).

2.1.2 Instrument characteristics required for RT modeling

The group reviewed where there were new requirements or gaps in the instrument data required for RT modelling. The following is a list of the new or existing sensors where the group recognized information is still required for accurate RT simulations:

- AVHRR Spectral Response Functions (SRFs): Pascal Brunel indicated he would provide AVHRR SRFs from TIROS-N to NOAA-18 to anyone who requested that information from him.

Action RTSP-8

Tom Kleespies to co-ordinate with Pascal Brunel and post links to all AVHRR SRFs.

- IASI SRF : Claude Camy-Peyret will provide updated SRF to the ISSWG by July 2005.

Action RTSP-9

Nicole Jacquinet-Husson to provide the updated IASI SRF dataset to the RTSP-WG as soon as it is available.

- SRFs for other METOP instruments (HIRS-4, AVHRR …)

Action RTSP-10

Peter Schluessel will be the point of contact for SRFs for ATOVS on METOP.

- AIRS SRFs and a list of blacklisted channels are maintained on the UMBC ftp site.

Action RTSP-11

RTSP-WG Co-Chairs to update RTSP-WG Web page information on AIRS SRF and channel blacklist referred to above.

2.1.3 Line by Line (LbL) model status

Due to time constraints a comprehensive review of the status of LbL models was not undertaken during the meeting. Rolando Rizzi undertook to contact LbL modellers to invite them to provide a summary of their model developments to the RTSP-WG Co-Chairs who will co-ordinate this material for the RTSP-WG Web pages.

Infrared LbL models to be surveyed include GENLN2, RFM, kCARTA, LBLRTM, 4A, σ-IASI, Hartcode, FLBL. Microwave LbL models to be included in the survey include MONORTM, MPM 89/92, Rosenkranz, ATM, STRANSAC and ARTS.

Action RTSP-12

Rolando Rizzi to contact LbL modelers and invite them to provide a summary of LbL model development status to RTSP-WG Co-Chairs by September 15, 2005. This summary should include model name, version, code access and licensing details, important technical features (including adjoint or analytical Jacobian capability, treatment of scattering) and literature references.

Action RTSP-13

RTSP-WG Co-Chairs to add a summary of LbL model information on RTSP-WG Web page by 15 December 2005.

IR LbL model developments presented at ITSC-XIV are summarized below:

FLBL from Shawn Turner (MSC) now has analytical Jacobian capability (ITSC-XIV poster B42).

Work at Bremen University and at the UK Met Office has recently demonstrated that ozone absorption affects the AMSU 183 GHz channels (brightness temperature changes of the order of 0.5 K).

Recommendation RTSP-1 to RT modellers

> **The RTSP-WG recommends that ozone absorption demonstrated to affect the AMSU 183 GHz channels is included in radiative transfer models.**

2.1.4 Assessment of spectroscopic databases

The 23 GHz water vapor line absorption half widths were recently revised according to the results from the ARM site and models should be revised accordingly.

Action RTSP-14

> **Stephen English will provide results of a study quantifying the impact for AMSU and SSMI radiances to the group.**

It was noted that in some instances there were some discrepancies between the spectroscopic parameters documented in peer-reviewed literature and those actually integrated within official releases of spectroscopic databases. Nicole Jacquinet-Husson highlighted significant differences in water vapour and methane spectroscopic parameters in some specific spectral regions.

Furthermore, the group noted that accurate referencing of subsets of line parameters, and revisions thereof, is also critical in model development and validation.

Recommendation RTSP-2 to spectroscopic database developers

> **The RTSP-WG urges spectroscopic database developers to adopt a standard and rigorous version control system for spectroscopic databases.**

2.1.5 Fast RT models

The Working Group was pleased to note significant advances in super-channel modeling for hyperspectral instruments (e.g. the Principal Component Radiative Transfer Model, PCRTM).

The Working Group commended the Community Radiative Transfer Model (CRTM) framework initiative. A prototype CRTM is undergoing testing and the first official release is planned for June 2005.

OPTRAN: Operational version in CRTM uses polynomial fits to compute transmittances to reduce memory requirements for hyperspectral instruments. Code under development: 1) transmittance correction term and individual transmittances instead of effective transmittances; 2) revised internal vertical coordinate; 3) constraints to assure smooth adjoints; 4) additional gases. CRTM uses interfaces to facilitate swapping of RTM components (transmittance, scattering, surface properties, cloud absorption, etc. Point of contact: Yong Han (Yong.Han@noaa.gov).

RTTOV: RTTOV-8 was released in November 2004. This release includes some of the RTIASI capability and supports carbon dioxide as a variable gas. There have been major changes to code structure with the use of derived data types. More details can be found in the RTTOV ITWG Technical Report, poster B40 and the associated paper. The RTTOV-9 release is planned for February 2007 (will include more variable gases). Point of contact: Roger Saunders.

GASTROPOD: Version v0.3.0 has been released and an includes an interface with Met Office 1DVar. Code and coefficients online at http://gastro.sf.net/. Point of contact: Vanessa Sherlock.

OSS: Version 1 released and implemented in CRTM. Validation in scattering atmospheres is on-going.

Development/testing of first accelerated version with multi-channel training should be completed for the fall of 2005. Point of contact: Jean-Luc Moncet.

MSCFAST: No new development. Used for assimilation of GOES-10 and 12 water vapor channel radiances at MSC and for retrievals of surface skin temperature. Point of contact: Louis Garand.

LMD fast models: Point of contact: Alain Chedin/Noelle Scott.

SARTA: Version 1.05 of the Stand-alone AIRS Radiative Transfer Algorithm, SARTA, was released in December 2004 and uses the January 2004 coefficient database. It is a clear air fast forward model with variable H2O, O3, CO, CH4, and CO2 (no Jacobian capability), and is based on HITRAN 2000 spectroscopic database and MTCKD v1.0 water continuum, with some tuning to match validation observations. This implementation of the AIRS-RTA is used in the DAAC version 4 processing and is available online: http://asl.umbc.edu/pub/packages/. Work continues on development of the AIRS-RTA algorithm. Several new features and improvements will be implemented for the next official release (December 2005). Point of contact: Scott Hannon.

PLOD/PFAAST: No change to code. Line-by-line data used to train the scheme were updated to LBLRTM-8.4, HITRAN-2000, AER 1.1 updates and UMBC-49. The training set includes an "ultra-cold" atmosphere. Point of contact: Hal Woolf.

RTIASI: The current release of RTIASI is RTIASI-5. In RTIASI-5 the integration of the RT equation is done on 90 levels using the linear in tau approximation to parameterise the Planck function. H2O, O3, CO2, N2O, CH4 and CO are treated as profile variables. Solar radiation is included in the interval 2000-2760 cm-1 assuming Lambertian reflectance for land surfaces, and explicit calculation of bidirectional reflectance over sea. RTIASI-5 includes a parameterization of multiple scattering and absorption for water clouds (5 classes), cirrus clouds (9 classes) and aerosols (10 classes). Work is ongoing to develop an emissivity model for a land/sea-ice/snow surface. Point of contact: Marco Matricardi (marco.matricardi@ecmwf.int).

PCRTM: Principal Component based Radiative Transfer Model. Version 1.0 completed in Fortran 90. Supports: NAST-I, IASI, AIRS. Features include Principal Component (PC) scores and analytical Jacobians of PC scores with respect to state vectors. Scattering not included. Variable gases are currently H2O and O3. Trained with LBLRTM using HITRAN-2000 spectroscopy. The vertical pressure grid has 101 levels. Point of contact: Dr. Xu Liu (Xu.Liu-1@nasa.gov).

The group agreed that information on the various fast model developments should be co-ordinated on the RTSP-WG Web site.

Action RTSP-15

Modellers to provide fast RT model summary including name, version, code access and licensing details, supported instruments, technical features (including FM/TL/AD or analytical Jacobians, scattering properties, variable gases, spectroscopy, training set, generating LbL, vertical discretisation), literature references to RTSP-WG Co-Chairs.

Action RTSP-16

RTSP Co-Chairs to add a summary of fast models to RTSP-WG Web page by 15 December 2005.

One action, for the RTSP-WG to provide guidance on developing and testing tangent linear and adjoint code, was carried over from ITSC-XIII.

Action RTSP-17

Tom Kleespies and Roger Saunders to collect notes on this topic and post a summary on the ITWG RTSP-WG Web site.

2.1.6 AIRS RT model comparison

The goals of the intercomparison were to:

- Compare the forward model calculations for all the AIRS channels from all the models for 52 diverse profiles and one tropical Pacific profile coincident with AIRS data.
- Assess the Jacobians from each model using the Garand measure of fit for a limited selection of channels.
- Estimate model error covariances.
- Document the time taken to run each model.

Results have been completed, and were presented at ITSC-XIV in poster B41 by Saunders et al. These results will form the basis of a journal publication.

The group noted that additional work is needed before publication, namely

- identify where differences are likely to result from spectroscopic differences or from fast model errors which are not linked to spectroscopy,
- present Jacobian error characteristics (for the selected subset of channels) using box and whisker plots (median, quartiles, minimum and maximum values of the Garand measure of fit).

The issue of the accuracy of Jacobians for weak absorption features should also be addressed or noted in the publication (this is probably not characterized with the current intercomparison channel subset).

In poster B06 Vanessa Sherlock assessed how these RT model differences could impact on retrieval accuracy using a 1D-Var code. This study had been proposed as part of a second phase of the AIRS RT intercomparison during ITSC-XIII. A journal publication is planned.

Action RTSP-18

All AIRS RT modellers should facilitate the publication of the intercomparison results without delay.

Recommendation RTSP-3 to RT modellers

The RTSP-WG recommends that future RT model validation studies be undertaken when collocated A-train sensor data sets become available.

2.1.7 Surface property models

Ben Ruston proposed the formation of a task group representing more specifically the Land Surface Property (LSP) activities of RTSP-WG to co-ordinate research efforts in land surface emissivity modelling.

The RTSP-WG supported this initiative, and in subsequent discussions it was agreed the task group would address surface property modelling for all surface types. The group will focus on co-ordinating research efforts in land surface emissivity atlas and model development in the first instance.

The RTSP-WG noted the SP task group needs to co-ordinate with the ITWG Satellite Sounder Science and Products Working Group (Lydie Lavanant) to provide a summary of existing atlases and surface type classification.

Action RTSP-19

A surface property task group of the RTSP-WG to be set up and co-ordinated by Ben Ruston.

Post Meeting note: Catherine Prigent and Fuzhong Weng have accepted to Co-Chair the SP task group and Ben Ruston and Sid Boukabara will report to RTSP-WG on the SP task group activities.

The SP task group met at ITSC-XIV. At that meeting several working points on land surface emissivity were identified. The SP task group will:

- Document the land emissivity implementation techniques and their impacts on forecasts from different NWP centers.
- Inter-compare retrieval methodologies.
- Standardize the spatial and temporal averaging methodology leading to infrared and microwave emissivity atlases.
- Review the output fields available from land surface modeling systems, and target those fields useful or necessary for forward modeling of emissivity.
- Recommend an aggregation strategy for global soil and vegetation databases for the use of emissivity modeling, and gathering of emissivity statistics.

The RTSP-WG group meeting discussed the current issues and limitations in emissivity modelling. A summary of this discussion follows:

2.1.7.1 Microwave emissivity

Ocean surface

The group agreed efforts should focus on model-model and model-observation discrepancy at low frequencies (below 20 GHz) and polarimetic capability.

Land/sea ice surfaces

The group recommended the SP task group should explore how to specify spectral emissivity at all observed microwave frequencies in absence of adequate emissivity data (extrapolation, modeling, retrieval, climatology).

2.1.7.2 Infrared emissivity

Ocean surface

The group noted modellers need to account for the temperature dependence of the infrared sea surface emissivity, particularly at temperatures less than 10 degrees C. The current consensus is that the effect of ocean salinity is small and is not worth including in the modeling.

Land surface

The RTSP-WG recommends the use of the CERES land classification (including water fraction) and requests the SP task group identify and recommend other relevant databases.

Recommendation RTSP-4 to RT modellers

The RTSP-WG recommends standardization of emissivity model interfaces, e.g. within CRTM framework.

Recommendation RTSP-5 to RT modellers

The RTSP-WG recommends studies into the relationship between retrieved IR and MW skin temperatures (and retrieved/modelled emissivities).

Guy Rochard argued for the need for clear scientific justification for radio frequency protection and requested the RTSP-WG work to identify ITSC-endorsed microwave surface emissivity data and atlases.

The RTSP-WG noted the SP task group should consider this request.

2.1.8 Radiative transfer modeling for cloudy scenes

The group noted significant advances in radiative transfer modelling in the presence of cloud over the past two years.

George Ohring presented the findings of a workshop on the assimilation of satellite cloud and precipitation observations in NWP models at the ITSC-XIV conference. A report on this workshop is available.

Action RTSP-20

> **F. Weng and R. Bennartz to summarize recent progress on modeling of radiation in cloudy/precipitating atmospheres (including discussion of the effects of FOV and 3D cloud structure).**

Claudia Stubenrauch presented the results of CIRAMOSA, a European Union study to assess the accuracy of different parameterizations of ice crystal single scattering properties for radiative transfer in cirrus clouds (see poster A05, Eddounia et al.). The CIRAMOSA final report will be available online: http://ww.lmd.polytechnique.fr/CIRAMOSA/Welcome.html, under the results link.

2.1.9 Review of group Web page

In light of the formation of the new Surface Property task group, the RTSP-WG Co-Chairs will review and revise the structure of the RTSP-WG Web site if necessary. The Co-Chairs will update the content of the Web pages to include the new information provided during ITSC-XIV and identified in this report. The RTSP-WG members are invited to propose additions and improvements at any time.

Action RTSP-21

> **RTSP-WG Co-Chairs to review and update RTSP-WG Web pages by 15 December 2005.**

2.2 TOVS/ATOVS DATA IN CLIMATE

Working Group members: J. Bates (Co-Chair), C. Stubenrauch (Co-Chair), S. Ackerman, M. Goldberg, B. Lapeta, M. McCarthy, C. Pierangelo, A. Reale, P. Schlüssel, J. Schulz, C. Shi, L. Shi, B. J. Sohn, P. Thorne, H. Zhang

2.2.1 Introduction

The length of the TOVS/ATOVS data record now exceeds 25 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. Although the World Meteorological Organization (WMO) has officially defined the period of climate normals only for the parameters of surface temperature and precipitation (the 30-year average of such fields), there remains no community definition of CDRs derived from satellite data. Recently, a report from the U.S. National Academies has defined several forms of climate data records, with a specific focus on their use of satellite data.

From the National Academies report, we adopt the following definitions of Climate Data Records (CDRs):

- 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.

In the following sections, we summarize other recent developments in the use of satellite sounding data in CDRs, discuss several continuing challenges, and look forward to the expanded number of products that will become available as hyperspectral infrared sounding moves from research with the AIRS instrument to operations with the IASI and CrIS instruments.

2.2.2 Assessing the maturity of CDRs

As the data records from satellites have become longer and the science of applying these data to climate problems has evolved, best practices for compiling CDRs have emerged. The objectives in compiling these best practices into an assessment model has arisen in order to: 1) reduce difficulty and confusion in the community about what attributes are important in climate data records, 2) produce an easily understood way of identifying maturity of data products and science data stewardship approaches, and 3) help identify areas needing improvement.

In an effort to capture these best practices and assess the maturity of various CDRs, three dimensions for assessing the maturity of a CDR have initially been proposed; scientific maturity, preservation maturity, and societal benefits.

The particular maturity level is assessed by defining the set of key process areas and the level of best practices that characterize each area. The result is a score ranging from 1 (very low) to 5 (very high) that can be used to provide a rating of the total maturity of a specific climate data record.

Action Climate-1

John Bates to provide the ITWG Climate WG with further details of the Climate Data

Record (CDR) measurement maturity index and include their feedback in the further development of the index.

2.2.3 Recent advances in climate data sets

Temperature record MSU-AMSU

There remains controversy over long-term trends in MSU/AMSU climate data records. Structural uncertainty arising through homogenization choices (particularly the intercalibration of overlapping satellites) continues to lead to long-term trend estimates that differ by a similar magnitude to the tropospheric climate signal. New attempts by Fu and colleagues to remove the stratospheric influence do not remove this discrepancy, nor do they fundamentally alter our understanding.

The availability of a range of independently derived datasets has led to a more thorough understanding of the dataset homogenization process. As a result of independent efforts several methodological artefacts have been identified. These help to clarify what the true signal is and lead to better physical consistency between channels. Very recently Remote Sensing Systems produced a 2LT (MSU channel 2 lower troposphere) product and identified a fundamental flaw in the University of Alabama in Huntsville's (UAH) diurnal correction technique for this retrieval that led to a strong spurious cooling in the tropics in their product. Resolving this issue has led to greater vertical consistency within the UAH product.

Water Vapor (HIRS, AMSU, SSMI)

Water vapor profiles
TOVS Path-B provides atmospheric profiles of temperature (9 layers up to 10hPa) and water vapor (5 layers up to 100hPa) for the time period 1987-1995. Water vapor has been evaluated in comparison with radiosonde measurements, SSMI and Meteosat observations. An extension of this dataset, using an improved retrieval is in progress.

NOAA's TOVS Radiance Pathfinder also continues to work on an intercalibrated radiance data set (a TOVS FCDR) as well as a neural network approach to retrieve temperature and water vapor profiles. In this method, the impact of CO2 increases on the different HIRS channels is being taken into account. Further work, however, is required on the intersatellite calibration.

Integrated water vapor content
SSM/I data have been utilized to derive long temporal records of integrated water vapor in several institutions in Europe, Japan, and the US. Examples of those data sets are the Hamburg Ocean and Atmosphere Parameters and Fluxes from Satellite Data (HOAPS, www.hoaps.org), the J-OFURO (Japanese Ocean Flux data sets with Use of Remote sensing Observations, http://dtsv.scc.u-tokai.ac.jp/j-ofuro), or the products provided by Remote Sensing Systems (www.remss.com). Most of them provide the series back to the year 1987 and are keeping processing actual SSM/I data and will continue the series by using SSMIS and later CMIS. Also products from the AMSR- instrument E (~3 years) on the AQUA and TMI (~7 years) on the TRMM satellites are available from Remote Sensing Systems.

One of the major problems encountered during processing SSM/I data was the need for an intercalibration of the different platforms that was solved by using overlapping periods of the DMSP platforms. The algorithms used to derive integrated water vapor from microwave radiometer measurements were comprehensively validated by radiosondes and differences between them are also analysed in the literature. Differences between the derived time series are likely to exist because different techniques for intercalibration of the DMSP platforms have been used, e.g. by choosing different reference satellites.

Ozone (SBUV/HIRS)

NOAA has developed a new total ozone product by combining high resolution infrared radiation sounder (HIRS) upper troposphere and lower stratosphere ozone retrievals with solar backscatter ultraviolet model (SBUV/2) middle to upper tropospheric ozone retrievals. This algorithm uses the best available information from each instrument to create a total ozone product (TOAST). This product from NOAA 16 has been running experimentally since 2002 and is available in near real-time to users. The TOAST product has improved accuracy over HIRS alone and is extremely useful in monitoring total ozone changes in the polar night area where the SBUV/2 instrument does not provide coverage.

Carbon dioxide and dust/aerosol

Carbon dioxide retrieved from HIRS (NOAA10) has been analyzed in terms of biomass burning emissions in the tropics. The monthly difference between the amount of carbon dioxide at 7.30 pm and 7.30 am shows strong signature over Africa and South America during the fire season. Analysis of NOAA12 data is in progress.

A new climate data set has been built with HIRS data (NOAA 10 and 12). It consists in monthly maps of optical depth and altitude of mineral dust aerosol (from 40°S to 40°N). The retrieval is possible both over land (including deserts) and sea, which is a great advantage for monitoring dust sources.

Preliminary work is also occurring at several centers on the direct retrieval of several greenhouse gases from hyperspectral infrared data from the AIRS instrument. This work appears very encouraging but further validation and refinement is needed of these techniques.

Clouds

TOVS Path-B cloud height has been evaluated using collocated LITE data, corresponding in general well to the height of the 'apparent middle' of the cloud system. High-level clouds appear more often in multi-layer systems (about 75%) and are also vertically more extended than low-level clouds. As part of the European CIRAMOSA (final report available), LMD has produced mean effective ice crystal diameters D_e and ice water path IWP of large-scale semi-transparent cirrus for NOAA-10 observations, with global averages (from 60°N to 60°S) of 55 μm and 30 gm^{-2}, respectively. The HIRS instruments of later observation periods do not provide the necessary 8 μm radiances anymore. Even if uncertainties can be up to 25%, this data set revealed in synergy with ERA-40 re-analyses correlations with air humidity and dynamical situations. Other fruitful synergies have been with ScaRaB flux data to determine the best suited D_e parameterization for radiation in climate models and combined use of upper tropospheric relative humidity obtained from TOVS Path-B and effective high cloud amount to study the impact of air traffic on cirrus coverage.

The UW-HIRS cloud data set provides cloud properties from the period December 1978 - December 2001. In this time period, HIRS globally averaged frequency of cloud detection (excluding the poles where cloud detection is less certain) has stayed relatively constant at 75%. High clouds in the upper troposphere (above 6 km) are found in roughly one third of the HIRS measurements; a small increasing trend of ~ 2% per decade is evident. High cloud cover increases of ~10% are found in the western Pacific, Indonesia, and over Northern Australia. The most significant feature of these data may be that the globally averaged cloud cover has shown little change in spite of dramatic volcanic and El Nino events. During the four El Nino events winter clouds moved from the western Pacific to the Central Pacific Ocean, but their global average in the tropics did not change. El Chichon and Pinatubo spewed volcanic ash into the stratosphere that took 1-2 years to fall out, but cloud cover was not affected significantly. The HIRS analysis differs from ISCCP which shows decreasing trends in both total cloud cover and high clouds during most of this period; HIRS detection of upper tropospheric thin cirrus accounts for most of the difference. GLAS observations of high thin clouds are found to be largely in agreement with the HIRS.

The two cloud climate data sets presented at ITSC-XIV (the 22-year record of UW HIRS and the 8-year record of TOVS Path-B) participate in the GEWEX Radiation Panel global cloud data set assessment. A first meeting was held in Madison, Wisconsin, US, in April 2005. The next is foreseen for April 2006 in Boulder, Colorado, US. They concluded that within the physical uncertainty of the different data sets, no trends on the large scale cloud amount were found. It was further noted that special care must be taken when using the data sets because statistically significant trends are evident in some of the data sets, but those changes are within the uncertainty of the analysis schemes. Some consistency between different data sets on the global scale variations at ±1% were shown leading to the belief that improvements in understanding the uncertainties in the algorithms and their improvement will lead to substantially more accurate estimates of the variations in the next few years. Detailed comparisons between different data sets are now planned to better understand the detectability of small amplitude variations.

Surface properties from infrared and microwave sounders

The retrieval of infrared emissivities at three wavelengths from HIRS has now been applied to the global scale, for NOAA 10 and 12. Emissivities are retrieved simultaneously with surface temperature, with a neural network approach. These emissivities are used to constrain the retrieval of dust properties over land.

Several groups have compiled climatologies and improved models for the microwave surface emissivity. The retrieval of microwave surface emissivity over the oceans is relatively well-understood and well-captured by present radiative transfer models. Over land, the situation is much more complex owing to the highly heterogeneous nature of the surface and strong diurnal cycle of land skin temperature.

Recommendation Climate-1 to agencies/investigators producing climate data records

> **It is vital to produce multiple independent climate data records for a given atmospheric parameter or satellite instrument to thoroughly understand the effects of methodological choices and better discern the true climate signal. The ITWG endorses the development of criteria to assess the level of capability and maturity of climate data records by defining a set of 'best practices' that would include criteria such as the multiple independent production of CDRs by different groups and their intercomparison.**

Recommendation Climate-2 to agencies/investigators producing climate data records

> **Many CDRs are produced within universities or other science institutions. To provide a continuous treatment and data access of those data sets meeting GCOS climate monitoring requirements, the ITWG climate group recommends continuation of such research efforts as well as the transition of mature products into operational climate activities.**

Recommendation Climate-3 to agencies/investigators producing climate data records

> **ITWG endorses activities that lead to a comprehensive analysis of the existing temporal records either by intercomparison in the framework of the GEWEX Radiation Panel (or its successor, the WCRP Observations and Analysis Program) or their use in applications at operational climate centers.**

Action Climate-2

> **ITWG Co-Chairs to report Recommendations Climate-1-Climate-3 to GEWEX radiation panel and any responses to these Recommendations to the ITWG Climate WG.**

2.2.4 Calibration issues

Optimal calibration of individual instruments

Although there are some existing efforts to provide for the intercalibration of GEO and LEO satellites in real-time, there is no co-ordination between these intercalibrations and those made by the climate community looking at longer time series. Calibration and intercalibration of satellite instruments occur in a number of ways and for both raw radiances and retrieved products. All satellites are subjected to some level of pre-launch calibration and instrument characterization, but information about these characterizations is often difficult to find. Once in orbit, raw radiances can be compared between instruments that either overlap or underfly one another as well as through comparison to simulated radiances produced as part of the monitoring programs at major numerical weather prediction centers. Similarly, retrieved products such as temperature and moisture products, ozone, aerosols, and radiation can each be compared with in situ observations of such geophysical variables. These comparisons are done in an ad hoc manner by each agency or center and there is no comprehensive clearing house to coordinate how these comparisons are done or to document the methodology. There are many good efforts, but the entire community needs to benefit from these efforts.

Intercalibration practices

Numerous intercalibration practices have been developed for the generation of homogeneous FCDRs and TCDRs. These include techniques for intercalibrating during the overlap of similar instruments, for accounting for the diurnal drift of the early NOAA satellites, and for the use of long-term quality radiosonde data for a transfer standard.

For the time period of 1987-1995 NOAA provided a collocated radiosonde - TOVS data set (the DSD-5 data set). To extend the TOVS Path-B climate data set back and forward in time, LMD has created bias adjustment constants from collocated radiosonde - TOVS observations which have been identified as clear sky. The collection of radiosonde measurements has been provided by ECMWF and was further processed and subject to additional quality control by LMD.

NOAA has developed a unique, new technique for the intercalibration of polar orbiting satellites by taking advantage of the crossings of the spacecraft in the polar regions. This technique, known as the simultaneous nadir overpass method (see poster A33), holds great promise for an improved intercalibration of satellites, including all polar orbiters. These data are just being evaluated by the community and further work is needed to assess their quality.

Recommendation Climate-4 to WMO Coordinator for satellite observations

> **Numerous efforts have been made to intercalibrate satellites with each other and against in situ data. Better coordination between relevant agencies and long-term archive and access is required to the various calibration and intercalibration efforts.**

Action Climate-3

> **ITWG Co-Chairs to report Recommendation Climate-4 to WMO and response of WMO to this recommendation.**

2.2.5 Reference network

For the purposes of climate monitoring, it is of vital importance to provide strong constraints on the characterization of time-varying biases. This requires the implementation of a ground-based climate reference network. A key component of such a network is the full characterization of all geophysical parameters of interest both for current and future satellite missions. Critical to the success of this is the requirement for measurement redundancy at such sites - each parameter must be measured by two or more independent instruments and these must be changed so as to provide a continuity of measurements. This requires much more than simply launching a radiosonde to coincide with satellite overpass. Rather the vision is for a suite of ground-based in-situ and upward looking instrumentation (lidar, radar, GPS, microwave scanner etc.). In fact, radiosondes can be launched at irregular overpass coincident times rather than at each overpass.

It is important that efforts are undertaken to prove the concept and learn from previous experiences at, for example, ARM CART sites to optimize network design. It is also vital that the network be accompanied by open access to full data and metadata. Efforts to plan such a network are underway by GCOS and NOAA.

Recommendation Climate-5 to GCOS/NOAA climate observation requirements WG

> **ITWG strongly supports the vision of a reference network that consists of multiple instruments to fully characterize the atmospheric column, providing a continuous rigorous ground truth, which would have benefits not just to the climate community. GCOS/NOAA are encouraged to continue to strongly pursue this vision and coordinate with other relevant bodies.**

Action Climate-4

> **Peter Thorne to advertise reports and progress from the GCOS/NOAA workshop series to the ITWG list to permit feedback from the ITWG community to ensure that the needs of the satellite community are incorporated.**

2.2.6 Status of re-analysis efforts

Since the last ITSC meeting there has been considerable use of the ERA-40 reanalyses system within the climate community. The Japanese have also recently completed a 25 year reanalysis effort over the TOVS/ATOVS era. Within the US there are plans for a set of three reanalyses covering 1860 to present (surface only data), 1958 to present (surface and raobs only) and the TOVS era to present (everything). However, these are unlikely to proceed in the near future. In the meantime, the NCEP frozen reanalysis system continues to be updated in near real-time. Both the Japanese and ECMWF plan further reanalyses and ECMWF plan an interim reanalysis that updates in real-time.

There remain obvious trend discontinuities within both ERA-40 and NCEP reanalyses that mitigate against their use for long-term trend analysis, particularly in the free atmosphere. This relates to the changing use of data over time which leads to changes in characteristics.

Recommendation Climate-6 to reanalysis centers

> **Reanalyses efforts would greatly benefit from undertaking observing system experiments to understand what input data, particularly the start of different observing systems such as TOVS/ATOVS and hyperspectral sounders, affect the analysis system. This will help future reanalyses mitigate these changes in the observing system and better capture long-term behavior free of biases.**

Action Climate-5

> **ITWG Co-Chairs to report Recommendation Climate-6 to appropriate reanalysis centers and any responses to recommendation to the ITWG Climate WG.**

2.2.7 Agency plans for satellite-based climate data records

A common need exists for the long-term preservation of both data and metadata for future generations to be able to exploit the full potential of the space-based observing era. This includes the acquisition, archival, and easy access to both the raw data, products, processing software, and rich metadata. Rich metadata should be captured and preserved in accordance with national and international standards and include characteristics in the following areas:

- Reference -provides catalog-type data that allows basic search and discovery
- Context - where the data were created and how they related to other similar data
- Provenance -history of processing, any changes to the data, who has had custody of the data
- Integrity -security, vulnerability, etc.

The longer time series provided by the operational satellite data coupled with the continuing importance of climate and global change on societies is leading to the creation of operational programs in the use of these data. Current plans are briefly summarized below.

NOAA plans

The goal of NOAA's Scientific Data Stewardship Program is to provide high quality Climate Data Records of the atmosphere, oceans and land surface. Satellites provide the only technology for achieving truly global coverage. These CDRs will focus on the following societal impact areas:

- Applied Climatology - provide a variety of decision makers with place-based information of known high quality for use in industry, water resources, the energy sector, agriculture, fisheries and other sectors of the economy.
- Climate Monitoring - provide decision makers with reliable information on the state of the Earth's climate.
- Climate Change Predictions - enable researchers to achieve an improved understanding of climate variability and change by providing global observations of forcing and response variables.

NASA plans

NASA has contributed greatly to the efforts on producing CDRs from the Mission to Planet Earth (MTPE), particularly through the large missions of TERRA, AQUA, and AURA. Particularly noteworthy are the efforts for reprocessing of the MODIS data sets and the joint effort by NASA and NOAA to provide AIRS sub-sampled data sets to the operational NWP community in near-real time. These efforts have resulted in rapid use of these research data sets in operations.

NASA and NOAA are now engaged in the transition of these results through the NPOESS Preparatory Project (NPP) to the next generation of operational satellites, the NPOESS series. To accomplish this, NASA has established a NPP Science Data Segment (SDS) and a set of climate analysis research systems (CARS). The science data segment will have no operational responsibilities and will be responsible for assessing the quality of NPP environmental data records (EDRs; the equivalent of level 2 retrieved products) for accomplishing climate research. Five thematic CARS efforts will be supported in the areas of ocean color, land, atmosphere, ozone, and soundings.

EUMETSAT plans

Data Provision

Data from the EUMETSAT Polar System (EPS/METOP) will be available from 2006 onwards. Besides the distribution to near-real time (NRT) users, data products, auxiliary information and meta-data will be archived in the Unified Meteorological Archiving and Retrieval Facility (UMARF). Products generated and archived include AMSU-A, MHS, HIRS, AVHRR level 0 (raw data) and level 1B (geolocated and calibrated radiances), ATOVS level 2 (geophysical products), IASI level 0 and level 1C (geolocated, calibrated and apodised radiances as well as AVHRR radiance analysis inside IASI IFOVs). NRT data will be disseminated via the EUMETCast system to European users, and by NOAA to users in the U.S. A sub-sample of ATOVS, AVHRR, and IASI level 1 and level 2 data will be distributed by the Global Telecommunications System (GTS).

Satellite Applications Facility on Climate Monitoring (CM-SAF)
The Satellite Application Facility on Climate Monitoring (CM-SAF) is dedicated to high-quality long-term monitoring of the climate system and its variability. Currently the CM-SAF is in its Initial Operation Phase (IOP) that aims to set up operational processing of climate data sets mostly for the Meteosat, NOAA, and METOP satellite series. At present the CM-SAF provides macro- and microphysical cloud parameters as well as radiation budgets at the top of the atmosphere and surface over the European region starting from October 2004. A water vapor product (integrated water vapor over five thick layers and total plus relative humidity) will be added during 2005. Details can be found at www.cmsaf.dwd.de.

The Continuous Development and Operation Phase (CDOP) is planned to start in 2007 and will see some substantial upgrades in the products. It is planned to provide water vapor and some of the cloud products globally. For water vapor there will be single sensor estimates from IASI, ATOVS including MHS, and SSM/I (SSMIS). It is also planned to incorporate the existing SSM/I water vapor climatology HOAPS (www.hoaps.org) into the CM-SAF processing to provide a 24-year time series (1987-2011) of total integrated water vapor by the end of the CDOP in 2012.

Additionally, the GRAS-SAF will derive a time series from the occultation measurements of the GRAS instrument that will be shared by the CM-SAF.

CM-SAF is archiving data from level 1 to level 3 including metadata. Presently, locally received AVHRR data, SEVIRI full disk data received via EUMETCast, and global ATOVS level 1c data are archived. This will be extended to global data sets for AMSU-A, MHS, HIRS, AVHRR, and IASI from the METOP and NOAA-N platform in 2006. Level 1 (geolocated and calibrated radiances) and level 2 (geophysical products at satellite resolution) data that are permanently archived within the UMARF at EUMETSAT are held in a rotating archive at CM-SAF for about two years including metadata on software versions used for the retrieval of level 2 data. Level 2 data are not publicly accessible via the internet but are offered offline. User products (level 3 products on grids and integrated over time) and its metadata are permanently archived at DWD and accessible via the internet free of charge. The access is possible via the CM-SAF Web user interface or the UMARF where a metadata catalogue of CM-SAF data and an order handler will be available at the end of the IOP.

Recommendation Climate-7 to space agencies

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

Recommendation Climate-8 to satellite archive centers

> **Satellite archive centers must ensure the collection, retention, and accessibility of complete and rich metadata. The rich metadata inventory should include compatibility with international standards for metadata and include reference, context, provenance, and integrity information.**

Recommendation Climate-9 to reanalysis groups

> **Reanalysis groups should seek to work with the new operational satellite climate centers on the optimal calibration and processing of archival data sets.**

2.2.8 Use of hyperspectral infrared sensors

The success of the AIRS hyperspectral infrared sensor and plans to fly hyperspectral infrared sensors on operational satellites by NOAA and EUMETSAT require us to consider how such data might optimally be used in climate studies in the future. We consider requirements below for both the use of the raw radiances (FCDRs) and geophysical retrievals from those data (TCDRs).

Fundamental CDR issues

As with all sounders, there is a need to provide for quality metadata for hyperspectral sounders including pre-launch calibration, in orbit calibration and validation, processing history, and other relevant information on the instrument performance. Although use of these data in numerical weather prediction often involves a reduction of the data volume in spectral space, we urge all satellite operators to keep the raw data record (level 0) data for climate reprocessing efforts to allow the maximum extraction of information from the data including the ability to update the calibration, navigation, and other processing.

The detailed spectral information in these observations provides for a direct observation of changes in greenhouse gases and their effects on the water vapor and temperature profiles from the surface into the stratosphere. Statistical properties of these spectra and their changes over time will be critical in future climate studies. One way to deal with the high data volume, and to allow wide use of the data, is to provide the data subsampled, or ‘thinned,’ in space. In order to allow for the long-term analysis of hyperspectral data, as well as comparison with filtered radiometer data for the past 25 years, the spectral regions covered by hyperspectral sounders should cover the widest possible range in the short, mid, and long wavelength portions of the infrared spectrum paying particular attention to maintaining coverage of the same spectral regions.

Thematic CDRs - new opportunities

Hyperspectral infrared sounders open the possibility for a suite of new and improved products to be retrieved. To ensure the optimal extraction of retrieved information, researchers require that the full spectral fidelity be retained in the raw data to ensure this can be accomplished. Based upon experience being gathered from research using the AIRS instrument, we encourage climate researchers to exploit opportunities in the following thematic areas:

- Increased vertical resolution for T and q
- Greenhouse gases
- IR surface emissivity
- Aerosols, dust, and cloud microphysical properties

Recommendation Climate-10 to space agencies

Space Agencies should archive and make easily accessible radiances of all spectral channels available including geographically subsampled data sets.

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

Working Group members: S. English (Co-Chair) and J. LeMarshall (Co-Chair), B. Amstrup, D. Anselmo, T. Auligné, N. Baker, N. Bormann, B. Candy, P. Dahlgren, J. George, B. Harris, G. Kelly, C. Köpken, Z. Liu, T. Montmerle, K. Okamoto, R. Randriamampianina, J. San-Woo, R. Souza, M. Szyndel, V. Thyness, C. Tingwell, H. Wei, Y. Zhigang, (part time members: A. Collard, M. Goldberg, R. Hess, T. Kleespies, V. Tabor, F. Weng)

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 1b sounder and imager radiances has continued with most 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 data continues to have the largest impact but one centre showed how using a wide diversity of satellite data increased robustness to the loss of any one.

AIRS is now assimilated at three NWP centres and others have plans to exploit AIRS. Most centres have shown a small positive impact arising from a very conservative use of the data. However larger impacts have also been found when more of the data (spatially) has been processed allowing more cloud-free data to be assimilated. As a result new thinned AIRS datasets have been made available by NOAA which should contain more cloud-free data. These are the AIRS warmest FOV dataset in which thinned observations have been selected as the warmest fov in the window region and the AIRS MODIS dataset where the least cloudy FOV has been identified using MODIS cloud flags. A number of presentations were given on fuller use of spectral information (reconstructed radiances, principal components, super-obs). However, the importance of correctly allowing for correlated observation error in so-called reconstructed radiances was also presented.

Initial radiative transfer experiments including the effects of clouds indicate 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 a solution should not be expected in the next 5 years.

AMSU-B is assimilated at a majority of NWP Centres and with reports of various levels of positive impacts particularly on the moisture fields and precipitation. This widespread use of the AMSU-B and AIRS data is representative of the general increase in the use of satellite radiance data among the various Centres. Initial work has also begun at a few centres on assimilating the first microwave sounder to use a conical scan geometry and a high noise but oversampling philosophy (SSMIS).

The use of satellite radiances in Limited Area Models continues to progress and there was a significant rise in the number of groups reporting positive impact from ATOVS in regional models. The impact of satellite data in regional/mesoscale (and often for global) data assimilation systems continues to be limited by many factors such as: incomplete use of data over land sea/ice; lateral boundary influences; low model top; background error not adequate for regional/meso scales; inadequacies in the data (e.g. clouds and vertical resolution). The WG recognizes that while significant progress in the use of satellite data in limited area data assimilation has occurred, it is still in the early stages and significant development is still necessary. Note that since the development and use of limited area models is often driven by the expected improvements in QPF and other smaller scale variables, the development of appropriate verification techniques for these models and forecast variables is necessary.

2.3.2 Evaluation and use of TOVS/ATOVS in DA/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 (both level 1b and level 1d) 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 WG 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. Three more centres have provided monitoring on their Web sites since ITSC-XIII.

The WG 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 WG would like to see support to AIRS as a standard for other missions now and in the future to aspire towards.

Action DA/NWP-1

> **Mitch Goldberg to enquire (through NESDIS) if the same level of detailed real time information which has been provided for AIRS can be replicated for other instruments and similarly the response to user enquiries.**

The WG felt that we do not always know the instrument scientist for each instrument (AIRS, HIRS, AMSU-A, AMSU-B, SSM/I, SSMIS) and requested NESDIS to provide this information.

Action DA/NWP-2

> **Mitch Goldberg to provide to the ITWG NWP WG a list identifying the most appropriate contact for instrument problems for each instrument.**

The WG is not sufficiently aware of existing information on the status of each channel on each instrument and that this information should be linked from the ITWG Web page. Furthermore it would be useful to see what channels the NWP centres considered to not be useable (this can be a larger list than one which is simply instrument problems, e.g. inadequate radiative transfer). The WG members agreed to provide information to a new ITWG Web page and to try to provide updates whenever their usage changed.

Action DA/NWP-3

> **John Le Marshall with ITWG input to facilitate the establishment of a Web page for instrument status (channel by channel being used where appropriate) and ensure this is linked to the ITWG Web page.**
> (Post meeting note: an existing page at http://www.oso.noaa.gov/poesstatus/ exists.)

Action DA/NWP-4

> **John LeMarshall to ask NWP WG members to provide information to him on their current channel usage for each instrument (used now, used in the past, never used) for input to a summary table which he will put on the ITWG Web page.**

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.

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

Institute	Retrievals in Global NWP	Retrievals in Regional NWP	Radiances in Global NWP	Radiances in Regional NWP	external WWW DATA MON
Australia	NESDIS		YES-PP (1DVAR)	YES-PP (1DVAR)	YES
Brazil	NESDIS	ICI			NO
Canada			YES-1C (4DVAR)	YES-1C (3DVAR)	YES
Denmark				Yes-1C (3DVAR)	YES
ECMWF			YES-1C (4DVAR)		YES
France			YES-1C (4DVAR)	YES-1C (3DVAR)	YES
Germany	NESDIS				YES
Hungary				YES-1C (3DVAR)	NO
India - IMD		ICI			NO
India - NCMRWF	NESDIS				NO
Japan		NESDIS/JMA	YES-1C (4DVAR)		NO
Korea			YES-PP (3DVAR)		NO
Spain				YES-1C (3DVAR)	NO
Sweden				YES-1C (3DVAR)	NO
UK			YES-1C (3DVAR)	YES-1C (3DVAR)	YES
USA (NCEP)			YES-1C (3D SSI)	YES-1C (3D SSI)	YES
USA (NRL)		NESDIS	YES-1C (3DVAR)		NO

Table 2.3-1. Use of satellite data in operational NWP (ITWG survey of systems at 01 / 05 / 2005).

Notes
1) It shows that the NWP community still has operational requirements for all levels of NOAA/NESDIS ATOVS data processing from level-1b radiances to preprocessed radiances (PP), through to retrieved products. However there has been a major move towards direct radiance assimilation (and to 4DVAR).

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

3) Many more centres have monitoring information on external Web services (though some are password protected). These are excellent and their use is strongly encouraged.

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).

Action DA/NWP-5
DA/NWP Co-Chairs and Tony McNally to provide information from ITWG NWP survey on ITWG Web page.

There continues to be questions raised at this meeting concerning the conversion of antenna temperatures to brightness temperatures for microwave instruments. The WG is concerned that biases are being introduced by the antenna correction and that users may start to use antenna temperature as if they were brightness temperatures. The WG would welcome further studies in this area.

2.3.3 Evaluation and use of AIRS in NWP

The WG agreed NESDIS should be congratulated for 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 WG 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. 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-6
Stephen English (Met Office) and Andrew Collard (ECMWF) to coordinate with NOAA the change to warmest fov over the US-Exeter link.

Recommendation DA/NWP-1 to ECMWF/Met Office
ECMWF/Met Office to evaluate AIRS "MODIS" product when it becomes available.

Action DA/NWP-7
Thomas Auligné and Stephen English to present recommendation DA/NWP-1 to ECMWF and Met Office for consideration.

Action DA/NWP-8
John LeMarshall to ask JCSDA to review AIRS 324 channel data set in light of full spectral resolution experiments and recommend any promising additions.

Recommendation DA/NWP-2 to NOAA
Add more MODIS cloud information on AIRS FOVS using existing AIRS BUFR tables rather than additional parameters.

Action DA/NWP-9

John LeMarshall to present recommendation DA/NWP-2 to NOAA, providing full details of what is required in consultation with the WG members.

2.3.4 Forward modelling

The WG welcomed the concept of CRTM where several radiative transfer model options have a common interface. The WG also noted that RTIASI and RTTOV-8 will merge with a common interface in RTTOV-9. The WG encourages developers of RTMs to continue to work towards use of common interfaces wherever possible.

Recommendation DA/NWP-3 to all RT model developers

Where possible use an existing interface (e.g. CRTM, RTTOV) for new models.

Action DA/NWP-10

Stephen English to ask Roger Saunders to communicate recommendation DA/NWP-3 to the wider RT development community.

Recommendation DA/NWP-4 to JCSDA (Paul van Delst) and NWP-SAF (Roger Saunders)

To work towards the same interface for CRTM and RTTOV.

Action DA/NWP-11

Stephen English to present recommendation DA/NWP-4 to the NWP SAF SG.

Action DA/NWP-12

John LeMarshall to present recommendation DA/NWP-4 to the JCSDA SG.

Recommendation DA/NWP-5 to NWP SAF (Stephen English)

To provide information to RTTOV users on sources of emissivity information and emissivity models.

Action DA/NWP-13

Stephen English to discuss with NWP SAF SG whether recommendation DA/NWP-5 can be undertaken by the NWP SAF.

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 WG recognizes that the inclusion of NWP early on in the preparation for provision of AIRS data was a positive step, and encourages future satellite programs to have similar programs.

It has been an ongoing concern of the ITWG NWP 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 systems 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 delivery time for the NPOESS satellites (20-30min) and the creation of the EUMETSAT EARS system should both allow a significant improvement in the availability of data. The creation of the EARS system has been particularly innovative in providing a low cost system to significantly improve delivery times for the data.

Recommendation DA/NWP-6 to CGMS

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

Action DA/NWP-14

Stephen English to communicate recommendation DA/NWP-6 to EUMETSAT and to ask John Eyre to bring it to the attention of WMO and CGMS.

Recommendation DA/NWP-7 to NOAA

To use new global ground stations to mitigate blind orbit problems for NPOESS data.

Action DA/NWP-15

John LeMarshall to present recommendation DA/NWP-7 to NOAA.

The use of research satellites in operational NWP centres has been increasing. The WG 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, there continues to be development of satellite programs with no or limited 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-8 to all satellite agencies

The assimilation community (all major NWP centres) to be part of the 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-16

John LeMarshall and Stephen English to ask ITWG Co-Chairs to ensure recommendation DA/NWP-8 is conveyed to all satellite agencies via appropriate international bodies (e.g. CGMS).

Recommendation DA/NWP-9 to all satellite agencies

While current operational practice and very considerable benefits are based mainly on the use of microwave data and the longwave and midwave IR components of the hyperspectral frequency range, the potential exists for continued gains to be made through additional application of the shortwave IR component of the spectrum. It is recommended that research addressing the problems of solar contamination and surface emissivity be given enhanced emphasis.

Action DA/NWP-17

Stephen English to ask the IASI Sounding Science WG Co-Chairs to note recommendation DA/NWP-9.

The WG welcomed the continuation of the "TOVS" heritage through future missions on METOP, FY-3, NPP and NPOESS. The WG reaffirmed the statement from past meetings that the positive impact of this data on NWP will be largest if satellite agencies choose complimentary overpass times which optimise the data coverage.

The WG is concerned that the instrument specification for ATMS channel noise exceeds current AMSU performance and that the choice of polarisations 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 DA/NWP-18

Nancy Baker to get detailed instrument actual performance figures for ATMS and to then study the relative performance of AMSU-A and ATMS through experiments in the NRL NWP system. Note: JCSDA also plans an OSSE using ATMS this year.

Action DA/NWP-19

Tom Kleespies to repeat Kleespies & Watts MHS study for ATMS compared to AMSU-A.

The WG also noted that the absence of a 6.7 µm channel on VIIRS will prevent a continuation of the MODIS polar atmospheric motion vector product which has been proven to give very positive impact at several centres.

Recommendation DA/NWP-10 to IPO

To add a 6.7 micron water vapour channel to VIIRS.

Action DA/NWP-20

John LeMarshall to present recommendation DA/NWP-10 to the IPO JARG.

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 WG needs more information on the policy for distribution of non-GTS products. A specific example is whether the USA can forward METOP non-GTS products to South American countries.

Action DA/NWP-21

John LeMarshall to establish and report to the WG the NPP and METOP non-GTS data distribution policy for countries outside Europe.

Several presentations at ITSC-XIV showed the preparations by satellite agencies and NWP centres for METOP data. The WG considered it important that NWP centres provide input into channel selection for the GTS IASI product and choice of channels etc. for Web based IASI monitoring so that IASI monitoring at different centres can be easily compared.

Action DA/NWP-22

Thomas Auligné to propose and then circulate a monitoring strategy for IASI to be adopted by all NWP centres, to allow easy comparison of monitoring between centres.

Action DA/NWP-23

Stephen English to ask NWP WG members to study the proposal by Andrew Collard for IASI GTS products and provide feedback to Andrew Collard by the end of July 2005 (other IASI GTS questions/comments should be fed to Simon Elliot at EUMETSAT).

During ITSC-XIV NOAA-N was launched. During the meeting it was clarified that NESDIS could provide both NOAA-16 and NOAA-18 in a timely fashion, except when NOAA-16 and NOAA-18 are in conflict when N16 would lose 2 contacts/day because NOAA-18 would be given priority. There are 21 days in conflict, then 23 days out of conflict, then repeat. The data are not lost, just delayed for an orbit.

Recommendation DA/NWP-11 to NWP Centres

NWP centres to provide feedback to NESDIS if NOAA-16 data reception is not acceptable during NOAA-18 commissioning.

Action DA/NWP-24

Stephen English to inform NWP centres of the expected situation for NOAA-16 to NOAA-18 transition and recommendation 14.11.

Recommendation DA/NWP-12 to EUMETSAT

EUMETSAT to provide NOAA-15, NOAA-16, NOAA-17, and NOAA-18 HRPT data as part of EARS where possible.

Action DA/NWP-25

Stephen English to inform EUMETSAT EARS team of recommendation DA/NWP-12.

2.3.6 Other data assimilation issues

The WG welcome the effort of the NWP SAF and ECMWF in particular in organising a bias correction workshop with an open invitation to NWP centres to send observers. This will be held in November 2005 and details can be found at the ECMWF Web site. The WG also said that the bias correction Web based guidance provided by the NWP SAF on its Web site is very helpful.

Action DA/NWP-26

Graeme Kelly to re-advertise details of ECMWF bias correction workshop to ITWG.

Action DA/NWP-27

Stephen English to re-advertise existence of NWP SAF Web based guidance on bias correction on NWP SAF Web page to ITWG and to pass on positive feedback about the Web page to the NWP SAF SG.

The WG noted that considerable progress has been made towards consistent calibration of HIRS in global and direct broadcast data. The effort of CMS Lannion and in particular Pascal Brunel was gratefully acknowledged. The WG requested that NESDIS and CMS confirm whether all possible assistance was being provided from NESDIS to direct broadcast users.

Action DA/NWP-28

Mitch Goldberg to check with CMS (Pascal Brunel) whether NESDIS can provide any information which would allow AAPP processing of HIRS to be even closer to global processing.

The WG noted that re-tuning of AIRS observation errors in combination with a number of other enhancements had a considerable impact e.g., in the NH at JCSDA but little impact at ECMWF. It was agreed we do not know enough about each others observation errors.

Action DA/NWP-29

Stephen English to ask NWP WG members to supply him with information on assumed observation errors for radiance assimilation in order to create a summary Web page for the ITWG NWP WG Web page. This can then be updated as and when necessary.

Action DA/NWP-30

Stephen English to ask NWP WG members to provide him with text (with Web links where appropriate) to describe current techniques used at their centre for estimating observation errors (e.g. Chapnik method).

The WG agreed that there were many ideas and tools but little sharing of information on verification.

Action DA/NWP-31

All WG members to submit information on verification methods (including software tools where available) to Brett Candy, who will create a Web page for the NWP WG Web site.

2.3.7 ITWG NWP WG administration issues

The WG expressed a strong desire to provide a useful Web page under ITWG and noted many items which could or should be provided on it, reflected in many of the actions in this report.

Action DA/NWP-32

Stephen English to get initial information for NWP WG Web page to Leanne Avila.

Action DA/NWP-33

NWP WG Co-Chairs to review the status of the actions and recommendations in September 2005 and at regular intervals before ITSC-XV and email a status report to WG members and ITWG Co-Chairs.

2.4 ADVANCED SOUNDERS

Working Group members: A. Huang (Co-Chair), W. Smith (Co-Chair), with H. Bloom, D. Blumstein, J. Cameron, Z. Cheng, D. Chu, A. Collard, D. Crain, C. Dong, I. Dyras, Z. Fengying, M. Goldberg, F. Hilton, T. King, D. Klaes, B. Lambrigtsen, A. Larar, P. Poli, Y. Qu, F. Rabier, A. Rea, V. Tabor, H. Wei, D. Zhou, L. Zhou, W. 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 where necessary. 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 Sounder field-of-view issue

Considerable discussion was held regarding the intended spatial resolution for the CrIS instrument. 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).

Recommendation AS-1 to space agencies

> **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 observations as well as decrease the field of view size. As a first step, a comparison of the yield of NOAA 18 HIRS clear air data versus NOAA 16 HIRS data should be conducted. If the results of these trade-off studies strongly support a change to the CrIS spatial sampling characteristics, a recommendation would be prepared to take to the Joint Agency Requirements Group.**

2.4.2 Measurement objectives for Advanced IR Sounders

In order to insure 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 the minimum radiometric measurement thresholds for advanced IR sounders to be carried on future polar and geostationary orbiting satellites.

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 vapor profiles for Numerical Weather Prediction (NWP) model initialization. The radiance spectra, or alternatively the retrieved profile data, to be assimilated need not be spatially contiguous for this application. Simultaneous microwave observations are generally available to assist in the interpretation of clouded 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 vapor dynamics, as needed to enable the nowcasting (i.e., short-term forecasting) of hazardous weather, and the production of water vapor 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 vapor motion winds used for NWP.

			Polar		Geostationary			
Channel cm^{-1}	**δν cm^{-1}**	**Purpose**	**P**	**δS[1] km**	**P**	**δt[2] min**	**δS[3] km**	**Remarks**
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_2O, Cld	1	15	1	15	5	Fundamental Band[5] Cls, Sfc., T/Emis. & H_2O
1000-1100	0.6	O_3	1	15	3	30	5	O3, Stratospheric Wind
1100-1590	1.2	T_s, H_2O Aerosol/Dust	1,2	15	2,1	15	5	Water Vapor Flux Trop. Wind Profiles[6]
1590-2000	1.2	H_2O, 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[7]
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 and Night Land Utility[8]

Table 2.4-1. Measurement Threshold for Future Advanced IR Sounders

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

[1] For cloud clearing, the highest spatial resolution is desired

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

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 limits 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.

Common Advanced IR Sounding Measurement Requirements:

- ***NEdT***: A spectrally random noise level of less than 0.2 K, for a US Standard Atmosphere scene temperature at the δt and δS specified above, is desired to optimize sounding vertical resolution. A spatially random noise level of less than 0.4 K, for a US Standard Atmosphere scene temperature at the δt and δS specified above, is desired to minimize the noise in the spatial gradients of the retrieved profiles.
- ***Co-registration***: Co-registration means the degree to which different channels see the same scene taking into account optical alignment, field of view response, diffraction, etc. This co-registration error is generally referred to as the Cij error. Hyperspectral radiances are observed within measurement bands (e.g., as provided by a single detector for a FTS instrument or provided by a focal plane array detector module for a dispersive instrument). It is desired to co-register all the fields of view of the tropospheric sensing spectral channels observed within a measurement band, (e.g., 600-1100cm^{-1}, 1100-2000cm^{-1}, and 2000-2700 cm^{-1}) to within 1% of the window channels (i.e., Cij ≥ 0.99) within that band (further refinement of the co-registration threshold requires further study). The window channels are used for cloud clearing and for accounting for surface emissivity and surface temperature contributions to the observed radiance as needed for atmospheric profile retrieval. The fields of view of all spectral channels within each measurement band should be spatially contiguous and co-registered as closely as practical with all spectral channels within all other measurement bands. Ideally, one would want all spectral channels to be co-registered to within 2% (Cij ≥ 0.98).
- ***Absolute radiometric accuracy***: An absolute accuracy better than 0.3 K is desired for weather and climate applications of the data.
- ***Temporal stability***: A temporal stability of the calibrated radiance measurements that is better than 0.1 K is desired for climate applications of the data.
- ***Spectral instrument line shape***: A knowledge and stability of better than 3 part / 10^6 is desired to achieve the high spectral precision needed for high vertical resolution atmospheric profiling, as well as for meeting the desired spatial and temporal stability of the radiance measurements desired for weather and climate applications of the data.

Recommendation AS-2 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 the minimum radiometric measurement requirements for advanced IR sounders to be carried on future polar and geostationary orbiting satellites.

2.4.3 Calibration and validation of Advanced Sounder data

The importance of calibration/validation (Cal/Val) activities associated with future advanced atmospheric sounders was discussed , and concern was expressed over a perceived lack of emphasis being placed in these areas in planning for upcoming missions (i.e. METOP, NPP, and NPOESS). Post-launch Cal/Val activities are critical for verifying the quality of the entire measurement system for advanced sounders (i.e. the sensor, processing algorithms, and direct/derived data products), and is a prerequisite step for optimising post-measurement data usage by the operational weather, climate research, chemistry, and broader scientific communities. The 1 K / km layer and 15 % / 2 km layer product accuracy, coupled with the very high radiometric accuracy and precision requirements imposed on the hyperspectral sounding spectrometers, makes adequate Cal/Val for these instruments problematic (i.e., the use of radiosondes and NWP model forecasts alone cannot provide sufficient validation to the levels of accuracy and precision required).

Recommendation AS-3 to the space agencies

> **Cal/Val for advanced sounders needs to be an activity which receives sufficient resources. While radiosondes and NWP fields can provide a basic validation, high-altitude airborne sensors, such as those associated with the NAST and ARIES airborne sensors, and upper air reference networks (see Climate WG Report) need to also be included in order to validate the radiances, and derived products, to the very high accuracy, and precision, specified for advanced sounding instruments.**

2.4.4 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 modeling and the transfer of large observation datasets from the satellite agencies. 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. 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.

In the day-1 METOP system, EUMETSAT cannot distribute the full IASI dataset on the GTS in near-real-time. A subset of 300-500 channels will therefore need to be distributed. A method for choosing such a subset using C. Rodger's selection method based on degrees of freedom for signal has been described in the poster presented at ITSC-XIV, by Collard and Matricardi.

Action AS-1

> **NWP centers should review the channel selection method proposed at ITSC-XIV to ensure that the channels selected will meet their initial requirements for NWP applications and provide any comments to the ITWG Co-Chairs.**

Recommendation AS-4 to advanced sounder research community

> **The advanced sounder research community needs to consider issues such as: (1) the ability to detect cloud such that the impact of undetected cloud on the observed radiances is less than 0.2K, (2) the correct usage of Principal Components (PCs), (3) effective and efficient quality control (particularly for PCs), (4) the continued development of fast models in super channel or PC space, that are robust, fast and sufficiently accurate, and (5) the quantification of the observational and forward model error covariance matrices.**

2.4.5 New initiatives for geostationary sounding

The progress, since ITSC-XIII, of advanced MW sounder/imagers for geostationary orbit was reviewed. In particular, the progress made with the synthetic aperture approach was reported at the meeting. The IGeoLab initiative to promote international cooperation to place a MW sounder/imager in orbit was also noted. As a result of these discussions the following recommendation was formulated.

Recommendation AS-5

> **It is recommended that relevant organizations conduct studies to identify the functions of microwave sounders, identify users, and develop consensus measurement requirements for future systems. This should be done for LEO as well as GEO sounders. It is recommended**

that this information be consolidated in a table similar to that presented above for the IR sounder.

Recommendation AS-6

For future microwave sounders, it is recommended that efforts be devoted to improving radiometric sensitivity and horizontal spatial resolution. It is further recommended that scattering models, which will enhance rain rate estimates and enable retrieval of vertically resolved rain, be further developed.

2.4.6 MW Sounder deployment with future IR Sounders

Examples were shown at ITSC-XIV of how microwave sounders provide data that can assist the interpretation of cloudy IR observations and provide valuable information for filling gaps in advanced sounder information below opaque cloud levels. 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 continuity. Such MW observations are desired for future advanced IR sounders.

Recommendation AS-7 to space agencies

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

2.4.7 IR 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 incurred 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-8 to space agencies

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

2.4.8 ATMS noise performance compared with actual AMSU performance

The current ATMS specification is consistent with the AMSU performance specification, which is significantly inferior to actual AMSU performance. The polarization of the ATMS in all channels is horizontal while it is vertical for most AMSU channels.

Recommendation AS-9 to space agencies

A study should be undertaken to determine the impact of horizontal and vertical polarization for future MW sounders, taking into account the impact on “clear sky” information content as well as the ability to detect clouds and precipitation. The goal of this study should be to compare the AMSU and ATMS systems to determine what is best for future microwave sounders. The study will also inform users what they can expect from the ATMS data.

2.4.9 Low inclination orbit for satellite cross calibration

A high accuracy spectrometer in a low inclination orbit (i.e. <20°) 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 can be cross-calibrated with a single 'standard' satellite.

Recommendation AS-10 to science community

> **The utility of applying the SNO (Simultaneous Nadir Observation) technique for an equatorial (inclination <20° degrees) LEO platform for the purpose of radiometric cross-calibration should be examined. Optimal orbital parameters (attitude and inclination), as well as sensor type, should be determined so that recommendations for possible sensors on future equatorial satellites can be put forward.**

2.4.10 Move to single contractor's responsibility for satellite Sounder systems

Historically, environmental satellite systems have been developed by a partnership of government (NASA, NOAA, & EUMESAT), 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 to the development of future satellite systems (e.g., the GOES-R system), 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-11 to space agencies

> **ITWG strongly recommends that certain elements of future satellite systems (e.g., the data processing, algorithm and product development system, the evaluation and validation, and the training program), be led by government agencies, together with its academic teams, in partnership with industry. It is also recommended that the users of the satellite system play a role in the definition of the characteristics of this system.**

2.4.11 Transmission of Recommendations

Action AS-2

> **Advanced Sounders WG Co-Chairs to forward recommendations to specified groups by end of 2005.**

2.5 INTERNATIONAL ISSUES AND FUTURE SYSTEMS

Working Group members: P. Menzel (Co-Chair), G. Rochard (Co-Chair), T. Achtor, S. Elliott, J. Eyre, D. Griersmith, L. Jian, D. Klaes, F. Romano, J. Purdom, P. Wilczynski

The Working Group discussed issues in four areas:

- Enhancing local access to satellite data and fostering global retransmission
- Evolving the Global Observing System
- Frequency protection
- Opportunities for input to education programs for satellite sounder science

2.5.1 Enhancing local access to satellite data and fostering global retransmission

Concerning data access, formats and dissemination for education and research, the Working Group noted that both the education and research communities need access to near real time and retrospective satellite data in digital format. Ease of access and browse capability to the data sets, as well as common formats, are important for users.

Recommendation IIFS-1 to research and operational satellite operators

Make data available in a form and browse display similar to that done by NASA on their rapidfire sites (e.g. http://rapidfire.sci.gsfc.nasa.gov/realtime/) that provide access to MODIS and AIRS data. While some providers may have specialized formats, all providers should strive to make their data also available in standard formats (e.g. hdf for images, BUFR for soundings).

Action IIFS-1

ITWG Rapporteur to take Recommendation II-1 forward at CGMS 2005.

In order to make IASI level 1 data available on the GTS, the Working Group noted that EUMETSAT plans to distribute a reduced data set in BUFR format. The reduction will be accomplished by selecting a subset of the available channels where the selection mainly serves NWP users outside of Europe. Informed consultation with potential users took place at ITSC-XIV.

Recommendation IIFS-2 to WMO Space Program Office and CGMS

Establish a process for similar data set distribution from other instruments whereby users can formally express their need for such data sets and conduct a dialogue with the data providers on issues of content and format.

Further regarding BUFR, the Working Group expressed support for the process agreed upon between the WMO Expert Team on Data Representation and Codes and CGMS for the specification of BUFR descriptors for satellite data. As part of this process, classes of element descriptors (BUFR Table B) and sequence descriptors (BUFR Table D) have been set aside for the representation of future satellite data. Proposals for the definition of these descriptors will be coordinated by a working group of CGMS, and then passed via a rapporteur to the WMO Expert Team for approval via the existing process. This will allow the WMO Expert Team to concentrate on data representation issues, rather than the details of the satellite data themselves.

Concerning direct read-out, the Working Group considers the direct broadcast for future polar orbiting satellites (i.e., METOP, NPP, NPOESS, and FY-3) as a paramount issue. The Working Group is encouraged by the planned first International Direct Broadcast Conference in Benevento, Italy in October 2005.

Recommendation IIFS-3 to the direct broadcast community

An International Direct Broadcast Working Group should plan meetings like the forthcoming Benevento, Italy meeting on a regular basis to provide a forum for the international direct broadcast users to exchange vital technical planning information regarding achieving access to and maintaining consistency of level 0 and level 1 data. Annual plenary meetings would suffice, however, more frequent sub-groups should be considered. Failure to do so may put at risk the continuity of data access at some NWP centers and synergy within the international user community. All international DB users should plan to be represented at the October workshop.

Action IIFS-2

The ITWG rapporteur to encourage consideration for establishing an IDBWG within CGMS in the near future.

Concerning timeliness of satellite data (Global NESDIS, RARS, NPP, NPOESS plans), the Working Group noted the success of the EUMETSAT Advanced Retransmission Service (EARS) in enabling NWP assimilation of more data within cutoff times. The first workshop on leveraging EARS to form a global rapid ATOVS data exchange system was held in Darmstadt, Germany in December 2004 and it furthered plans for the establishment of a number of coordinated RARS (Regional Advanced Retransmission Service) around the globe. This system will likely expand to many other satellite data types (as in Europe) and will provide key components of future meteorological data dissemination systems. Realizing this system will require considerable coordination and support by relevant agencies, including National Meteorological and Hydrological Services (NMHS), the Working Group congratulated EUMETSAT for sharing their EARS knowledge to prospective RARS partners in the recent WMO organized workshop.

Recommendation IIFS-4 to the WMO Space Program Office

The WMO, with CGMS assistance, should continue to promote the implementation of a globally coordinated system of RARS. The 6th Asia-Pacific Satellite Data Exchange and Utilization (APSDEU-6) meeting in Seoul in June 2005 will seek to reach agreement on implementation of an Asia-Pacific RARS. The WMO Space Program Office should organize a further global RARS meeting thereafter.

Recommendation IIFS-5 to the WMO Space Program Office

To coordinate the development of backbone reception stations and dissemination nodes, contacts and implementation standards, including quality, formats, and processing software requirements. A Web site should be established as a central reference for all global RARS information.

2.5.2 Evolving the Global Observing System

The Working Group discussed at length polar orbit coordination and optimization among space operators. Concerning equator crossing times of planned polar orbiting satellites, it was noted that insertion of satellites into similar orbital planes should be coordinated so that data reception problems are minimized (e.g. two satellites should not appear simultaneously above the local horizon) and contribution to the Global Observing System be optimized (e.g. continuity of ageing instruments).

Recommendation IIFS-6 to CGMS

To continue to provide a forum for discussion and coordination among satellite operators to avoid orbit overlap as much as possible.

Action IIFS-3

ITWG Rapporteur to CGMS to present Recommendation 14.6.

Recommendation IIFS-7 to IPO

To consider placing NPP into a 1430 local time ascending orbit (instead of the planned 1030 descending orbit) in order to complement the pending METOP/IASI with NPP/CrIS and to provide continuity with Aqua/AIRS.

Action IIFS-4

Goldberg to present Recommendation 14.7 to the IPO/JARG.

Recommendation IIFS-8 to NOAA NESDIS

To pursue added support from the new IPO/NESDIS antenna located in Svalbard, Norway to eliminate the blind orbits and hence significantly improve data timeliness for existing polar orbiting international users.

The Working Group also discussed strategies for achieving an optimized space based component of the Global Observing System that is integrated for NWP and climate. It was concluded that there is a strong need for enhancing the capabilities of the space based component of the GOS and as much as possible a distributed approach amongst the space operators and R&D agencies should be taken toward achieving new remote sensing capabilities (i.e., agencies agree for each to emphasize different development tasks to achieve maximum capability growth in the GOS with the available resources).

Recommendation IIFS-9 to CGMS

To add discussion of the distribution of development tasks to their agenda in November 2005.

Action IIFS-5

ITWG Rapporteur to CGMS to present Recommendation 14.9.

The Working Group noted the "Implementation Plan for Evolution of the Space and Surface- based Sub-systems of the GOS" that was endorsed by the CBS and recently published as WMO TD 1267. It was felt that this document provided a suitable list of those remote sensing capabilities that are missing or need improvement.

Recommendation IIFS-10 to ITWG members

To review WMO TD 1267.

Action IIFS-6

ITWG Co-Chairs to seek volunteers to review the WMO TD 1267 who will provide their comments to P. Menzel by end of July 2005.

The Working Group noted the WMO Space Program initiative to draft a strategy for Intercalibration of the space based component of the GOS. Space operators will be convened in the summer of 2005 to discuss possible short term initiatives and long term commitments. The Working Group strongly endorsed this initiative and requested that the WMO Space Program Office provide an update on the progress at the next ITSC.

2.5.3 Frequency protection

The Working Group noted the considerable progress made in awareness of the importance of frequency protection for environmental remote sensing and the continuing need for protective vigilance. It further noted the need for a document containing the scientific use of each of the frequencies to be protected.

Recommendation IIFS-11 to the WMO Space Program Office

To organize the production of a WMO Technical Document containing the characteristics,

environmental utility, and need for each requested frequency.

2.5.4 Opportunities for input to education programs for satellite sounder science

The Working Group noted that WMO and CGMS have developed the Virtual Laboratory for Training in Satellite Meteorology (VL). The VL is on track with its implementation plan and in several cases had surpassed expectations. Major successful training events have been held in Nanjing, Melbourne, Barbados and Costa Rica. In Costa Rica the VL achieved a major milestone in introducing the electronic notebook concept as a component of the training activity. A major global training event is planned for late 2006.

Action IIFS-7

(a) ITWG Members to review and provide guidance for VL Materials on VRL Electronic Notebook to help assure updated materials for VRL (Available through WMO Space Program Web site for Virtual Lab and linking to CIRA VRL site). (b) ITWG to establish an outreach and education focal point to serve as liaison between ITWG and VL focus group.

2.6 SATELLITE SOUNDER SCIENCE AND PRODUCTS

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

Working Group members: T. Reale (Co-Chair), L. Lavanant (Co-Chair), T. Achtor, N. Atkinson, E. Borbas, I. Dyras, S. Elliot, F. Romano, D. Griersmith, B. Lapeta, E. McKernan, G. Rochard, D. Singh, G. Songyan, R. Souza, H. Wei, H. Woolf, F. Zhang

2.6.1 Background

The SSSP was formed to report and promote the science of derived meteorological products from environmental satellite measurements. The importance of such work is manifested in improving our understanding of the utility of satellite borne radiometric data to depict the atmospheric weather state. The rich learning environment associated with such work, both operational and research (global and HRPT), is fundamental to achieving optimal use and understanding of these data.

The wide variety of applications worldwide, the multiple parameters measured and derived, evolving opportunities for cross calibration and validation, and numerous programs for coordinating the expanding global observing systems challenges SSSP to facilitate full access and dissemination of this information.

2.6.2 HRPT Facility Inputs

Inputs from HRPT facilities concerning status for current processing and plans are not yet complete. These inputs for the SSSP Web site will continue to be solicited through the existing survey and HRPT sites list. The existing topic area will be restructured to provide a tabular/listing which identifies all registered sites, and for the subset of sites for which inputs have been received, a link which identifies the satellites, instrument data, processing packages, measurements and products available, validation and distribution practices, and a link to the site.

Action SSSP-1

> **Lydie Lavanant to continue HRPT survey and collect data and Leanne Avila to put the information on the ITWG/SSSP Web page.**

2.6.3 Local and Global data output format differences

Current local (HRPT) and global data output formats are not always the same (e.g. AVHRR METOP). This makes it difficult for users of Level 1 and Level 2 data from HRPT and Global systems to interface with these data. Also the archive format may be different from the near-real time dissemination format.

Recommendation SSSP-1 to space agencies and direct readout package developers

> **Future NPP, METOP, FY-3 and NPOESS programs should provide data and products in a standard reference format. If not, then global centres should provide an interface routine (i.e., in FORTRAN and/or C languages which converts the data into a reference format such as HDF and/or BUFR). Local packages for direct readout should also use these formats or provide an appropriate interface similar to the global centres.**

Action SSSP-2

> **SSSP Co-Chairs to forward these recommendations to space agencies and identified direct readout package developers.**

2.6.4 Access to near-time simulated IASI data

The capability to get near-time simulated IASI data from national agencies (NOAA, EUMETSAT) through an automatic routine (CRONTAB) and for a selected area is important for the preparation and operational availability of local, direct readout processing packages.

Recommendation SSSP-2 to NOAA and EUMETSAT

> **Make available simulated IASI measurements (from NWP) in a routine manner, for example through ftp, to facilitate ITWG user access. It is recommended that such data be archived and accessible through interfaces to define time period and if possible geographic windows (i.e., similar as for ECMWF archived data) to help mange the high volume of these data.**

Action SSSP-3

> **SSSP Co-Chairs to forward this recommendation to NOAA and EUMETSAT.**

2.6.5 Local and Global processing package coherence

The coherence between local and global processing packages is important for the simultaneous assimilation of both products in NWP systems.

Recommendation SSSP-3 to space agencies

> **When defining their global processing systems, space agencies (EUMETSAT, NOAA) should consider the portability and availability of their software on standard platforms (e.g. Linux PCs). This would facilitate comparisons of local and global processed data that would be mutually beneficial to data providers and users alike. These comparisons should be routinely conducted by identified centres (e.g. NWP-SAF), and results made available to all users (i.e., via the SSSP Web site).**

Action SSSP-4

> **SSSP Co-Chairs to forward these recommendations to space agencies and direct readout package developers.**

2.6.6 Cross validation

Opportunities for the cross validation among existing (and past?) satellite products and sensors exists, across operational and research communities. Coordination is needed to compile baseline datasets and protocols for providing such information from respective platforms and programs including, as available, in conjunction with evolving standardized upper-air reference programs for climate. Existing activities at NOAA-NESDIS to define protocols for compiling real-time collocations of satellite sensor and product data from ATOVS, AIRS and GOES with global radiosonde observations are recognized as a good starting point. Validation results from such efforts will be reported in a designated “Validation” topic area of the SSSP Web site.

Action SSSP-5

> **Hal Woolf/A. Reale to include some "global" ATOVS products from IAPP (available from CIMSS) in the cross-validation studies.**

2.6.7 Standardized, multi-platform software for historical TOVS 1b data

The need for standardized software (on multiple computer platforms) to read historical TOVS 1b-level datasets that are executable on a variety of computer platforms is needed. There is also a need for the recovery and documentation of available metadata records with respect to TOVS concerning, format (i.e., 1b-level) changes, calibration and offsets, systematic bias, etc.

Action SSSP-6

The SSSP Co-Chairs shall forward these concerns to appropriate NOAA agencies in an effort to locate sources of information and software concerning the status of available meta-data and processing software for 1b-level TOVS from 1979-2001.

2.6.8 GPS RO + ATOVS

Studies on combining GPS radio occultation (RO) and ATOVS radiometric measurements showed that the combination yields improved tropospheric temperature and moisture profiles over those inferred from either system alone. Currently three GPS receiver satellites operate and in the near future a 6 GPS satellite configuration (COSMIC) will be launched.

Action SSSP-7

Eva Borbas to provide information on the SSSP Web site under agency planning for RO-GPS. Specifically provide links to respective programs (NASA, UCAR, EUMETSAT) with respect to GPS data, and associated sites where such data and software (i.e., SAF GRAS) are available.

2.6.9 SSSP agency survey

Inputs from Agency surveys concerning the status for current and future satellites, data distribution and plans are not yet complete.

Action SSSP-8

SSSP Co-Chairs to identify contact points for agencies from China and Russia, contact them, gather information and include them on the SSSP Web site.

2.6.10 Scientific Product inputs on SSSP Web site

Inputs for scientific products as reported on SSSP Web site have in some cases not been updated (for several years) and new inputs are requested from those who have not yet registered their work.

Action SSSP-9

SSSP Co-Chairs and their collaborators will write a letter requesting that information on the SSSP Web site be updated and maintained. They will also solicit new inputs (including from non-ITWG members).

2.6.11 SSSP Web site upgrade

The SSSP Web site has undergone a significant upgrade over the past 18 months and now includes the original topic area of product reports, and new areas describing agency plans, HRPT sites and data distribution (EARS), sources of global satellite data, helpful ancillary data sources (i.e. topography atlas), and operational and research instrument status and metadata. We recognize the tremendous support of our WG members and in particularly from CIMSS and Ms Leanne Avila.

Action SSSP-10

The site needs to be reviewed by ITWG members with suggestions, recommendations and in particular areas of concern provided to the SSSP Co-Chairs.

3. TECHNICAL SUB-GROUP REPORTS

3.1 ATOVS AND AVHRR PROCESSING PACKAGE (AAPP)

Since ITSC-XIII (October 2003) AAPP version 4 has been extended to provide support for Linux systems, at the request of users. Version 5, supporting NOAA-N and NOAA-N', is in the final stages of preparation, and work has been started on Version 6, for METOP. There are also plans to support NPP and NPOESS at the pre-processing stage. See presentations 10.2 (N Atkinson) and 10.3 (P Marguinaud) for full details of these developments.

Regarding future support, the sub-group confirmed that there is a strong requirement to support AAPP beyond the end of the Initial Operating Phase of the NWP-SAF in February 2007.

The group recognized that some aspects of AAPP are out of date - for example the FORTRAN77 code and the build scripts. However they work well, are understood by users and are compatible with most Fortran 90 compilers, so the effort that would be required to re-write the code, and the possible risks, are not justified at present.

The group acknowledged the work done by Meteo-France in modifying the IASI-OPS code so that it would be sufficiently portable to be included in AAPP - the effort being more than was originally envisaged. The group recommended that in the case of any future ground segment projects that feed into user software, portability should be specified from the start - saving time and effort later on.

Several users expressed the view that AAPP should have the capability of writing output in standard formats such as HDF5 or NetCDF, which can be read directly by standard display and analysis software. The NWP-SAF does not have the resources to undertake this at the moment but it was agreed to canvass users to find out what conversion software or display software had been written by users. Any relevant links could be added to the AAPP Web pages.

It was confirmed that there are no plans for AAPP to support other direct readout missions, such as FY-3, but obviously any direct readout software supplied by the operating agencies would be of great interest to the AAPP user community.

3.2 INTERNATIONAL ATOVS PROCESSING PACKAGE (IAPP)

The following highlights presented at the conference were discussed in detail in the subgroup:

- As of February 2005, IAPP is Open Source, and can be obtained at no cost by anonymous ftp via the CIMSS Web site http://cimss.ssec.wisc.edu/opsats/polar/iapp/IAPP.html
- To provide assistance to users until the IAPP/NWP interface is made more flexible, global ancillary netCDF files, created from selected NCEP GFS datasets, are now available in a 7-day moving archive.
- Global radiosonde data in the format expected by the IAPP SRX-to-netCDF conversion program are also available in a 7-day moving archive.
- IAPP has been ported to Linux (RedHat Enterprise 4.0) using the GNU g95 compiler.

In the course of debugging the port, several serious logic errors were detected and corrected. The revisions have been incorporated into the versions running routinely on IBM (AIX 4.3) and Sun (Solaris 7). While those versions had never crashed, in spite of the logic errors, some users running Solaris 8 had reported problems which in retrospect appear to be attributable to those errors.

NETCDF-3.4, which has been bundled with IAPP, would not compile under Linux 4.0; it will be replaced in the next release with version 3.5 or later.

The METAR (surface data) to netCDF conversion program also benefited from the port, with several logic errors detected and corrected. That program, which historically has run with failure rates on the order of 0.1 % on the IBM and 15-35 % on the Sun, is now failing on the latter system on the order of (at worst) once every two to three weeks.

To complete the Linux support included in the new version, the installation scripts and documentation will be updated. The endian-ness of the radiative-transfer and regression-retrieval coefficient files needs to be handled in a user-friendly fashion. Those files have already been updated for NOAA-18 (launched 20 May). Release of the upgraded package will be deferred until it has been tested on live data from the new spacecraft.

Tentative date for release of IAPP version 2.1 is 1 October 2005.

CIMSS is committed to maintaining and supporting the IAPP through NOAA-N-prime.

3.3 INTERNATIONAL MODIS/AIRS PROCESSING PACKAGE (IMAPP)

The International Moderate Resolution Imaging Spectroradiometer/Atmospheric Infrared Sounder (MODIS/AIRS) Processing Package (IMAPP) provides users with EOS satellite Terra and Aqua direct broadcast systems 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. IMAPP can be downloaded via anonymous ftp at http://cimss.ssec.wisc.edu/~gumley/IMAPP/.

The number of products within IMAPP continues to grow and currently includes:

- MODIS calibrated/navigated radiances, cloud mask, cloud top properties and cloud phase, retrievals of atmospheric profiles (temperature and moisture), total precipitable water, sea surface temperature and aerosol optical depth (all updated to collection 5);
- AIRS calibrated/navigated radiances, and single field of view clear retrievals of temperature and moisture (regression algorithm);
- AMSR-E calibrated/navigated antenna temperatures, and rain rate.

Additional products anticipated for release in the near future include updated MODIS Level 1 (collection 5); AIRS standard Level 2 product retreival (v4.0), and combined MODIS/AIRS cloud-cleared radiance and sounding retrievals.

3.4 FAST RADIATIVE TRANSFER MODEL, RTTOV

The development of the RTTOV fast radiative transfer model - part of the EUMETSAT-sponsored NWP-SAF activities - has continued since the release of RTTOV-7 in March 2002. Over the last two years, more developments have been made, leading to the release of RTTOV-8 to users in Nov 2004. Around 70 users worldwide have already received the new code. For your free copy, visit the URL below and click on 'software requests' in the right panel. A poster on the current status of the fast radiative transfer model, RTTOV, was given during ITSC-XIV and can be viewed from the ITSC-XIV agenda.
For full details the RTTOV documentation can be viewed at:
http://www.metoffice.gov.uk/research/interproj/nwpsaf/rtm/

The main differences for RTTOV-8 are:

- The code is completely rewritten so that passing of variables is now achieved through structures and all the arrays are allocatable to be more efficient in terms of memory usage.
- The required units for water vapour and ozone profile concentrations for input to RTTOV-8 are changed from *kg/kg* to *ppmv*.
- The ozone and cloud liquid water profiles are now optional and are activated with logical flags; optionally a CO2 profile can now be provided.
- The number of levels for the input profile is now variable and defined by the coefficient file.
- The optical depth prediction can be either as in RTTOV-7 (for backward compatibility) or using new predictors which separates out the water vapour line and continuum absorption.
- The selection of whether the surface emissivity is computed internally or not is now via a logical *calcemiss* and this can be selected for each input channel. If *calcemiss* is .false. the value input is used.
- There is an improved version of the microwave sea surface emissivity model FASTEM-3, but FASTEM-2 and FASTEM-1 can still be invoked (the latter is not supported).
- The code now allows simulations of polarimetric radiometers such as WINDSAT.
- There are changes to the infrared cloud optical properties in the RTTOV_CLD programme to improve the cloudy IR simulations and the option of choosing different parameterisations.
- A new wrapper programme RTTOV_SCATT has been developed to allow the simulation of rain affected microwave radiances.

It should be noted that for those RTTOV-7 users who want to use the new RTTOV-8 code but do not want to change their code interfaces to RTTOV some subroutines are provided to allow RTTOV-8 to be called from an 'RTTOV-7 like' interface. However this is only for a limited set of options for the forward model only.

A table of the current list of satellite platforms and sensors that RTTOV-7 and 8 support is given on the next page.

Platforms	Sensor	Channels simulated
TIROS-N NOAA-6-18 NOAA-2-5	HIRS, MSU, SSU, AMSU-A AMSU-B, MHS, AVHRR, VTPR	1-19, 1-4 1-3, 1-15 1-5, 1-5 1-3, 1-8
DMSP F-8-15	SSM/I	1-7
DMSP F-16	SSMI(S)	1-24
Meteosat-2-8	MVIRI SEVIRI	2 4-11
GOES-8-12	Imager Sounder	1-4 1-18
ERS-1/2 ENVISAT	ATSR AATSR	1-3 1-3
GMS-5, MTSAT	Imager	1-3,1-4
Terra Aqua	MODIS,AIRS AMSU-A, HSB, AMSR	1-17, 1-2378 1-15, 1-4, 1-14
TRMM	TMI	1-9
Coriolis	WindSat	1-10
FY-1, FY-2	MVISR, VISSR	1-3, 1-2

Table 3.4-1. Sensors currently simulated by RTTOV-7 and 8.

3.5 FREQUENCY MANAGEMENT

Web site: http://cimss.ssec.wisc.edu/itwg/groups/frequency/

This technical sub-group was created at ITSC-XII with Guy Rochard (chair). The group is open to all interested persons.

An update on the actions from ITSC-XII:

- The ITWG hosted the Space Frequency Co-ordination Group meeting (SFCG-25) in Perros-Guirec, France in September 2004 and presented a paper at: http://guy.rochard.free.fr/meteo/fichiers/SFCGITWG.doc (1500k) and a talk: http://cimss.ssec.wisc.edu/itwg/groups/frequency/sfcg1/sfcg1_04.htm (2500k). Some pictures from the event are at: http://guy.rochard.free.fr/meteo/fichiers/SFCGPERROSGUIREC.pdf (4400k). The SFCG members enjoyed this productive meeting and the ITWG has taken an action (see below) to be reported at SFCG-26 in Beijing in October 2005: http://guy.rochard.free.fr/meteo/fichiers/SFCG-24_Action_3_1.doc (20k)
- The action was to organise a meeting to quantify the scientific justification for using various microwave frequency bands for meteorological applications which was held in Washington DC on 5/6 April 2005. See http://guy.rochard.free.fr/meteo/fichiers/Washington.doc (1200k). A reference example of the scientific justification for a passive microwave band is at: http://guy.rochard.free.fr/meteo/fichiers/SENGLISH24GHz.doc (167k). The same MUST be done for all the required bands between 1 to 1000 GHz and is URGENT for the bands between 1 to 40 GHz. http://guy.rochard.free.fr/meteo/fichiers/SPIE50.doc (1300k).
- The work will not be completed by October 2005 and so it is planned to hold a second meeting by the end of 2005. The aim is to finish the work by spring 2006.
- We URGENTLY need volunteers to help for land surface sensing bands.
- Support from George Ohring and John Bates was provided at ITSC-XIV. A useful document about climate requirements is the report NISTIR 7047 from NIST: "Satellite Instrument Calibration for Measuring Global Climate Change."
- During ITSC-XIV, progress has been made about the future availability of microwave emissivity atlases over the Earth's surface. Such atlases are crucial for monitoring the contamination of the passive microwave spectrum by human activities. See: http://guy.rochard.free.fr/meteo/fichiers/Protect.ppt (7500k). Information on the progress concerning these atlases will be made available on the ITWG Web site at: http://cimss.ssec.wisc.edu/itwg/groups/rtwg/rtwg.html
- The technical sub-group's Web site: http://cimss.ssec.wisc.edu/itwg/groups/frequency/ will be updated but also note the information at: http://guy.rochard.free.fr/meteo/fichiers/
- The tables of "Delta T" given in the ITU-R REC(s) 1028-2 and 1029-2 at: http://guy.rochard.free.fr/meteo/fichiers/10282.doc and http://guy.rochard.free.fr/meteo/fichiers/10292.doc should also be used to specify the required agreement between calibrated radiances processed through "global" and "local/direct readout" pre-processing software.

3.6 ACTIVITIES OF THE ATMOSPHERIC RADIATION ANALYSIS GROUP AT LMD

Reanalysis of TOVS Path-B: Longterm atmospheric properties

8 years of TOVS Path-B data (1987 - 1995) are available in HDF format at NASA DAAC. The analysis of this time series of data has led to some minor improvements, essentially in cloud detection due to the effects of Mt Pinatubo aerosols. The recently reanalyzed data set is stored at LMD, and cloud properties of this data set will soon be made available on the Web (http://www.ara.lmd.polytechnique.fr/). Mean effective ice crystal sizes and ice water path for cirrus clouds are retrieved for medium thick cirrus clouds ($0.3 < N\varepsilon_{cld} < 0.85$), taking advantage of the fact that spectral cirrus emissivity differences between 11 and 8 μm depend on this parameter. This method is sensitive to sizes up to 70 μm. So far, NOAA-10 data have been treated as part of the European programme CIRAMOSA (http://www.lmd.polytechnique.fr/CIRAMOSA/Welcome.html).

The above data set has been established using bias adjustment constants obtained from collocated radiosonde-TOVS data for clear sky scenes, the DSD5 data set provided by NOAA/NESDIS for this time period. These monthly mean constants were used to remove systematic biases due to the radiative transfer model, instruments and unexpected events (such as the Mt Pinatubo eruption). To extend this data period, the ARA group has created a similar data set for the construction of bias adjustment constants covering the whole period from 1979 up to now. The complete radiosonde collection used for the ERA40 reanalysis has been transferred from ECMWF. A complex quality control procedure followed by a clear sky identification algorithm have been developed, and the channel biases have been determined and evaluated. One remaining problem is the fact that the radiosonde daytime temperatures of the ECMWF collection have not been corrected in the stratosphere.

The new reanalysis will also use improved versions of the 4A and 3R (fast parameterized) models, as well as extended TIGR and GEISA (Gestion et Etude des Informations Spectroscopiques Atmosphériques) databases.

The 4A model is now licensed and available from Noveltis.

The current TIGR database contains 2311 atmospheric profiles. Surface emissivities from FASTEM-2 (S. English) and O3 profiles from the UGAMP climatology have been integrated. Temperature and water vapor are now extrapolated towards the stratosphere in comparison with measurements of the ATMOS mission. The 3I inversion scheme had to be adapted for the use of the new TIGR database, and a new neural network inversion for water vapor profiles and surface temperature has been introduced.

ITSC-XIV AGENDA

Wednesday 25 May 2005

9:00-9:30	Welcome	Co-Chairs Tom Achtor, Roger Saunders Dr. Yu Rucong, Deputy Adminstrator of CMA
	Local Arrangements	Dongfeng Luo
	Review Agenda/Key Issues	

9:30-10:30
Session 1: ATOVS Radiance Studies — Chair: Dong Chaohua

1.1	**William L. Smith**	Ultra High Spectral Resolution Satellite Remote Sounding - Results from Aircraft and Satellite Measurements
1.2	**Lydie Lavanant**	A global cloud detection scheme for high spectral resolution instrument
1.3	**Bormin Huang**	Cloud Classification of Satellite Radiance Data by the Local Region of Influence Method
1.4	**Allen Larar**	Satellite Infrared Radiance Validation Studies using a Multi-Sensor/Model Data Fusion Approach

10:30-11:00 BREAK

11:00-11:30
Session 1: ATOVS Radiance Studies (continued)

1.5	**Chian-Yi Liu (for Jun Li)**	An optimal cloud-clearing method for AIRS radiances using MODIS
1.6	**Allen Huang**	Characterization of Infrared Imager/Sounder and Infrared/Microwave Sounder Synergistic Cloud-Cleared Infrared Radiances

11:30-12:15
Session 2: ATOVS Retrieval Studies — Chair: Bill Smith

2.1	**Devendra Singh**	A neural network based algorithm for the retrieval of TPW from AMSU measurements
2.2	**Fuzhong Weng**	Microwave Integrated System for Retrieving Atmospheric Temperature, Water Vapor and Cloud Water Profiles
2.3	**Zhigang Yao**	Preliminary Results of Atmospheric Temperature Retrievals with Least Squares Support Vector Regression

12:15-13:45 LUNCH

13:45-14:45
Session 2: ATOVS Retrieval Studies — Chair: Peter Schlüssel

2.4	**Tony Reale (for A. K. Sharma)**	NOAA/NESDIS updates for sounding data products and services
2.5	**Peter Wang**	The analysis of typhoon parameters by using AMSU data
2.6	**B. J. Sohn**	Estimating stability indices from MODIS infrared measurements over the Korean Peninsula
2.7	**Bjorn Lambrigtsen (for Sung-Yung Lee)**	Version 4 AIRS Data Products

14:45-15:15 BREAK

15:15-16:15

Session 2: ATOVS Retrieval Studies **Chair: Allen Huang**

2.7	**Clémence Pierangelo**	Retrieving the effective radius of Saharan dust coarse mode with AIRS observations
2.8	**Eva Borbas**	Combining GPS occultations with AIRS infrared measurements for improved atmospheric sounding
2.9	**Deming Jiang**	Neural Networks for Atmospheric Temperature Retrieval from AQUA AIRS/AMSU/HSB Measurements on Different Types of Terrain
2.10	**Dan Zhou**	Initial retrieval inter-comparisons from the European AQUA Thermodynamic Experiment

16:15-18:00 Poster Session A

Thursday 26 May 2005

8:30-9:30

Session 3: ATOVS Cloud Studies **Chair: Rolando Rizzi**

3.1	**Paul Menzel**	Using 22 Years of HIRS Observations to infer Global Cloud Cover Trends
3.2	**Claudia Stubenrauch**	Survey of cirrus and atmospheric properties from TOVS Path-B: Natural variability and impact of air traffic on cirrus coverage
3.3	**Filomena Romano**	Cloud Parameters from Infrared and Microwave Satellite Measurements
3.4	**Hong Zhang**	Sensitivity study of the MODIS cloud top property algorithm to CO2 spectral response functions

9:30-10:00

Session 4: Climate Applications **Chair: Mitch Goldberg**

4.1	**John Bates**	Analysis of Systematic Errors in Climate Products
4.2	**Peter Thorne**	Climate monitoring of the free atmosphere: past mistakes and future plans

10:00-10:30 BREAK

10:30-11:15

Session 4: Climate Applications **(continued)**

4.3	**Tony Reale**	Satellite Coincident Reference Upper Air Network and Potential Impacts for Climate and NWP
4.4	**Yinghui Liu**	Spatial and Temporal Characteristics of Satellite-Derived Clear-sky Atmospheric Temperature Inversions in the Arctic, 1980-1996
4.5	**Lei Shi**	Using HIRS observations to construct long-term global temperature and water vapor profile time series

11:15-12:00

Session 5: NPOESS Preparation **Chair: Mitch Goldberg**

5.1	**Hal Bloom**	Overview and Status of the NPOESS System: Providing Improved Real-Time Data To Meet Future Needs
5.2	**Peter Wiczynski**	The National Polar-orbiting Operational Environmental Satellite System (NPOESS) and NPOESS Preparatory Project (NPP) Access to Data

5.3 General Discussion on Future Direct Readout

12:00-13:30 Lunch

13:30-15:00 Poster Session B

15:00-16:45 ITSC-13 Action Items presented by WG Chairs — Moderators: Tom Achtor/ Roger Saunders

- Radiative Transfer and Surface Property Modeling (Roger Saunders)
- ATOVS/TOVS in Climate Studies (John Bates)
- ATOVS/TOVS in NWP (Steve English)
- Advanced Infrared Sounders (Allen Huang)
- International Issues and Future Systems (Guy Rochard)
- Satellite Sounder Science and Products (Tony Reale)

16:45-17:00 Working Group Formation — Chairs: Roger Saunders and Tom Achtor

Friday 27 May 2005

8:30-10:30
Session 6: Radiative Transfer and Surface Models — Chair: Louis Garand

6.1	**Jean-Luc Moncet**	The OSS method: current research and new prospects
6.2	**Ralf Bennartz**	The successive order of interaction (SOI) radiative transfer model and its possible applications to radiance assimilation of clouds and precipitation
6.3	**Xu Liu**	Validations of a Principal Component-based Radiative Transfer Model Using AIRS and NAST-I Observed Radiances
6.4	**Paul Poli**	Using microwave and infrared radiances from off-nadir pixels: application of radiative transfer to slanted line-of-sight and comparisons with NASA EOS Aqua data
6.5	**Nicole Jacquinet-Husson**	Assessing spectroscopic parameter archives for the second generation vertical sounders radiance simulation; illustration through the GEISA/IASI database
6.6	**Tom Kleespies**	Comparison of Simulated Radiances, Jacobians and Information Content for the Microwave Humidity Sounder and the Advanced Microwave Sounding Unit-B
6.7	**Fatima Karbou**	On the estimation and use of land surface microwave emissivities
6.8	**Fuzhong Weng (for Yong Han)**	Development of the JCSDA Community Radiative Transfer Model (CRTM)

10:30-11:00 BREAK

11:00-12:15
Session 7: Operational Applications — Chair: John LeMarshall

7.1	**Graeme Kelly**	Use of satellite radiances in the 4D-VAR ECMWF system
7.2	**Brett Harris**	Use of Level-1D ATOVS Radiances in GASP
7.3	**Fiona Hilton**	Current Use of Satellite Data in the Met Office Global NWP Model

7.4	**Thibaut Montmerle**	Respective contributions of polar orbiting and geostationary radiances within Météo-Frances's operational 3D-Var assimilation system at regional scale
7.5	**Florence Rabier**	Use of radiances in the operational assimilation system at Météo-France

12:15-13:45 Lunch (Plus poster session preparation)

13:45-15:15
Session 8: Use of ATOVS in NWP **Chair: John Eyre**

8.1	**Andrew Collard**	Improved use of AIRS data at ECMWF+IASI channel selection
8.2	**Louis Garand**	AIRS assimilation at MSC
8.3	**John Le Marshall**	AIRS Associated Accomplishments At The JCSDA
8.4	**Chris Tingwell**	Assimilation of Level-1D ATOVS Radiances in the Australian Region LAPS System
8.5	**John George**	Impact of ATOVS data in a mesoscale assimilation- forecast system over Indian region
8.6	**Peiming Dong**	The Use of ATOVS Microwave Data in the Grapes-3Dvar System

15:15-15:45 BREAK

15:45-17:00
Session 8: Use of ATOVS in NWP **(continued)**

8.7	**David Anselmo**	The assimilation of ATOVS and SSM/I brightness temperatures in clear skies at MSC
8.8	**Roger Randriamampianina**	On the use of bias correction method and full grid AMSU-B data in a limited area model
8.9	**Brett Candy**	Improved use of AMSU-B data in UK Met Office regional models
8.10	**Lei Zhang**	Assimilation of total precipitable precipitation in a 4D-Var system: A case study
8.11	**Thomas Auligne**	Progress of bias correction for satellite data at ECMWF

Saturday 28 May 2005

Working Groups
9am-12pm (or as arranged by chairmen)

Sunday 29 May 2005

Working Groups
6-8pm (or as arranged by chairmen)

Monday 30 May 2005

8:30-10:30
Session 9: International Status Reports — Chair: Paul Menzel

9.1	**Jim Purdom**	The Redesign and Evolution of the Global Observing System
9.2	**Dong Chaohua (for Wenjian Zhang)**	China's current and future meteorological satellite systems
9.3	**Xu Jianmin**	Products from FY2C Geostationary Meteorological Satellite
9.4	**Devendra Singh**	Report on Indian Meteorological Satellite Program
9.5	**Tom Achtor (for Alexander Uspensky)**	Report on Russian Meteorological Satellite Program
9.6	**Dieter Klaes**	EUMETSAT Plans
9.7	**John Eyre**	The NWP SAF: what can it do for you?
9.8	**Mitch Goldberg**	NESDIS Plans for AIRS, CrIS and IASI: Program and Science
9.9	**John Bates**	Overview of the CLASS and Scientific Data Stewardship programs within NOAA

10:30-11:00 BREAK

11:00-11:45
Session 9: International Status Reports (continued)

9.10	**Guy Rochard**	Frequency Management
9.11	**George Ohring**	Assimilation of Satellite Cloud and Precipitation Observations in NWP Models: Report of a Workshop
9.12	**Jim Purdom**	The Virtual Laboratory for Satellite Training and Data Utilization: Maximizing the Use of Satellite Data across the Globe

11:45-12:30
Session 10: Direct Reception/Software Packages — Chair: Guy Rochard

10.1	**Einar Grønås**	MEOS POLAR - A cost effective Direct Broadcast terminal for current and future L and X-band polar orbiting satellites
10.2	**Nigel Atkinson**	AAPP status report and review of developments for NOAA-N and METOP
10.3	**Philippe Marguinaud**	The IASI L1 processing software and its integration within AAPP

12:30-14:00 Lunch

14:00-15:30
Session 11: Preparations for METOP — Chair: Dieter Klaes

11.1	**Denis Blumstein**	IASI on METOP: On ground calibration of the FM2 instrument
11.2	**Peter Schlüssel**	Super Channel Selection for IASI Retrievals
11.3	**Thomas King**	Development of the IASI operational processing and distribution system
11.4	**Simon Elliott**	Dissemination of global products from MetOp
11.5	**Marc Schwaerz**	A Joint Temperature, Humidity, Ozone, and SST Retrieval Processing System for IASI Sensor Data: Properties and Retrieval Performance Analysis
11.6	**Éamonn McKernan**	Calibration and Validation of Metop/ATOVS and AVHRR products

15:30-16:00 BREAK

16:00-16:45
Session 12: Future Instruments **Chair: Jim Purdom**

12.1	**Paul Menzel (for Jeff Puschell)**	NPOESS VIIRS: Design, Performance Estimates and Applications
12.2	**Vince Tabor**	Initial Joint Polar-orbiting Satellite System (IJPS) Era Processing and Beyond at the Information Processing Division (IPD) of the National Environmental Satellite, Data and Information Service (NESDIS)
12.3	**Bjorn Lambrigtsen**	Microwave Sounder for GOES-R - A GeoSTAR Progress Report

Tuesday 31 May 2005

9:00-10:00 Technical and Working Group reports and actions summary
- AAPP, IAPP, 3I, ERA-40
- Radiative Transfer and Surface Property Modeling (Louis Garand)
- ATOVS/TOVS in Climate Studies (John Bates)
- ATOVS/TOVS in NWP (Steve English)

10:00-10:30 BREAK

10:30-11:30 Working Group reports and actions summary (continued)
- Advanced Infrared Sounders (Bill Smith)
- International Issues and Future Systems (Paul Menzel)
- Satellite Sounder Science and Products (Tony Reale)

11:30-11:45 Future meetings relevant to ITWG

11:45-12:00 Plans for next meeting and closing remarks Co-Chairs Tom Achtor, Roger Saunders

Poster Session A: Wednesday 25 May 2005

A01 **Fuzhong Weng:** Intersatellite calibration of HIRS from 1980 to 2003 using the simultaneous nadir overpass method for improved consistency and quality of climate data

A02 **Zhaohui Cheng:** Study of MSU Channel-3 Brightness Temperature Time Series Using SNO calibration method

A03 **Clémence Pierangelo:** 8-year climatology of dust aerosol in the infrared with HIRS

A04 **Clémence Pierangelo:** Impact of tropical biomass burning emissions on the diurnal cycle of mid to upper tropospheric CO2 retrieved from NOAA-10 satellite observations

A05 **Claudia Stubenrauch:** Evaluation of parametrizations of microphysical and optical properties for radiative fluxes computations in climate models using TOVS-ScaRaB satellite observations

A06 **Chunxiang Shi:** Study on Cloud Classifications by using AVHRR, GMS-5 and Terra/MODIS satellite data

A07 **Donald Chu:** Resolving Tropical Storm Inner Core Temperatures with a Three-Meter Geostationary Microwave Sounder

A08 cancelled

A09 **Jeff Puschell:** Wind Imaging Spectrometer and Humidity-sounder (WISH)

A10-A16 cancelled

A17 **Bjarne Amstrup:** First experiences with RTTOV8 for assimilating AMSU-A data in the DMI 3DVAR data assimilation system

A18 **Steve English:** Implications for modelling ocean surface emissivity for AMSU, ATMS and CMIS from the Windsat mission

A19 **Steve English (for Bill Bell):** The assimilation of SSMIS radiances at the Met Office

A20 **Ralf Bennartz:** The Second International Precipitation Working Group (IPWG-2004) Workshop

A21 **Jakob Grove-Rasmussen:** Implementation of AMSU-A usage over sea-ice regions in DMI-HIRLAM
A22 **Sang-Won Joo:** Recent Development of ATOVS usage in Korea Meteorological Administration
A23 **Fatima Karbou:** On the assimilation of AMSU-A & -B raw radiances over land at Météo-France
A24 **Kozo Okamoto:** Assimilation of SSM/I radiances in the NCEP global data assimilation system
A25 **Yoshihiro Yamasaki:** TOVS and the MM5 analysis over Portugal
A26 **Vibeke Thyness:** Assimilating AMSU-A over sea ice
A27 **Per Dahlgren:** Data Assimilation of ATOVS at SMHI, Sweden
A28 **Izabela Dyras:** The retrieval of the atmospheric humidity parameters from NOAA/AMSU data for winter season
A29 **Songyan Gu:** Soil Moisture Retrieval Test over The West of China by Use of AMSU Microwave Data
A30 **Zhe Liu:** Analysis of typhoon rananim using products retrieved from ATOVS
A31 **Zhiquan Liu:** Robust Variational Inversion : A Study with ATOVS data
A32 **Mitch Goldberg (for S. Kondragunta):** Total Ozone Analysis from SBUV/2 and TOVS (TOAST)
A33 **Mitch Goldberg (for Cheng-Zhi Zou):** MSU channel 2 brightness temperature trend when calibrated using simultaneous nadir overpasses
A35 **Peter Wang:** Assessment of Precipitation Characters between Ocean and Coast area during Winter Monsoon in Taiwan
A36 **Thwong-Zong Yang:** Rain Rate Estimation in Summer of Taiwan
A37 **Tom Kleespies (for Yong Han):** Optran Version 7
A38 **Tom Kleespies (for Paul van Delst):** The Community Radiative Transfer Model (CRTM) Framework
A39 **Fiona Hilton:** Establishing a Microwave Land Surface Emissivity Scheme in the Met Office 1D-Var
A40 **Chengli Qi:** Atmospheric transmittance calculation of Infrared atmospheric sounder of FY-3A meteorological satellite
A41 **Dieter Klaes:** First results from NOAA-N with the ATOVS and AVHRR Product Processing Facility for EPS
A42 **Fengying Zhang:** Overview of ATOVS data processing and applications at NSMC of China

Poster Session B: Thursday 26 May 2005

B01 **Domenico Cimini:** Analysis of radiosonde quality characteristics by ground- and satellite-based simultaneous observations during the WVIOP2004 experiment
B02 **Tony Reale:** Satellite Coincident Reference Upper Air Network and Potential Impacts on Real-time and Retrospective Satellite Products
B03 **Tony Reale:** NOAA Operational Sounding Products for Advanced -TOVS: 2004/5
B04 **Jörg Schulz:** The Humidity Composite Product of EUMETSAT's Climate Monitoring SAF: Towards Optimal Merging of Satellite Data Sets
B05 **Vanessa Sherlock:** Preliminary results from the Lauder site of the Total Carbon Column Observing Network (TCCON)
B06 **Vanessa Sherlock:** A simulation study of the impact of AIRS fast model errors on the accuracy of 1D-Var retrievals from AIRS radiances
B07 **Steve Ackerman:** Cloud Detection: Optical Depth Thresholds and FOV Considerations
B08 **Jian Liu:** An Automated, Dynamic Threshold Cloud Detection Algorithm
B09 **Rolando Rizzi:** Preliminary results combining ground based-Raman lidar and airborne spectrometers to describe the evolution of a cirrus cloud (Italian Eaquate campaign)
B10 **Chaohua Dong:** Experimental study on water vapor amount calculation using 940 NM absorption spectral band data
B11 **Yang Hu:** FY3 MicroWave Imaging Radiometer (MWIR) surface parameters inversion algorithm and validation in China
B12 **Chian-Yi Liu:** Applications of the GOES-R HES (Hyperspectral Environmental Suite) Infrared measurements
B13 **Chian-Yi Liu:** Improvement on sounding retrievals from GOES Sounder measurements
B14 **Chian-Yi Liu:** Synergistic Use of the ABI and HES for Atmospheric Sounding and Cloud Property Retrieval

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B33 **Jing Huang:** Estimating the Retrievability of Atmospheric Temperature from Satellite Infrared Simulation data
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B35 **Rodrigo Souza:** ICI Atmospheric profiles over Rondonia using HSB data emulated from AIRS information
B36 **Rodrigo Souza:** Performance of the AQUA/NASA and NOAA-16/ICI soundings over Rondonia during the dry-to-wet LBA Experiment
B37 **Rodrigo Souza:** Investigation of Methodologies for Atmospheric Retrieval for the CPTEC Operational System
B38 **Martin Stengel:** Remote sensing of vertical integrated water vapor using SEVIRI infrared measurements
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B41 **Roger Saunders:** Results of a comparison of radiative transfer models for simulating AIRS radiances
B42 **David Shawn Turner:** The Gradient Fast Line-by-Line Model
B43 **Hal Woolf:** Do Training Datasets Make a Difference?
B44 **Thomas Achtor:** The International MODIS - AIRS Processing Package (IMAPP)
B45 **Adam Dybbroe:** Improved navigation of Advanced Very High Resolution Radiometer data at high latitudes
B46 **Thomas King (for Walter Wolf):** A Near Real-Time AIRS Processing and Distribution System: Current Products and Future Plans
B47 **Lihang Zhou:** The Application of Principal Component Analysis (PCA) to AIRS Data Compression
B48 **Yunlong Lin:** Introduction to Spatial Heterodyne Observations of Water (SHOW) Project and its Instrument Development
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ITSC-XIV ABSTRACTS

SESSION 1

1.1: Ultra High Spectral Resolution Satellite Remote Sounding - Results from Aircraft and Satellite Measurements

Presenter: William L. Smith

William L. Smith[1], H-L. Allen Huang[2], Henry E. Revercomb[2], and Daniel K. Zhou[3]
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[2]University of Wisconsin, Madison WI, USA
[3] NASA Langley Research Center, Hampton, VA.

Ultra high spectral sounding measurements are now being obtained from the Aqua satellite Atmospheric Infrared Sounder (AIRS) fulfilling the dream of obtaining high vertical resolution temperature and moisture profiles remotely from space. The AIRS was proposed as a result of the successful aircraft demonstration of the ultra high spectral resolution sounding concept conducted in 1986 with the High resolution Interferometer Sounder (HIS), from the high altitude NASA ER-2 aircraft. Since that time two cross-track scanning successors to the HIS, the NAST-I and the S-HIS have been flying to validate the AIRS and to pave the way for ultra high spectral resolution interferometer sounders soon to fly on the NPOESS and METOP operational satellites. This presentation reviews the historical development of the ultra high spectral resolution sounding concept, showing various milestone results of the program. Plans for the implementation of the ultra high spectral resolution sounding concept on geostationary satellites, in order to obtain four dimensional imagery of the atmosphere, is also discussed.

1.2: A global cloud detection scheme for high spectral resolution instrument

Presenter: Lydie Lavanant

Lydie Lavanant
Météo-France/DP/CMS/R&D

The atmospheric Infrared Sounder (AIRS) was launched in May 2002 on board the AQUA platform and the IASI instrument is foreseen for mid 2006 on board METOP. These new high spectral resolution instruments provide several thousands of channels covering the spectral range between 3,7 μm to 15 μm which should allow an efficient cloud detection.

Conclusions from a previous study (see ITSC13, Lavanant) indicates that there is no real difficulty to detect and characterize easy clouds (e.g. opaque cold clouds) with classical methods such as the CO2-slicing or the ECMWF schemes using high resolution sounders alone. However, these schemes are not very efficient for clouds with small radiative effects on the observation (e.g. thin semi-transparent clouds, fractional clouds) having a signal similar to NWP errors.

The main goal of this study is to test different approaches for cloud detection more sensitive to clouds having low radiative effects and to quantify the level of sensitivity of a 1D-Var scheme to these clouds. The three following schemes have been tested:

- Cloud mask using a selection of sounding channels
- Processing of the spectrum principal components
- Use of the IASI level1c clusters from imager

and compared to the cloud mask applied to the co-registered full resolution imager (AVHRR, MODIS). A proposed strategy for a robust cloud scheme is then given.

1.3: Cloud Classification of Satellite Radiance Data by the Local Region of Influence Method

Presenter: Bormin Huang

Bormin Huang[1], Steven A. Ackerman[1], W. Paul Menzel[2]
[1]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison
[2]Office of Research and Applications, NOAA/NESDIS

We developed a new technique, the local region of influence (LROI) method, for supervised cloud classification of satellite radiance data. The classification of each new observation is performed within the LROI, where the center of each class is calculated as a weighted average of its training class members with respect to the observation. The probability of each class is assigned to each observation, which represents the fraction of each class within the observed field of view (FOV). The proposed LROI scheme is applied to the Moderate Resolution Imaging Spectroradiometer (MODIS) radiances observed from the scenes of clear skies, ice clouds, or water clouds. The classification results are compared with those from the maximum likelihood (ML) classification method, the multicategory support

vector machine (MSVM) and the operational MODIS cloud mask algorithm. The lowest misclassification error rates show the advantage of the LROI scheme. Unlike the other schemes, the LROI scheme also provides the information of cloud fraction of each cloud type within each FOV, which is a desired parameter for cloudy remote sensing.

1.4: Satellite Infrared Radiance Validation Studies using a Multi-Sensor/Model Data Fusion Approach

Presenter: Allen Larar

Allen M. Larar[1], William L. Smith[2], Daniel K. Zhou[1], Xu Liu[1], and Stephen Mango[3]
[1]NASA Langley Research Center
[2]Hampton University
[3]NPOESS Integrated Program Office

Global remote sensing of the Earth system to enhance our scientific understanding and monitoring capability of the land, ocean, atmosphere, clouds and, ultimately, climate requires accurate and precise long-time-series of radiometric measurement data from multiple instruments on multiple platforms. Understanding and correctly interpreting these data require the ability to separate geophysical variability from instrument response changes, as well as some absolute reference to the true geophysical state. This requires a detailed instrument system-level characterization pre-launch, as well as extensive in-flight calibration and validation activities. Field validation measurements from high-altitude airborne interferometric sensors are critical for this validation task, since only such observations can provide the proper spatial and temporal context needed as well as an accurate emulation of the satellite measurement system being validated. This study addresses some of the challenges encountered validating high spectral resolution infrared systems, using data from the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Airborne Sounding Testbed--Interferometer (NAST-I), along with data from other independent measurement systems and model simulations.

1.5: An optimal cloud-clearing method for AIRS radiances using MODIS

Presenter: Chian-Yi Liu (for Jun Li)

Jun Li[1], Chian-Yi Liu[1], H.-L. Huang[1], Xuebao Wu[1], Timothy J. Schmit[2], and W. Paul Menzel[2]
[1] Cooperative Institute for Meteorological Satellite Studies
[2] NOAA/NESDIS

The Atmospheric Infrared Sounder (AIRS), onboard NASA's EOA Aqua satellite, provides atmospheric vertical temperature and moisture sounding information with high vertical resolution and accuracy for Numerical Weather Prediction (NWP). Due to its relatively poor spatial resolution (13.5 km at nadir), the chance for an AIRS footprint to be clear is small. However, the Moderate Resolution Imaging Spectroradiometer (MODIS), also onboard Aqua, provides co-located clear radiances at several infrared (IR) spectral broad bands with 1 km spatial resolution within many AIRS cloudy footprints. An optimal cloud-removal or cloud-clearing (CC) algorithm is developed to retrieve the AIRS clear column radiances from the combined MODIS IR clear radiances with high spatial resolution and the AIRS cloudy radiances on a single footprint basis. The AIRS cloud-removed or cloud-cleared radiance spectrum is convoluted to all the MODIS IR spectral bands with spectral response functions (SRFs), and the convoluted brightness temperatures (BTs) are compared with MODIS clear BT observations within all successful cloud-cleared footprints. The bias and the standard deviation between the convoluted BTs and MODIS clear BT observations is less than 0.25 K and 0.5 K, respectively, over both water and land for most MODIS IR spectral bands. The retrieved AIRS soundings from cloud-cleared radiance spectra are compared with the ECMWF analysis and dropsonde data for CC performance evaluation. The AIRS cloud-cleared BT spectrum is also compared with its nearby clear BT spectrum, the difference, accounting the effects due to scene non- uniformity, is reasonable according the analysis. It is found that more than 30% of the AIRS cloudy (partly and overcast) footprints in this study have been successfully cloud-cleared using the optimal cloud-clearing method, revealing the potential application of this method on the operational processing of future GOES-R Hyperspectral Environmental Suite (HES) cloudy radiance measurements when the collocated Advanced Baseline Imager (ABI) IR data is available.

1.6: Characterization of Infrared Imager/Sounder and Infrared/Microwave Sounder Synergistic Cloud-Cleared Infrared Radiances

Presenter: Allen Huang

H.-L. Huang[1], Li Guan[1], Kevin Baggett[1], Jun Li[1], Chian-Yi Liu[1], Xuebao Wu[1], Timothy J. Schmit[2], and W. Paul Menzel[2]
[1] Cooperative Institute for Meteorological Satellite

Studies, University of Wisconsin-Madison
[2] Office of Research and Applications, NOAA/NESDIS

Satellite infrared sounders, such as AIRS, CrIS, and IASI, have relatively large fields of view that the probability of an entirely cloud-free observation is characteristically low. The direct assimilation of cloudy radiances and cloudy sounding retrievals is currently prohibitive due to the difficulty in accurate modeling and treatment of the cloud signal part of the measurements. Efforts have only just begun to model the microphysical complexity of clouds and their radiative responses, Still under development is the parameterization of cloud properties that will deliver much needed improvements in the speed and accuracy of forward radiative transfer models. In the interim, indirect use of cloud contaminated radiances by way of cloud-cleared radiances has since received great attention to improve both the spatial and spectral yields of useful satellite infrared radiances and sounding products.

Two classes of cloud-clearing retrieval approaches for IR radiances developed so far involve the synergistic use of 1) collocated infrared and microwave measurements, and 2) collocated infrared imaging and sounding measurements. For example, the NASA Earth Observing System (EOS) is currently demonstrating the AIRS/AMSU and AIRS/MODIS cloud-clearing algorithms. These algorithms are to be adopted by NPP/NPOESS as that will have similar measurements available from the instrument suites CrIS/ATMS and CrIS/VIIRS.

In this paper we will evaluate the characteristics of these cloud-cleared radiances and their potential for improvements of numerical weather prediction and cloudy sounding applications. Preliminary results have shown that these two approaches, though quite different in character, and processing methodology, are both effective and have certain unique characteristics and deficiencies. Where microwave measurements are unavailable, the synergistic imaging/sounding approach to cloud-clearing is the only reliable indirect use of cloud contaminated infrared measurements. This is the case for the U.S. Geostationary Operational Environmental Satellite (GOES) next generation system (GOES-R) that will carry only the infrared imager ABI (Advanced Baseline Imager) and infrared sounder HES (Hyperspectral Environmental Suite).

SESSION 2

2.1: A neural network based algorithm for the retrieval of TPW from AMSU measurements

Presenter: Devendra Singh

Devendra Singh, R. C. Bhatia and Sant Prasad
India Meteorological Department

In the present study a neural network based algorithm for the retrieval of TPW has been developed using Advanced Microwave Sounding Unit (AMSU-A) measurements from NOAA-16 satellite. This algorithm uses the limb adjusted brightness temperatures at four frequencies 23.4 Ghz, 301.4 Ghz, 50.3 Ghz and 89.0 Ghz obtained from AMSU-A on board NOAA-16 satellite as input and TPW derived from radiosonde profiles as output over Arabian Sea and Bay of Bengal. The collocated pairs of input and output are restricted to the homogeneous emitting areas e.g. ocean only. The retrieval accuracy in terms of bias and rmse of TPW based on neural network algorithm and that of radiosonde derived TPW are found to be 0.06 mm and 4.18 mm respectively. Further the intercomparisons have also been carried out with lot more accurate TPW data provided by DAAC/NASA through Internet from Advanced Infrared Sounder onboard the EOS Aqua platform. These inter comparisons have been made for the month of January and July 2004. It has been observed that TPW retrieved using neural network algorithm from AMSU measurements onboard NOAA16 satellite are comparable with that of AIRS retrieved TPW data. These two data sets are found to be correlated significantly. The bias and rmse errors of TPW from neural network algorithm are also comparable to other data sets of TPW derived from different satellites.

2.2: Microwave integrated system for retrieving atmospheric temperature, water vapor and cloud water profiles

Presenter: Fuzhong Weng

Fuzhong Weng, Mark Liu, Yong Han, and Mitch Goldberg
NOAA/NESDIS

The Advance Microwave Sounding Unit (AMSU) measurements are increasingly utilized to derive a variety of atmospheric and surface parameters such as total precipitable water, cloud liquid and ice water, as well as surface snow and sea ice concentration. These products are now routinely generated from the AMSU measurements at a few window channel frequencies which are insensitive to the vertical structures of atmospheric profiles [1]. In particular, atmospheric parameters such as vertically integrated water vapor and cloud liquid water can be derived analytically over oceans where the surface emissivity is low and relatively uniform, and the atmospheric emission from clouds and water vapor is predominant. This study develops a microwave integrated retrieval system (MIRS) to derive the profiles of atmospheric parameters such as temperature, water vapor, and cloud hydrometeors over land and oceans by using the measurements from AMSU window and sounding channels. An advanced radiative transfer model including atmospheric and surface scattering and polarization is developed and integrated as part of the MIRS. With the microwave surface emissivity model, water vapor and cloud water can be retrieved over land. With the scattering radiative transfer model, the algorithm is now generally applicable under all weather conditions. A combined use of both microwave window and sounding channels makes it possible to simultaneously derive the cloud water profiles in addition to temperature and water vapor profiles. This integrated approach will lead to more robust advanced microwave products from current and future satellite microwave instruments having both imaging and sounding channels.

2.3: Preliminary Results of Atmospheric Temperature Retrievals with Least Squares Support Vector Regression

Presenter: Zhigang Yao

YAO Zhigang GU Hongfang CHEN Hongbin
LAGEO, Institute of Atmospheric Physics, CAS

The goal of this work is to investigate the performance of Least Squares Support Vector Regression (LS-SVR) for retrieving atmospheric temperatures from satellite sounding data. LS-SVR is a new regression tool and has not been widely used for geophysical parameter retrievals from satellite sounding data. Compared to artificial neural networks, LS-SVR has the advantage that it leads to a global model, which is capable of dealing efficiently with dimensional input vectors. The temperature retrievals with LS-SVR using the collocated RAOB and AMSU-A measurements over the East Asia in 2002-2004 are conducted. The overall root mean square (RMS) error in the retrieved profiles of a testing dataset is remarkably smaller than the overall error using a multi-linear regression. While the offset of 0.5 K or the noise of 0.2 K is added to all channels simultaneously, the increase in the overall RMS error is less than 0.1 K. The experiments of the variation of the training data show that for the small training dataset LS-SVR could obtain significantly more information from the sounding data than the linear regression.

2.4: NOAA/NESDIS updates for sounding data products and services

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

A.K. Sharma
NOAA/NESDIS

The National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services (NOAA/NESDIS) generates and distributes atmospheric sounding products as a part of its operation for operating a fleet of civilian, Polar Orbiting Environmental Satellites (POES) and providing users and researchers a suite of operational atmospheric and environmental data products. Sounding products are generated using the advance TIROS Operational Vertical Sounder (ATOVS) measurements. The current 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/3) instrument. Sounding products have been generated from all three satellites until late October 2003, when AMSU-A on NOAA-17 failed and soundings were terminated from NOAA-17. NOAA-N is planned to be launched in May 2005 will have Advanced Very High Resolution Radiometer (AVHRR/3), HIRS/4, AMSU-A and Microwave Humidity Sounder (MHS) instruments used in deriving the sounding data products. This presentation will include the discussion on the improvements of the data quality and timeliness 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 sounding data products from the upcoming NOAA satellites NOAA-N, and NOAA-N' and the European Organization for the Exploitation of Meteorological (EUMSAT) satellites, Meteorological Operational Satellite (MetOp-1) and MetOp-2 will be discussed.

2.5: The analysis of typhoon parameters by using AMSU data

Presenter: Peter Wang

Chien-Ben Chou[1], Ching-Yuang Huang[2], Peter Wang[1], Mei-Hui Liao[1], and Lee-Nan Shee[1]
[1]Central Weather Bureau
[2] Institute of Atmospheric Physics, National Central University

The Advanced Microwave Sounding Unit (AMSU) can be used to retrieve the parameters of typhoon, because the obstructed effect of the cloud to the microwave is minor than to the infrared and the higher resolution of AMSU than the Microwave Sounding Unit (MSU). The three dimension rotational winds component can be obtained by solving the nonlinear balance equations using the retrieval temperature from AMSU under following assumption: hydrostatic balance, the height of 50hPa over the top of typhoon is same as environment and gradient balance. The divergent wind component can be evaluated from the omega equation. The diabatic term in the omega equation was estimated from the rainfall rate that obtained from AMSU observations. The frictionally-induced convergence in the boundary layer was represented by a parameterization. In this article we formulate a procedure to analyze the structure of temperature and winds in typhoon through AMSU observation. Some analysis cases have been presented. Some typical feature of typhoon can be captured by AMSU data. And one simulation case using MM5 with retrieval wind also has been accomplished. The simulation results show the potential of AMSU data in numerical weather forecast.

2.6: Estimating stability indices from MODIS infrared measurements over the Korean Peninsula

Presenter: B. J. Sohn

B. J. Sohn[1], Sung-Hee Park[1], Eui-Seok Chung[1], Marianne Koenig[2]
[1]School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea
[2]EUMETSAT

A retrieval algorithm was developed to estimate stability indices (SI) over the Korean Peninsula using Terra/Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) brightness temperature (TB) measurements. SI is defined as the stability of the atmosphere in hydrostatic equilibrium with respect to vertical displacements and is a critical factor in severe weather development. Atmosphere profiles, required for estimating SI, are retrieved from MODIS infrared channel measurements using Regional Data Assimilation and Prediction System (RDAPS) data as initial-guess profiles. A fast radiative transfer model, RTTOV-7, is utilized to reduce computational burden related to physical relaxation method. K index, KO index, lifted index, and maximum buoyancy are obtained.

The estimated TBs based on satellite-derived algorithm are in good agreement with observed MODIS TBs. To test usefulness of this method for short-term forecast, the algorithm is applied to several cases of rapidly developing convective storms observed over the Korean Peninsula. Compared with SI calculated from RDAPS forecast, satellite estimated SI was able to predict instability well over pre-convective areas. Thus, it is expected that the nowcasting and short-term forecast can be improved by the operational SI product from satellite measurements.

2.7: Version 4 AIRS Data Products

Presenter: Bjorn Lambrigtsen (for Sung-Yung Lee)

Sung-Yung Lee, George Aumann, Eric Fetzer, Steve Gaiser, Stephanie Granger, and Evan Manning
Jet Propulsion Laboratory
California Institute of Technology

The AIRS science team finished the work on version 4 data processing software. Goddard DAAC is processing and releasing AIRS version 4 data products. The reprocessing of past AIRS data since September 2002 will be finished later this year. There were only few minor changes to calibration software. The improvements include smoothing of calibration coefficients to reduce striping on certain channels, geolocation of AIRS footprints and quality control of AIRS radiance products. The changes to radiances are very small in this version. This is the second release of level 2 data products, or retrieved geophysical parameters. The changes include improvement of retrievals over land surfaces, new quality flags for many retrieved parameters, and significant improvement to the cloud parameters. This version is the first release of AIRS level 3 data products, or mapped geophysical parameters. Many of the AIRS level 2 data products are averaged on a one degree by one degree grid. Retrievals from ascending orbits are averaged separately from those from descending orbits. Some MW only data products are also gridded. It has been observed that huge data volume of AIRS hinders the analysis of AIRS data, as well as data processing at Goddard DAAC. The AIRS data products now use the HDF internal data compression. This reduces the data volume by more than half without impacting the quality of data or the ease of its usage.

2.8: Retrieving the effective radius of Saharan dust coarse mode with AIRS observations

Presenter: Clémence Pierangelo

Clémence Pierangelo[1], Michael Mishchenko[2], Yves Balkanski[3], Alain Chédin[1]
[1] Laboratoire de Météorologie Dynamique / IPSL
[2] Goddard Institute for Space Studies / NASA
[3] Laboratoire des Sciences du Climat et de l'Environnement / IPSL

Dust size distribution constitutes a key parameter to assess clear-sky shortwave aerosol radiative forcing. A large number of in-situ or remote sensing experiments have been developed to retrieve information on this key parameter. In this study, we show that the effective radius of dust coarse mode can be retrieved from Aqua/Advanced Infrared Sounder (AIRS) observations, with a two step process. First, for each AIRS observation, the dust infrared optical depth, the mean altitude of the dust layer and an estimate of the temperature and water vapor tropospheric profiles are obtained from 8 channels, using a Look-Up-Table approach. Second, once these parameters are determined, the effective radius is retrieved from an additional AIRS channel, sensitive to dust size and not to ozone variations or dust shape (channel 165: 1072.5 cm^{-1} or 9.32 µm). We present a comparison between dust coarse mode effective radius retrieved from AIRS over the Atlantic Ocean for the period April to June 2003 and in-situ measurements, General Circulation Model simulations and sun-photometer retrievals. We determine from our retrieval that the coarse mode effective radius decreases with transport, from 2.4 µm near the African coast to 1.9 µm over the Caribbean islands.

2.9: Combining GPS occultations with AIRS infrared measurements for improved atmospheric sounding

Presenter: Eva Borbas

Eva E. Borbas[1], Elisabeth Weisz[1], Jun Li[1], and W. Paul Menzel[2]
[1]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin/Madison
[2]NOAA/NESDIS Office of Research and Applications

After simulating the effect of GPS/RO data on IR/MW measurements and confirming the results with tests on real ATOVS and CHAMP data, the focus of this work has turned to combining high spectral resolution AIRS measurements with GPS data regression based profile retrievals.

AIRS, AMSU from the Aqua satellite collocated with radiosonde (for validating retrievals) and GPS measurements from CHAMP and SAC-C satellite were collected from September 2002 to December 2003. 1872 collocations were found under all weather conditions. After testing various cloud masks, 373 clear sky collocations remained.

This paper presents the results after testing two regression algorithms on these data: a linear statistical regression algorithm and a principal component regression. A new in-house training dataset was used to calculate the regression coefficients. Calculated AMSU and AIRS brightness temperatures for a fixed number of optimal channels and calculated GPS refractivity profiles were regressed against radiosonde temperature and humidity profiles. These regression coefficients were then applied to the 373 collocations (real data) and the retrievals were validated with RAOB data. GPS is found to provide valuable upper tropospheric information that improves the profile retrieval from AIRS and AMSU.

2.10: Neural networks for atmospheric temperature retrieval from AQUA AIRS/AMSU/HSB measurements on different types of terrain

Presenter: Deming Jiang

Deming Jiang[1,3], Dong Chaohua[2], Zhang Peng[2], Wu Xuebao[2]
[1] Nanjing Institute of Meteorology
[2] National Satellite Meteorological Center
[3] Hunan Meteorological Institute

The high spectral resolution sounding suite instruments amounted on EOS Aqua are expected to provide estimated atmospheric profiles with higher accuracy and better vertical resolution. To validate and test its performance with its orbital measurements data, temperature profiles at 100 pressure layers, up to 0.005 hPa, were retrieved on different types of terrain and on different spectral bands in the middle latitude by using a three-layered feed-forward neural networks with back-propagation algorithm. RMS temperature errors between estimated profiles and the co-located ECMWF analysis profiles were analyzed.

2.11: Initial retrieval inter-comparisons from the European AQUA Thermodynamic Experiment

Presenter: Daniel Zhou

Daniel K. Zhou[1], William L. Smith[2], Allen M. Larar[1], Jonathan Taylor[3], Gelsomina Pappalardo[4], and Stephen A. Mango[5]
[1]NASA Langley Research Center
[2]Hampton University
[3]Met Office
[4]Istituto di Metodologie per l'Analisi Ambientale
[5]NPOESS Integrated Program Office

The European AQUA Thermodynamic Experiment (EAQUATE) was conducted during September, 2004 in Italy and the United Kingdom to demonstrate certain ground-based and airborne systems useful for validating hyperspectral sounding observations from satellites. The main focus of the EAQUATE was placed on validation of the AIRS instrument on the EOS Aqua satellite. We report on some initial inter-comparisons between thermodynamic products from these ground-, airborne-, and satellite-based measurements, and demonstrate the validation capability of the field instruments used during the EAQUATE campaign.

SESSION 3

3.1: Using 22 Years of HIRS Observations to infer Global Cloud Cover Trends

Presenter: W. Paul Menzel

W. Paul Menzel[1], Donald P. Wylie[2], Darren L. Jackson[3], John J. Bates[4]
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[2]Space Science and Engineering Center, University of Wisconsin -Madison
[3]Cooperative Institute for Research in Environmental Sciences
[4]NOAA / NCDC

The frequency of occurrence of upper tropospheric clouds have been extracted from NOAA/HIRS polar orbiting satellite data from 1979 to 2001. A consistent 22-year record is available from the HIRS-2 sensor flown on nine satellites from TIROS-N through NOAA 14. CO2 slicing is used to infer cloud amount and height. Since 1979, HIRS measurements have found clouds most frequently in two locations; (1) the Inter-Tropical Convergence Zone (ITCZ) in the deep tropics where trade winds converge and (2) the middle to high latitude storm belts where low pressure systems and their fronts occur. In between are latitudes with fewer clouds and rain called sub-tropical deserts over land and sub-tropical high pressure systems over oceans. Globally averaged frequency of cloud detection (excluding the poles where cloud detection is less certain) has stayed relatively constant at 75%; there are seasonal. fluctuations but no general trends. High clouds in the upper troposphere (above 6 km) are found in roughly one third of the HIRS measurements; a small increasing trend of ~ 2% per decade is evident. The decadal average cloud cover has not changed appreciably from the 1980s to the 1990s; high cloud cover has changed some with increases of 10% in the western Pacific, Indonesia, and over Northern Australia. The most significant feature of these data may be that the globally averaged cloud cover has shown little change in spite of dramatic volcanic and El Nino events. During the four El Nino events winter clouds moved from the western Pacific to the Central Pacific Ocean, but their global average in the tropics did not change. El Chichon and Pinitubo spewed volcanic ash into the stratosphere that took 1-2 years to fall out, but cloud cover was not affected significantly.

The HIRS analysis differs from ISCCP which shows decreasing trends in both total cloud cover and high clouds during most of this period; HIRS detection of upper tropospheric thin cirrus accounts for most of the difference. GLAS observations of high thin clouds are found to be largely in agreement with the HIRS.

3.2: Survey of cirrus and atmospheric properties from TOVS Path-B: Natural variability and impact of air traffic on cirrus coverage

Presenter: Claudia Stubenrauch

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The TOVS Path-B data set provides atmospheric temperature and water vapor profiles as well as cloud properties over the globe, from 1987 to 1995. Their relatively high spectral resolution yields reliable cirrus properties, day and night. First, we present a survey of cirrus properties over this period and some new results of a reanalysis of the TOVS data which will extend the present data set back to 1979 and up to present.

The increase in anthropogenic aerosols and in air traffic has led to theoretical and observational investigations of the impact on the formation of cirrus clouds. Contrails form when the hot and humid exhaust gases from the combustion of fuels by an aircraft mix with the ambient, cold atmosphere. Their persistence depends on upper tropospheric humidity and temperature. We have determined upper tropospheric relative humidity from TOVS in order to distinguish situations favorable for persistent contrails. Then mean values and trends of effective high cloud amount have been analyzed in regions with high and low air traffic density. A significant increase of effective high cloud amount is found in regions with high air traffic densities, but only in situations with sufficiently cold and humid air masses favorable for persistent contrails. In such situations, which occur in about 5 to 10 % of all situations, and with effective high cloud amount averages of about 13 to 17 %, the cloud amount increased by about 5 % per decade over Europe and the North Atlantic Flight corridor. On average over all situations, the increase amounts to at least 0.3 % per decade in these regions.

3.3: Cloud Parameters from Infrared and Microwave Satellite Measurements

Presenter: Filomena Romano

D. Cimini[1], V. Cuomo[1], S. Laviola[1], T. Maestri[2], P. Mazzetti[1], S. Nativi[1], J. M. Palmer[1], R. Rizzi[2] and F. Romano[1]
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[2] ADGB - Dip. Fisica

Simultaneous measurements at infrared, visible and microwave obtained by sensors (MODIS, AIRS, AMSU) flying aboard Aqua platforms are used to investigate vertical cloud structure. Collocated MODIS 1km classification mask helps to determine whether an AIRS and AMSU pixels are partly cloudy or overcast, and whether it is characterized by single-layer clouds or multi-layer clouds. In a while AIRS high spectral resolution data will be able to improve IR-only cloud detection especially as far as ambiguous scenes are concerned, like stratus cloud regimes (characterized by very low spatial variability in the LW IR). Cloud top pressure, cloud thickness and cloud phase have been estimated using AIRS and AMSU data.

The obtained product will be validated using MSG and MODIS products and ground-based measurements such as multi-parametric weather radars data. In particular, weather radars working at C and S bands (2÷8 GHz) can provide useful information about cloud structure on wide areas with high spatial and time resolution. RHI (Range-Height Indicator) scans analysis allows to detect characteristics like the base and top of cloud, and melting layer altitude. Hydrometeor classification algorithms applied to RHI and PPI (Plan Position Indicator) or CAPPI (Constant Altitude PPI) scans allow to analyze the cloud structure in terms of hydrometeors types and phases.

3.4: Sensitivity study of the MODIS cloud top property algorithm to CO_2 spectral response functions

Presenter: Hong Zhang

Hong Zhang[1], Richard Frey[1] and Paul Menzel[2]
[1] Cooperative Institute for Meteorological Satellite Studies, Space Science and Engineering Center, University of Wisconsin, Madison, WI
[2] Office of Research and Applications, NOAA/NESDIS, Madison, WI

The operational algorithm of cloud top property product (MOD06/MYD06) from MODIS (MODerate-Resolution Imaging Spectroradiometer) on EOS Terra and Aqua has been developed at University of Wisconsin-Madison. The CO2 slicing algorithm was used to infer cloud top pressure and effective cloud amount. The accuracy of cloud product retrieval depends critically on the knowledge of the Spectral Response Function (SRF) used in a fast radiative transfer model. Intercalibration with AIRS (Atmospheric Infrared Sounder) has suggested a SRF shift of 1.0 /cm, 0.8/cm, and 0.8/cm for CO_2 band 36 (14.2 μm), 35 (13.9 μm), and 34 (13.6 μm), respectively. The shifted SRF has been studied in Aqua/MODIS granules; the early results have shown high thin clouds are very sensitive to the spectral adjustment, introducing a significant improvement of cloud top properties retrieval. Comparison of cloud top properties between AIRS and MODIS is studied to demonstrate the advantage of the spectral adjustment.

SESSION 4

4.1: Analysis of systematic errors in climate products

Presenter: John J. Bates

John Bates, Dongsoo Kim, Lei Shi
NOAA National Climatic Data Center
Remote Sensing Applications Division

Remote sensing of the Earth's atmosphere and surface properties using observations from operational satellites has yielded significant advances in both weather prediction and, more recently, climate studies. In order for observations from operational satellites to be useful in climate studies, considerable attention must be paid to minimizing any systematic errors in the time series of observations from multiple satellites.

Systematic errors can arise from several different causes: the intercalibration of one satellite to another in order to 'stitch together' a long time series, instrument and satellite health issues, and in the mathematical solution to the radiative transfer equation. There has been considerable discussion of the first two causes of systematic bias, relatively little attention has been paid to the latter and it is thus, the focus of this discussion.

There are two ways that systematic errors can become amplified and propagate through solutions to the radiative transfer equation: 1) by amplifying small systematic errors that are transient or slowly varying and hence usually otherwise neglected, and 2) by the initial guess implicit in some solutions, particularly in linear regression solutions. Because linear regression solutions are employed in several techniques widely used for retrieval of sea surface temperature (SST) and tropospheric temperature (e.g., from the Microwave Sounding Unit or MSU), we will focus our effort on these examples.

4.2: Climate monitoring of the free atmosphere: past mistakes and future plans

Presenter: Peter Thorne

Peter Thorne
Hadley Centre, Met Office
(also chair of GCOS Atmospheric Observation Panel for Climate Working Group on Temperature Trends)

Recent efforts to reconcile observed free-atmosphere climate variations with those observed at the surface will be discussed. This will draw heavily on work undertaken for the first U.S. Climate Change Science Program report. The major advance in interpreting apparently disparate temperature trend estimates since the last IPCC report has been a more thorough understanding of the large uncertainty in historical changes aloft. From a climate monitoring perspective we are searching for temperature trends of order 0.1K/decade, requiring an accuracy of the order 0.01K on these timescales in our reconstructions. This has not been achieved historically from either ground-based radiosonde or satellite-based MSU/AMSU observing platforms nor from current climate reanalyses products which aim to optimally combine these and other data. Hence for climate monitoring purposes it is essential that we instigate an observing system or system of systems that enables us to provide more rigorous constraints upon future long-term changes if the expensive efforts underway to monitor our global environment are to prove optimal. This includes both ground-based and satellite based monitoring and the development of a reference network which can provide strong constraints on time-varying biases. Work in progress by the WMO Global Climate Observing System, NOAA and other agencies to provide this architecture will be summarised. This is planned to result in a proposal by the end of 2005 and the setting up of a reference upper air network by 2009. This has been accorded the highest priority in the GCOS Implementation Plan, available at http://www.wmo.int/web/gcos/gcoshome.html. Any reference network will also have clear benefits for users outside the direct climate community. Finally, GCOS climate monitoring principles for satellites will be outlined. Feedback will be welcomed.

4.3: Satellite Coincident Reference Upper Air Network and Potential Impacts for Climate and NWP

Presenter: Tony Reale

Tony Reale
NOAA/NESDIS

During the past 25 years of NOAA operational polar satellites, it has become evident that a growing problem concerning their utilization in Climate and also Numerical Weather Prediction (NWP) applications are the systematic errors and uncertainties inherent in the satellite measurements. Similar arguments can be made for global radiosonde observations. These uncertainties are often larger than the sensitive signals and processes that satellite and radiosonde measurements are designed to reveal, particularly in the realm of climate. Possible strategies to quantify and compensate for these problems include the analysis of satellite overlap data and/or available collocations of satellite, radiosonde and numerical weather prediction (NWP) observations. However, overlap observations are typically not available except in extreme polar regions, and current strategies for analyzing collocated radiosonde and satellite (and NWP) observations are insufficient, further compounding the inherent uncertainties in these respective data platforms.

A satellite coincident Reference Upper Air Network is proposed to provide reference radiosonde and in-situ ground based measurements coincident with operational polar satellite(s) overpass. This proposed network would consist of approximately 40-50 sites, including existing Global Upper Air Network (GUAN) and Atmospheric Radiation Measurement (ARM) stations. The overall design would be to provide a robust and reliable sample of collocated global radiosonde and satellite observations conducive to the monitoring and validation of satellite and radiosonde observations and associated scientific approaches including radiative transfer models. The routine operation of such a network in conjunction with operational polar satellites would provide a long-term record of performance for these critical observations, of particular importance for climate, as well a shorter term monitoring useful for numerical weather prediction.

Details concerning the latest protocols for designing and operating such a network are presented. This includes specific recommendations from the recently held joint NOAA/Global Climate Observing System (GCOS) Workshop for upper air observations (February, 2005) that a program to establish a Reference Upper Air Network be pursued. Preliminary activities to establish routine data collection from ARM sites, NOAA-NWS sites and existing global sites already providing satellite coincident observations are also presented.

The potential impact of the proposed reference network with respect to the suite of integrated global measurements (including derived satellite products) available for respective climate and NWP applications is also discussed. Such data require that systematic errors and uncertainties be compensated for prior to assimilation. The poor historical record of such parameters has compromised the value of critical upper air observations particularly for climate.

4.4: Spatial and Temporal Characteristics of Satellite-Derived Clear-sky Atmospheric Temperature Inversions in the Arctic, 1980-1996

Presenter: Yinghui Liu

Yinghui Liu[1], Jeffrey R. Key[2], Axel Schweiger[3], Jennifer Francis[4]
[1]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison
[2]Office of Research and Applications, NOAA/NESDIS
[3]Polar Science Center, University of Washington
[4]Rutgers University

Low-level atmospheric temperature inversions are ubiquitous at high latitudes during the polar winter, spring, and autumn. Temperature inversions influence the magnitude of heat and moisture fluxes through openings in the sea ice, the depth of vertical mixing in the boundary layer, cloud formation, aerosol transport, surface wind velocity, and lead formation. In this study, a statistical retrieval algorithm is applied to TIROS-N Operational Vertical Sounder (TOVS) water vapor and infrared window brightness temperatures to derive the seasonal mean inversion strength and trends over the period 1980-1996. Inversion strength is defined as the difference between the surface temperature and the maximum temperature in the lower troposphere. To alleviate inter-satellite calibration problems, coefficients of the algorithm are derived for the different satellites and years. The clear-sky seasonal mean inversion strength and trend show good agreement with those from radiosonde data in spring, autumn, and winter. In contrast, inversion strength calculated from TOVS temperature profile retrievals show biases on the order of 20-40%.

Temperature inversion strength has the largest mean value in winter, with greater inversion strength over the pack ice and river valleys in the Eurasian Arctic. The weakest winter inversions are over Norwegian and Barents Seas, with inversion strength increasing to the east. The spatial distribution of inversion strength is similar in autumn and spring, though autumn inversions are somewhat weaker. Inversion strength is near zero over land and approximately 2.5K over the entire Arctic Ocean in summer. Seasonal inversion strength shows decreasing trends over the Chukchi and East Siberian Seas in spring, autumn and winter, decreasing trends near Novaya Zemlya in spring, decreasing trends over northern Europe in winter, and increasing trends over northern Russia in winter. The correlation between inversion strength and the Arctic Oscillation is negative over northern Europe, north central Russia and East Siberian Sea, and positive over northern Canada.

4.5: Using HIRS observations to construct long-term global temperature and water vapor profile time series

Presenter: Lei Shi

Lei Shi and John J. Bates
NOAA NESDIS National Climatic Data Center

The HIRS instrument has been flown onboard the NOAA polar satellite series since 1978. The long-term measurement provides a valuable source for assessing global climatic change in the past decades. Previous work has generated a time series of cloud-cleared dataset at HIRS's original swath resolution. Further data processing is performed to correct the limb effort. A retrieval scheme based on neural network technique is developed to derive temperature and vapor profiles from the surface to around 50hPa. The training dataset is constructed with a diverse sample of atmospheric profiles from ECMWF reanalysis data and simulated HIRS brightness temperatures by the latest version of the broad band radiative transfer model RTTOV8.

Considering that the majority of HIRS channels are located in the carbon dioxide absorption band, the impact of carbon dioxide increase on the long-term HIRS measurement is examined in this study. The variation of carbon dioxide is included as one of the input variables in the retrieval scheme. The long-term variations of temperature and water vapor and the global distribution of these variables at different levels of the atmosphere will be shown.

SESSION 5

5.1: Overview and Status of the NPOESS System: Providing Improved Real-Time Data To Meet Future Needs

Presenter: Hal Bloom

Hal J. Bloom
NPOESS Integrated Program Office

The tri-agency Integrated Program Office (IPO) manages the development of the National Polar-orbiting Operational Environmental Satellite System (NPOESS). NPOESS will replace the Defense Meteorological Satellite Program (DMSP) and Polar-orbiting Operational Environmental Satellites (POES) that have provided global data for weather forecasting and environmental monitoring for over 40 years. Beginning in late 2009, NPOESS spacecraft will be launched into three orbital planes to provide significantly improved operational capabilities and benefits to satisfy critical civil and national security requirements for space-based, remotely sensed environmental data. NPOESS will observe more phenomena simultaneously from space than its operational predecessors and deliver a data volume significantly greater than the POES and DMSP systems with substantially improved delivery of data to users. Higher (spatial, temporal, and spectral) resolution and more accurate imaging and sounding data will enable improvements in short- to medium-range weather forecasts. NPOESS will support the operational needs of meteorological, oceanographic, environmental, climatic, and space environmental remote-sensing programs and provide continuity of data for climate researchers. With the development of NPOESS, we are evolving operational “weather” satellites into integrated global environmental observing systems by expanding our capabilities to observe, assess, and predict the total Earth system - atmosphere, ocean, land, and the space environment. The paper will provide a discussion on the aspects of the NPOESS system and status of key satellite and ground systems development.

5.2: The National Polar-Orbiting Operational Environmental Satellite System (NPOESS) and NPOESS Preparatory Project (NPP) Access to Data

Presenter: Peter Wilczynski

Peter A. Wilczynski and John W. Overton
NPOESS Integrated Program Office (IPO)

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.

The NPP is a joint-agency mission intending to serve the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO) and the National Aeronautics and Space Administration (NASA) and their user communities. The NPP provides the Earth science community with data continuity and also provides the IPO and its users a risk reduction demonstration of capabilities for critical NPOESS instruments. Current NPP status and the NPP architecture will be discussed as part of this presentation.

All NPOESS satellites will operate at a nominal 833 km altitude orbit with an inclination of 98.7 degrees (sun-synchronous) and have nodal crossing times to minimize critical revisit times. NPP will operate at a nominal 824 km altitude orbit at a 1030 descending node time. NPP and NPOESS have undertaken a far-reaching program of sensor development and satellite transition to provide complete coverage of meteorological conditions for civil, military, and scientific purposes while cutting operational costs dramatically. The program will adapt existing technology and develop new sensors.

To accomplish its mission, NPOESS satellites in three orbital planes will replace the two-satellite DMSP and POES constellations. The data will be processed into Raw Data Records (RDRs), Sensor Data Records (SDRs), and Environmental Data Records (EDRs) for use by a number of operational communities.

NPOESS delivers data to a variety of users. National and international weather, climate, hydrological, and space weather analysis and prediction centers serve the needs of billions of people worldwide. International services such as Search and Rescue Satellite-Aided Tracking (SARSAT) and ARGOS are part of the NPOESS mission.

NPOESS will provide regional data to all users in two direct broadcasts, global data within 90 minutes of observation to US Weather Centers, and global data to NOAA NESDIS's Archive System for worldwide subscription service. High Rate Data (HRD) will be broadcast using CCSDS packets at 15 Mbps at 7812 MHz and 20 Mbps at 7834 MHz. HRD will contain full resolution imagery and radiometric from all manifested environmental sensors. Low Rate Data (LRD) will be broadcast using CCSDS packets at 3.88 Mbps at 1707 MHz. LRD will contain information to produce imagery, cloud base height, and Sea Surface Temperature. LRD is only available on NPOESS satellites.

Stored Mission Data (SMD) will be transmitted to strategically placed receiving antennas necessary to achieve a 90 minute data latency. SMD data will be transmitted using CCSDS packets at 8212.5 MHz, or 26700.0 MHz. International users will have access to SMD via the NOAA NESDIS Archive.

Software to produce NPOESS XDRs will be made available to users through commercial vendors by the NPOESS Integrated Program Office. NPOESS will provide a continuing improvement in the accuracy of weather and climate forecasts for many years to come.

The paper will discuss the NPP and NPOESS SMD, HRD & LRD concept of operations, ground system requirements and development status. The paper will also discuss user involvement in the design and fielding of NPP and NPOESS.

SESSION 6

6.1: The OSS method: current research and new prospects

Presenter: Jean-Luc Moncet

Jean-Luc Moncet and Gennady Uymin
Atmospheric and Environment Research, Inc.

The Optimal Spectral Sampling (OSS) method models band averaged radiances as weighted sums of monochromatic radiances. The method is fast and accurate and has the advantage over other existing techniques that it is directly applicable to scattering atmospheres. Other advantages conferred by the method include flexible handling of trace species and ability to select variable species at run time without having to retrain the model, and the possibility of large speed gains by specializing the model for a particular application. The OSS method is used in the CrIS and CMIS retrieval algorithms and it is currently being implemented in the Joint Center for Satellite Assimilation (JCSDA) Community Radiative Transfer Model (CRTM). At the initial stage of development a so-called "localized" search approach has been considered. This approach provides the minimum number of nodes required for modeling the radiative transfer in individual channels. We also have been exploring the possibility of using the OSS approach as a generic tool applicable to narrowband and broadband radiative transfer modeling across the spectrum. This paper discusses current research topics with relevance to infrared sounding and assimilation in numerical weather prediction models. These include generalized node selection techniques for dealing with multiple-channels across wide spectral domains and multiple sensors, optical depth database compression and training of OSS for scattering atmospheres.

6.2: The successive order of interaction (SOI) radiative transfer model and its possible applications to radiance assimilation of clouds and precipitation

Presenter: Ralf Bennartz

Ralf Bennartz[1], Christopher O'Dell[1], Thomas Greenwald[2], Andrew Heidinger[3]
[1]University of Wisconsin-Madison
[2]Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison
[3]NOAA/NESDIS

Radiative transfer models for global data assimilation purposes have to fulfill stringent requirements in terms of computation speed, memory usage, and accuracy. In a project supported by the Joint Center for Satellite Data Assimilation (JCSDA) we developed a new, fast forward and adjoint radiative transfer model. This so-called successive order of interaction (SOI) model combines the successive order of scattering and doubling techniques to efficiently solve the scattering radiative transfer equation. The work aims at preparing for the assimilation of observed radiances of current and future passive microwave satellite sensors into NCEP's Global Data Analysis System (GDAS) under cloudy and precipitating conditions. Especially in precipitating situations scattering by rain droplets and precipitation-sized ice particles becomes important and has to be considered adequately in the radiative transfer. We will give an outline on the accuracy and speed of the SOI model and show application examples. The model has recently been extended to also work in the infrared spectral range and to account for scattering of cloud droplets. We will present first simulations of high resolution AIRS spectra.

6.3: Validations of a Principal Component-based Radiative Transfer Model Using AIRS and NAST-I Observed Radiances

Presenter: Xu Liu

Xu Liu[1], William L. Smith[2], Daniel Zhou[1], Allen Larar[1], Mitchell D. Goldberg[3]
[1]NASA Langley Research Center
[2]Hampton University
[3]NOAA/NESDIS

To effectively assimilating data observed from modern sensors with thousands of channels, rapid and accurate radiative transfer models are needed. Principal Component-based Radiative Transfer Model (PCRTM) is a rapid algorithm developed to meet this need. The PCRTM does its radiative transfer modeling in principal component domain instead of normal channel domain. The model has been successfully developed for various sensors. The current talk will present results of applying the PCRTM to AIRS and NAST-I radiance spectra.

6.4: Using microwave and infrared radiances from off-nadir pixels: application of radiative transfer to slanted line-of-sight and comparisons with NASA EOS Aqua data

Presenter: Paul Poli

Paul Poli[1] and Joanna Joiner[2]
[1]Meteo France CNRM/GMAP, previously at Global Modeling and Assimilation Office
[2]NASA Goddard Space Flight Center

The passive infrared and microwave nadir sounders such as (A)TOVS observe the atmosphere from a polar orbit by directing their scan pointed at the ground up to about 49 degrees from nadir. Except for the pixels located right on the satellite ground track, the radiance measurements collected by these instruments characterize hence atmospheric emission paths which are slanted with respect to the zenithal direction at the ground. At the outer swath edges, the deviations from nadir reach about 60 degrees in terms of Satellite Zenith Angle (SZA). The radiative transfer codes used in operational Numerical Weather Prediction applications make the appropriate corrections to account for the extra path induced by the non-zero SZA. However, no corrections are made to account for the fact that the atmospheric profiles along the slanted line-of-sight (LOS) are different from the vertical because of horizontal gradients in the atmosphere. Using NASA EOS Aqua satellite's orbits, zenith and azimuth angles, as well as three-dimensional fields of temperature, water vapor, and ozone produced by the NASA Global Modeling and Assimilation Office, we extracted slanted atmospheric profiles for actual soundings performed by the AIRS and AMSU-A instruments onboard EOS Aqua. We will present the results of our study comparing the calculated brightness temperatures along slanted LOS and vertical LOS with AIRS and AMSU-A observations.

6.5: Assessing spectroscopic parameter archives for the second generation vertical sounders radiance simulation; illustration through the GEISA/IASI database

Presenter: Nicole Jacquinet

Nicole Jacquinet, N.A. Scott, A. Chédin, R. Armante, K. Garceran, Th. Langlois
Laboratoire de Météorology Dynamique, Ecole Polytechnique

Line-by-line compilations of spectroscopic parameters are used for a vast array of applications and especially for terrestrial atmospheric remote sensing. Related with the radiance simulation for actual or near future atmospheric sounders, a review of the current state and recent developments of public spectroscopic databases such as GEISA, HITRAN and MIPAS has been made. Actually, the performance of instruments like AIRS (Atmospheric Infrared Sounder), in the USA, and IASI (Infrared Atmospheric Sounding 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, since these are essential input in the forward models used to simulate recorded radiance spectra.

For these upcoming atmospheric sounders, the so-called GEISA/IASI sub-database system has been elaborated, from GEISA. GEISA/IASI has been created with the specific purpose of assessing 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) Polar System preparation (EPS). EUMETSAT will implement GEISA/IASI into the EPS ground segment.

The purpose of this presentation is to show the results of a critical assessment, in terms of spectroscopic line parameters archive, of related databases such as GEISA, HITRAN and MIPAS. The actual content of GEISA/IASI will be presented. Spectrosocopic parameters quality requirements, as recommended by the GIDS, will be discussed in the context of comparisons between recorded and calculated experimental spectra, using the ARA/4A forward line-by-line radiative transfer modeling code in its latest version.

All the archived 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

6.6: Comparison of Simulated Radiances, Jacobians and Information Content for the Microwave Humidity Sounder and the Advanced Microwave Sounding Unit-B

Presenter: Thomas Kleespies

Thomas J. Kleespies[1] and Philip Watts[2]
[1]NOAA/NESDIS
[2]EUMETSAT

The Microwave Humidity Sounder (MHS) has similar scan characteristics to the Advanced Microwave Sounding Unit-B (AMSU-B). However, the radiometric characteristics are somewhat different, particularly for two channels. Both of these channels will sense somewhat deeper into the atmosphere for the MHS than the AMSU-B. The MHS also has higher information content than the AMSU-B due to its improved noise characteristics.

6.7: On the estimation and use of land surface microwave emissivities

Presenter: Fatima Karbou

Fatima Karbou
Météo-France/CNRM/GMAP

Abstract not available.

6.8: Development of the JCSDA Community Radiative Transfer Model (CRTM)

Presenter: Fuzhong Weng (for Yong Han)

Y. Han[1], F. Weng[1], J. Derber[2], P. van Delst[3], J. Moncet[4], Q. Liu[5], L. M. McMillin[1], T. J. Kleespies[1], C. Weaver[6], K. N. Liou[7], A. J. Gasiewski[8], and R. Bennartz[9]
[1]NOAA/NESDIS/ORA
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[3]CIMSS, University of Wisconsin-Madison
[4]AER, Inc
[5]QSS Group Inc
[6]NASA Goddard Space Flight Center
[7]University of California, Los Angeles
[8]NOAA/OAR/ETL
[9]University of Wisconsin-Madison

In recent years the Joint Center for Satellite Data Assimilation (JCSDA) has been developing a new generation of the fast radiative transfer model for use in the data assimilation systems to simulate satellite instrument radiances and their Jacobians. It is called the Community Radiative Transfer Model (CRTM), with contributions from government, academic and industrial research groups. The model integrates the components for fast and accurate computation of scattering and absorption due to gases, aerosols, clouds and precipitation. It also includes state-of-the-art surface emissivity and reflectivity algorithms for many surface types and conditions. The model covers visible, infrared, microwave sensors, both hyper-spectral and broadband. In this presentation, the model components will be described and important issues will be discussed.

SESSION 7

7.1: Use of satellite radiances in the 4D-VAR ECMWF system

Presenter: Graeme Kelly

Graeme Kelly
ECMWF

The paper will summarise the use of satellite data in the ECMWF 4D-VAR assimilation system and include likely changes in near future.

Currently in operations only clear satellite radiances are used. It is planned to use cloud-affected and rain-affected radiances in operations by the end of this year. Some results will be discussed.

The use of AMSUA data over land uses surface emissivity estimates based on the work from NOAA/NESDIS, 'day 1 AMSU algorithms.' An alternative method to calculate surface land emissivity has been developed and tested using clear sky AMSUA radiances together with the ECMWF model skin temperature. A comparison of results will be discussed.

Results will be presented showing the impact of assimilating radiances from two microwave sensors, SSMI/S and AMSR-E.

RTTOV8 and RTIASA are currently being merged and will become part of RTTOV9. A summary of the improvements to RTTOV with this merge will be discussed.

7.2: Use of Level-1D ATOVS Radiances in GASP

Presenter: Brett Harris

Brett Harris, Chris Tingwell, Peter Steinle. Bill Bourke, Michael Naughton, Greg Roff, Jaan Paevere
Bureau of Meteorology, Australia

In this study we show that using AAPP ATOVS based level-1D radiances in the BMRC Global Assimilation and Prediction (GASP) system can significantly improve prediction performance in both the mid-latitudes in the Southern Hemisphere and the Tropics. For this project we have implemented the GASP assimilation and prediction systems at a resolution of T239/L60, with the uppermost level at 0.1 hPa . We have compared the use of NESDIS level-1D ATOVS radiances as available on the GTS with AAPP derived 1D radiances as obtained via a direct link to the UKMO. There are significant differences between the two data streams particularly with the AMSU-A brightness temperatures. The UKMO data stream from AAPP provides higher spatial resolution of the soundings and also AMSU-B data which are not sent as part of the NESDIS product on the GTS. The impact of AMSU-B radiance assimilation within this framework will also be described. The integration of globally available AAPP ATOVS radiances with the Australian direct read-out AAPP radiances is being developed to enable a unified treatment of radiance assimilation in both the global and regional assimilation systems used in operations in the Bureau of Meteorology.

7.3: Current use of satellite data in the Met Office Global NWP model

Presenter: Fiona Hilton

Fiona Hilton, Nigel Atkinson, William Bell, James Cameron, Brett Candy, Andrew Collard, Amy Doherty, Stephen English, Una O'Keeffe*
Met Office, UK
**now at ECMWF, UK*

Since the last ITSC there have been important changes in the operational assimilation of satellite data at the Met Office. This paper will describe briefly the current global model configuration, including the change to 4D-Var in October 2004. It will then summarize the improvements made in the use of ATOVS and the introduction of AIRS in May 2004, and the addition of MODIS winds in February 2005. The current areas of research will be presented, which include: the use of SSMIS data; upgrading the forward model to RTTOV-8 and changing the pressure levels of the radiative transfer; the use of ATOVS over land; and microwave radiative transfer in scattering atmospheres. Longer term work includes preparing for METOP, in particular developing the processing methodology for IASI, and also researching the use of cloudy infrared radiances.

For a discussion of the use of ATOVS in Met Office regional models, see the paper by Candy et al., and for more information on the use of advanced IR sounder data see the paper by Cameron et al.

7.4: Respective contributions of polar orbiting and geostationary radiances within Meteo-Frances's operational 3D-Var assimilation system at regional scale

Presenter: Thibaut Montmerle

Thibaut Montmerle
Météo-France/CNRM/GMAP

Since March 2005, the 3D-Var ALADIN data assimilation system is used pre-operationally at Meteo-France with a 10 km horizontal resolution over Western Europe and 6 hours assimilation cycles. The system uses lateral boundary conditions coming from the global model ARPEGE, an incremental variational formulation and an ensemble based Jb calculated from an ensemble of Arpege/Aladin analyses and forecasts. First results will be shown here with a special emphasis on the use of ATOVS and SEVIRI radiances at high resolution. The latter radiometer, which is onboard the recently operational geostationary satellite Meteosat-8, presents evident advantages for LAM studies since it provides continuous access to information about the variation rates of temperature and humidity fields at high temporal and spatial resolutions. The use of the SAF NWC/MSG cloudy products allows furthermore to keep with confidence low-peaking channels in the cloud-free areas and channels above the cloud for cloudy pixels.

The discussion will focus on the relative impact of these two types of radiances observed from polar orbiting and geostationary satellites for weather prediction at regional scale. In particular, The sensitivity of the analyses to these observations will be addressed.

7.5: Use of radiances in the operational assimilation system at Météo-France

Presenter: Florence Rabier

Florence Rabier[1], Elisabeth Gérard[1], Thibaut Montmerle[1], Delphine Lacroix[1], Paul Poli[1], Mohamed Dahoui[2]
[1]Météo-France/CNRM/GMAP, Toulouse, France
[2] Direction de la Météorologie Nationale, Morocco

The use of raw radiances has now been extended to all ATOVS instruments: AMSUA as a first step in 2002, then HIRS in 2003, and AMSU-B in 2004. Furthermore, EARS data and locally received data are now used in complement to the global set of radiances.

The purpose of this presentation is to document the developments associated with the operational modifications to follow: use of AMSU-B data and use of locally received Lannion and EARS ATOVS data in addition to the currently used NESDIS/Bracknell data in short cutoff time analyses where largest impact is found. Results of Observing System Experiments will also show the expected impact of AIRS data in our global numerical model, and prior tests on the use of cloudy radiances.

SESSION 8

8.1: Improved use of AIRS data at ECMWF + IASI channel selection

Presenter: Andrew Collard

A. Collard[1], A. McNally[1], W. Wolf[2]
[1]ECMWF
[2]QSS Group, Inc.

The initial implementation of the assimilation of AIRS radiances at ECMWF was necessarily conservative and resulted in a small but significant positive impact on forecast scores. Experiments have been run investigating more aggressive use of AIRS data. This is either through the use of more data spatially; the use of more aggressive assumed observation errors; or the use of reconstructed radiances.

More data may be used spatially in the lower troposphere, by more intelligent pre-thinning of the AIRS data. In the baseline system, only the central of the nine AIRS fields of view (FOVs) in each AMSU-A FOV was provided. It is found that if this is replaced by the warmest FOV (used as a proxy for the clearest observation) the data yield is increased for the lowest sounding channels by up to 70% and a positive impact is seen in the forecast scores.

The reduction of assumed observation errors has been explored in both the 15μm CO_2 band (where the assumed error is 0.6K) and the 6.3μm H_2O band (where 2.0K is assumed). In neither case was a significant improvement seen, even though the expected observation plus forward model standard deviations are much less than these values. Possible explanations for this include the effect of inter-channel correlated forward model error, non-linearity error and representation error. The bias model assumed may also have an effect.

Reconstructed radiances use prior knowledge of the variability of the observations to optimally smooth the AIRS spectrum so that the information from the entire spectrum can be best represented by a subset of channels. Thus one might hope that the impact from the full 2378 channel AIRS spectrum can be represented in the 170 channels used for assimilation. Reconstructed radiances are produced routinely in near real time at NOAA/NESDIS from the 200 leading principal components of the full AIRS spectrum. The impact on forecast scores of using these reconstructed radiances, while keeping all other parameters fixed, is neutral. Further investigations with this data type include the explicit specification of the correlated observation error that results from the smoothing process.

8.2: AIRS assimilation at MSC

Presenter: Louis Garand

Louis Garand and Alain Beaulne
MSC

Progress toward the assimilation of AIRS radiances at MSC is described. The first implementation should use about 100 channels. Cloud top and amount are inferred by our adaptation of the CO2 slicing technique using twelve radiance pairs. Radiances insensitive to clouds are considered for assimilation. A simple bias correction scheme is used with automated updating. Channels which are not considered include those sensitive to ozone, to sun illumination, to the atmosphere above the model top, or characterized by complex Jacobian shapes such as long stratospheric tails. First results from assimilation cycles should be available at the time of the conference.

8.3: AIRS Associated Accomplishments At The JCSDA

Presenter: John Le Marshall

John F. Le Marshall, J. A. Jung, S. J. Lord, J. C. Derber, R. Treadon, M. Goldberg, W. Wolf, H.C. Liu, J. Joiner, J. Woollen and R. Todling
NASA, NOAA, U.S. Navy, U.S. Air Force, Joint Center for Satellite Data Assimilation

The Joint Center for Satellite Data Assimilation (JCSDA) was established by NASA, NOAA and the DoD in 2001. The goal of the JCSDA is to accelerate the use of observations from earth-orbiting satellites in operational numerical analysis and prediction systems for the purpose of improving weather forecasts, improving seasonal climate forecasts and increasing the accuracy of climate data sets. As a result the assimilation of AIRS data into operational Numerical Weather Prediction (NWP) systems and the assessment and optimization of their impact is a priority for the JCSDA. Initially 324 channels of synthetic AIRS data were distributed from August 2001 to allow NWP Centers to set up and test systems to receive and assimilate the hyper-spectral data. In October 2002 the synthetic data were replaced by real observations from the AIRS instrument. A high priority activity of the JCSDA has been to establish a fast Community Radiative Transfer Model (CRTM) for all AIRS channels. The CRTM model was completed and tested pre-launch. The AIRS data has been used subsequently in the NCEP Global Data Assimilation System (GDAS) and the NASA ƒvGSIDAS for a number of parallel impact trials and data sensitivity studies. The initial studies have used the data available in real-time to the global operational community. These have a spatial density of one in eighteen footprints and contains a selected subset of channels which well describe the spectral information content of the instrument. In initial studies, the spectral channels which were determined to be clear were assimilated. In subsequent studies higher spatial resolution data available in real time have been assimilated with refined cloud characterization and error covariances. The forecasts indicate significant improvements in global forecast skill compared to the operational system without AIRS data. The improvement in forecast skill at 6 days is equivalent to gaining an extension of forecast capability of several hours. This magnitude of improvement is quite significant when compared to the rate of general forecast improvement over the last decade. A several hour increase in forecast range at 5 or 6 days normally takes several years to achieve at operational weather centers.

8.4: Assimilation of Level-1D ATOVS Radiances in the Australian Region LAPS System

Presenter: Chris Tingwell

C. Tingwell, B. Harris, P. Steinle, W. Bourke, M. Naughton, G. Roff and J. Paevere
Bureau of Meteorology Research Centre

Implementation of the assimilation of locally received and processed ATOVS level-1D radiances in the Australian Region Local Assimilation and Prediction System (LAPS) has been a major priority in BMRC: the timeliness of local reception and processing will increase the quantity of radiance data available to the operational system, which employs an early data cut-off. The recent availability of local radiance data processed to 1D level via the AAPP package, along with the successful realization of a T239L60 configuration of the Bureau's global model (GASP), has provided the basis for trials of a 60-level (L60) version of LAPS, with the aim of producing an operational system able to assimilate AAPP derived radiance data, whether received and processed locally or from overseas centres, equivalently. We report here the results of trials conducted to date and the likely impact the use of the 1D radiance data will have on operational forecast skill.

8.5: Impact of ATOVS data in a mesoscale assimilation- forecast system over Indian region

Presenter: John George

John P. George and Munmun Das Gupta
National Centre for Medium Range Weather Forecasting
Department of Science and Technology
Government of India

MM5 forecast system is used at National Centre for Medium Range Weather Forecasting (NCMRWF), India for the mesoscale forecast over Indian region. Recently a regional 3dvar assimilation system (MM5-3DVAR) is implemented to provide high resolution initial condition for MM5 (90/30/10 km resolution). The assimilation scheme require high density data for the realistic analysis. Indian sub-continent is surrounded by data sparse oceanic regions. The formation and intensification of most of the tropical weather system, which affect Indian region, occurs over these oceanic areas. ATOVS temperature and humidity profiles are crucial for adequate definition of initial condition over these region. MM5-3DVAR had provision for assimilating only TOVS thickness data. Assimilation of ATOVS temperature and moisture profile required the development of suitable modules. Separate modules have been developed for inclusion of ATOVS data. In this study we have made an attempt to assimilate the ATOVS temperature and humidity profiles available through GTS, which are derived at NESDIS. The analysis produced by the MM5-3DVAR is used as the initial condition for the MM5 model forecast. Data assimilation is carried out in cyclic mode (6 hr intermittent) for a period 21 to 31, July 2004. During this period, a monsoon depression was formed over Bay of Bengal and moved north westward. In the control (CTRL) analysis, all conventional GTS data were used whereas in the ATOVS analysis, ATOVS data is also included in addition to the GTS data.

The analysed wind filed shows that the cyclonic circulation over Bay of Bengal is not much different in CTRL and ATOVS analysis. In the formative stage (00UTC 27th July 2004), the system is slightly weaker in ATOVS compared to CTRL analysis. But, in the later stage, i.e. on 00UTC of 28 and 29 winds became stronger in ATOVS analysis. The system is also more intense in height filed in ATOVS compared to CTRL analysis on all these days. However, in ATOVS analysis, the centre of circulation in wind field coincides the centre of low in height field on all the days, whereas in CTRL there are disagreement in wind and height fields.

The forecast of MM5 model shows that utilisation of ATOVS improved the track prediction of this system up to 48hrs.

8.6: The Use of ATOVS Microwave Data in the Grapes-3Dvar System

Presenter: Peiming Dong

Peiming Dong[1] Zhiquan Liu[2] Jishan Xue[1]
[1] Chinese Academy of Meteorological Sciences
[2] National Satellite Meteorological Center of China

With the development of Grapes-3Dvar, a three-dimensional data assimilation system constructed by the Research Center for Numerical Meteorological Prediction, Chinese Academy of Meteorological Sciences, ATOVS microwave radiance is directly incorporated in the data analysis for numerical weather prediction.

Five important components in the use of the ATOVS microwave data are discussed:

1 The fast radiance transfer model RTTOV 7 is currently being used;
2 A independent bias correction scheme was supplied to correct the bias;
3 The quality control is performed to ensure the rejection of bad data;
4 Channel selection;
5 The NOAA/NESDIS microwave land emissivity model (developed by Dr. F Weng) was introduced into the Grapes-3Dvar. An adjusted parameter scheme is designed to provide the surface parameters for the microwave land emissivity model.

Following, the effect of the use of ATOVS microwave data on the analysis and numerical forecast is investigated.

8.7: The assimilation of ATOVS and SSM/I brightness temperatures in clear skies at MSC

Presenter: David Anselmo

David Anselmo and Godelieve Deblonde
Data Assimilation and Satellite Meteorology Division, Meteorological Service of Canada

In recent years the assimilation of satellite data has become a vital component of the global and regional assimilation systems at the Canadian Meteorological Centre (CMC). Specifically, the direct assimilation of satellite radiance measurements from AMSU-A, AMSU-B, and GOES, as well as automated motion vectors derived from GOES and MODIS observations, has resulted in notable improvements in the short and medium range CMC forecasts. This has been demonstrated in Observation System Experiments (OSEs) conducted by CMC.

In preparation for the operational assimilation of Special Sensor Microwave Imager (SSM/I) brightness temperatures in the soon-to-be implemented 4D-Var global assimilation cycle at CMC (spring 2005), 3D-Var experiments are conducted. Brightness temperatures from the 7 SSM/I microwave channels are assimilated in clear skies and over open oceans using the fast radiative transfer model RTTOV7. Simultaneously, more strict filtering of AMSU data is applied. For example, AMSU-A CH3 (50.3V) and AMSU-B CH2 (150.0H) are removed due to their non-negligible sensitivity to clouds, and more aggressive filtering of AMSU-B CH3 (183.3±1 H), CH4 (183.3±3 H), CH5 (183.3±7 H) is invoked using CH2 to identify cloudy pixels.

With the new configuration, improvements are evident in the analysed Integrated Water Vapour (IWV) and surface wind speed fields when compared against independent observations. Furthermore, small gains are realized in the forecasts that are generated using the new analyses, when validated against RAOBS data. Other indicators such as anomaly correlation, RMSE, and QPF scores show a net positive effect.

8.8: On the use of bias correction method and full grid AMSU-B data in a limited area model

Presenter: Roger Randriamampianina

Roger Randriamampianina[1], Regina Szoták[1], and Elisabeth Gérard[2]
[1] Hungarian Meteorological Service
[2] Météo France

In the frame of the continuous development of the 3D-Var system at the Hungarian Meteorological Service our aim is to use as many data and in as fine resolution as possible. The AMSU-A data are already implemented in the data assimilation system of the limited area model ALADIN/HU and used operationally. Our recent work consists of studying the impact of E-AMDAR, atmospheric motion vectors (AMVs) and full grid AMSU-B data on the model analysis and short-range forecasts. We handle the locally received ATOVS data as well as the ones preprocessed and transmitted through the EUMETcast broadcasting system. In this presentation we discuss our experience on the choice of the proper bias correction for a limited area model (LAM). Thus, bias corrections computed using the global ARPEGE and the ALADIN/HU limited area models background are compared. Results on the implementation of the AMSU-B data in the LAM ALADIN/HU are also presented.

8.9: Improved use of AMSU-B data in UK Met Office regional models

Presenter: Brett Candy

Brett Candy, Stephen English & William Bell
Met Office

Regional Numerical Weather Prediction (NWP) models attempt to provide enhanced detail for forecast quantities such as cloud cover, visibility and rainfall. Previous work at the Met Office has shown that improving the humidity analysis through the assimilation of AMSU radiances improves the accuracy of these quantities. This talk will highlight several new developments in the assimilation of AMSU-B radiances in regional models, including the use of data at the full resolution of 16km and the selection of channels to use in the analysis. This channel selection method uses the cloud liquid water in each profile estimated from a 1DVar scheme and results of this will be shown. Screening the data for effects such as cloud-ice and rain is also very important and several tests which can be used will be discussed.

Results from several case studies using the new AMSU-B assimilation scheme in two regional models will be shown, with particular emphasis on examining the impact on the rain fields. These impacts can be assessed objectively using radar observations as the validation source.

8.10: Assimilation of total precipitable precipitation in a 4D-Var system: A case study

Presenter: Lei Zhang

Zhang Lei[1], Ma Gang[2], Wang Yunfeng[3], Fang Zongyi[2], Qiu Chongjian[1]
[1]Department of Atmospheric Science of Lanzhou University
[2]National Satellite Meteorological Center of China
[3]LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences

A mesoscale 4D-Var system was used to examine the impact of total precipitable precipitation retrieved from ATOVS data to the rainfall of model forecast. Take MM5 4D-Var system for example, a punishment term from the total precipitable precipitation is added to the cost function. And the model total precipitable precipitation on grids are derived from the water vapor profiles of MM5, the observations are obtained by the ATOVS data. After these data are introduced into the assimilation, the initial humidity fields were improved, especially over the areas full of could. Meanwhile, the initial temperature fields were more precise too. Experiment involving the total precipitable precipitation and the test excluding these data are performed to find the impact from these data. The conclusion shows an evident difference during the 6-hours assimilation window. And the model precipitation prediction was also improved obviously in 24-hours precipitation forecast. To the longer precipitation prediction, the similar improved forecast is produced from the mesoscale model after the assimilation of these total precipitable precipitation from ATOVS data.

8.11: Progress of bias correction for satellite data at ECMWF

Presenter: Thomas Auligne

Thomas Auligne, Tony McNally
ECMWF

Systematic differences usually called biases occur between satellite observations and the calculated equivalent from Numerical Weather Prediction (NWP) models. They can be explained by instrument and processing errors, representativity discrepancies, uncertainties in the radiative transfer model, residual cloud contamination, or unperfect knowledge of the atmospheric and surface.

A diagnostic study is performed on observation minus first guess departures for several sounding instruments aboard polar orbiting satellites (AMSU-A, AMSU-B, HIRS and AIRS). An Air-Mass Index is introduced as a diagnostic of the air-mass dependency of the biases. The fit to a gamma bias model (P. Watts) that involves an adjustment to the absorption coefficient within the radiative transfer model is then investigated.

Different bias models have been implemented in NWP from a constant flat correction to more complex schemes such as gamma coefficients in the radiative transfer model and regressions using predictors from the NWP model itself. Their impact on analysis and forecast performance are compared. Investigations are carried out to distinguish the observation biases from NWP model errors or cloud and rain residual contamination. In this respect, an independent source of information that does not need to be bias corrected would be very valuable. GPS radio occultation measurement seems to be interesting in this respect for bias correction.

Bias correction can also be updated in different ways. Currently being studied at ECMWF, variational bias correction (D. Dee) includes the bias model parameters inside the 4DVar control variable, the bias being updated during the analysis. This low maintenance code can cope with long-term drifts as well as sudden instrument failures, but it also raises new questions such as its interactions with the meteorological analysis, the calculation of the model error and the cloud detection.

SESSION 9

9.1: The Redesign and Evolution of the Global Observing System

Presenter: James F. W. Purdom

James F.W. Purdom[1] and W. Paul Menzel[2]
[1]Chair OPAG IOS, CBS, WMO and CIRA, Colorado State University, Fort Collins, CO
[2]Chair Expert Team on Observational Data Requirements and Redesign of the GOS, WMO, OPAG IOS, CBS, WMO and NOAA NESDIS Office of Research and Applications, Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin

Within the Commission for Basic Systems of WMO under the Open Program Area Group on Integrated Observing Systems work has been underway to develop a pathway for evolution of the Global Observing System that satisfies the observational data requirements of the WWW as well as other WMO and international program supported by WMO. That work has included developing Statements Of Guidance concerning the strengths and deficiencies in the existing GOS and evaluating the capabilities of new observing systems and possibilities for improvements of existing observing systems to reduce deficiencies in the existing GOS, taking particular care to examine the implications of changes in observing technology on the effectiveness of all WMO Programs. The effort has utilized experts from various applications areas, relied on information derived from the review of several Observing System Experiments (OSEs) that tested possible re configurations of the GOS, as well as results from Third WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction (March 2004). The effort has included a review of the capability of both surface-based and space-based systems that are candidate components of the evolving composite Global Observing System, and has culminated in the development of an implementation plan for the evolution of the GOS. The implementation plan was presented at the 13th session of CBS in February 2005, and includes: a) 20 recommendations that address the space-based sub-system of the GOS. They build upon known plans of the operational and R&D satellite operators and call for rigorous calibration of remotely sensed radiances as well as improved spatial, spectral, temporal, radiometric accuracies. b) 22 recommendations that address the surface-based sub-system of the GOS. They include more complete and timely data distribution; optimized rawindesonde distribution and launches; improved upper tropospheric and lower stratospheric moisture measurements; operational use of targeted observations; inclusion of ground-based GPS, radars, and wind profilers; increased oceanic coverage. And, c) five recommendations address NWP interactions with data from evolving GOS, further study of observing system design and training issues.

This presentation will focus on plans for evolution of the GOS over the next 15 years, paying particular attention to the space-based sub-system and its interface with the surface-based sub-system, discuss the importance of workshops in studying changes to the GOS, and look to input from the ITWG that could contribute to the evolution of the GOS.

9.2: China's current and future meteorological satellite systems

Presenter: Dong Chaohua (for Wenjian Zhang)

ZHANG Wenjian[1], DONG Chaohua[2], XU Jianmin[2] and YANG Jun[2]
[1]Department of Observation and Telecommunication
[2]National Satellite Meteorological Center (NSMC)
China Meteorological Administration (CMA)

The paper presents an overview and prospect of Chinese meteorological satellite program, including current status of on-orbit satellites, current satellites and ground segment developments, as well as considerations for the future developing strategies. Currently China operates polar-orbiting satellite FY-1D and geostationary satellite FY-2C as the operational configuration, and acquiring all of the overpass meteorological satellites for the operational applications and services.

FY-2C will be put into full operation in April 2005, with the new ground segment and varies products. FY-2D is under development, which will be launched in 2006. FY-3A, the first satellite among the second generation of Chinese polar-orbiting satellite program is developing according to the scheduled timetable. A more extended polar-orbiting satellite ground segment and application system is under development.

For meeting the needs of China's strategic plan for the meteorological modernization, with the new priorities for the first 20 years of 21st century for the public service, national economy and security, as well as best management of national natural resources, China must further enhance it's meteorological and environmental satellites program. The major future focus is on the operational polar-orbiting constellation of FY-3 series and operational geostationary constellation of FY-4 series (the second generation of China's geostationary satellite series).

The Chinese meteorological satellite program reflects the contribution of China to the space-based global meteorological and environmental satellite system of World Weather Watch (WWW) program of World Meteorological Organization (WMO), as well as the new initiative of Global Earth Observation System of Systems (GEOSS).

9.3: Report on Indian Meteorological Satellite Program

Presenter: Devendra Singh

Devendra Singh
India Meteorological Department

Abstract not available.

9.4: Report on Russian Meteorological Satellite Program

Presenter: Tom Achtor (for Alexander Uspensky)

Alexander Uspensky
Scientific Research Center "Planeta"

Abstract not available.

9.5: EUMETSAT Plans

Presenter: Dieter Klaes

Dieter Klaes
EUMETSAT

EUMETSAT is currently developing, jointly with ESA the EUMETSAT Polar System (EPS) and commissioning the Meteosat Second Generation (MSG). MSG-1 has been successfully launched in

2002 and became operational in January 2004 as Meteorsat-8. Three MSG satellites are foreseen, the payload of which will be a 12 channel imager (SEVIRI=Spinning Enhanced Visible and Infrared Imager) and a GERB (Geostationary Earth radiation Budget) radiometer, a fourth one is planned. The launch of the first Metop satellite is planned for April 2006. It will then be renamed Metop-A. The EUMETSAT Polar System is the European contribution to the U.S./European Initial Joint Polar System (IJPS) and will assure the morning orbit (AM) of the two- satellite system. The NOAA POES system will continue to assure the afternoon (PM) orbit. The Metop spacecraft will provide imagery and sounding information, with innovative capabilities. Three Metop spacecraft are foreseen within EPS. EUMETSAT activities also include the EUMETSAT ATOVS Retransmission (EARS) service and the optional Jason-2 Programme.

9.6: The NWP SAF: what can it do for you?

Presenter: John Eyre

John Eyre and Bryan Conway
Met Office, UK

The EUMETSAT Satellite Applications Facility for Numerical Weather Prediction (NWP SAF) is led by the Met Office (UK), in partnership with ECMWF, Météo-France and KNMI, with part-funding from EUMETSAT. The SAF's objective is to improve and support the interface between satellite data/products and activities in global and regional NWP. The SAF responds primarily to European user requirements, but products are freely available to users world-wide. The products of the SAF are mainly portable software modules suitable for implementation within the satellite data processing and data assimilation systems of operational NWP centres, and for use at research institutes. These include: fast radiative transfer code (RTTOV), the ATOVS and AVHRR Processing Package (AAPP), software for processing Quikscat data, and three one-dimensional variational retrieval (1D-Var) packages. In addition, the SAF supports: monitoring activities for a wide range of satellite data, with results available in near real-time through the SAF's web site, http://www.metoffice.gov.uk/research/interproj/nwpsaf/index.html; reports on specific aspects of satellite data processing; workshops; and a visiting scientist programme. In addition to improved and extended versions of the products listed above, future products will include the extension of AAPP to process data from IASI on METOP, and “superobbing” code for SSMIS.

This presentation provides a brief summary of the programme and products of the NWP SAF, followed by a description of the pre-processor planned for IASI data as part of an extended AAPP.

9.7: NESDIS Plans for AIRS, CrIS and IASI: Program and Science

Presenter: Mitch Goldberg

M. Goldberg[1], C. Barnet[1], L. Zhou[2], W. Wolf[2], and M. Divakarla[3]
[1]NOAA/NESDIS /ORA
[2]QSS Group Inc.
[3]DSTI

Operational hyperspectral remote sensing sounding capabilities at NESDIS started with the launch of the AQUA Atmospheric InfraRed Sounder (AIRS) in May 2002, and will continue through out this decade with EUMETSAT’s Infrared Atmospheric Sounding Interferometer (IASI) and NPOESS Cross-track InfraRed Sounder (CrIS). The advantage of high spectral resolution in the infrared is very clear. In addition to vastly improved accuracies and vertical resolution of temperature and moisture soundings, and improved impacts in NWP, high spectral resolution provides the capability to derive trace gases such as ozone, carbon dioxide, carbon monoxide, methane, sulfur dioxide and other key climate parameters such as clouds and aerosols. NESDIS is generating many of these products from AIRS in real-time for both weather and climate applications. Using the AIRS retrieval system as a benchmark, NESDIS/ORA is developing the NOAA operational IASI processing system and the NOAA-unique CrIS processing system. The software system will be able to process soundings and cloud-cleared radiances from AIRS, IASI or CrIS using the same science for all three instruments. Using the same science (e.g radiative transfer, cloud correction, etc) is critical for deriving climate data records and blending different datasets. At the meeting, we will give an overview of the operational processing plans (including distribution) for AIRS, IASI and CrIS, and also will show the accuracy of our different products, which will include temperature, moisture, cloud cleared radiances, and trace gases. The products will be validated against model analyses and radiosondes. We will show the impact of using MODIS to improve AIRS cloud clearing, and we will also compare simulated clear radiances from NCEP and ECMWF model with AIRS observed clear radiances (to show which model agrees better with the observed radiances).

9.8: Overview of the CLASS and Scientific

Data Stewardship programs within NOAA

Presenter: John J. Bates

John Bates
NOAA National Climatic Data Center
Remote Sensing Applications Division

Abstract not available.

9.9: Frequency Management

Presenter: Guy Rochard

Guy Rochard
Météo-France

Abstract not available.

9.10: Assimilation of Satellite Cloud and Precipitation Observations in NWP Models: Report of a Workshop

Presenter: George Ohring

George Ohring and Fuzhong Weng
Joint Center for Satellite Data Assimilation
Ron Errico
NASA/GSFC Global Modeling and Assimilation Office
Jean-Francois Mahfouf
Environment Canada
Joe Turk
Naval Research Laboratory
Peter Bauer
ECMWF
Ken Campana, Brad Ferrier
NOAA/NCEP

This paper summarizes the findings and recommendations of the International Workshop on the Assimilation of Satellite Cloud and Precipitation Observations in NWP Models, held near Washington, DC on May 2-4, 2005. The focus of the Workshop was on how to use satellite observations to improve the initialization of clouds and precipitation in forecast models. To date, assimilation of satellite measurements has centered on the clear atmosphere. But satellite observations in the visible, infrared, and microwave provide a great deal of information on clouds and precipitation. Since clouds and precipitation often occur in sensitive regions for forecast impacts, such improvements are likely necessary for continuing significant gains in weather forecasting. The Workshop brought together experts in: cloud/precipitation remote sensing, radiative transfer in cloudy or precipitating atmospheres, modeling clouds and precipitation in NWP models, and assimilating cloud and precipitation observations. These experts critically reviewed the state of the art in: satellite observations (both passive and active) of clouds and precipitation; modeling of clouds and precipitation in NWP; and assimilation of clouds and precipitation observations to initialize the models. The workshop developed a number of recommendations to accelerate the development of cloud and precipitation assimilation systems in NWP. The Workshop was organized and sponsored by the NOAA-NASA-DoD Joint Center for Satellite Data Assimilation.

9.11: The Virtual Laboratory for Satellite Training and Data Utilization: Maximizing the Use of Satellite Data across the Globe

Presenter: James F. W. Purdom

James F.W. Purdom
Chair OPAG IOS, CBS, WMO
and CIRA, Colorado State University, Fort Collins, CO

This talk will focus on the role of international cooperation in maximizing the exploitation of satellite data as we move together into the challenges of the 21st century. Meeting the demands of this challenge is possible because of the combined efforts of the World Meteorological Organization (WMO) and the world's producers of operational meteorological satellite data as represented through the Coordination Group for Meteorological Satellites (CGMS) in the formation of the Virtual Laboratory for Satellite Training and Data Utilization (VL). The VL was formally established in mid-May, 2001, with its main purpose being to help maximize the exploitation of satellite data across the globe. It is a collaborative effort joining the major operational satellite operators (NESDIS, JMA, EUMETSAT and NSMC) with WMO "centers of excellence" in satellite meteorology. The "centers of excellence" are five WMO Regional Meteorological Training Centers and the Australian Bureau of Meteorology and each is sponsored by one of the major operational satellite operators. Those "centers of excellence" serve as the satellite-focused training resource for WMO Members across the globe. The ITWG, along with the International Precipitation Working Group (IPWG) and the International Winds Working Group (IWWG), is one of three supporting science groups affiliated with the VL.

Although still in an evolutionary stage, the VL had had major impact on WMO sponsored training events hosted in China, Australia (2002), Barbados (2003) and Costa Rica (2005), and has been of major benefit

to all “centers of excellence” as a part of their routine on site training. This paper will discuss the VL, how it got to where it is, lessons learned and its future direction. Included in those future directions is the use of electronic notebooks for training; after the training event (beginning with Costa Rica), they are left with the trainees for their use in training others within their WMO Member State. Those notebooks contain lectures, training tools (such as multi and hyper-spectral analysis tools), links to algorithms (such as precipitation derivation from satellite imagery) and a variety of other information useful for on-site and remote training. This talk will conclude with a message for the ITWG on their responsibilities as a supporting science group to the VL and suggest pathways forward to enhance training and utilization of satellite sounding data across the globe.

SESSION 10

10.1: MEOS POLAR - A cost effective Direct Broadcast terminal for current and future L and X-band polar orbiting satellites

Presenter: Einar Grønås

Dr. Frank Øynes, Einar Grønås
Kongsberg Spacetec AS

This paper describes the design of the Kongsberg Spacetec MEOS POLAR terminal for reception and processing of data from current and future L and X band satellites. Standard calibration of imaging and sounding instruments are provided as well as higher level processing of imaging instruments. The key characteristics of the system and processing algorithms are presented. The system is in use by meteorological institutes and service providers for providing meteorological, oceanographic and land services. The hardware and software of the current implementation and trends for future are discussed.

10.2: AAPP status report and review of developments for NOAA-N and METOP

Presenter: Nigel Atkinson

Nigel Atkinson and Amy Doherty
Met Office

The talk will review the status of the ATOVS and AVHRR Pre-processing Package (AAPP). Since ITSC-13, developments have included:

- Support for Linux platforms (various compilers)
- Can be run under Windows using Microsoft Services For Unix
- Improved decommutation code, allowing processing of a higher proportion of orbits, particularly NOAA-15
- AAPP web site and FTP site are now hosted by the Met Office, as lead institute for the NWP-SAF

AAPP version 5 is due to be released after the launch of NOAA-N. It contains a number of enhancements compared with version 4, including support for NOAA-N and NOAA-N’, calibration and pre-processing of MHS, improved navigation modules (Two-Line element capability) and a new HIRS calibration algorithm, as well as various technical improvements.

Preparations for a METOP-compatible version of AAPP (version 6) are well under way. The talk will outline the design of the METOP processing elements, to accommodate both direct-readout AHRPT data and global/regional data distributed by EUMETSAT via EUMETCast.

A major change for METOP is the addition of the IASI instrument. For the direct readout data, IASI processing will make use of calibration software originally supplied by CNES, and subsequently modified by Météo-France to allow its use in the AAPP context. A modified atovpp will allow the user to map AMSU-A and MHS data to the IASI grid.

The large data volumes of IASI pose a particular challenge. AAPP will therefore have various user options for reducing the data volume to make it suitable for NWP use. These include spatial thinning (based on cloud tests), simple channel selection and the ability to represent the spectra in a limited number of Principal Components. The user will be able to define the number of channels and/or Principal Components to be included in the IASI level 1d format.

Finally the extension of AAPP for NPP and NPOESS will be considered. Assuming that global NPP data will be made available by NOAA in a suitable format, the intention is to process ATMS and CrIS to level 1d in a similar way to AMSU/MHS and IASI in METOP. It is also hoped to interface AAPP to the direct readout software being prepared by NASA, to allow processing of the X-band direct broadcast transmission from NPP and NPOESS.

10.3: The IASI L1 processing software and its integration within AAPP

Presenter: Philippe Marguinaud

Philippe Marguinaud

Meteo-France, CMS/RD

The IASI L1 processing software has been developped by Thales under the direction of CNES, for direct integration in the core ground segment of EUMETSAT.

The NWPSAF has been authorized by the CNES to modify the software in order to adapt it to the needs and constraints of AAPP. The IASI processing software (IASI OPS) has therefore been interfaced with AAPP modules and libraries, and ported to several popular UNIX platforms.

This presentation gives an overview of the IASI OPS architecture; it describes the inputs and the products of IASI L1 processing, some of the inner workings of the software, focussing on practical aspects rather than on scientific issues. The performances of IASI OPS on several platforms are also presented.

SESSION 11

11.1: IASI on Metop: On Ground Calibration of the FM2 Instrument

Presenter: Denis Blumstein

D. Blumstein[1], B. Tournier[2], T.Carlier[1], T.Maciaszek[1], T.Phulpin[1], G. Chalon[1]
P.Astruc[3], D.Miras[3], D.Siméoni[3]
[1]Centre National d'Etudes Spatiales
[2]Noveltis - Parc Technologique du Canal
[3]ALCATEL SPACE

The Infrared Atmospheric Sounding Interferometer (IASI) is a key payload element of the METOP series of European meteorological polar-orbit satellites. It is developed jointly by CNES and EUMETSAT. It has been designed for operational meteorological soundings with a very high level of accuracy (Specifications on Temperature accuracy : 1K for 1 km and 10 % for humidity) and also for estimating and monitoring trace gases on a global scale. The IASI system includes the 3 instruments, a data processing software integrated in the EPS ground segment and a technical expertise centre (TEC) implemented in CNES Toulouse.

The measurement technique is based on passive IR remote sensing using an accurately calibrated Fourier Transform Spectrometer operating in the 3.7 - 15.5 µm spectral range and an associated infrared imager operating in the 10.3-12.5 µm spectral range. The optical configuration of the sounder is based on a Michelson interferometer. Interferograms are processed by the on-board digital processing subsystem which performs the inverse Fourier Transform and the radiometric calibration. The integrated infrared imager allows the co registration of the IASI sounder with AVHRR imager on-board METOP.

The second model (FM2) will be the first IASI instrument in-flight (April 2006). It has successfully completed a verification program conducted at ALCATEL SPACE premises in Cannes. This paper provides the key performance results obtained during this test campaign.

11.2: Super Channel Selection for IASI Retrievals

Presenter: Peter Schlüssel

Peter Schlüssel
EUMETSAT

The Infrared Atmospheric Sounding Interferometer (IASI), to be flown on Metop as part of the EUMETSAT Polar System (EPS), will be used to derive a number of atmospheric parameters. A challenging task will be to make proper use of the 8461 spectral radiance samples provided by IASI. Despite the development of fast radiative transfer models it will not be possible to make direct use of all samples in a variational retrieval scheme or to assimilate them all in numerical weather forecasts because of the huge amount of data. As many of the spectral radiances are well correlated with each other it seems straightforward to combine highly correlated ones to so-called super channel clusters. The advantages are reduced noise of the super channels, when compared to that of measured single spectral samples, and the possibility to chose only one of the samples to represent each cluster in radiative transfer calculations. The composition of the super channels and their usefulness for the retrieval of temperature and water vapour profiles in diverse atmospheric situations is studied by means of RTIASI-5 simulations for globally distributed sets of atmospheric and surface situations. A variational retrieval that makes use of super channels has been implemented in the core ground segment of the EPS for the generation of level 2 products.

11.3: Development of the IASI operational processing and distribution system

Presenter: Thomas King

T. King[1], H. Sun[1], W. Wolf[1], M. Goldberg[2], C. Barnet[2], and L. Zhou[1]
[1]QSS Group Inc
[2]NOAA/NESDIS/ORA

Development and testing of the IASI processing and distribution system is ongoing at NOAA/NESDIS/STAR. Level 1C IASI data for 8461 channels will be available to NESDIS/NOAA from EUMETSAT shortly after MetOp 1 launch (scheduled for April 2006). In preparation, an IASI simulation system is currently providing pseudo near-real time data for system testing and code refinement. The simulated level 1C data are subset both spectrally and spatially and then placed into BUFR format for a number of products including: Level 1C (calibrated, apodized, and navigated) brightness temperatures and PCA reconstructed radiances. This simulation system will allow for a smooth and immediate transition to the actual data processing when it becomes available. System validation will consist of comparing the products to collocated radiosonde observations and model forecasts.

11.4: Dissemination of global products from MetOp

Presenter: Simon Elliott

Simon Elliott
EUMETSAT

After consultation with its user community, EUMETSAT has undertaken to extend its EUMETCast direct distribution system as a replacement for the originally planned, near real time dissemination system (NRT), at least for level 1 and level 2 data. The EUMETCast system uses DVB technology to provide a multicast service via a commercial satellite provider. This allows users to receive many types of data, and gives EUMETSAT the flexibility to control access to the different data streams.

From an early stage in the commissioning of MetOp, EUMETSAT will distribute level 1 and level 2 global data sets. These data will be made available using direct dissemination via EUMETCast, and a subset of the data will be distributed globally via the GTS. Level 1b data from AMSU-A, HIRS and MHS will be distributed in BUFR both via the GTS and EUMETCast. The full spectrum of IASI level 1c data will be available in BUFR via EUMETCast, and it is planned to distribute a carefully selected subset of 300 channels via the GTS. Furthermore, level 2 data from ATOVS and IASI will also be distributed in BUFR via the GTS and EUMETCast; these data being at reduced spatial resolution for GTS distribution.

Distribution of data via the GTS allows users outside of the EUMETCast footprint to gain access to the global data sets. The GTS infrastructure is already in place, but restrictions on the available bandwidth mean that the subset of data to be distributed has to be carefully selected.

Level 1 sounder data from the NOAA spacecraft are already being disseminated by EUMETSAT as part of its Advanced Re-transmission Service (EARS). These data are received at a number of local reception stations situated around the North Atlantic region. They are locally processed using AAPP and the resulting data are sent back to data for re-transmission via EUMETCast and the GTS. This service provides the level 1c data with a timeliness of better than 30 minutes, providing a very valuable input for regional models. In the future, EARS will be extended to also provide AVHRR and ASCAT level 1b data via EUMETCast.

11.5: A Joint Temperature, Humidity, Ozone, and SST Retrieval Processing System for IASI Sensor Data:Properties and Retrieval Performance Analysis

Presenter: Marc Schwaerz

M. Schwaerz and G. Kirchengast
Wegener Center for Climate and Global Change (WegCenter) and
Institute for Geophysics, Astrophysics, and Meteorology (IGAM),
University of Graz

The IASI (Infrared Atmospheric Sounding Interferometer) instrument will be part of the core payload of the METOP series of polar-orbiting operational meteorological satellites currently prepared for EUMETSAT (first satellite to be launched in 2006). Compared to existing operational satellite radiometers, this high spectral resolution instrument allows significantly improved accuracy and vertical resolution of retrieved temperature and humidity profiles, and also delivers ozone profiles and sea surface temperature (SST). Applications like numerical weather prediction as well as climate studies will benefit from these improvements. The aim of our data analysis preparations is eventual utilization of the retrieved data for climatological purposes, in particular for simultaneously monitoring climatic changes in the thermal structure of the atmosphere, in upper troposphere moisture, in stratospheric ozone, and in SST.

We show the clearly improved performance of the joint retrieval algorithm of temperature, humidity, ozone, and SST (more precisely, the latter is the surface skin temperature of the ocean) compared to more specific retrieval setups. The joint algorithm was developed based on optimal estimation methodology and carefully tested under quasi-realistic conditions (using high resolution ECMWF analysis fields). The algorithm contains in a first step an effective and fast channel selection method based on information content theory, which leads to a reduction of the total number of IASI channels (>8400) to about 3.5% only (~300), which are subsequently used in the retrieval processing. We show that this reduction is possible without retrieval performance decrease compared to using many more (~ 2000) channels. Additionally, it is shown that using standard climatology fields in the channel selection process does also not decrease performance while significantly increasing computational efficiency. Finally, the application and real-data-test of the algorithm with AIRS (Advanced Infrared Sounder) data, a next step planned, is addressed.

11.6: Calibration and Validation of Metop/ATOVS and AVHRR products

Presenter: Éamonn McKernan

Éamonn McKernan[1], François Montagner[2], Dieter Klaes[2], Peter Schlüssel[2], Yves Buhler[2]
[1]Rhea System S. A
[2]EUMETSAT

The first of three morning-orbiting Metop satellites will be launched in the spring of 2006. It will embark the AVHRR, AMSU-A, and HIRS instruments, such as are already operating on the current series of NOAA satellites. Metop will also embark the Microwave Humidity Sounder (MHS), which replaces the NOAA/AMSU-B instrument. In collaboration with our partner organizations, and in particular with the support of NOAA, EUMETSAT has planned out an extensive list of activities to calibrate ATOVS and AVHRR products from Metop and to establish and monitor their quality. A Calibration and Validation facility has been procured, and additional tools will also be made available to select users to extract, visualize and carry out simple analyses on these products.

Cal/Val activities fall into two major categories. The first category of activities is the core analysis, involving initial checks and ongoing monitoring. These will tune the processing and demonstrate performance against the applicable user requirements. In the second category, more detailed analyses will be carried out on a lower priority basis to refine the processing and to improve the understanding of the product quality. Through this latter category of activities, EUMETSAT will demonstrate its commitment both to continual improvement in the products, and to building upon state-of-the-art scientific results.

This paper will briefly outline the activities to be carried out, demonstrating continuity with the work done by NOAA for these instruments on their satellite platforms, and also describing an approach of ongoing incremental improvement in the service of the user community.

SESSION 12

12.1: NPOESS VIIRS: Design, Performance Estimates and Applications

Presenter: Paul Menzel (for Jeff Puschell)

Carl F. Schueler, Shawn W. Miller and Jeffery J. Puschell
Raytheon Space and Airborne Systems, Goleta, California
Thomas F. Lee , Steven D. Miller, Jeffrey D. Hawkins, F. Joseph Turk and Kim Richardson
Naval Research Laboratory, Monterey, California
John Kent
Science Applications International Corporation, San Diego, California

This paper summarizes design, performance estimates and applications of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Visible Infrared Imager Radiometer Suite (VIIRS). VIIRS is progressing toward Engineering Development Unit (EDU) integration and flight model assembly for launch on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) satellite. Applications of VIIRS are anticipated to represent dramatic improvements over heritage capability from the Defense Meteorological Satellite Program (DMSP) Operational Line-scanning System (OLS) and the National Oceanic and Atmospheric Administration (NOAA) Polar-orbiting Operational Environmental Satellite (POES) Advanced Very High Resolution Radiometer (AVHRR). VIIRS draws heavily on the NASA Earth Observing System (EOS) MODerate resolution Imaging Spectroradiometer (MODIS) currently operating aboard the Terra and Aqua satellites, offering similar spectroradiometry at better spatial resolution. VIIRS on-orbit performance simulations based on MODIS data illustrate the dramatic improvements VIIRS will offer compared to current operational satellites for meteorology.

12.2: Initial Joint Polar-orbiting Satellite System (IJPS) Era Processing and Beyond at the Information Processing Division (IPD) of the National Environmental Satellite, Data and Information Service (NESDIS)

Presenter: Vince Tabor

Vince Tabor
Information Processing Division, NOAA/NESDIS

Many changes are being planned for future data processing at the Information Processing Division of the National Environmental Satellite, Data and Information Service (NESDIS). Many of these changes are planned to take place in the Initial Joint Polar-orbiting Satellite System (IJPS) era and still more changes are being planned for the National Polar Orbiting Environmental Satellite System (NPOESS) era. The IJPS constellation will consist of the National Oceanic and Atmospheric Administration (NOAA)-N, NOAA-N', Meteorological Operational Satellite (MetOp)-1 and MetOp-2. This report will focus on the planned changes to Pre-Product Processing (PPP) such as changes to 1b format, earth location and calibration. It will also cover IPD's plans for processing of Metop unique instruments level zero and level one data and plans for pipeline processing to accommodate for the slow rate at which Metop data will be received at NOAA. The report will also briefly examine IPD's role envisioned for the NPOESS Preparatory Program (NPP) and NPOESS era.

12.3: Microwave Sounder for GOES-R - A GeoSTAR Progress Report

Presenter: Bjorn Lambrigtsen

Bjorn Lambrigtsen, William Wilson, Alan Tanner, and Pekka Kangaslahti
Jet Propulsion Laboratory

The Geostationary Synthetic Thinned Aperture Radiometer (GeoSTAR) is a new concept for a microwave sounder, intended to be deployed on NOAA's next generation of geostationary weather satellites, GOES-R. A ground based prototype has been developed at the Jet Propulsion Laboratory, under NASA Instrument Incubator Program sponsorship, and is now undergoing tests and performance characterization. The initial space version of GeoSTAR will have performance characteristics equal to those of the AMSU system currently operating on polar orbiting environmental satellites, but subsequent versions will significantly outperform AMSU. In addition to all-weather temperature and humidity soundings, GeoSTAR will also provide continuous rain mapping, tropospheric wind profiling and real time storm tracking. In particular, with the aperture synthesis approach used by GeoSTAR it is possible to achieve very high spatial resolutions even in the crucial 50-GHz temperature sounding band without having to deploy the impractically large parabolic reflector antenna that is required with the conventional approach. GeoSTAR therefore represents both a feasible way of getting a microwave sounder in GEO as well as offers a clear upgrade path to meet future requirements. GeoSTAR has a number of other advantages relative to real-aperture systems as well, such as 2D spatial coverage without mechanical scanning, system robustness and fault tolerance, operational flexibility, high quality beam formation, and open ended performance expandability. The technology and system design required for GeoSTAR are rapidly maturing, and it is expected that a space demonstration mission can be developed before the first GOES-R launch. GeoSTAR will be ready for operational deployment 2-3 years after that.

POSTER SESSION A: WEDNESDAY

A01: Intersatellite calibration of HIRS from 1980 to 2003 using the simultaneous nadir overpass method for improved consistency and quality of climate data

Presenter: Fuzhong Weng (for Changyong Cao)

Changyong Cao, Pubu Ciren, Mitch Goldberg, and Fuzhong Weng
NOAA/NESDIS/Office of Research and Applications

The Simultaneous Nadir Overpass (SNO) method is used in this study to characterize the intersatellite calibration biases for HIRS onboard NOAA-6 to NOAA-17 from 1980 to 2003. The SNO method takes advantage of intersatellite calibration with nadir observations that are taken within seconds at the orbital intersections between each succeeding pair of satellites. The low uncertainty using this approach allows us to study subtle radiometric and spectral calibration differences for HIRS on different satellites.

This provides us an independent check of the instrument performance, and helps users better understand the nature of the intersatellite biases in constructing long-term time series of satellite data.

Analysis of such datasets from 1980 to 2003 reveals unambiguous intersatellite radiance differences, as well as calibration anomalies. The results show that in general, the intersatellite relative biases are relatively small for most HIRS channels. The large biases in different channels differ in both magnitude and sign, and are likely to be caused by the differences and measurement uncertainties in the HIRS spectral response functions. The seasonal bias variations are found to be highly correlated with the lapse rate factor, approximated by the channel radiance differences. The method presented in this study works particularly well for channels sensing the stratosphere because of the relative spatial uniformity and stability of the stratosphere, for which the intercalibration accuracy and precision are mostly limited by the instrument noise. The SNO method is simple, robust, and the results are highly repeatable and unambiguous. Intersatellite radiance calibration with this method is very useful for the on-orbit verification and monitoring of instrument performance, and is potentially useful for constructing long-term time series for climate studies.

A02: Study of MSU Channel-3 Brightness Temperature Time Series Using SNO calibration method

Presenter: Zhaohui Cheng

Zhaohui Cheng[1], Cheng-Zhi Zou[2] and Mitch Goldberg[2]
[1]QSS Group, Inc
[2]Office of Research and Applications, NESDIS/NOAA

Observations of Microwave Sounding Units (MSUs) have been widely used for the study of the global warming issue. Most of the previous investigations focused on the Channel 2 brightness temperature (BT) because the peak of the channel 2 observations locates at around 550mb, which is a best representative of the deep-layer mean of the lower troposphere (850mb-300mb) temperature. However, the weighting function shows that the channel 2 observations contain contributions of atmospheric radiation from not only the lower troposphere, but also from a part of the upper troposphere and a part of the lower stratosphere. One recent study from Fu et al. (2004) indicated that the stratosphere cooling could affect the accuracy of the trend of the tropospheric temperature. To obtain the trend of the lower tropospheric temperature with better accuracy, both the stratospheric and upper troposphere impacts should be taken out from the channel 2 observations. Goldberg (2004) suggested a method to combine channel 2 and channel 3 to remove the stratospheric cooling effect since the peak of the channel 3 weighting function locates at around 250mb-200mb.

Before combining channel 2 and 3, however, both channel 2 and channel 3 trends need to be analyzed. Zou et al. (2005) have analyzed the channel 2 time series using simultaneously nadir overpass (SNO) calibration method. This paper will focus on the trend analysis of channel 3 BT observations using the same method developed by Zou et al. (2005). In particular, one of big issues in MSU data analysis is how to reduce the inconsistency among the different satellite observations and how to merge the multi-satellite time series. Zou et al. (2005) showed that using the Mo et al’s (2001) new nonlinear calibration algorithm plus the SNO dataset to carefully calibrate each satellite had successfully reduced the bias between two satellites with the biases an order of magnitude smaller than studies with previous NESDIS operational calibration algorithm for channel 2 data analysis. We would like to test Zou et al’s merging method for channel 3. A direct application of Zou’s calibration to channel 3 data showed that the bias was not as small as that of the channel 2 data. More investigations (such as choosing a different reference satellite) will be carried out to reduce the biases in channel 3 dataset. Once a reliable channel 3 temperature trend is obtained, we would like to see the combined trend of the channel 3 and channel 2 data.

A03: 8-year climatology of dust aerosol in the infrared with HIRS

Presenter: Clémence Pierangelo

Clémence Pierangelo, Alain Chédin, Raymond Armante, Claudia Stubenrauch, Soumia Serrar
Laboratoire de Météorologie Dynamique / IPSL
Ecole Polytechnique

The last report from the Intergovernmental Panel on Climate Change (IPCC, 2001) pointed out that aerosols are one of the major sources of uncertainty in the climate system. Since then, many studies have been conducted, most of them focusing on the solar spectrum. Yet, the closure of the Earth radiative balance also needs knowledge of the aerosol effect on terrestrial and atmospheric infrared radiation. This is why we focus here on remote sensing of aerosol at infrared wavelengths.

We show that it is possible to build an aerosol index over sea using HIRS observations. The algorithm is based on a regression using the brightness temperatures of HIRS channel 8 (11.1 µm) and 10 (8.3 µm) and the sea surface temperature retrieved from TOVS. Great care has been put into discrimination between aerosols and possibly remaining low altitude clouds.

Here, we present daily and monthly results over the ocean in the tropics, for the period 1987-1995, both for day-time and night-time observations. Validation with in-situ and satellite retrievals are presently being conducted; moreover, emphasis will be put on the comparison between visible and infrared products.

The global coverage of HIRS, the availability of 25 years of observations and the ability to monitor aerosols both during day and night open the way to a very promising archive of mineral aerosol products in the infrared.

A04: Impact of tropical biomass burning emissions on the diurnal cycle of mid to upper tropospheric CO_2 retrieved from NOAA-10 satellite observations

Presenter: Clémence Pierangelo

A. Chédin[1], S. Serrar[1,2], N. A. Scott[1], C. Pierangelo[1], and Ph. Ciais[2]
[1]Laboratoire de Météorologie Dynamique, IPSL, Ecole Polytechnique
[2] Laboratoire des Sciences du Climat et de l'Environnement, CEA/IPSL, L'Orme des Merisiers

Four years (July 1987 to June 1991) of monthly mean mid to upper tropospheric CO_2 mixing ratios over the tropics are retrieved from the observations, at 7.30 am (day) and 7.30 pm (night) local time, of the meteorological satellite NOAA-10. Analysis of night minus day differences (N-DD) shows large diurnal variations of CO_2, of the order of 2-3 ppm, during months and over regions affected by biomass burning. The patterns of these diurnal variations are in very good agreement with the diurnal and seasonal variations of biomass burning activity. We interpret them as the signal of CO_2 plumes being rapidly uplifted by fire-induced convection into the upper troposphere during the daytime peak of fire activity, and then rapidly dispersed at night by large scale atmospheric transport. The upper air CO_2 diurnal cycle closely follows the seasonal distribution of burned areas from the European Space Agency's monthly Global Burnt Scar (GLOBSCAR) satellite product, which is recognized as yielding reasonable estimates of burnt areas for large and presumably intense fires. The largest N-DD values are found in 1990 over southern Africa in agreement with the reported inter-annual variability of fire activity. However, the magnitude of these extreme signatures, in the order of 5 ppm locally, is larger than what can reasonably be expected from either in situ observations or from simulations, suggesting some contamination of the N-DD retrieval by fire emission products other than CO_2. It is concluded from a detailed sensitivity analysis, that the presence of high altitude and large optical depth aerosols, or of elevated tropospheric ozone concentrations, as often encountered in fire plumes, may significantly contaminate the retrieved CO_2 signal (by up to 2-3 ppm for extreme events). The possible contaminating effects of undetected fire-induced thin cirrus (optical depths less than 0.05 at 14 µm), is also quantified.

A05: Evaluation of parametrizations of microphysical and optical properties for radiative fluxes computations in climate models using TOVS-ScaRaB satellite observations

Presenter: Claudia Stubenrauch

F. Eddounia[1], C. J. Stubenrauch[1], J. M. Edwards[2]
[1]C.N.R.S. - IPSL Laboratoire de Météorologie Dynamique (LMD), Ecole Polytechnique
[2]Met Office

In this study we have determined the most appropriate parametrizations of microphysical and optical properties of cirrus clouds for radiative flux computations in climate models. Atmospheric and cirrus properties retrieved from TOVS observations are given as input to the radiative transfer model to simulate TOA fluxes. These simulated fluxes are then compared to time space co-located fluxes retrieved from ScaRaB observations. Three parametrizations of cirrus ice crystal optical properties, developed by Mitchell, Baran and Fu, are used for the simulations. These parametrizations are based on different physical approximations and different hypotheses on crystal shape. The first two parametrizations suppose ice crystals to have the shape of aggregates and the last suppose crystals to have the shape of hexagonal columns. Our quantitative study shows that the parametrization assuming hexagonal columns seems to be plausible only for cirrus with small ice water path (IWP). The assumption of aggregates fits the simulated cirrus albedos for larger IWP. From our analysis we conclude that cirrus parametrizations in climate models should use an increase of effective ice crystal diameter (D_e) with IWP instead of an increase of D_e with temperature.

A06: Study on Cloud Classifications by using AVHRR, GMS-5 and Terra/MODIS satellite data

Presenter: Chunxiang Shi

SHI Chunxiang, ZHANG Wenjian, GUO Wei, ZHANG Liyang
National Satellite Meteorological Center, China Meteorological Administration

This paper presents the automated pixel-scale neural network classification methods being developed at National Satellite Meteorological Center (NSMC) of China to classify clouds by using NOAA/AVHRR and GMS-5 satellite imageries. By using Terra satellite MODIS imageries, a automated pixel-scale threshold techniques has been developed to detect and classify clouds. The study focuses on applications of these cloud classification techniques to the HUAIHE and the Yangtize River drainage basin. The different types of clouds show more clearly on this cloud classification image than single band image. The results of the cloud classifications are the basis of studying cloud amount, cloud top height and cloud top pressure. Cloud mask methods are widely used in SST, LST, and TPW retrieval schemes. Some case studies about cloud mask and cloud classification in satellite imageries, which relate with the study of Global Energy and Water Cycle Experiment (GEWEX) in the HUAIHE and the Yangtize River drainage basin are illustrated.

A07: Resolving Tropical Storm Inner Core Temperatures with a Three-Meter Geostationary Microwave Sounder

Presenter: Donald Chu

Donald Chu[1], William Blackwell[2], Norman Grody[3], Michael Madden[4]
[1]Swales Aerospace
[2]MIT-Lincoln Lab
[3]NOAA/NESDIS/ORA
[4]NOAA/NESDIS/OSD/RPSI

Geostationary weather satellites have heretofore differed from low-Earth orbiting weather satellites in that they have not carried microwave radiometers. The reason has been that to get low-Earth resolution from geostationary altitude, one would have to carry an antenna about forty times as large. Even forty times the relatively small AMSU antenna size would be six meters. Operating a dish of this size at 183 GHz in geostationary orbit is beyond current capabilities. A smaller antenna would still provide adequate resolution for precipitation and provide an initial guess for infrared soundings in cloudy conditions. So far, this has not been adequate justification to launch a geostationary microwave radiometer. One remaining objection has been that tropical storm inner core temperature profiles could not be resolved.

This paper attempts to demonstrate how inner core temperatures may be measured from geostationary orbit using a three-meter antenna and deconvolution processing. Because this trades sensitivity for resolution, system noise must be quite low. Other error sources include imperfect boundary temperature knowledge and antenna pattern uncertainty. Besides 20 km horizontal resolution, product requirements include the need to measure temperature profiles to 1 K resolution in less than an hour. Simulations and covariance analyses suggest that the required system noise temperatures, while not yet commercially available, may not be far off. Although one might have to choose between this and hourly full-disk sounding, it would eliminate one more objection to flying a modest size microwave radiometer at geostationary altitude.

A08: cancelled

A09: Wind Imaging Spectrometer and Humidity-sounder (WISH): a practical and effective NPOESS P3I sensor

Presenter: Allen Huang (for Jeff Puschell)

J. J. Puschell[1], H.-L. Huang[2] and H. Bloom[3]
[1]Raytheon Space and Airborne Systems
[2]University of Wisconsin-Madison
[3]National Oceanic and Atmospheric Administration

Tropospheric wind is a top priority NPOESS Pre-Planned Product Improvement (P3I) EDR candidate. We propose to retrieve this EDR by tracking high spatial resolution altitude-resolved water vapor sounding features in imagery provided by a humidity-sounding imaging spectrometer. Our Wind Imaging Spectrometer and Humidity-sounder (WISH) is suitable for flight on any of the NPOESS spacecraft and can be developed in time for NPOESS C2. WISH takes advantage of payload capacity available for P3I demonstrations in NPOESS and serves as a risk reduction and technology demonstration for future NOAA environmental satellite missions.

A10-A16 cancelled

A17: First experiences with RTTOV8 for assimilating AMSU-A data in the DMI 3DVAR data assimilation system

Presenter: Bjarne Amstrup

Bjarne Amstrup
Danish Meteorological Institute

Abstract not available.

A18: Implications for modelling ocean surface emissivity for AMSU, ATMS and CMIS from the Windsat mission

Presenter: Stephen English

Stephen English and Brett Candy
UK Met Office

The Windsat mission is the first to put a fully polarimetric microwave radiometer into space. That means it can measure the full Stokes vector for a range of frequencies. The 3rd and 4th elements of the Stokes vector are primarily sensitive to the ocean surface wind vector whereas the first two elements are sensitive to a wide range of atmospheric and surface parameters. New modelling efforts for Windsat have enabled the modelling of the variation of sea surface emissivity with wind direction and azimuthal look angle and this has given very encouraging results for Windsat. The standard deviation of the brightness temperature difference between observed and modelled (from background) is reduced by around 10% when these azimuthal variations are taken into account. This result will hold for SSM/I, CMIS and may extend to AMSU and ATMS. This poster will present the Windsat results and consider the relevance for AMSU and ATMS.

A19: The assimilation of SSMIS radiances at the Met Office

Presenter: Stephen English (for Bill Bell)

Bill Bell
UK Met Office

Abstract not available.

A20: The Second International Precipitation Working Group (IPWG-2004) Workshop

Presenter: Ralf Bennartz

During 25-28 October 2004, the second session of the International Precipitation Working Group (IPWG) was hosted by the Naval Research Laboratory (NRL) Marine Meteorology Division (MMD) in Monterey, California, United States. This event brought together the world's leading experts in quantitative precipitation estimation. Over fifty participants from more than nineteen countries spanning all WMO Regions attended. WMO sponsored participants from Argentina, Brazil, Costa Rica, Peru and Spain.

IPWG's genesis started with encouragement from the WMO, who had strongly encouraged the Coordination Group for Meteorological Satellites (CGMS) to participate in the formation of an International Precipitation Working Group with active participation by WMO and the Global Precipitation Climatology Program (GPCP) within the framework of CGMS. The first session of IPWG was held in Madrid, Spain in September 2002. One important outcome from the first session was the establishment of an inventory of precipitation algorithms for routinely produced precipitation estimates, and the establishment of a now-ongoing and expanding series of validation programs for satellite-based (and several NWP model) precipitation estimates.

Topics discussed during the second session included: international projects and satellite programmes; operationally-oriented precipitation datasets; validation and error analysis; and research activities. After several days of intensive and in-depth presentations, IPWG reconvened in three working groups: Operational/Techniques; Validation Activities; and Research Activities. The 2nd IPWG session ended with a formal presentation of letters of appreciation from the WMO (presented by Dr. Hinsman of the WMO) to the outgoing IPWG co-chairs, Dr. Vincenzo Levizzani and Dr. Arnold Gruber.

The new incoming IPWG co-chairs were announced, who will be Dr. Joe Turk of NRL-MMD and Dr. Peter Bauer of the European Centre for Medium Range Weather Forecasts (ECMWF). The next IPWG meeting is tentatively planned for autumn 2006. IPWG recommendations will be considered at the 33rd session of CGMS (CGMS-XXXIII) to be held in Japan in November 2005.

A21: Implementation of AMSU-A usage over sea-ice regions in DMI-HIRLAM

Presenter: Jakob Grove-Rasmussen

Jakob Grove-Rasmussen and Bjarne Amstrup

Danish Meteorological Institute

To increase the benefit from the available ATOVS AMSU-A observations the usage of the observations is being extended from data only over open water to also include data over sea-ice and land in DMI-HIRLAM. This extended usage includes proper surface masking, new bias estimations for the involved surface types and estimation of the error covariance for the individual channels. The bias is estimated based on previous works with the DMI-HIRLAM system with seven predictors for each of three latitude bands, but now for each of the three surface types (open water, sea-ice and land). The error covariances are estimated based on the bias calculations.

The result is expected to be an increase in the quality of the weather forecasts, especially in the Greenland region due to the added usage of data over sea-ice. Increasing data coverage over land might also benefit the forecast quality over the Atlantic ocean.

The presentation will cover the work with the implementation of the new surface types, the results from the bias estimation and experiences with the increased data coverage, especially over sea-ice as the DMI-HIRLAM model top height reduces the benefit from data over land.

A22: Recent development of ATOVS usage in Korea Meteorological Administration

Presenter: Sangwon Joo

Sangwon Joo, Eun-Ju Lee, and Seung-On Hwang
Numerical Weather Prediction Division, Korea Meterological Administration

The direct assimilation of ATOVS data with 3dVar is in operation at the Korea Meteorological Administration. The 1dVar is applied as a quality control before the direct assimilation. The bias correction is done in 1dVar and bias corrected innovation is passed to the 3dVar. The scan angle and air mass bias correction is performed. The predictors for the air mass bias correction is AMSU A 5,7, and 9 channels and SST. The observation error is not fixed but computed from the innovation and background error covariance in radiance space at every soundings. The observation error helps to present the details of atmospheric situation. The analyzed ozone profile is used for the radiative transfer model. The impact is small yet but it can be important to assimilate ozone channels in future.

The forecast results of direct assimilation is verified. The impact is significant most of the area including the Northern Hemisphere. Typhoon track is well predicted and it is assumed that strength and location of the north pacific high pressure is precisely analyzed with the help of ATOVS data.

A23: On the assimilation of AMSU-A & -B raw radiances over land at Météo-France

Presenter: Fatima Karbou

Fatima Karbou, Elisabeth Gérard, and Florence Rabier
Météo-France/CNRM/GMAP

If AMSU-A and -B raw radiances are operationally assimilated over oceans in many NWP systems, their assimilation over land is still limited. At best only channels that are not sensitive to surface are considered. Efforts are performed at Météo-France to use more AMSU channels over land when the surface is reliably described with previously calculated AMSU emissivity maps.

The purpose of this work is to describe the research developments undertaken to assimilate AMSU radiances over land together with some preliminary assimilation results.

A24: Assimilation of SSM/I radiances in the NCEP global data assimilation system

Presenter: Kozo Okamoto

Kozo Okamoto
JMA

An assimilation scheme for SSM/I radiances over ocean and its impacts on the global analysis/forecast are presented.

Although NCEP uses SSM/I retrieval precipitation rates and ocean surface wind speeds in the current operational global data assimilation system, no moisture information in rain-free areas from SSM/I measurements is used. Assimilating SSM/I clear radiances is an approach to make more use of SSM/I information and a first step to use measurements, including cloud/rain-affected radiances in the future, from various microwave imager instruments.

SSM/I radiance assimilation is achieved by extending the current AMSU-A radiance assimilation and developing quality control (QC) and, if necessary, bias correction (BC) procedures specific to SSM/I radiances. Because the radiative transfer model used does not include cloud/rain effects, the QC and BC procedures exclude observations with significant cloud/rain signal. Proper identification of these observations is crucial for the performance of the assimilation.

It is found that, from cycle experiments of July through August 2004, the SSM/I radiances have the impacts of adding moisture in the northern hemisphere and tropics and reducing moisture in mid- to high-latitudes of the southern hemisphere. Although the resulting moisture may be excessive in the tropics, these impacts lead to the improvement of the dynamics in the analysis and forecast. In addition, the moistening is effective in reducing the spin-up of the precipitation forecast.

A25: TOVS and the MM5 analysis over Portugal

Presenter: Yoshihiro Yamasaki

Yoshihiro Yamasaki and Maria de Los Dolors Manso Orgaz
University of Aveiro, Portugal

The TOVS data retrieved from NOAA-16 satellite, by the World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT), have been analyzed and compared with the one-way 3 nested domain integration of the Fifth-Generation NCAR/Penn State Mesoscale (PSU/NCAR) Modeling System (MM5). The analysis has been conducted through comparison with available observational data, from Lisbon radio-sounding station (Portugal), irrespective of few hour differences between the availability of observational data and the satellite temperature and humidity profiles, as well as with the model simulation results. It was found that vertical temperature profiles have small departures, compared with its humidity counterpart, with respect to both observation and model simulation. In order to figure-out the effectiveness of TOVS data in reducing the sounding data retrieval errors, particularly near surface, and to improve the precipitation forecast, the rainfall occurrence days, during October 2004 over Portugal, was selected to simulate these events using a weak constrained 4DVAR satellite retrieved data assimilation procedure. The results revealed that although humidity has quite large retrieval errors it improves the precipitation events forecast.

A26: Assimilating AMSU-A over sea ice

Presenter: Vibeke Thyness

Vibeke W. Thyness, Harald Schyberg, Frank T. Tveter
Norwegian Meteorological Institute

AMSU-A observations over the North-Atlantic and Arctic are available within 30 minutes after observation through the EUMETSAT ATOVS retransmission service (EARS). Up to now, AMSU-A observations over open ocean are the only ones used by the operational assimilation system (HIRLAM 3D-Var) at the Norwegian Meteorological Institute (met.no).

In the IOMASA (Integrated Observing and Modeling of the Arctic Sea ice and Atmosphere) project met.no develops methods for assimilating AMSU-A brightness temperatures over sea ice surfaces in HIRLAM 3D-Var. Usually the properties of the ice surface changes slowly, so information from recent passages of microwave radiometers can help determine the surface emissivity in the AMSU-A channels. As a first approach, surface emissivities are calculated from the sea ice type and concentration models operationally running under the EUMETSAT Ocean and Sea Ice Satellite Application facility (OSI SAF). The calculated surface emissivities are given to the forward model RTTOV7.

The poster will present methods that are currently developed at met.no for exploiting microwave soundings over ice surfaces. Statistics for biases, predictors used to correct them, and some preliminary results from impact studies with HIRLAM 3D-Var, will also be presented.

A27: Data Assimilation of ATOVS at SMHI, Sweden

Presenter: Per Dahlgren

Per Dahlgren, Tomas Landelius, Nils Gustafsson
SMHI

Cloud cleared AMSU-A radiances over sea are operationally assimilated into the HIRLAM model analysis (3DVAR) at SMHI. Data is collected via EARS (EumetsAt Retransmission Service) to gain data over the Atlantic, and statistical verification of forecasts show positive impact on temperature and MSLP.

The use of humidity soundings from AMSU-B over sea is on its way. We wish to describe how we do quality control, bias correction and deal with low peaking radiances affected by the ground. Results from the first assimilation experiments are planned to be ready for the meeting.

In the framework of the EC-sponsored project IOMASA we are investigating if AMSU-B can be used over the Arctic region. The first experiments are focused on how to identify radiances contaminated by clouds. Can the cloud mask with its cloud type information from the Ocean and Sea Ice (OSI) SAF be used for this purpose?

A28: The retrieval of the atmospheric humidity parameters from NOAA/AMSU data for winter season

Presenter: Izabela Dyras

I. Dyras, B. Lapeta, D. Searfin-Rek
Satellite Research Department, Institute of Meteorology and Water Management

The passive microwave AMSU data from the NOAA-KLM satellite series allow obtaining the information on atmosphere's humidity. The regression algorithms were developed to retrieve the cloud liquid water path (LWP), rain rate (RR) and total precipitable water (TPW) over the land surfaces.

The algorithms were created using the satellite observations calibrated by the ground-based precipitation measurements as well as radio-sounding data from Central Europe. The obtained results were in qualitative agreement with the standard meteorological data for snow-free surfaces. However, the use of RR and LWP algorithms in cloud-free conditions over snow cover on land led to erroneous results.

The paper presents the method enabling elimination of the snow impact in estimating RR and LWP values. The proposed solution uses another AMSU derived parameter - total precipitable water. The application of the RR and LWP algorithms is restricted to the areas where TPW is higher than the established threshold value. The method was used for the NOAA 16 data in winter season and the obtained results are discussed in the paper.

A29: Soil Moisture Retrieval Test over The West of China by Use of AMSU Microwave Data

Presenter: Songyan Gu

Gu Songyan, Zhang Wenjian, Qiu Hong
CMA NSMC

Remote sensing of soil moisture by microwave radiometry has been a subject of intensive studies in the past two decades. Following the studies done before, a new approach to retrieve surface layer soil moisture is accomplished in this paper, in which the passive microwave data from operational satellites (NOAA-15/AMSU) has been used to retrieve surface microwave emissivity, and the retrieved emissivity is further used to derived surface soil moisture.

The coefficients in the retrieval equation of surface microwave emissivity were corrected based on the results of microwave radiance forward model simulation. The new set of coefficients is suitable for non-frozen earth area in the West. Surface moisture information in regional scale over the West in May 2001 was retrieved by use of semi-empirical method based on the results of surface microwave radiance forward simulation. In the simulation, two kinds of situation, with canopy and no canopy, were involved at the AMSU-A window channels frequency points. Good results were got after comparing with surface region analysis result and point observation data.

The algorithm can make the surface moisture dynamic detection into application. The retrieval results will be a new data source of land surface physical parameters for sand storm simulation.

A30: Analysis of typhoon rananim using products retrieved from ATOVS

Presenter: Zhe Liu

Liu Zhe, Han Zhigang, Zhao Zengliang, Zhang Fengying
Institute of Meteorology

The number 0414 typhoon rananim has caused serious damage to part of the districts in ZheJiang province of China. In this paper, the strength of rananim was analyzed with the products of temperature and humidity profiles retrieved from ATOVS, which can receive the microwave radiation through the cirrus clouds above typhoon and detect the temperature anomalies of it. Under hydrostatic assumption, with four sets of ATOVS data mapped with rananim, the minimum sea level pressure were also calculated respectively and compared with the typhoon warning report of Central Meteorological Station (CMS) estimated from the visible and infrared method, the mean discrepancy is found to be 11.8hPa, showing similar time-variant tendency of rananim as described by CMS.

A31: Robust Variational Inversion : A study with ATOVS data

Presenter: Zhiquan Liu

Liu Zhiquan
National Satellite Meteorological Center, Beijing

Actually most technique for retrieval is based upon the least-square principal traced back to Gauss in 1809. The advantage of the least-square method is that the algorithm is easy to be implemented computationally. However, the least-square method is known to be non-robust. That is, the method is very sensitive to the outliers (data with the gross error), and generally needs a strict procedure of quality control to reject the outliers. In fact, some robust methods have been developed in the statistics community since 1960s. For example, a so-called “M-estimators” method from Peter Huber is well known in the “robust statistics.”

In this study, we will examine general “Robust Variational Inversion (RVI)” methods based upon the M-estimators. In one side, the method is of variational due to the use of the adjoint technique. In another side, the method is robust by taking into account the Non-Gaussian feature of data. The method is implemented in the framework of the 1D retrieval with ATOVS data. The robustness and efficiency of the various RVI methods based upon the different Non-Gaussian functions (e.g., famous Huber’s function) is examined. The results will be presented in the conference.

A32: Total Ozone Analysis from SBUV/2 and TOVS (TOAST)

Presenter: Mitch Goldberg (for S. Kondragunta)

S. Kondragunta[1], Q. Zhao[2], D. McNamara[3], A. Neuendorffer[1], L. E. Flynn[1]
[1] NOAA/NESDIS/Office of Applications and Research
[2] STG Inc.
[3] NOAA/NESDIS/OSDPD/Satellite Services Division

NOAA/NESDIS developed a new total ozone product by combining High-resolution Infrared Radiation Sounder (HIRS) upper troposphere and lower stratosphere ozone (LOZ) retrievals with Solar Backscatter UltraViolet model 2 (SBUV/2) mid-to-upper stratospheric ozone (UOZ) retrievals. This algorithm uses the best available information from each instrument, HIRS ozone from surface to 23 km and SBUV/2 ozone from 24 km to top of the atmosphere, to create a total ozone product. The TOAST product from NOAA-16 has been experimentally running at NOAA/NESDIS since 2002 and is available in near real time to the users. One of the main users of the product is the World Meteorological Organization (WMO), which uses it in its annual Antarctic and Arctic ozone bulletins. The TOAST product has improved accuracy over HIRS and is extremely useful to monitor total ozone changes in the polar night area where instruments such as SBUV/2 do not have coverage. Its accuracy is determined to be at the 2% level.

In this paper, we will describe the algorithm, present some specific case studies that highlight the advantages of a dual-sensor algorithm, and present time series analysis of offsets between TOAST and other satellite and ground based ozone measurements to evaluate the performance of the algorithm under varying seasonal and inter-annual conditions.

A33: MSU channel 2 brightness temperature trend when calibrated using the simultaneous nadir overpass method

Presenter: Mitch Goldberg (for Cheng-Zhi Zou)

Cheng-Zhi Zou, Mitch Goldberg, Zhaohui Cheng, Norman Grody, Jerry Sullivan, Changyong Cao, and Dan Tarpley
NOAA/NESDIS/Office of Research and Applications

The MSU channel 2 on board nine different NOAA polar-orbiting satellites has been measuring the deep-layer tropospheric temperature for more than 25 years. Due to its continuity as well as its channel characteristics, the MSU measurement represents a unique opportunity for providing possible answers to the question of whether the troposphere is warming or cooling over the last several decades. However, the temperature trends derived from these measurements are under significant debate. In particular, different calibration algorithms, different merging methods for the multi-satellite time series, different treatments of the satellite orbital drift, and different modeling efforts for the diurnal cycle in the time series may all affect the MSU trend analyses. Current results range from nearly no trend (Christy et al. 2003) to a relatively large trend of 0.260C /decade (Vinnikov and Grody 2004) for the MSU channel 2 dataset. More recently, Grody et al., (2004) found that the trend decreased from 0.260C /decade to 0.170C using more accurate calibration adjustments. It is desirable that more efforts be devoted to investigate the problems.

As part of the NOAA/NESDIS/ORA effort, this study intends to construct a well-merged MSU channel 2 time series at the 1B level using the simultaneous nadir overpass (SNO) method. We use the new nonlinear calibration algorithm suggested by Mo et al. (2001) to convert the MSU raw counts to the Earth-view radiance. The algorithm consists of the dominant linear responses of the MSU radiometer raw counts to the Earth-view radiance plus a weak quadratic term caused by an ‘imperfect’ square-law detector. The cold space view and an on board warm target view are used as two reference calibration points. Uncertainties in the calibration algorithm are represented by a constant offset and errors in the coefficient for the nonlinear quadratic term. To merge the multiple NOAA satellites together, a reference satellite has to be specified a prior. In this study, NOAA 10 is taken as the reference satellite. The offset value for the reference satellite is assumed to be zero and its nonlinear coefficient is determined by the pre-launch calibration with the chamber test data plus information on the radiometer body temperature.

A unique feature of this study is that the offset values and nonlinear coefficients for the other satellites are determined by the SNO method. The SNO dataset, generated using the SNO method developed by Cao et al. (2004), contains simultaneous nadir observations of less than 2 minute apart of the Earth over the polar region for the nadir pixels from any two NOAA satellites, including both morning and afternoon satellites. Thus, it provides a unique opportunity for an accurate post-launch calibration and merger of different satellites. In this study, different satellites are merged together sequentially starting from the reference satellite. An ordinary linear regression method is used to derive the offset and nonlinear coefficients using the SNO dataset in this sequential adjustment procedure. The coefficients obtained with this method are ‘optimal’ in a least-squares sense and, by definition, they automatically remove the biases between any two satellite measurements in the SNO datasets and a temperature-dependent non-uniformity in the biases caused by orbital drift.

Applying these offset and nonlinear coefficients to the entire MSU observations, we obtain a merged MSU 1B dataset. A 5-day averaged (pentad) dataset is then derived from the 1B data and used to investigate the trend of the MSU channel 2 observations. A great advantage of the current calibration is that the biases for the global ocean between two satellites in the pentad dataset are only on the order of 0.05 to 0.1 K for their overlap periods. This is an order of magnitude smaller than previous investigations using NESDIS operational MSU 1B data. After these small biases are removed in the pentad dataset, we obtain a MSU channel 2 trend of 0.17 K decade-1 for the global ocean for a 15-year merged time series containing NOAA 10, 11, 12, and 14.

A35: Assessment of Precipitation Characters between Ocean and Coast area during Winter Monsoon in Taiwan

Presenter: Peter Wang

Peter K.H. Wang
Central Weather Bureau

The microwave sensor is sensitively to liquid water and surface emissivity. Emission based algorithms are applied on ocean and Scattering based algorithms are applied on whole areas. Winter monsoon in North East Taiwan is significant and almost is raining whole season. Characters of winter monsoon in NE Taiwan are stratus cloud, steady rainfall, wide area and uniform rainfall. 5 year’s data set over whole Taiwan area was selected which is collocated includes surface rain gauges, surface weather station, wind vector and SSM/I observation. The observation over a small island in north of Taiwan was chosen as ground truth over ocean, compared with data over coast area near this island. Neural Network is used for data analysis also. The results show rain rate is less than coast area for the topography effect. Precipitation is close related to polarized brightness temperature. Daily rainfall variance are significant, it is caused by thermal wind variance. Combine those factor we may retrieve more reasonable rainfall rate. Frequency of SSM/I is similar with AMSR-E, these algorithm is expected to be applied on AMSR-E.

A36: Rain Rate Estimation in Summer of Taiwan

Presenter: Thwong-Zong Yang

Thwong-Zong Yang
Central Weather Bureau

Using the method of Limin Zhao and Fuzhong Weng to estimate the rain rate of AMSU data in summer of Taiwan area, for no-rain area its accuracy of not-raining is about 92%, for raining area its accuracy of raining is about 83%, the root mean square error of rain rate is still in estimating, some cases of Typhoons will be discussed.

A37: OPTRAN Version 7

Presenter: Tom Kleespies (for Yong Han)

Yong Han[1], Larry McMillin[1], Xiaozhen Xiong[2], Paul Van Delst[3] and Thomas J. Kleespies[1]
[1]Office of Research and Application, NOAA/NESDIS
[2]QSS Group Inc.
[3]CIMSS, University of Wisconsin-Madison

OPTRAN (Optical Path TRANsmittance) is a fast and accurate radiative transfer model for simulating radiometric measurements and computing radiance Jacobians of the atmospheric state variables. Since 1999, when OPTRAN version 6 was presented at the Tenth International TOVS conference, a number of important improvements have been made and implemented in OPTRAN version 7, including a constrained regression to improve Jacobian profiles, a reduction of the number of layers from 300 to 100 and a new way to handle polychromatic effects in channel transmittance calculations. In this presentation, we will review the changes that contribute to the improvements and demonstrate the statistics on the accuracy and efficiency of its forward and Jacobian models. We will also describe our plans for its future development.

A38: The Community Radiative Transfer Model (CRTM) Framework

Presenter: Tom Kleespies (for Paul van Delst)

Paul van Delst[1], Yong Han[2], and Quanhua Liu[3]
Joint Center for Satellite Data Assimilation
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[3]QSS Group Inc., Lanham, MD 20706

The mission of the Joint Center for Satellite Data Assimilation (JCSDA) is to accelerate and improve the quantitative use of satellite data in weather and climate prediction models. The Community Radiative Transfer Model (CRTM) is an important component of this by introducing additional capabilities - such as scattering by clouds and aerosols, and a more integrated treatment of surfaces - into the computation of satellite instrument radiances. As part of this process, external research groups funded by the JCSDA are making contributions to the CRTM development. In order to help developers to understand the requirements of the data assimilation system and to reduce the inconsistencies among the components developed by various groups, a software framework has been devised for the CRTM. The main goal of this CRTM framework is to provide developers with the information and utilities necessary to produce software that is flexible (in both development and usage), understandable, and easily maintained.

The CRTM framework breaks the radiative transfer model into components (e.g. gaseous absorption, scattering, surface optics); each of which defines its own data structure and algorithm modules to facilitate independent development of each component. This characterisation is obviously an ideal one since there are dependencies that do not allow every component to be developed in isolation from the others. As such, the CRTM framework is not intended to be a replacement for necessary dialogue between developers, but to provide some form of “big picture” for all those involved to minimise or eliminate potential software conflicts and redundancies.

Due to the complexity of the radiative transfer problem and the difficultly of balancing code efficiency and flexibility, we fully anticipate problems arising when the framework is applied in the development process. This poster is part of this process to present the framework to the community and to solicit feedback from interested parties for improvements to help realise the JCSDA goals of faster operational implementation, and increased usage, of satellite data in Numerical Weather Prediction models.

A39: Establishing a microwave land surface emissivity scheme in the Met Office 1D-Var

Presenter: Fiona Hilton

Fiona Hilton, Stephen English
Met Office, UK

Several strategies for establishing a land surface emissivity scheme for AMSU have been tested at the Met Office in recent years. Initial approaches involved the use of an atlas to give a first guess estimate of emissivity. These estimates proved to have little effect on the distributions of observed minus background (O-B) brightness temperatures. Tests were carried out on a scheme which converted the atlas into a set of parameters to be used in FASTEM, the fast microwave emissivity parameterization used within the RTTOV forward model. The parameters were then used to calculate the channel-dependent emissivities as part of a 1D-Var retrieval. This approach was not overly successful either, being hampered by poor convergence rates and a lack of significant improvement in the observed minus analysis (O-A) brightness temperatures. A new approach is under development to use Weng and Yan's (2003) microwave snow emissivity model to provide a first guess emissivity where appropriate and to retrieve emissivities directly in the 1D-Var. The reduced O-B values from this scheme are a promising step.

A40: Atmospheric transmittance calculation of Infrared atmospheric sounder of FY-3A meteorological satellite

Presenter: Chengli Qi

Chengli Qi
NSMC,CMA

FY-3 meteorological satellite is the second generation of polar-orbit meteorological satellite in China, it will carry InfRared Atmospheric Sounder (IRAS), Microwave Atmospheric Sounder, Microwave Atmospheric Humidity Sounder for the first time. In order to provide some helpful information to the IRAS' manufacturer, much simulation should be done to verify the characteristics of IRAS so that the satellite can be in good working state and the satellite data can be useful.

Fast radiative transfer model's (RTTOV7) transmittance coefficients of IRAS were calculated and verified bases on the characteristics and spectral response function of the primary IRAS sounding channels and GENLN2 line-by-line spectral transmittance database. Several atmospheric profiles' channel transmittance and weighting function as well as the simulating satellite observed radiance were also calculated and compared with those of High Resolution Infrared Sounder (HIRS). It shows that the IRAS' transmittance coefficients is satisfying, the channel transmittance and weighting function curves are reasonable, they have little differences from that of HIRS, can indicate the contribution of each atmospheric layer make to the upwelling radiance from the whole atmosphere. The levels of peak energy contribution were mostly consistent with the propositional target, although some channels' peak-levels are a little rised from the desigh object, the variety trend is consistent with HIRS/3 instrument. IRAS' simulating channel observed radiance also has little differences from that of HIRS and it can be used in the atmospheric profile retrieval.

A41: First results from NOAA-N with the ATOVS and AVHRR Product Processing Facility for EPS

Presenter: Dieter Klaes

Dieter Klaes, Jörg Ackermann, Rainer Schraidt, Peter Schlüssel
EUMETSAT

The ATOVS/AVHRR Product Processing Facility (PPF) of the EPS (EUMETSAT Polar System) Core Ground Segment comprises the Level 1 processing of the data from the ATOVS sounding instruments AMSU-A, MHS and HIRS/4, and the imager AVHRR/3 into calibrated and navigated radiances. A second component includes the level 2 processing, which uses as input the level 1 products of the aforementioned instruments. This paper provides first results from the processing of data from the NOAA-N spacecraft, which is the first operational satellite of the Initial Joint Polar System (IJPS). The latter includes the EPS/Metop System for the morning (AM) orbit and the NOAA/POESS system for the afternoon (PM) orbit. NOAA-N is the first satellite that carries the Microwave Humidity Sounder (MHS), which replaces the AMSU-B instrument.

A42: Overview of ATOVS data processing and applications at NSMC of China

Presenter: Fengying Zhang

Zhang Fengying, Ran Maonong, Wu Xuebao, Zhang Wenjian, Dong Chaohua, Li Guangqing
National Satellite Meteorological Center, China Meteorological Administration

Since the end of 1998, the National Satellite Meteorological Center (NSMC) of China Meteorological Administration (CMA) has been receiving and processing the HRPT ATOVS data. The ATOVS data operational processing system has been built based on the AAPP and ICI/IAPP by the ATOVS group. The PC-ATOVS display systems have been developed by using IDL and C++ languages for checking the ATOVS L1C/L1D products from the AAPP and retrieval products from ICI/IAPP. The validations of the atmospheric parameters generated from the ICI and IAPP have been done. The progress of ATOVS data applications has been made for recently years, such as, the AMSU-B L1C data are directly applied to monitor the thunderstorm in NSMC routinely, the ATOVS L1D data are applied to the variational assimilation system of NWP models in the several centers of CMA, the ATOVS the atmospheric temperature and moisture profiles are used in the case study of weather analyses, and so on. We believe that more and more meteorological centers of China will take the ATOVS data into their NWP model in the future in order to improve the weather forecast.

POSTER SESSION B: THURSDAY

B01: Analysis of radiosonde quality characteristics by ground- and satellite-based simultaneous observations during the WVIOP2004 experiment

Presenter: Domenico Cimini

D. Cimini[1,2], E. R. Westwater[2,3], V. Mattioli[4], A. J. Gasiewski[3], M. Klein[2,3], F. Romano[1], and V. Cuomo[1]
[1] IMAA/CNR, Potenza, Italy
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[4] DIEI, University of Perugia, Italy

During the period from March 9 to April 9, 2004, an Intensive Operating Period (IOP) was conducted at the U. S. Department of Energy's Atmospheric Radiation Measurement (ARM) Program's site in Barrow, Alaska, USA. During the IOP, a variety of balloon-borne in situ measurements and ground-based remote observations were collected. Up to seven radiosondes per day were launched from three close locations, and several multi-radiosonde experiments were carried out using three different radiosonde packages (Vaisala RS90, Meteolabor Snow White, and Sippican MarkII). On the other hand, microwave radiometers were deployed over a broad frequency range (22.235 to 400 GHz), including several channels near the strong water vapor absorption line at 183.31 GHz. Also, colocated longwave (400-3300 cm-1) infrared observations are available from the ARM Atmospheric Emitted Radiation Interferometer.

The initial results indicate good agreement between the RS90 and the Snow White measurements. Conversely, large differences in RH, of the order of 20%, for upper-tropospheric and lower-stratospheric humidity were found in the comparison of the Mark II with both the RS90 and the Snow White. The clear sky atmospheric down- and up-welling emitted radiances have been computed from the different radiosonde profiles and compared with observations from the ground-based radiometers involved in the IOP and simultaneous measurements from similar satellite-based instrumentation, such as AIRS, AMSU, and MODIS, flying on NASA AQUA. Finally, comparisons of measurements and simulations are shown to discuss the observed differences in the measured atmospheric profiles.

B02: Satellite Coincident Reference Upper Air Network and Potential Impacts on Real-time and Retrospective Satellite Products

Presenter: Tony Reale

Tony Reale
NOAA/NESDIS

A satellite coincident Reference Upper Air Network is proposed to provide reference radiosonde and in-situ ground based measurements coincident with operational polar satellite(s) overpass. This proposed network would consist of approximately 40-50 sites, including existing Global Upper Air Network (GUAN) and Atmospheric Radiation Measurement (ARM) stations. The overall design would be to provide a robust and reliable sample of collocated global radiosonde and satellite observations conducive to the monitoring and validation of satellite and radiosonde observations and associated scientific approaches including radiative transfer models. The routine operation of such a network in conjunction with operational polar satellites would provide a long-term record of performance for these critical observations, of particular importance for climate, as well a shorter term monitoring useful for numerical weather prediction.

Details concerning the latest protocols for designing and operating such a network are presented. This includes specific recommendations from the recently held joint NOAA/Global Climate Observing System (GCOS) Workshop for upper air observations (February 2005) that a program to establish a Reference Upper Air Network be pursued. Preliminary activities to establish routine data collection from ARM sites, NOAA-NWS sites and existing global sites already providing satellite coincident observations are also presented.

The potential impact of the proposed reference network with respect to the suite of integrated global measurements (including derived satellite products) available for respective climate and NWP applications is also discussed. Such data require that systematic errors and uncertainties be compensated for prior to assimilation. The poor historical record of such parameters may be compromising the value of critical upper air observations particularly for climate; examples are shown.

The integration of this network and planned scientific upgrades for ATOVS derived products to better meet anticipated user requirements for real-time NWP and retrospective climate products is also presented.

B03: NOAA operational sounding products for Advanced TOVS: 2004/5

Presenter: Tony Reale

Tony Reale
NOAA/NESDIS

The National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite Data and Information Service (NESDIS) operates a fleet of civilian, polar-orbiting, environmental satellites which provide users and researchers with a continuous suite of atmospheric and surface products on a global scale. The first Advanced TIROS Operational Vertical Sounder (ATOVS) radiometer configuration, onboard NOAA-15, was successfully launched into an early evening orbit on May 13, 1998. ATOVS featured the new 13-channel Advanced Microwave Sounding Unit (AMSU) module A1, the 2-channel AMSU-A2, and 5-channel AMSU-B radiometers which replaced the MSU and SSU, along with a similar HIRS and AVHRR instrument payload that had been operational since 1979. ATOVS onboard NOAA-16 was successfully launched into an afternoon orbit on September 21, 2000, followed by NOAA-17 into a late evening orbit on June 24, 2002 and the first ever three (3) satellite constellation of operational polar satellites (ATOVS). Unfortunately, the AMSU-A1 module onboard NOAA-17 failed on October 28, 2003 (approximately 04Z) and associated sounding products were discontinued. NOAA-N is currently scheduled for launch in April, 2005.

The following report briefly summarizes the current operational satellite status and scientific products from NESDIS operational ATOVS systems, including a series of results from the three (3) operational satellite configuration of NOAA-15, 16 and 17 that existed for about an 18-month period prior to the NOAA-17 MSU-A1 failure. Results focus on the value of such products in the analyses of global and regional scale weather, including direct comparisons against collocated numerical weather prediction (NWP) forecast and radiosonde data.

The report concludes with a detailed analysis of planned scientific upgrades for ATOVS derived products to meet expected user requirements in the future. Proposed methods are designed to better enable the ATOVS operational products to serve as a baseline for validating planned products from next generation METOP and NPOESS satellites. As discussed, these upgrades represent a scientific convergence with planned algorithms from the respective satellite platforms as well as with existing approaches available from direct readout processing packages.

B04: The Humidity Composite Product of EUMETSAT's Climate Monitoring SAF: Towards Optimal Merging of Satellite Data Sets

Presenter: Joerg Schulz

Joerg Schulz[1], Ralf Lindau[2], Nathalie Selbach[1]
[1]Deutscher Wetterdienst, Satellite Application Facility on Climate Monitoring
[2]Meteorological Institute, University of Bonn

The need for a comprehensive and accurate global water vapour data set as an assisting tool for scientific studies in the atmospheric sciences has been acknowledged during the last 10 years. Such a data set is extremely useful for all aspects of climate science being dependent on accurate water budget data, e.g. general circulation model verification as well as global and regional climate studies. The Humidity Composite Product (HCP) of the Satellite Application Facility on Climate Monitoring consists of total precipitable and layered precipitable water estimates as well as data sets of temperature and relative humidity. A first version using data from ATOVS and SEVIRI will be available in fall 2005. For future versions it is intended to use a universally applicable technique to merge different satellite data sets to create daily mean water vapour fields and corresponding error fields.

Within this presentation we will give an overview on the structure of the HCP product including a description of the processing techniques used and the validation of underlying retrievals. The HCP employs in its first version ATOVS data from the NOAA satellites as well as SEVIRI data from Meteosat-8. The next version will employ the suite of 4 instruments dedicated to provide water vapour estimates on the MetOp satellite. These are the well known HIRS and MHS instruments and the new IASI spectrometer and the GRAS which is a GPS instrument. All instruments have their strengths and weaknesses, e.g. IASI is assumed to be the most accurate in the troposphere but can only deliver estimates under almost cloud free conditions. MHS estimates are possible under cloudy conditions but suffer from coarse ground resolution. Finally, GRAS is expected to give estimates even under rainy conditions and probably also in the lower stratosphere but does not provide a very good spatiotemporal sampling. Because the HCP should combine the strengths of each of the sensors the main focus will be on the optimal merging of precipitable water estimates from different sensors using a Kriging approach that will also give information on the errors due to the merging process. As an application we will demonstrate the use of this technique using precipitable water estimates from ATOVS, SEVIRI, SSM/I, and AMSU-A.

B05: Preliminary results from the Lauder site of the Total Carbon Column Observing Network (TCCON)

Presenter: Vanessa Sherlock

V. Sherlock[1], B.J. Connor[1], S.W. Wood[1], A. Gomez[1], G.C. Toon[2], P.O. Wennberg[3], and R. A. Washenfelder[3]
[1]NIWA
[2]JPL
[3]CalTech

In this poster we give a brief description of the Total Carbon Column Observing Network (TCCON), a new network of ground-based Fourier Transform spectrometers (FTS) dedicated to measurement of greenhouse gas absorption (CO2, CO, CH4, N2O) in the near infrared. We present some preliminary retrievals of total column densities from the TCCON site in Lauder, New Zealand, and discuss how we plan to compare the ground-based FTS retrievals with in-situ surface observations and greenhouse gas retrievals from satellite radiances.

B06: A simulation study of the impact of AIRS fast model errors on the accuracy of 1D-Var retrievals from AIRS radiances

Presenter: Vanessa Sherlock

V. Sherlock[1] and A. Collard[2]
[1]NIWA
[2]ECMWF

In this poster we characterise the forward model differences between two AIRS fast models participating in the ITWG AIRS fast model intercomparison (Gastropod v0.3.0 and RTTOV7.1). We then examine the impact of these model differences (and their spectral correlation) on the accuracy of full nonlinear iterative 1D-Var retrievals from synthetic AIRS radiances with and without bias correction using the NESDIS channel selection. Retrieval error covariance matrices and degrees of freedom for signal are estimated for ensembles of 1D-Var retrievals and are compared with predictions from linear theory.

B07: Cloud Detection: Optical Depth Thresholds and FOV Considerations

Presenter: Steven Ackerman

Steven A. Ackerman, Richard A. Frey, Edwin Eloranta, and Robert Holtz
Cooperative Institute for Meteorological Satellite Studies

New satellite instruments, such as MODIS, GLI and AIRS, provide new capabilities in cloud detection. This poster addresses the impact of cloud optical depth on cloud detection using passive remote sensing instruments on a satellite or high-altitude aircraft platform.

What is a cloud? The answer to that question is determined by the application. What is considered a cloud in some applications may be defined as clear in other applications. For example, detection of thin cirrus clouds is important for applications of infrared remote sensing of sea surface temperature, but of little concern for microwave remote sounding of atmospheric temperature. The MODIS and GLI cloud masks were designed to support various applications, but the optical depth limit of detection has not been defined. This paper compares MODIS and MAS cloud detection retrievals with lidar observations to estimate the optical depth limit of detection for these passive instruments.

B08: An Automated, Dynamic Threshold Cloud Detection Algorithm

Presenter: Jian Liu

Liu Jian, Xu Jianmin
Nation Satellite Meteorological Center

An operational scheme for cloud detection for FY data is presented. The scheme consists of two major parts: total cloud detection and high cloud detection. Cloud detection separates cloud from underline surface, for every pixel, it is either clear pixel or is cloudy pixel. High cloud detection separates high cloud from other cloud types.

The algorithm is based on multispectral threshold technique applied to each pixel of the image. It includes histogram analysis, threshold detection, deviation analysis, and so on. Infrared and visible channels are basic data. Near infrared channel is also used. Dynamic threshold is used with visible and infrared channel data to create a cloud mask for each pixel on a single image automatically. Histogram analysis was used to get dynamical threshold for each small area of pixels. For an area that contain either clear pixels or cloud pixel, it would appear a peak that is corresponding to low grey level (high temperature or low reflectance). This peak possibly represented clear surface. In threshold extracting, surface type and elevation are thought about carefully. If the maximum scaled second derivate wasn't be found, that means pixels of the area has the similar properties, at this situation, we used another kind of cloud detection method. Clear pixel and cloud pixel have clearly contract at reflectance at the most case. So the visible channel is very useful to detect cloud. In reflectance image, dynamic cloud detection threshold is much easier to find than infrared channel. But when sun zenith is too large, visible channel data are invalid. Different types of surface have different properties. We must think about surface properties and topography. If there were more than two kinds of surface types or the DEM difference was so larger, we should analysis dynamic thresholds for every kind of surface type. So the surface classification data and DEM data are necessary ancillary data to detect cloud.

Except dynamic threshold method, we also used some simple but very useful methods to detect cloud. For example, we used brightness temperature difference between different infrared channels to detect cloud. Cloud always was mixed with snow in single channel. Dynamic threshold method sometimes failed for the case. We use near infrared channel to distinguish cloud and snow. Deviation method can help to detect broken cloud at sea. Sea has uniformity properties. If sea pixels were polluted by small and broken cloud, the deviation of these pixels would become larger. At that time, 15-day composite clear data and numerical weather forecasting data are also used as ancillary data to help cloud detection.

B09: Preliminary results combining ground based-Raman lidar and airborne spectrometers to describe the evolution of a cirrus cloud (Italian Eaquate campaign)

Presenter: Rolando Rizzi

Rolando Rizzi[1], Paolo Di Girolamo[2], Tiziano Maestri[1], Filomena Romano[3] and Donato Summa[2]
[1] Dip. di Fisica, U. di Bologna
[2] Dip. di Ingegneria e Fisica dell'Ambiente - U. della Basilicata
[3] Istituto di Metodologie per l'Analisi Ambientale - IMAA - CNR

In the evening of Sept. 6, 2004, as part of the Southern Italy Eaquate campaign, the Proteus aircract flew four times over a moderately thick high cirrus cloud in the Potenza region, southern Italy. The evolution of the cloud was monitored by the DIFA Raman lidar ground station in Potenza and three radiosondes were released from the IMAA ground station, thus providing potentially a good description of the atmospheric gaseous and particulate state. The general evolution of the cloud field was monitored using MSG infrared images, available every 15 minutes.

Among the instrument flying on Proteus, the sensors NAST-I, NAST-M and S-HIS were used to compare with accurate radiance simulations based on the description provided by the ground based instrumentation and radiosondes. Based on the quality of the comparison among simulated and measured radiances, the vertical structure in terms of fluxes and cooling/heating rates could be defined thus providing a link between the measured state and the time evolution of the cirrus cloud.

B10: Experimental study on water vapor amount calculationusing 940 nm absorption spectral band data

Presenter: Dong Chaohua

DONG Chaohua HUANG Yibin LIU Zhiquan PAN Ning
National Satellite Meteorological Center (NSMC)
China Meteorological Administration (CMA)

It is difficulty to get more accurate water vapor amount in low-level atmosphere using infrared band data. The near infrared spectral band can provide more water vapor information than IR data based on the simulation studies.

The instrument MERSI, will be onboard FY-3, has channels in 940 nm band. The channel reflectance is calculated, and its sensitivities to various environmental parameters are analyzed. Using its statistical relation to the ratios of the reflectance in several channels, which are selected and grouped from the 940 nm weak water vapor absorption band and the vicinal window region simulates the water vapor amounts. The results show that the signals from channels in the 940 nm band carry water vapor information from the whole atmosphere.

The computed water vapor amounts have an average relative error of 6% by compared with independent radiosonde observations.

B11: FY3 Microwave Imaging Radiometer (MWIR) surface parameters inversion algorithm and validation in China

Presenter: Yang Hu

Yang Hu
National Satellite Meteorological Center, CMA

FY3 is new generation polar orbit meteorological satellite of China plan to launch in 2006. There is total of 11 different remote sensing sensor onboard it, design to get the geophysical parameters of atmosphere, land, and ocean surfaces at the same time all day and night and in all weather conditions. The MWRI is a 10-channel five-frequency linearly polarized, passive microwave radiometer imager system onboard the FY3, which measures atmospheric, ocean, and terrain microwave brightness temperatures at 10.65, 18.7, 22.3, 36.5, and 89 GHz. In this paper, in order to derive surface temperature and soil moisture from the MWRI data, a new developed microwave RT model, AIEM was used to simulate the microwave emission characteristic of bare soil, and an new surface soil moisture inversion algorithm was established, which is only need the 10.65GHz V and H channel data. Applying the algorithm to AMSR-E orbit data, which is very similar with the FY3/MWIR, the daily globe soil moisture distribution was derived. The surface temperature was also derived by using a empirical model. To compare the inversion results with insitu data, the meteorological data in china area was collected, and points were interpolated to area with the resolution of MWIR by using a new interpolate model of complex terrain.

B12: Applications of the GOES-R HES (Hyperspectral Environmental Suite) Infrared measurements

Presenter: Chian-Yi Liu (for Tim Schmit)

Timothy J. Schmit[1], Jun Li[2], W. P. Menzel[3], Mathew M. Gunshor[2], and James Gurka[4]
[1] NOAA/NESDIS, Office of Research and Applications, Advanced Satellite Products Team (ASPT)
[2] Cooperative Institute for Meteorological Satellite Studies
[3] NOAA/NESDIS, Office of Research and Applications
[4] NOAA/NESDIS, Office of Systems Development

The increased spectral, temporal and spatial resolutions of the Hyperspectral Environmental Suite (HES) on the Geostationary Operational Environmental Satellite (GOES)-R and beyond will provide a substantial increase in the quantity and quality of the products. The GOES-R, slated for launch in 2013, will offer improved data from an advanced operational, geostationary sounder HES. The HES will be a multi- or high-spectral imager and hyperspectral sounder instrument suite with three threshold tasks. HES will provide high-spectral resolution Hemispheric Disk Soundings (DS), Severe Weather Mesoscale (SW/M) soundings, and Coastal Waters (CW) imaging. HES DS will provide better than 10 km spatial resolution from 3.7 μm to 15.4 μm 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 4 minutes, at 4 km spatial resolution for the infrared (IR) bands. The GOES-R HES will be a very flexible instrument that can provide hourly coverage of the near full disk, or provide more frequent coverage of smaller areas (1000 x 1000 km in 4 minutes) with 4 km horizontal resolution. 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 in 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) distinguishing between ice and water cloud and identifying cloud microphysical properties; 4) providing a 4 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). There are many areas where the HES sounder capabilities and applications offer a distinct advantage over the current filter-wheel GOES Sounders. Two such examples are the improved spatial coverage and the vertical moisture information. Due to a coverage rate 5 times faster than current GOES, the HES will allow much improved spatial coverage. The current GOES sounder only scans the continental U.S. and some surrounding oceans, while GOES-R will be able to cover the land and ocean regions within 62 degrees of satellite sub-point in one hour. Due to its high spectral resolution, the HES will provide an hourly three-dimensional picture of water vapor as never before seen from geostationary orbit.

Improvements mentioned above and additional applications of HES on GOES-R are demonstrated in this talk by using current satellite and aircraft measurements as well as simulated data.

B13: Improvement on sounding retrievals from GOES Sounder measurements

Presenter: Chian-Yi Liu (for Jun Li)

Jun Li[1], Christopher C. Schmidt[1], Zhenglong Li, James P. Nelson III[1], Anthony J. Schreiner[1], Timothy J. Schmit[2], W. Paul Menzel[2]
[1]Cooperative Institute for Meteorological Satellite Studies (CIMSS)
[2] NOAA/NESDIS

The Sounder instrument aboard the Geostationary Operational Environmental Satellite series (GOES-8, 9, 10, 11, and 12) currently provides information on changes in atmospheric state through a physically-based retrieval of vertical temperature and moisture profiles. The GOES Sounder typically samples the continental U.S. and surrounding oceanic regions on an hourly basis at a 10 km horizontal resolution. As a first step in the retrieval process, guess profiles of temperature and moisture are obtained, usually from short-term numerical model forecasts. Following this, the first guess profiles are then adjusted so that forward calculations match the Sounder measured radiances within some pre-determined noise level. This iterative process results in the final temperature/moisture retrieval. To date GOES moisture retrievals have provided a noticeable improvement over the first guess, while temperature retrievals have remained very similar to the first guess. The lack of temperature profile improvement in the physical retrieval process might be caused by insufficient use of the GOES Sounder radiance information, or the implementation of the radiative transfer calculation in the physical retrieval. This study demonstrates that both guess temperature and moisture profiles can be improved (by up to ~ 0.5 K for temperature and ~5% for Total Precipitable Water) when the GOES Sounder radiance measurements are used in a simple statistical retrieval approach that modifies the guess profiles prior to the physical retrieval. Another aspect of retrieval improvement involves taking into account both the time continuity of GOES Sounder radiance observations and the spatial stability of the upper atmosphere within the retrieval process. Lastly, a spatial and temporal filtering operator can be applied to reduce the random and striping noise in the GOES Sounder radiance measurements, while preserving the optimal information for subsequent sounding retrieval generation. The improvement of GOES Sounder products (sounding retrievals, total ozone, etc.) realized via noise reduction will be demonstrated. Together, these improvements are significant for better use of current GOES Sounder data, and are also important in preparation for the next generation of GOES Sounder - the Hyperspectral Environmental Suite (HES), scheduled for launch in 2013.

B14: Synergistic Use of the ABI and HES for Atmospheric Sounding and Cloud Property Retrieval

Presenter: Chian-Yi Liu

Chian-Yi Liu[1], Jun Li[1], Timothy J. Schmit[2] and W. Paul Menzel[2]
[1] Cooperative Institute for Meteorological Satellite Studies, Space Science and Engineering Center, University of Wisconsin, Madison, WI USA
[2] Office of Research and Applications, NOAA/NESDIS, Madison, WI USA

The Advanced Baseline Imager (ABI) and the Hyperspectral Environmental Suite (HES) on the GOES-R series will enable improved monitoring of the distribution and evolution of atmospheric thermodynamics and clouds. The HES will be able to provide hourly atmospheric soundings with spatial resolution of 4 ~ 10 km with high accuracy using its high spectral resolution infrared measurements. However, the presence of clouds affects the sounding retrieval and needs to be dealt with properly. The ABI will provide at high spatial resolution (0.5 ~ 2km) a cloud mask, surface and cloud types, cloud-top phase information, cloud top pressure (CTP), cloud particle size (CPS), and cloud optical thickness (COT), etc. The combined ABI/HES system offers the opportunity for atmospheric and cloud products to be improved over those possible from either system alone. The key step for synergistic use of ABI/HES radiance measurements is the collocation in space and time. Collocated ABI can (1) provide HES sub-pixel cloud characterization (mask, amount, phase, layer information, etc.) within the HES footprint; (2) be used for HES cloud-clearing for partly cloudy HES footprints; (3) provide background information in variational retrieval of cloud properties with HES cloudy radiances. The Moderate-Resolution Imaging Spectroradiometer (MODIS) and the Atmospheric Infrared Sounder (AIRS) measurements from the Earth Observing System's (EOS) Aqua satellite provide the opportunity to study the synergistic use of advanced imager and sounder measurements. The combined MODIS and AIRS data for various scenes are analyzed to study the utility of synergistic use of ABI products and HES radiances for better retrieving atmospheric soundings and cloud properties. ABI can also help HES for cloud-clearing of footprints in partial cloud cover. Currently there is an option that ABI and HES might be located on different satellites, this design will have impact on the ABI/HES synergism. In order to answer the question on what the impact will be on the ABI/HES synergism if the two satellites are separated by a distance of 1, 2.5, or 5.0 degree in longitude, a study is carried out to simulate the ABI BT differences within collocated HES footprints due to the two-satellite system for ABI and HES.

B15: NOAA-KLM HIRS Level 1b Data Issues

Presenter: Thomas Kleespies

Thomas J. Kleespies[1], Changyong Cao[1], Ken Jarva[2]
[1]NOAA/NESDIS
[2]Computer Sciences Corporation

The description of the High Resolution Infrared Radiation Sounder (HIRS) data found in the NOAA KLM User's Guide appears to be incorrect. In fact, the description is correct, but the data themselves are incorrect. This paper describes the error that led to this problem and suggests possible mitigation.

B16: Plotting Realistic Instantaneous Field of View Ellipsoids on an Arbitrary Earth Projection

Presenter: Thomas Kleespies

Thomas J. Kleespies
NOAA/NESDIS

The instantaneous field of view (fov) of a nadir scanning satellite instrument normally is circular at nadir and increases in size both along and cross track as the scan angle increases. The cross track distortion is due to the fact that the fov edge closer to nadir is also farther away from the horizon, which causes a stretching of the fov. The along track distortion is simply due to the fact that fov angle is fixed, but the distance from the satellite to the viewing location on the earth increases as the scan moves away from nadir. This paper presents the mathematics necessary to draw the fov ellipses on an arbitrary earth projection.

B17: Microwave Sounder Scan Bias Analysis From AIRS/AMSU Observations

Presenter: Bjorn Lambrigtsen

Bjorn Lambrigtsen and Zi-Ping Sun
Jet Propulsion Laboratory

The Atmospheric Infrared Sounder (AIRS) instrument suite, which includes the Advanced Microwave Sounding Unit A (AMSU-A) as well as a near-copy of the AMSU-B - the Humidity Sounder for Brazil (HSB), was launched on the NASA Aqua satellite in May 2002. During the on-orbit checkout it became apparent that the microwave instruments, in particular AMSU-A, exhibit a significant scan angle dependent bias. This phenomenon has also been noticed in the AMSU instruments operated by NOAA on NOAA-15 through NOAA-17 and is expected to also be a feature of the next series of AMSU instruments, on NOAA-N and NOAA-N’ as well as on equivalent European satellites. The Advanced Technology Microwave Sounder (ATMS), to be launched first in 2006 on the NASA NPP satellite and thereafter on a number of NPOESS satellites, is also expected to have significant scan bias. This bias is a major hindrance to the effective use of the microwave observations, both operationally and in atmospheric research, and much effort has been devoted by NOAA as well as NASA to analyze it, with a view toward correcting the measurements on an objective basis from first principles. These efforts have not yet been entirely successful, and many data users have resorted to making empirically derived corrections instead. While that may be satisfactory for operational use, it is not desirable for climate research and similar applications. The effort to model the bias therefore continues. In this paper we report on work that has been done at the Jet Propulsion Laboratory in this regard, including some progress in modeling the bias.

B18: Frequency Management

Presenter: Guy Rochard

Guy Rochard
Météo-France

Abstract not available.

B19: Introduction to China Meteorological Satellite Operational System

Presenter: Licheng Zhao

Zhao Licheng
National Satellite Meteorological Center, CMA

Affiliation to the China Meteorological

Administration, the National Satellite Meteorological Center (NSMC) is responsible for receiving, processing, distributing the meteorological satellite data in China.

There are two satellite operational systems operated by the NSMC: polar-orbiting and geostationary. The polar system consists of three satellite data receiving stations in Beijing, Guangzhou, Urumuqi, respectively. The data received by the three stations are transmitted to the Data Processing Center in Beijing. The ground segment of geo-stationary satellite consists of a primary processing center at NSMC and three ranging stations. Sub-systems include CDAS, SOCC, DPC ASC, CNAS and USS. Currently, NSMC receives data from 11 satellites (FY-1D, FY-2B/2C, Meteosat-5, GOES-9, NOAA-14/16/17, EOS/TERRA/AQUA).

More than 40 imagery and quantitative products are generated every day and distributed to users through dedicated meteorological communications network and internet. Also, a DVB-S system distributes level-1b data and various products, about 50Gb of data volume, to 86 users over the country every day. The satellite data and products are being used in weather forecast, climate and environment change, and disaster monitoring. Space weather service is being explored with the measurements of Space Environment Monitor and X-ray Monitor onboard the geo-stationary satellite.

B20: IASI on Metop : In-Flight Calibration Plan

Presenter: Denis Blumstein

D. Blumstein[1], B. Tournier[2], G. Ponce[1], T.Phulpin[1], G. Chalon[1]
[1]Centre National d'Etudes Spatiales
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The Infrared Atmospheric Sounding Interferometer (IASI) is a key payload element of the METOP series of European meteorological polar-orbit satellites. It is developed jointly by CNES and EUMETSAT. It has been designed for operational meteorological soundings with a very high level of accuracy (Specifications on Temperature accuracy : 1K for 1 km and 10 % for humidity) and also for estimating and monitoring trace gases on a global scale. The IASI system includes the 3 instruments, a data processing software integrated in the EPS ground segment and a technical expertise centre (TEC) implemented in CNES Toulouse.

The first IASI model is planned to be launched in April 2006. This paper presents the CNES plan for the in-flight calibration and monitoring of the IASI performance (Instrument and processing up to Level 1, i.e. radiances computation) that will be performed by the TEC. A companion paper in this conference presents the results of the on-ground calibration of the instrument.

B21: Selection of a subset of IASI Channels for Near Real Time Dissemination

Presenter: Andrew Collard

A. Collard and M. Matricardi
ECMWF

IASI is currently due to be launched on the MetOp-1 satellite towards the end of 2005. Global IASI Level 1C data will be distributed to European users, probably by EUMETCast. Users have requested that it be distributed lossless, i.e. either all 8461 channels, or using PCA data compression plus residuals.

Global IASI Level 1C data will be distributed to many users on the GTS. Here the bandwidth limitations are greater, and so the working assumption is that channel selection will be used, at least on Day 1. Currently AIRS is distributed in near real time to NWP centres in a similar manner with 324 out of 2378 channels being provided (the data volume is further reduced by distributing only one field of view in nine).

A subset of IASI channels that may be distributed should be chosen such that the total loss of information is a minimum. This is achieved through consideration of the loss of information content in the context of a retrievals using a short range NWP forecast as prior information. Before the final channel selection, extensive pre-screening is performed to ensure channels are not chosen where there are large forward model errors or interfering species.

B22: The introduction of clouds and aerosols in RTIASI

Presenter: Andrew Collard (for Marco Matricardi)

Marco Matricardi
ECMWF

A new version of RTIASI, the ECMWF fast radiative transfer model for the Infrared Atmospheric Sounding Interferometer (IASI) has been developed that features the introduction of multiple scattering by aerosols and clouds. In RTIASI, multiple scattering is parameterized by scaling the optical depth by a factor derived by including the backward scattering in the emission of a layer and in the transmission between levels (scaling approximation).

The RTIASI radiative transfer can include by default eleven aerosol components, five types of water clouds and eight types of cirrus clouds. The database of optical properties for aerosols and water droplets has been generated using the Lorentz-Mie theory assuming these particles have a spherical shape. For cirrus clouds, a composite database of optical properties has been generated using the Geometric Optics method for large crystals and the T-matrix method for small crystals. In either case, ice crystals have been assumed to have the shape of a hexagonal prism randomly oriented in space.

To solve the radiative transfer for an atmosphere partially covered by clouds, RTIASI 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 in RTIASI). The total radiance is then obtained as the sum of the radiances for the single columns weighted by the column fractional coverage.

To assess the accuracy of the scaling approximation we have compared approximate radiances with reference radiances computed by using a doubling-adding algorithm. For aerosols, the largest errors are observed for the desert dust type. For this case, errors are less than 1 K in the thermal infrared and less than 0.25 K in the short wave. For water clouds, errors are typically less than 1K in the thermal infrared and less than 4 K in the short wave. For the cirrus cloud type, we found a remarkable agreement between approximate and reference radiances. For a tropical profile, errors introduced by the scaling approximation never exceed 0.5K whereas for an arctic profile errors are typically less than 0.1 K.

Work has started to incorporate the science of RTIASI into RTTOV. This will lead to the release of a new version of RTTOV that can process IASI and AIRS radiances using many of the advanced capabilities of RTIASI. The new RTTOV will include a finer vertical pressure grid, variable trace gases, solar radiation, a new parameterization of the Planck function and an altitude dependent computation of the local viewing angle.

B23: Assimilation of infrared limb radiances from MIPAS in the ECMWF model

Presenter: Niels Bormann

Niels Bormann and Sean Healy
ECMWF

ECMWF is developing the capability to assimilate emitted infrared limb radiances from the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), and possibly other passive limb sounders in the future. It is the first time that the direct assimilation of limb radiances is being attempted. MIPAS is a very high-spectral resolution sounder (0.025 cm^{-1} wavenumber resolution) onboard the European Envisat satellite. The presentation will give an overview of the current status of the assimilation of limb radiances, ranging from data selection and information content studies to first 4DVAR experiments.

A set of MIPAS channels/tangent heights has been selected for assimilation studies, using an approach that maximizes information content while avoiding observations affected by larger errors in the forward model. A theoretical information content study shows that assimilation of the selected MIPAS radiances has the potential to significantly reduce the analysis error of water vapour and ozone throughout the stratosphere and lower mesosphere, and MIPAS can add significant information to the background fields of temperature in the stratosphere and lower mesosphere above about 30 km.

Experiments with real MIPAS radiances have been performed in 1DVAR and 4DVAR contexts. The results from these first experiments will be discussed and contrasted against results from an assimilation of MIPAS retrievals. Advantages and challenges for the limb radiance assimilation will be highlighted and discussed, including aspects of horizontal gradients, and the implications arising from biases in the stratospheric background data and the radiances.

B24: RTMIPAS: A fast radiative transfer model for the assimilation of infrared limb radiances from MIPAS

Presenter: Niels Bormann

Niels Bormann, Sean Healy, and Marco Matricardi
ECMWF

A new fast radiative transfer model to compute emitted clear-sky infrared limb radiances for the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) has been developed and extensively validated. The scheme, referred to as

RTMIPAS, can simulate apodised radiances for all channels of the very high-spectral resolution MIPAS instrument in the 685-2000 cm^{-1} wavenumber region. RTMIPAS is part of a wider effort to develop the capability to assimilate infrared limb radiances into the ECMWF model.

The scheme uses linear regression models to parameterize the effective layer optical depths, following RTTOV methodology. It can simulate the effect of variable water vapour and ozone; contributions for many other gases are included, but a fixed climatological profile is assumed. The development of the model has involved the calculation of an accurate line-by-line transmittance database, the selection of suitable predictors for the gases and the viewing geometry modelled, and the generation of regression coefficients for 43,205 MIPAS channels. Tangent linear and adjoint codes have also been developed.

Comparisons against accurate line-by-line simulations show that RTMIPAS can reproduce line-by-line radiances to an accuracy that is below the noise-level of the instrument for most spectral points and tangent heights. The comparison of RTMIPAS transmittances with line-by-line model equivalents indicates that the accuracy of the RTMIPAS transmittance model is comparable to that of similar regression-based radiative transfer models for the nadir viewing geometry. Comparisons between MIPAS observations and radiances simulated with RTMIPAS from ECMWF fields further confirm the accuracy of the transmittance parameterization. The influence of 2-dimensional aspects on the transmittance model will also be discussed.

B25: Operational use of AIRS Observations at the Met Office

Presenter: James Cameron

James Cameron[1], Andrew Collard[2], Stephen English[1]
[1]Met Office
[2]ECMWF

Observations from the Atmospheric Infrared Sounder (AIRS) have been operationally assimilated into the Met Office's Numerical Weather Prediction (NWP) model since 26 May 2004. AIRS observations are first screened by a 1D-Var pre-processing stage before being passed to the Met Office's 4D-Var data assimilation system. The 1D-Var pre-processing stage is used to carry out quality control, bias correction, monitoring, variational cloud detection and channel selection. The bias correction is a function of the scan position and the 850-300 hPa and 200-50 hPa model thickness. Currently only cloud-free fields-of-view over the sea are selected for data assimilation. The most sophisticated quality control step is to test for good convergence in a 1D-Var retrieval, using the 6-hour forecast field from the previous assimilation cycle as the background. A subset of 45 and 60 channels are used for assimilation for day-time and night-time fields of view respectively.

Three pre-operational trials were carried out. Two one-month trials were run to determine the impact of the new system for summer and winter periods and both indicated positive impact. The changes required to assimilate AIRS observations were added to the Met Office's operational system as part of a package of satellite data changes. The entire package was tested by incrementally adding each component of the package to a trial running parallel to operations. The results of these pre-operational trials indicate a positive impact of around 0.5% on the forecast index from the use of AIRS observations which is a satisfactory result given the conservative nature of the initial system. Plans for future improvements to the system in order to exploit more fully the potential of AIRS data are also discussed.

B26: Estimation of the Representivity Error for AIRS

Presenter: James Cameron

James Cameron
Met Office

High resolution infra-red instruments generally have several thousand channels the weighting functions of which significantly overlap. Extracting the full vertical resolution from these measurements while not introducing noise may require a careful treatment of the statistics of channel differences. Covariances in the observation error for similar channels may limit the effective vertical resolution. It is therefore desirable to be aware of the structure of the observation error, which is made up of the instrument error, forward model error and errors of representivity.

The error of representivity for AIRS observations in a global model data assimilation system is estimated. The method follows the Hollingsworth-Lonnberg technique by studying the covariance of nearby, cloud-free fields-of-view for different spatial separations. It is argued that the covariance at the smallest separation studied, 80km, is a reasonable approximation to the magnitude and structure of the instrument noise plus representivity error.

B27: cancelled

B28: Assimilation of cloudy radiances from hyperspectral infrared radiances

Presenter: Louis Garand

Sylvain Heilliette and Louis Garand
MSC, Dorval, Canada

Research is carried out aiming at assimilating cloudy hyperspectral infrared radiances, thereby extending the sounding down to the uppermost cloud layer. 1D-Var assimilation tests are made with real AIRS data combined with a NWP first guess. The pre-processing defines two cloud parameters: cloud top height and cloud fraction from a scheme using CO_2 slicing estimates of these parameters as a first guess. Currently, only temperature sounding channels in the 13.5-15.5 micron part of the spectrum are used so that the assumption of a constant cloud emissivity remains reasonable. This initial study aims at identifying most favorable situations for a successful assimilation and positive impact.

B29: Status of Assimilating Satellite Data at DWD

Presenter: Reinhold Hess

Reinhold Hess
Deutscher Wetterdienst

Deutscher Wetterdienst (DWD) has recently enforced efforts to assimilate satellite radiances. Hitherto only satellite retrievals (SATEMS) and atmospheric motion wind products (SATOBS) were assimilated.

At a first step more satellite data is used in a quite innovative way: In order to take part at ECMWF's great expertise in using satellite data, profiles of temperature, humidity and wind of IFS analyses over sea are assimilated as conventional radiosonde data with the operational Optimal Interpolation analysis system. These data (called PSEUDO-TEMPS) are used one time per day in an update run. In this way the global system takes part in the abundance of satellite data used at ECMWF, whereas it is still driven independently with its own analysis and forecast modules. Humidity profiles are assimilated only above 700 hPa in order to not affect the boundary layer climate of the global model GME of DWD.

Meanwhile development of 1D-Var retrievals for ATOVS is mature for operation application. In the northern hemisphere the forecast quality of the PSEUDO-TEMPS method is almost reached using 1D-Var retrievals of AMSU-A instead, in the southern hemisphere, however, it seems that it is required to assimilate more satellite data in order to approach the quality of IFS profiles, that are rich in satellite information.

Currently also a 3D-Var analysis system is being implemented at DWD that allows to assimilate radiances directly. Based on the experience at other centers it is expected that this further improves forecast quality. It is therefore currently under discussion to which extent the PSEUDO-TEMPS approach shall be continued.

Details on forecast quality and further results using PSEUDO-TEMPS and 1D-Var profiles will be given on the poster.

B30: SEVIRI radiance assimilation at ECMWF

Presenter: Matthew Szyndel

Matthew Szyndel
ECMWF

The European organization for the exploitation of meteorological satellites (EUMETSAT) produce a number of products from data gathered by the spinning enhanced visible and infrared imager (SEVIRI) instrument carried by the Meteosat second generation series of spacecraft (Meteosat-8 onwards), including the clear sky radiance (CSR) product. This product consists of area averaged, cloud cleared radiance data from the SEVIRI infrared channels. The European Centre for Medium-ranged Weather Forecasts (ECMWF) have operationally monitored the CSR product since March 2004 and began to assimilate data from the water vapor sensitive channels in September 2004. We describe the CSR product, describe results of the monitoring of SEVIRI radiance data and present the results of assimilation trials.

B31: The assimilation of AIRS radiance over land at Météo-France

Presenter: Hua Zhang

Hua Zhang[1,2],Florence Rabier[1], Alain Joly[1], Malgorzata Szczech-Gajewska[3], Delphine Lacroix[1]
[1]Météo-France/CNRM/GMAP
[2]CMA/Chinese Academy of Meteorological Sciences

[3]Institute Meteorology and Water Management

For the data void areas over land and with the erosion of the radiosonde coverage in some areas over land, AIRS data assimilation over land is a very important issue. The problem of using AIRS data over land is that most channels of AIRS are very sensitive to the surface conditions, surface temperature and emissivity. Accurate knowledge of the land surface characteristics is required for NWP radiance assimilation. For that purpose, an atlas of surface spectral emissivity (SSE) climatology has been developed at Météo-France, which has 18 wavebands in the infrared spectral range and is available for each month. In order to probe use of AIRS data over land, a series of four-dimensional variational (4D-Var) data assimilation and forecast experiments has been run with the French ARPEGE (Action de Recherche Petite Echelle et Grande Echelle), using these SSE.

B32: Global profile training database for satellite regression retrievals with estimates of skin temperature and global ecosystem-based emissivity

Presenter: Eva Borbas

Eva E. Borbas[1], Suzanne Wetzel Seemann[1], Allen Huang[1], Jun Li[1] and W. Paul Menzel[2]
[1]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin/Madison
[2]NOAA/NESDIS Office of Research and Applications

Regression retrievals of atmospheric properties require a global dataset of temperature, moisture, and ozone profiles in addition to estimates of skin temperature and emissivity to train the regression. A new data set consisting of greater than 12,000 global profiles of temperature, moisture, and ozone has been created, drawing from NOAA-88, ECMWF, TIGR-3, ozonesondes, desert radiosondes. In addition, a skin temperature and emissivity value has been assigned to each profile. In earlier satellite regression retrieval algorithms, skin temperature and emissivity were assigned relatively randomly to each profile.
In this study, we present a more physical basis for characterizing the surface. Skin temperature estimates are based on a study of the skin temperature/surface air temperature difference over different land types, and a global ecosystem-based emissivity is developed. Application of the database to MODIS retrievals of temperature and moisture will be presented.

B33: Estimating the retrievability of atmospheric temperature from satellite infrared simulation data

Presenter: Jing Huang

Jing Huang, Chongjian Qiu, and Gang Ma
College of Atmospheric Sciences, Lanzhou University

A method is developed to assess retrievability, the retrieval potential for atmospheric temperature profiles, from satellite infrared data in clear-sky situation. This technique is based upon generalized linear inverses theory and empirical orthogonal function (EOF) analysis. Using the NCEP globe temperature reanalysis data in Jan and July from 1999 to 2003, the retrievabilities from AIRS and HIRS/3 sounding channels data have been derived respectively for each standard pressure level on a global scale. As an incidental result of this study, the optimum truncation number in the generalized linear inverses method is deduced too. The results showed that the retrievabilities gained with two data were similar in space distribution and season change characters. Comparing with HIRS/3 data, the retrievability from AIRS data can be improved between 0.15 and 0.40.

B34: Investigating AMSU and AMSR-E rainfall estimates using active microwave sensors

Presenter: Paolo Mazzetti

D. Cimini, V. Cuomo, S. Laviola , P. Mazzetti, S. Nativi, and F. Romano
Istituto di Metodologie per l'Analisi Ambientale, IMAA/CNR

The present work deals with the integration of data obtained from passive and active microwave sources, in order to develop procedures to suitably calibrate and validate satellite-based passive microwave rainfall algorithms using multiparameter weather radar information. Near simultaneous measurements, obtained by the following microwave radiometers: AMSU and AMSR-E (flying aboard Aqua platform) and by the Chilbolton S-band radar, are used to improve rainfall estimate.

This work investigates the different channel penetration issue and the so-called beam-filling problem, in order to improve algorithms for rainfall estimate. Precipitation related parameters, worked out from radiometers, are compared with multiparametric radar information, obtained from the Chilbolton radar set near Winchester in Hampshire. RHI (Range-Height Indicator), PPI (Plan Position Indicator) and CAPPI (Constant Altitude PPI) radar data provides useful information on cloud vertical structure in order to improve the understanding of signature of passive microwave channels and the effect due to inhomogeneous rainfall coverage. For a significant rainfall event, AMSU and AMSR-E rainfall maps are achieved, applying well-accepted (or reference) algorithms; these estimates are carefully analyzed, considering the near coincident radar information.

B35: ICI atmospheric profiles over Rondonia using HSB data emulated from AIRS information

Presenter: Rodrigo Souza

Rodrigo Augusto Ferreira de Souza, Juan Carlos Ceballos, João Carlos Carvalho
Instituto Nacional de Pesquisas Espaciais (INPE)

It was analyzed the performance of the Inversion Coupled with Imager (ICI) software over the Amazon region, with set up for AMSU/NOAA-16 channels but using information from AQUA sounding system (AMSU and AIRS). AIRS channels were used to recovering the absence of HSB data, whose behavior should be similar to AMSU-B. The HSB brightness temperature in clear sky conditions was simulated by a linear combination of AIRS channels sensitive to water vapor band. The selected AIRS channels were the five best correlated with HSB (183 GHz) in a set of 3000 pixels distributed over oceanic areas for one training day (August 31, 2002). The simulated HSB data together with AMSU-A/AQUA information were used to recover vertical profiles of temperature and moisture, using ICI with two data bases: a) TIGR climatological profiles; b) CLASS1 Brazilian climatological profiles. The retrievals obtained over the Amazon region suggest that temperature profiles inferred by ICI with the TIGR and CLASS1, and using only the microwave channels, are close to radiossonde “ground truth.” The use of CLASS1 improves the results for moisture profile when compared with TIGR, particularly within low troposphere.

B36: Performance of the AQUA/NASA and NOAA-16/ICI soundings over Rondonia during the Dry-to-Wet LBA experiment

Presenter: Rodrigo Souza

Rodrigo Augusto Ferreira de Souza[1], Juan Carlos Ceballos[1], and Christopher Dwight Barnet[2]
[1]Instituto Nacional de Pesquisas Espaciais (INPE)
[2]NOAA/NESDIS

The purpose of this work was to analyze the performance of the AQUA sounding system (NASA inversion model, version C60) and of the Inversion Coupled with Imager (ICI) software to recover atmospheric profiles of temperature and moisture over Rondonia State (Amazon region) during the DRY-TO-WET Large Scale Biosphere-Atmosphere (LBA) experiment along September and October, 2002. The atmospheric profiles retrieved by both inversion models were compared with the radiossonde data ("ground truth") of the campaign, considering satellite retrievals within a 100 km radius around the sounding site. The bias and RMS of deviations were assessed for the whole available data of the campaign. Similar comparisons were performed for the quality of Numerical Weather Prediction (NWP) analyses of the National Center for Environmental Prediction (NCEP). The results showed that temperature profiles from ICI, NCEP and NASA C60 model had similar performance for pressure level above 750 hPa. All of them had similar standard deviation in the lower troposphere (about 2 K), but ICI and the analysis showed lower bias (1 to 2 K) compared with C60 (about -5 K, near ground level). On the other hand, the mixing ratio profiles estimated from the NASA inversion model suggested the expected accuracy of about 1 g/kg, a performance comparable to and even better than that observed in ICI and NWP estimates.

B37: Investigation of Methodologies for Atmospheric Retrieval for the CPTEC Operational System

Presenter: Rodrigo Souza

Elcio H. Shiguemori[1], Rodrigo A. F. de Souza[2], Wagner Flauber A. [2], Joao C. Carvalho[3], Haroldo F. de Campos Velho[1], Jose Demisio S. da Silva[1]
[1] Laboratory for Computing and Applied Mathematics - LAC-INPE
[2] Center for Weather Forecasting and Climate Studies - CPTEC-INPE
[3] Earth Observation - OBT-INPE
INPE: National Institute for Space Research - Brazil

The Center for Weather Forecasting and Climate Studies (CPTEC) is responsible for producing weather maps for the numerical prediction in Brazil. One key issue for numerical prediction is related to provide good estimation of the initial conditions for the atmospheric simulation code. One procedure consists to retrieve vertical atmospheric profiles for temperature and moisture.

The CPTEC operationally uses the Inversion Coupled with Imager (ICI-3) software in dynamic mode (CPTEC analysis) with the ATOVS/NOAA-16 system to supply such vertical profiles. However, CPTEC is also investigating new retrieval schemes that they have been developed by INPE. One of these schemes performs the profiles by means of a generalized least square problem, where a new regularization operator is employed. Such regularization operator is based on a maximum entropy of second order [1, 2]. An artificial neural network (ANN) is the another scheme for retrieving the atmospheric profiles. The ANN is the multi-layer perceptron, with backpropagation learning strategy [3].

The goal of this paper is to compare these three different methods, focus on the operational procedures. The comparison is carried out using two databases: TIGR and NESDISPR. About of 500 profiles from TIGR and 400 profiles from NESDISPR, and associated radiances, are selected from these database for testing the three strategies. The average over profiles is used to perform the comparison among the inversion methodologies, and these analysis will be shown here.

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B38: Remote sensing of vertical integrated water vapour using SEVIRI infrared measurements

Presenter: Martin Stengel

Martin Stengel[1], Maximilian Reuter[1], Rene Preusker[1], Ralf Bennartz[2], Jürgen Fischer[1]
[1]Institut für Weltraumwissenschaften - Freie Universität Berlin
[2]AOS - University of Wisconsin, Madison

A methodology for the retrieval of atmospheric water vapor is presented which utilizes the infrared-channels of the Spinning Enhanced Visible and Infrared Imager (SEVIRI) on board the geostationary satellite METEOSAT8. The measured SEVIRI brightness temperatures depend on the amount of integrated water vapor (IWV) and allow therewith its estimation.

The developed algorithms are based on different data sets, which relate SEVIRIs measured brightness temperatures to the corresponding IWV. First, we performed a huge number of radiative transfer simulations for a wide range of atmospheric and surface conditions. Second, we utilized the IWV products from NASAs Moderate Resolution Imaging Spectroradiometer (MODIS) on TERRA for land pixel and ESA's microwave radiometer on ENVISAT for sea pixel. The inversion is made by means of multiple non-linear regressions.

Considering the different datasets two algorithms were developed: Simulation Based Algorithm (SBA) and Measurement Based Algorithm (MBA).

First results of both algorithms were compared to the derived integrated water vapor from MODIS and microwave radiometers. The comparisons show an accuracy between 0.3 and 0.7 g/cm^2 for the MBA and between 0.7 and 1.3 g/cm^2 for the SBA. One reason for the lower accuracy of the SBA water vapor might be related to an emphasis on certain atmospheric and surface conditions used to set up the radiative transfer simulations.

The MBA shows a good agreement with the compared products and allows the retrieval of the integrated water vapor above land and ocean regions during the day and at night. The MBA product can be realized every 15 minutes for the full disk.

B39: Land surface emissivity database for conically scanning microwave sensors

Presenter: Jean-Luc Moncet

C. Grassotti, J.-L. Moncet, R. Aschbrenner, A. Lipton and J. Galantowicz
Atmospheric and Environment Research, Inc.

Accurate knowledge of local surface emissivity is required for lower tropospheric microwave remote sensing over land. Ideally, for a stand alone microwave system, accuracies of 0.01 or less are needed for minimizing the impact of cloud liquid water on temperature and water vapor retrievals and for improving surface temperature retrievals. Because surface properties may change rapidly, the emissivity database must be frequently updated. Surface emissivity may be well characterized in the clears-sky using co-located microwave and infrared observations although, in certain areas, terrain and surface type inhomogeneities may be a limiting factor. In cloudy (non-precipitating) skies one must rely on temporal persistence. The use of such an approach is necessarily limited to areas for which frequency of occurrence of "clear" measurements is higher than the rate at which surface properties change. Surface emissivity in the AMSR-E channels is being retrieved from combined observations from the AMSR-E, AIRS and MODIS instruments on the EOS/Aqua platform in relatively clear conditions. In this paper, we examine the temporal variability of retrieved local surface emissivity over selected regions of the globe and provide a preliminary assessment of the usefulness of the product for cloudy microwave retrievals.

B40: RTTOV-8 the latest update to the RTTOV models

Presenter: Roger Saunders

Roger Saunders[1], Stephen English[1], Peter Francis[1], Peter Rayer[1], Pascal Brunel[2], Peter Bauer[3]
[1]Met Office
[2]MétéoFrance
[3]ECMWF

The development of the RTTOV fast radiative transfer model, which is part of the EUMETSAT sponsored NWP-SAF activities, has continued since the release of RTTOV-7 in March 2002. Over the last 2 years more developments have been made leading to the release of RTTOV-8 to users in Nov 2004. This poster will document the developments which comprise RTTOV-8 and give users of RTTOV-7 an idea of whether they need to upgrade to the new model or not. Some examples of the use of the model will be presented. In addition details of how to obtain the model free of charge from the NWP-SAF will also be given. Finally developments planned for RTTOV-9 will also be outlined.

B41: Results of a comparison of radiative transfer models for simulating AIRS radiances

Presenter: Roger Saunders

R. Saunders[1], A. Von Engeln[1], P. Rayer[1], N. Bormann[2], S. Hannon[3], S. Heilliette[4], Xu Liu[5], F. Miskolczi[5], G. Masiello[6], J-L Moncet[7], Gennady Uymin[7], Y. Han[8], V. Sherlock[9], D.S. Turner[10]
[1]Met Office
[2]ECMWF
[3]UMBC
[4]CNRS/LMD
[5]NASA Langley Research Center
[6]IMAA-CNR
[7]AER
[8]NOAA
[9]NIWA
[10]MSC

At the workshop for Soundings from High Spectral Resolution Observations in May 2003 an AIRS radiative transfer model comparison was proposed under the auspices of the ITWG. Results from 12 models have been submitted. An initial analysis of the differences was presented as a poster at ITSC-13. The aim of the intercomparison is (i) to compare the forward model calculations for all the AIRS channels from all the models for 52 diverse profiles and one tropical Pacific profile coincident with AIRS data. (ii) to estimate forward model error covariances, (iii) to assess the jacobians from each model using the Garand measure of fit for a limited selection of channels and (iv) document the time taken to run each model. The results have now been fully analysed and will be presented. There are significant differences between models related to the assumptions made about line mixing, water vapour continuum and inclusion of CFCs. In addition a comparison with AIRS observations will also be presented.

B42: The Gradient Fast Line-by-Line Model

Presenter: D. S. Turner

D.S. Turner
Meteorological Service of Canada

An analytical gradient model of MSC's Fast Line-by-Line Model has been developed. In addition to the forward model quantities, the gradient model produces the derivative of the radiance with respect to the pressure, temperature and volume mixing ratio profile levels. The gradient plus the forward model generally requires twice as much CPU time as the forward model by itself. This article describes the current state of the model.

B43: Do Training Datasets Make a Difference?

Presenter: Hal Woolf

Harold M. Woolf
University of Wisconsin-Madison/CIMSS

Members of the remote sensing community, and especially those working in the area of atmospheric-profile retrieval science, often expend considerable energy and resources in the construction of training datasets for two of the primary components of that work: (1) fast transmittance models, and (2) regression first-guess schemes. Recently the author has begun to wonder just how significant those efforts are in terms of the end result -- the quality of the retrieved profiles of temperature and humidity.

A study has been undertaken, utilizing the IAPP and the flyover, or direct-readout, NOAA-15 and -16 ATOVS datasets received at Madison, Wisconsin, to assess the influence of different training datasets on retrieval accuracy. In the area of fast transmittance model generation, the CIMSS-32 (31 profiles plus the Standard Atmosphere) and UMBC-49 (48 profiles plus the Standard Atmosphere) training datasets have been employed to construct coefficients for the PLOD/PFAAST algorithm. For regression first-guess development, the NOAA-88b and SEEBORv3 datasets have been used.

Retrievals have been produced from all available flyover passes since 10 February 2005, using the following "combinations of ingredients":

A. the existing "operational" version, consisting of CIMSS-32 fast transmittance and NOAA88b first guess;
B. UMBC-49 fast transmittance and NOAA88b first guess;
C. UMBC-49 fast transmittance and SEEBORv3 first guess.

For all three versions, the retrievals are also run with NWP first guess.

Assessments of retrieved temperature and humidity quality, based on radiosonde matchups, are presented for the six cases, and conclusions are drawn as to the significance of the choice of training datasets for the two components.

B44: International MODIS/AIRS Processing Package (IMAPP) Current Status and Future Prospects

Presenter: Thomas Achtor

Hung-Lung Huang, Liam Gumley, Kathleen Strabala, Jun Huang, Kevin Baggett, James E. Davies, Li Guan, Jun Li, and Tom Achtor
Cooperative Institute for Meteorological Satellite Studies
Space Science and Engineering Center
University of Wisconsin-Madison

The International Moderate Resolution Imaging Spectroradiometer / Atmospheric Infrared Sounder (MODIS/AIRS) Processing Package (IMAPP) provides users with 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. IMAPP can be downloaded via anonymous ftp at http://cimss.ssec.wisc.edu/~gumley/IMAPP/.

IMAPP continues to evolve by developing and releasing software that meets users' demands for near real-time regional environmental products. Software portability, reliability and usability continue to be the primary requirements driving the project. The number of products within IMAPP continues to grow and currently includes MODIS/AIRS calibrated/navigated radiances, MODIS cloud mask, cloud top properties and cloud phase, retrievals of atmospheric profiles (temperature and moisture), total precipitable water, sea surface temperature and aerosol optical depth. AIRS Level 1 and 2 products include: level 1b, single field of view clear retrievals of temperature and moisture and AMSR-E level 1B/2A processing software. The near term algorithm releases include MODIS/AIRS cloud-cleared radiance and sounding retrieval, and AMSR-E rain rate.

While IMAPP development will continue into the near future, 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 NPOESS prime contractor and NASA Direct Readout Laboratory (DRL). The RDR/SDR/EDR processing software system known as Field Terminal System (FTS) will then be used by NPP/NPOESS direct broadcast users for the production of Sensor Data Records (SDRs) and Environmental Data Recoreds (EDRs). The proposed International NPOESS/NPP Processing Package (INPP) will support the NPOESS mission application element by developing value added services to 1) support northern American real-time regional users, 2) add value to the mission application products generated including regionally optimized/unique and specialty/synergistic products, 3) provide continuous calibration/validation & evaluation support, and 4) engage the global direct broadcast community in NPP/NPOESS mission.

In summary, in this poster paper we will highlight the current status and future prospects for IMAPP and its successor, INPP. Specifically, we shall address the role these software packages play in bringing to the international polar orbiting direct broadcast community the considerable capabilities of the NOAA series satellites, EOS of NASA, and, into the future, NPOESS of IPO (Integrated Program Office).

B45: Improved navigation of Advanced Very High Resolution Radiometer data at high latitudes

Presenter: Adam Dybbroe

Adam Dybbroe
Swedish Meteorological and Hydrological Institute, SMHI

Uncertainties in the orbit prediction and attitude control of the NOAA spacecrafts often cause the geolocation of the AVHRR data to be in error of several kilometres. Applying the Automatic Navigation Adjustment (ANA) software developed at the Céntre de Météorologie Spatiale (CMS), Météo-France, Bordes et al. (1992) and Brunel and Marsouin (2000), in general improves AVHRR navigation significantly. ANA combines a physical image deformation model and automatic adjustment on coastal landmarks, and allows for interpreting the landmark navigation errors in terms of the satellite attitude.

However, especially at high latitudes and during nighttime and during the winter season the ANA landmark detection often fails, leaving either very few landmarks for the attitude estimation, or even worse, no valid landmarks at all, and therefore no attitude correction. For one full year (2003) of 1149 NOAA 17 overpasses received at SMHI ANA failed to derive an attitude in 19.7% of these. During wintertime (October till March) this ratio increase to 20.6%, and during nighttime (19 till 5 UTC) the rate of failure is 24.4%.

This paper presents a new landmark classification method developed mainly for nighttime. The method is based on a k-means clustering approach using all five AVHRR spectral channels. The method was tested on a large number of NOAA 15, 16 and 17 overpasses received at Norrköping during the winter months November till March of the years 2003 and 2004.

The rate of success in the landmark detection rate increases significantly when using the new method. The number of nighttime NOAA 17 overpasses for which a pitch error was derived increased from 74% using the existing histogram method to 82% with the k-means clustering method.

B46: A Near Real-Time AIRS Processing and Distribution System: Current Products and Future Plans

Presenter: Thomas King (for Walter Wolf)

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A near real-time AIRS processing and distribution system has been fully operational at NOAA/NESDIS/ORA for over two years. This system was developed to distribute AIRS data to the Numerical Weather Prediction Centers for data assimilation. Due to the large volume of AIRS data, the full data set could not be distributed; therefore, the data set had to be spatially and spectrally subset. Current AIRS subset products include brightness temperatures and principal component scores for one field of view selected from every other collocated AMSU field of regard. Although the AIRS data have shown positive model impact, this subset scheme may not be the optimal set for assimilation since the selection of the data on a fixed grid was arbitrary. To determine the effectiveness of this AIRS subset scheme, NOAA/NESDIS/ORA has created two new AIRS data subsets for distribution. The first new dataset only uses AIRS data to determine the clearest footprints to be distributed. The second data set uses MODIS data, in conjunction with the AIRS data, to determine the highest quality footprints to be distributed. Both of these new subset methods will be presented.

The AIRS system developed at NOAA/NESDIS/ORA is being used as a baseline to prepare for the processing and distribution of both IASI data from MetOP and CrIS data from NPP and NPOESS. Both IASI data and CrIS data orbits will be simulated and their radiances will be produced using model forecast data and fast radiative transfer programs. The simulated data will then be subset and placed into BUFR format for distribution. These systems will be implemented the same way that the AIRS simulation system was run prior the launch of AQUA. The details of these future systems will be discussed.

B47: The Application of Principal Component Analysis (PCA) to AIRS Data Compression

Presenter: Lihang Zhou

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Data compression is one of the key issues for high spectral resolution infrared sounders because their data volumes are too large to distribute in full to the users and the data assimilation centers. The Atmospheric Infrared Sounder (AIRS) (Aumann et al. 2003), launched on May 4, 2002 on the AQUA-EOS satellite, is the first of a new generation of high spectral resolution infrared sounder having 2378 channels measuring outgoing radiance between 650 cm^{-1} and 2675 cm^{-1}. NOAA/NESDIS is processing and distributing AIRS data and products in near real-time to operational NWP centers. This offers us a great opportunity to use real AIRS observations as a test-bed for data compression study of the hyper spectral sounding instruments.

The desired features of hyper spectral data compression include high compression ratio, fast processing time, and the preservation of relevant information. Principal Components Analysis (PCA) provides an effective way to reach these goals. Since the information from the 2000 plus AIRS channels are not independent, PCA can be used to reduce the dimension while retaining the significant information content of the data. The AIRS spectrum can be represented by a much smaller amount of PCA scores. Individual channels can be reconstructed with minimal signal loss. Reconstruction errors can be coded using Huffman coding. Instead of the individual channel radiances, principal component (eigenvector) coefficients can be provided to the users, thus reducing the size of the data volume. The coded reconstruction errors and the corresponding statistical metadata can be provided along with the data if lossless compression is desired.

Our preliminary study shows that compression factors of up to 50 can be obtained with this approach, without losing any accuracy of the data. In NOAA NESDIS, a data compression system based on this approach is being developed, which will allow us to archive and distribute the compressed AIRS level 1B data and the corresponding metadata in near real time. In this poster we present our studies of the application of this approach to other AIRS data compression techniques. The generation and application of the eigenvectors, the process of Huffman coding the reconstruction errors and the creation of the corresponding statistical metadata will be described. The knowledge that we are gaining from the AIRS data will be useful for high spectral infrared radiance data compression for future satellite observations.

B48: Introduction to Spatial Heterodyne Observations of Water (SHOW) Project and its instrument development

Presenter: Yunlong Lin

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Water is a critically important constituent throughout the stratosphere and mesosphere. The SHOW project will develop a new instrument to measure water vapour from 15km to 85km height, on a global scale, using the unique capabilities provided by Spatial Heterodyne Spectroscopy (SHS). This work builds on Canadian expertise in fabricating solid Michelson interferometers to fill a significant niche in our current capability.

The SHS setup the FTS with the mirrors replaced by diffraction gratings at littrow configration, wavelength depended Fizeau fringes are recorded by a 320*256 CCD camera without any scanning elements, the high resolution spetral information along one detector dimension can be obtain from Fouier analysis, and the other dimention will provide the spatial information. At a limb view point, a field-widened SHS with half-angle of 6 degrees for water observations at 1364nm is desired, the resolution is 0.02nm within full bandwidth of 2nm, and the resolving power is about 68,000.

B49: MEOS POLAR - A cost effective Direct Broadcast terminal for current and future L and X-band polar orbiting satellites

Presenter: Einar Grønås

Dr. Frank Øynes, Einar Grønås
Kongsberg Spacetec AS

This paper describes the design of the Kongsberg Spacetec MEOS POLAR terminal for reception and processing of data from current and future L and X band satellites. Standard calibration of imaging and sounding instruments are provided as well as higher level processing of imaging instruments. The key characteristics of the system and processing algorithms are presented. The system is in use by meteorological institutes and service providers for providing meteorological, oceanographic and land services. The hardware and software of the current implementation and trends for future are discussed.

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