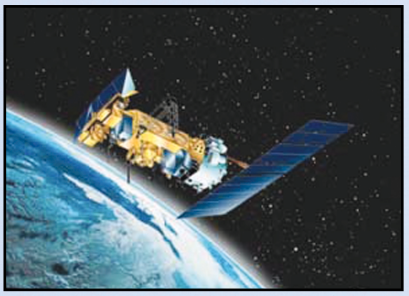
INTERNATIONAL ATOVS WORKING GROUP



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

A Report on the Thirteenth International TOVS Study Conference

Sainte-Adèle, Québec, Canada
29 October - 4 November 2003

Photo by Jakob Grove-Rasmussen

A Report on
The Thirteenth International
TOVS Study Conference

Sainte-Adèle, Québec, Canada
29 October - 4 November 2003

Conference sponsored by:

Met Office (U.K.)
NOAA NESDIS
EUMETSAT
World Meteorological Organization
Alcatel
ABB
Raytheon Company and
ITT Industries

Report prepared by:

Thomas Achtor and Roger Saunders
ITWG Co-Chairs

Leanne Avila
Editor

Published and Distributed by:

University of Wisconsin-Madison
1225 W. Dayton St.
Madison, WI 53706
USA

ITWG Web Site: http://cimss.ssec.wisc.edu/itwg/

March 2004

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 Thirteenth International TOVS Study Conference (ITSC-XIII) was held at the Hotel Le Chantecler in Sainte Adèle, Québec, Canada from 29 October to 4 November 2003. This conference report summarises the scientific exchanges and outcomes of the meeting. A companion document *The Technical Proceedings of The Thirteenth International TOVS Study Conference* contains the complete text of ITSC-XIII scientific presentations. The ITWG Web site (http://cimss.ssec.wisc.edu/itwg/) contains electronic versions of the conference presentations and publications. Together, these documents and Web pages reflect the conduct of a highly successful meeting in Sainte Adèle. An active and mature community of TOVS and ATOVS data users now exists, and considerable progress and positive results were reported at ITSC-XIII in a number of areas, including many related to the new ATOVS system and to the current and impending advanced sounders.

ITSC-XIII was sponsored by the Met Office (U.K.), NOAA NESDIS, EUMETSAT, the World Meteorological Organization (WMO), Alcatel, ABB, the Raytheon Company and ITT Industries. The support of these government agencies and private industry companies is gratefully acknowledged. We wish to thank the local organising committee from Environment Canada, particularly Louis Garand and Clement Chouinard of the Data Assimilation and Satellite Meteorology Division. We also thank and appreciate the contribution of the Environment Canada staff, particularly Maryse Ferland and Danielle O'Shaughnessey, who assisted ably in the organization and conduct of the Conference at Sainte Adèle. We also thank the staff of Hotel Le Chantecler for their assistance during the Conference. Finally, we thank the numerous contributions from Leanne Avila of the University of Wisconsin who assisted in conference planning, on-site meeting organization, and preparation and publication of this Report, the Technical Proceedings and the ITWG Web site.

Roger Saunders
Co-Chair ITWG
Met Office (U.K.)

Thomas Achtor
Co-Chair ITWG
University of Wisconsin-Madison

ITSC-XIII Poster

THE THIRTEENTH INTERNATIONAL
TOVS STUDY CONFERENCE (ITSC-XIII)
Sainte Adèle, Québec, Canada: 29 October - 4 November 2003

International TOVS Working Group (ITWG) Co-Chairs

Thomas Achtor, University of Wisconsin-Madison, USA
Roger Saunders, Met Office, UK

Organising Committee for ITSC-XIII

Thomas Achtor, University of Wisconsin-Madison, USA
Roger Saunders, Met Office, UK
Clement Chouinard, Environment Canada
Louis Garand, Environment Canada
Maryse Ferland, Environment Canada
Danielle O'Shaughnessey, Environment Canada
Leanne Avila, University of Wisconsin-Madison, USA
Maria Vasys, University of Wisconsin-Madison, USA

ITSC-XIII Participants

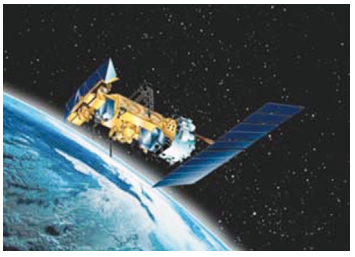
Tom Achtor	CIMSS / University of Wisconsin - Madison	USA
Steven A. Ackerman	CIMSS / University of Wisconsin - Madison	USA
Bjarne Amstrop	Danish Meteorological Institute	Denmark
David Anselmo	Environment Canada	Canada
Paolo Antonelli	CIMSS/University of Wisconsin - Madison	USA
Nigel Atkinson	Met Office	UK
Thomas Auligne	Météo-France	France
George Aumann	Jet Propulsion Laboratory (JPL)	USA
Leanne Avila	CIMSS/University of Wisconsin - Madison	USA
Nancy Baker	Naval Research Laboratory - Monterey	USA
John M. Blaisdell	NASA/GSFC/SAIC	USA
Hal Bloom	NPOESS IPO	USA
Eva Borbas	CIMSS/Univ. of Wisconsin - Madison	USA
Pascal Brunel	Météo-France	France
Henry Buijs	ABB Bomem Inc.	Canada
Mike Chalfant	NOAA/NESDIS/ORA	USA
Clément Chouinard	Environment Canada	Canada
Pubu Ciren	QSS Group Inc.	USA
Andrew Collard	Met Office	UK
David Crain	ITT Aerospace/Communications	USA
Cyril Crevoisier	Laboratoire de Météorologie Dynamique	France
Per Dahlgren	Swedish Met Service (SMHI)	Sweden
Godelieve Deblonde	Environment Canada	Canada
Ralph Dedecker	CIMSS/Univ. of Wisconsin - Madison	USA
John Derber	NOAA/NWS/NCEP/EMC	USA
Chaohua Dong	China Meteorological Administration	P.R. China
Adam Dybbroe	Swedish Met Service (SMHI)	Sweden
Izabela Dyras	Institute of Meteorology and Water Management	Poland
Stephen English	Met Office	UK
Luc Fillion	Meteorological Service of Canada	Canada
Evan Fishbein	NASA Jet Propulsion Laboratory	USA
Gilles Fournier	Meteorological Service of Canada	Canada
Ignacio Galindo	Universidad de Colima	Mexico
Ma Gang	National Satellite Meteorological Center	P.R. China
Louis Garand	Environment Canada	Canada
Albin Gasiewski	NOAA Environmental Technology Laboratory	USA
Pierre Gauthier	Meteorological Service of Canada	Canada

Elisabeth Gerard	Météo-France/CNRM/GMAP	France
Mitchell D. Goldberg	NOAA/NESDIS/ORA	USA
David Griersmith	Commonwealth Bureau of Meteorology	Australia
Jacob Grove-Rasmussen	Danish Meteorological Institute	Denmark
Yong Han	NOAA/NESDIS	USA
Brett Harris	Bureau of Meteorology Research Centre	Australia
Reinhold Hess	DWD	Germany
Lisa Horrocks	Met Office	UK
H. L. Allen Huang	CIMSS/University of Wisconsin - Madison	USA
Ron Isaacs	Atmospheric and Environmental Research, Inc. (AER)	USA
Nicole Jacquinet-Husson	Laboratoire de Météorologie Dynamique	France
Viju Oommen John	University of Bremen	Germany
Steve Johnson	ITT Aerospace/Communications	USA
Masahiro Kazumori	Japan Meteorological Agency	Japan
Graeme Kelly	ECMWF	UK
Dieter Klaes	EUMETSAT	Germany
Thomas Kleespies	NOAA / NESDIS	USA
Robert Knuteson	CIMSS/University of Wisconsin - Madison	USA
Christina Köpken	Deutscher Wetterdienst (DWD)	Germany
Aarno Korpela	National Institute of Water and Atmospheric Research	New Zealand
Bjorn Lambrigsten	NASA Jet Propulsion Laboratory	USA
Allen Larar	NASA Langley Research Center	USA
Lydie Lavanant	Météo-France	France
Sung-Yung Lee	NASA Jet Propulsion Laboratory	USA
Jun Li	CIMSS/SSEC/UW-Madison	USA
Alan Lipton	Atmospheric and Environmental Research, Inc.	USA
Xu Liu	Atmospheric and Environmental Research, Inc.	USA
Zhiquan Liu	China Meteorological Administration	P.R. China
Stephen Macpherson	Meteorological Service of Canada	Canada
Jean-François Mahfouf	Meteorological Service of Canada	Canada
Philippe Marguinaud	Meteo France	France
Marco Matricardi	ECMWF	UK
Mark McCarthy	Hadley Centre, Met. Office	UK
Larry McMillin	NOAA/NESDIS/ORA	USA
Tony McNally	ECMWF	UK
Carl Mears	Remote Sensing Systems	USA
Herschel Mitchell	Meteorological Service of Canada	Canada
Jean-Luc Moncet	Atmospheric and Environmental Research, Inc.	USA
Thibaut Montmerle	Météo-France	France
Chris O'Dell	University of Wisconsin-Madison	USA
Michael Pavolonis	CIMSS/SSEC/UW-Madison	USA
Thierry Phulpin	Centre National d'Etudes Spatiales (CNES)	France
Youri Plokhenko	CIMSS/University of Wisconsin - Madison	USA
Saroja Polavarapu	Meteorological Service of Canada	Canada
Joe Predina	ITT Aerospace/Communications Division	USA
Jeff Puschell	Raytheon Santa Barbara Remote Sensing	USA
Yanni Qu	ITT Aerospace/Communications	USA
Florence Rabier	Météo-France/CNRM/GMAP	France
Gaby Rädel	LMD/IPSL	France
Roger Randriamampianina	Hungarian Meteorological Service	Hungary
Tony Reale	NOAA/NESDIS	USA
Hank Revercomb	SSEC/CIMSS/University of Wisconsin - Madison	USA
Guy Rochard	Météo-France	France
Filomena Romano	IMAA/CNR	Italy
Hervé Roquet	Météo-France	France
William B. Rossow	NASA Goddard Institute for Space Studies	USA
Roger Saunders	Met. Office	UK
Peter Schluessel	EUMETSAT	Germany

Marion Schroedter-Homscheidt	Deutsches Zentrum für Luft- und Raumfahrt (DLR)	Germany
Marc Schwaerz	University of Graz	Austria
Soumia Serrar	Laboratoire de Météorologie Dynamique	France
Awdhesh Sharma	NOAA/NESDIS	USA
Vanessa Sherlock	National Institute for Water and Atmospheric Research	New Zealand
Devendra Singh	India Meteorological Department	India
Bill Smith	NASA Langley	USA
David Steenbergen	Meteorological Service of Canada	Canada
Larrabee Strow	University of Maryland - Baltimore County	USA
Malgorzata Szczech-Gajewska	Institute of Meteorology and Water Management	Poland
Peter Thorne	Hadley Centre, Met. Office	UK
Christopher Tingwell	Bureau of Meteorology Research Center	Australia
David Shawn Turner	Meteorological Service of Canada	Canada
Michael Uddstrom	National Institute for Water and Atmospheric Research	New Zealand
Alexander Uspensky	PLANETA, Roshydromet	Russia
Gilles Verner	Meteorological Service of Canada	Canada
Michèle Vesperini	Laboratoire d'optique atmosphérique, Université de Lille	France
Nicolas Wagneur	Meteorological Service of Canada	Canada
Kung-Hwa (Peter) Wang	Central Weather Bureau	Taiwan
Elisabeth Weisz	CIMSS/Univ. of Wisconsin - Madison	USA
Fuzhong Weng	NOAA / NESDIS / ORA	USA
Walter Wolf	NOAA/NESDIS (QSS Group, Inc.)	USA
Hal Woolf	CIMSS/Univ. of Wisconsin - Madison	USA
Xuebao Wu	Peking University	P.R. China
Jishan Xue	Chinese Academy of Meteorological Sciences	P.R. China
Dan Zhou	NASA Langley Research Center	USA
Lihang Zhou	QSS Group Inc.	USA
Shiyu Zhuang	Chinese Academy of Meteorological Sciences	P.R. China

ITSC-XIII Group Photo at Le Chantecler

Table of Contents



1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The thirteenth International TOVS Study Conference, ITSC-XIII, was held in Sainte Adèle, Québec, Canada from 29 October - 4 November 2003 and marked the milestone of 25 years of TOVS data starting with the launch of TIROS-N in October 1978. Around one hundred and thirty participants attended the Conference and provided scientific contributions. Twenty countries, and two international organizations were represented: Australia, Austria, Canada, China, Denmark, France, Germany, Hungary, India, Italy, Japan, Mexico, New Zealand, Norway, Poland, Russia, Sweden, Taiwan, the United Kingdom, the United States of America, ECMWF and EUMETSAT. This was the largest conference to date in terms of number of presentations and posters.

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

- Operational use of ATOVS
- New applications for NWP
- Instrument studies
- Radiative transfer and surface modelling
- Retrieval of atmospheric, surface and cloud parameters
- Use of ATOVS for climate studies
- Future systems and processing

There were 90 oral and 58 poster presentations during the conference. The programme for ITSC-XIII can be found starting on page 53.

Working Groups were formed to consider six key areas for the International TOVS Working Group (ITWG): Radiative Transfer and Surface Property Modelling; Use of TOVS and ATOVS in Numerical Weather Prediction; Use of TOVS and ATOVS for Climate Studies; 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 but the key points arising from the conference are listed below.

During the Conference, a session on Status Reports considered summaries of activities that had taken place since ITSC-XII. It also reviewed progress on the Action Items identified by the ITSC-XII Working Groups. Many of these items formed the basis for further discussion by Working Groups at ITSC-XIII. Several technical sub-groups met during ITSC-XIII to discuss frequency protection and developments and plans concerning specific software packages, shared and in common use at TOVS, ATOVS and Advanced Sounder processing centres. Brief reports on these sub-group meetings are recorded in Section 3. The conference also recognised the achievements of one of the pioneers of satellite sounder science, Dave Wark, who died on 30 July 2002 and was a long term supporter of these conferences.

1.2 SUMMARY OF MAJOR CONCLUSIONS

Overall, the meeting documented significant gains in many areas and noted areas for future activity. In particular, it noted that:

1. Recent observing system experiments have shown that the impact on medium range weather forecasts from using ATOVS data in NWP now exceeds that from the radiosonde network. The AMSU data contribute most of the impact.

2. The impact of 3 ATOVS platforms with different equator crossing times was shown to improve on

the current baseline 2 polar orbiter system. As a result ITWG reaffirms the requirement for both the 0530LT and 1330LT NPOESS platforms to include both CrIS and ATMS measurements.

3. In a recent review for the ITWG it was noted that many NWP centres are now using level 1b ATOVS radiances in their variational assimilation systems but a significant number of centres still use the level 2 retrievals.

4. NWP centres have agreed to increase their co-ordination in exchanging their ATOVS monitoring results in order to identify instrument anomalies as quickly as possible.

5. The timeliness requirements for global ATOVS datasets needs to be reviewed as NWP models are now reducing their data cut-off times to well below three hours. It was suggested that the WMO re-examine the timeliness criteria for NWP in light of NWP centres changing their data timeliness requirements. Satellite agencies should also continue to strive to reduce the time delays of the global data.

6. The EUMETSAT ATOVS Retransmission Services (EARS) now covers a significant part of the Northern Hemisphere and provides ATOVS level 1c radiances within 30 minutes of measurement time. Plans are well advanced to use these data for both regional and global NWP. Satellite agencies should consider this option for future polar orbiters particularly if delays are likely to be greater than 60 minutes for the global datasets.

7. NWP centres are now beginning to see beneficial impacts in the assimilation of ATOVS data in local area models, although it is still in the early stages and significant development is necessary to increase the impacts.

8. More centres are now assimilating the microwave humidity sounding data from AMSU-B with positive impacts particularly on the moisture fields and precipitation.

9. Since ITSC-XII a high spectral resolution sounder workshop was held at the University of Wisconsin-Madison in May 2003 to allow a more detailed presentation of scientific issues related to advanced sounders. These workshops can educate and train young scientists entering the field. It is planned to hold another workshop before ITSC-XIV.

10. There is now a significant effort to demonstrate the impact of advanced infrared sounder data in NWP using the AIRS near real-time datasets available from NESDIS. One centre is already using the data operationally.

11. Only a small fraction of the full AIRS dataset is currently being assimilated in NWP model experiments and research is underway to exploit more of the data both spectrally, spatially, over land and cloud to increase the impacts in NWP models.

12. The community software packages for processing locally received ATOVS data continue to be developed. In particular preparations for processing the new datasets to be received from NOAA-N (i.e., HIRS-4 and MHS) are underway. The free distribution of ATOVS processing software has been essential in the use of ATOVS data by the meteorological community.

13. Community software for processing Aqua AIRS, AMSU-A, HSB and MODIS locally received data is now available. AMSR-E processing capability will be added soon. Equivalent software needs to be developed for the NPOESS direct readout data.

14. The AIRS advanced sounder data have proven to be stable and accurately calibrated and so is an excellent dataset for validating radiative transfer model simulations.

15. The intercomparison of radiative transfer calculations continues to be coordinated by the group and an effort to compare radiative transfer models for AIRS is underway.

16. Several presentations demonstrated the feasibility of including the effects of both cloud and precipitation in radiative transfer models, preparing the way for assimilation of cloud and rain affected radiances.

17. The retrieval of land surface infrared emissivity for advanced sounder channels is an area where research has expanded and is showing promise.

18. The retrieval of mid-tropospheric CO_2 over the tropics using both HIRS and AIRS data has been demonstrated and validated with aircraft data.

19. There was an increased involvement of the climate monitoring community in this conference with presentations on the HIRS-12 water vapour and MSU temperature records. The group was informed of the NOAA White Paper which proposes to co-ordinate a reprocessing of satellite data including the TOVS 25 year dataset. The group broadly supported this initiative.

20. Plans were presented to provide a continuous monitoring of operational polar orbiting satellites and radiosondes through a carefully defined network of radiosonde reference stations with balloon launches coincident with satellite overpass times. Additionally a sensor for satellite inter-calibration in a medium earth orbit was proposed. Such transfer standards need to be established to reduce the uncertainties in the satellite data for climate monitoring applications.

21. The ITWG were informed of the discrepancies between the various MSU climate records and invited to help resolve the differences.

22. The ITWG will support the satellite frequency co-ordination group meeting, SFCG-24, in September 2004 in Lannion, France.

23. The ITWG noted the use of the 23.6-24.0 GHz band for atmospheric sounding is under threat by proposed automobile collision avoidance radars.

24. The ITWG will gather information on education and training activities of its members, including the satellite operators and NWP centres, and provide this information on its Web site. It will also seek to connect members to the WMO co-ordinated efforts in education and training to utilise resources globally.

25. The ITWG reaffirmed the need to maintain a robust system in both AM and PM orbits optimally spaced to maximise the coverage both for NWP and climate monitoring applications.

26. Access to documents describing NPOESS/NPP ground processing and raw data and sensor data records (content and format) needs to be established to allow review by members of the group.

1.3 FUTURE PLANS

ITWG will continue its ongoing activities of informing the ATOVS community of new 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 in Europe during 2004. The AIRS radiative transfer model intercomparison sponsored by ITWG will be completed in 2004. The links with international bodies such as WMO and CGMS will be maintained and a report of this meeting will be made to CGMS by our rapporteur, Paul Menzel.

In addition to this report a proceedings for ITSC-XIII from the papers submitted will be provided to attendees on CD-ROM. The oral and poster presentations from ITSC-XIII are already available as pdf files which can be downloaded from the ITWG Web site. The next meeting of the ITWG is planned for Spring 2005. Topics of interest may include further exploitation of advanced IR sounder data, plans for use of METOP data and status of climate datasets derived from (A)TOVS.

ACTIONS AND RECOMMENDATIONS

WORKING GROUP ON RADIATIVE TRANSFER AND SURFACE PROPERTY MODELING

2.1.1 Atmospheric profile datasets for Radiative Transfer

Action

Roger Saunders to post profile interpolation code on ITWG-RTWG Web page.

Action

Roger Saunders to put trace gas profiles on ITWG-RTWG Web site.

2.1.2 Instrument characteristics required for RT modeling

Action

Tom Kleespies to inform ITWG before NOAA-N launch.

Action

Tom Kleespies to provide SSMIS channel characteristics.

Action

Tom Kleespies to obtain and provide WINDSAT measured channel responses.

2.1.3 Line by Line (LbL) model status

Recommendation

Infrared line by line models can now be validated using AIRS data with collocated profiles for a wide range of atmospheric situations. Model developers should be encouraged to update their models and/or spectroscopic databases in the light of this new dataset.

2.1.4 Assessment of spectroscopic databases

Action

Nicole Jacquinet-Husson to send Roger Saunders copy of ‘road map’ document for distribution to the group.

Action

All members of the group to send information on validation datasets to RTWG Co-Chairs for posting on the ITWG-RTWG Web site on a new validation page.

2.1.5 Fast RT models

Action

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

2.1.6 AIRS RT model comparison

Recommendation

All AIRS RT modellers should be encouraged to participate in the AIRS RT model comparison to assist in the estimation of forward model error covariances.

Action

Roger Saunders to obtain profiles and AIRS data from Larrabee Strow and provide to modellers.

2.1.8 Review of group Web page

Action

Co-Chairs to update Web pages and ITWG-RTWG to propose additions and improvements.

WORKING GROUP ON TOVS/ATOVS DATA IN CLIMATE

2.2.1 Introduction

Recommendation

We recommend that ITWG broadly supports the white paper.

Action

The NOAA NESDIS white paper is available on the ITWG Web site. All members of the Climate Working Group (and other interested parties) should provide feedback and comments on the white paper to Mitch Goldberg and John Bates.

Action

Mitch Goldberg and John Bates to provide summary of responses and report back via the ITWG email list.

2.2.3 Issues related to long-term homogeneity

Action

Tony Reale to pursue SUAN funding and agreement through relevant bodies (NOAA, NASA, WMO, GCOS etc.). This needs to be effectively targeted which will require research and further collaboration with interested parties before being presented.

Recommendation

ITWG encourages an inter-calibration sensor to be considered for the first medium earth orbit evaluation payload.

Recommendation

ITWG should promote the GCOS observing principles to satellite agencies.

Recommendation

When changing instrumentation satellite agencies should try and ensure that the new sensor has backward compatibility to ensure long-term climate monitoring can continue.

Recommendation

ITWG members should help to resolve the observed MSU dataset trend discrepancy for the climate community by providing their expertise and guidance gleaned from other applications of MSU.

Action

Evan Fishbein and Carl Mears to assess the optimal choice of equator crossing times for climate applications and report back to ITWG.

2.2.4 Reanalysis datasets

Recommendation

ITWG to ask ECMWF to try rerunning a 2-year segment from early 1986 to remove the early NOAA-9 platform warm bias and allow potential analysis of true NOAA-9 platform bias in MSU2.

Recommendation

ITWG should reaffirm to funding bodies the potential benefits of new high quality reanalysis products.

2.2.5 Relations to international climate programs and other bodies

Action

ITWG climate group to form a sub-group to discuss this issue and report back.

Recommendation
ITWG to promote using standardised sensors on non-NOAA platforms as a way to increase spatial and temporal coverage for climate records.

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

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

Recommendation (to DA/NWP Centres)
The Working Group recommends the continued exchange of monitoring results and encourages each centre to develop their own Web page to post their results. A master document linking all Web pages has been developed and linked on the NWP SAF site and a similar link will be set on the ITWG Web site to enable easy examination and comparison of results between groups. Centres are encouraged to share pre-submitted papers and any valuable material on the following topics:

1. Bias correction procedures for regional and global systems
2. Scan-dependent biases
3. Thinning procedures for regional and global systems
4. Background error correlation and variance studies
5. Mesoscale verifications

Action
C. Chouinard will coordinate the development of the NWP Web page until June 2004 after which S. English will take responsibility.

Recommendation (to DA/NWP Centres)
That an e-mail list be set up and used to quickly alert each other of potential problems and their severity so actions can be taken in a timely manner. (Action: J. Derber to setup the e-mail list) Note: this e-mail list is intended as an informal exchange between NWP centres not a formal communication with data providers. The original list is made up of NWP WG members but will likely be extended to others.

Recommendation (to DA/NWP Centres)
The Group recognizes the difficulty in implementing and validating radiance/retrieval data in a DA/NWP system and recommends that those that have prepared so-called single observation experiments in the development of their assimilation system post them on their Web page with sufficient details on the Web site for another to replicate these independently.

Recommendation (to DA/NWP Centres)
Encourage the production of Observing System Experiments at various NWP centres to be presented at the next meeting and most importantly post these results on the ITWG Web site.

Recommendation (to ITSC)
The Group recommends that the McNally survey summary grid be continued and posted on the ITWG Web site. When changes are made at various NWP centres on the use of data, that McNally be advised, the grid updated accordingly, and the changes be logged on the ITWG Web site. The WG noted that the table and survey should be expanded and include more information on how the data are prepared and used at various centres. This would be reflected by a more complete summary with additional columns and/or notes. (Action: T. McNally to coordinate)

Recommendation (to NOAA/NESDIS and EUMETSAT)
The Group recommends that the data providers should continue to improve the quality assurance of all data, including level 1b and level 1d. The quality of the data (e.g., including navigation) should be

monitored at all stages including the final stage, which may have been reformatted. The provider should attempt to identify and flag questionable or poor quality data. Data providers, e.g., EUMETSAT and NOAA/NESDIS, are encouraged to use NWP monitoring results to help them in diagnosing data problems. The Group recognizes that it is easy to identify gross errors, while subtle errors are more difficult to detect. (Action: NESDIS, EUMETSAT)

Recommendation
To document, evaluate and improve the current procedures to convert antenna temperatures to brightness temperatures. (NESDIS and DoD)

Action
To collect documentation of the current status of antenna correction procedures for current microwave instruments from DoD, NESDIS, EUMETSAT and NASA and present at next ITSC meeting. (G. Deblonde)

2.3.3 Forward modelling

Recommendation
We encourage the developers of new instruments to either expand or enhance current RT models, or develop general codes applicable to all instruments and make them available.

2.3.4 Observing systems and real-time access to data

Recommendation
That satellite agencies and the WMO GOS WG consider 3xAMSU or equivalent in orthogonal orbits as minimum requirement to maximize global coverage for operational NWP.

Recommendation
That satellite agencies support the use of the WMO standard and produce data in a common format (e.g., BUFR). Also, the agencies should collaborate early and often on definitions and provisions of test data sets.

Recommendation
That EARS be continued and where possible, extended to include more of NH and possibly SH.

Recommendation
The data providers should continue to strive to speed up delivery of data and eliminate blind orbits. (Action EUMETSAT, NESDIS)

Recommendation
Real-time access to the observations by NWP centres should be considered for all satellite observation programs which may be useful for NWP. (All satellite agencies)

Recommendation
Both operational and research programs should develop collaborative efforts with NWP centres to evaluate the new data and allow the earliest possible access to the data for the NWP centres.

Recommendation (to NOAA, EUMETSAT)
Specification for future instruments at least matches or improves upon the capabilities of current instruments.

WORKING GROUP ON ADVANCED SOUNDERS

2.4.2 Status of plans for advanced sounding instruments

Action

J. Eyre to update IR and MW sounder tables on ITWG Web site before ITSC-XIV.

Action

A. Huang to implement a Web page for the Advanced Sounders Working Group on the ITWG Web site.

2.4.3 New initiatives for geostationary sounding

Recommendation (to Space Agencies)

The ITWG recommends that system design simulations and other studies be completed for the purpose of identifying optimized performance/cost/risk/benefit approaches for candidate geostationary and MEO microwave sensors. This microwave system would supply data for temperature and moisture soundings and time-resolved precipitation mapping.

2.4.4 The use of the NPOESS requirements change process

Recommendation to ITWG

Any recommendation concerning NPP and NPOESS advanced sounding instruments' requirements change should use this process by presenting the relevant study results to the JARG through Mitch Goldberg.

2.4.5 Implementation of advanced sounders

Recommendation (to NPOESS Joint Agency Requirements Group (JARG))

ITWG recommends that the entire interferogram be sampled and transmitted to the ground for all three spectral bands of the NPOESS CrIS instrument. This will allow full spectral resolution to be achieved for the midwave and shortwave N_2O/CO_2 bands as well as for the longwave bands. Full spectral resolution in all three bands is important for improving boundary layer temperature and upper tropospheric water vapor sounding as well as for extraction of trace gas profiles for climate data records. In addition the longwave extent of the shortwave band of the CrIS should be extended to include the 4.7 μm band of CO lines. Measurement of tropospheric CO is important for monitoring and forecasting air quality and for associated impacts to atmospheric chemistry climate.

Recommendation (to NPOESS Joint Agency Requirements Group (JARG))

ITWG recommends that the 0530LT and 1330LT NPOESS platforms retain full CrIS and ATMS measurement capability. These two satellites together with the 0930 METOP satellite will be able to provide 4-hour frequency high resolution soundings that are important for improved global weather predictions (see recommendation in 2.3.4 related to this).

Recommendation (to NASA)

ITWG recommends that the orbit of the NPP satellite be changed from 1030 to a time that better complements the 0930 orbit of the METOP satellite. This is important to improve the global sampling of high vertical resolution soundings for global weather prediction.

Recommendation (to NPOESS Joint Agency Requirements Group (JARG))

The Field-of-View size for CrIS should be redefined so as to optimize sounding performance under partly cloudy sky conditions.

2.4.6 Data processing, inversion and assimilation

Action (Hal Bloom)

ITWG requests that the user communities be provided with, and invited to review, the draft specifications (content and format) for the raw data records (RDRs) and sensor data records (SDRs) for NPOESS/NPP instruments.

Recommendation (to IPO and NPOESS Joint Agency Requirements Group (JARG))
ITWG recommends that the user communities be invited to assess and comment on the performance of NPOESS/NPP sensors and processing algorithms, especially calibration data and algorithms, in a timely fashion to enable suitable preparation for processing and interpretation of data from the flight mission.

Action (Allen Larar / Chair of SOAT)
Interact with the NPOESS IPO to facilitate a mechanism for ITWG members to obtain NPOESS ground processing and field terminal design parameters, including draft input data file formats, draft processing design documents, draft interface control documents and draft hardware specification documents through collaborations with the NPOESS SOAT.

Recommendation (to CGMS)
ITWG recommends that responsible agencies establish focal points to ensure that ingest and pre-processing code for future advanced sounders (and their complementary imagers) is provided, in a form suitable for use with locally-received direct read-out data, and yielding output consistent with globally processed data. Furthermore, activities are to be undertaken to integrate this code into processing packages available for international distribution in a timely manner.

Recommendation (to IPO and NASA)
ITWG recommends that ingest code for NPP instruments (CrIS, ATMS and VIIRS) be made available by IPO to the external scientific community, and that such algorithms should be integrated into a processing package for locally received data available for international distribution.

2.4.7 Characterization of spatial response

Recommendation (to Space Agencies)
ITWG recommends that the spatial responses of advanced sounders should be characterized to a level at which the associated error does not cause the total noise budget of the instrument to be exceeded, and, where achievable at reasonable cost, to a level at which the associated error is a negligible contribution to the total system noise.

2.4.8 Validation of data and products

Recommendation (to NOAA and NASA)
The Advanced Sounder working group strongly supports the Satellite Upper Air Network (SUAN) initiative proposed by the Satellite Sounder Science and Products working group (see action in 2.6.11).

2.4.9 Workshop for Soundings from High Spectral Resolution Sounders

Recommendation (to ITWG)
The Advanced Sounders working group recommends that ITWG organize periodic Advanced Sounding workshops to be held independently of the main ITSC meetings and plans should be made to hold a workshop in Europe before ITSC-XIV.

WORKING GROUP ON INTERNATIONAL ISSUES AND FUTURE SYSTEMS

2.5.3 Timeliness of satellite data

Recommendation (to WMO/CGMS)
It was recommended that WMO review the requirement for timeliness of satellite data for global NWP in the light of NWP centres changing requirements.

2.5.4 Software and documentation

Recommendation (to space agencies)
The Working Group recommended that the satellite operators continue their excellent efforts to provide

documentation and software to support optimal use of environmental satellite data with the view to have complete compatibility between global and local geophysical parameters (at least to level 1b).

2.5.5 Equator crossing time

Action (D. Hinsman)

Provide link to CGMS table to ITWG Webmaster.

2.5.6 Frequency protection

Recommendation (to National Radiofrequency Agencies)

Given the current levels of uncertainty in the studies for potential interference to EESS applications within the 23.6-24.0 GHz band by proposed automobile collision avoidance radars it was recommended that:

1) automobile radar manufacturers make efforts to develop systems that operate outside this band

2) any interference study of the impact of automobile radars on EESS applications using this band incorporate margins of at least 13 dB (20x) below the necessary EESS sensitivity levels to account for the uncertainties.

2.5.7 Education, training and promotion

Action (to ITWG)

All members of ITWG to consider contributing to ITWG training Web page.

WORKING GROUP ON SATELLITE SOUNDER SCIENCE AND PRODUCTS

2.6.2 Working group interaction and scientific contributions

Action (all WG members)

The WG Co-Chairs and individual members will promote the synergy between SSSP and other ITWG Working Groups, continue to seek scientific contributions from members and from the international community, and enhance the SSSP and ITWG Web site to meet these goals. The group will also seek to identify sources of information on the use of sounding data through questionnaires.

2.6.3 Access to global data from current polar satellites

Recommendation (to Satellite Agencies)

All satellite operators providing global polar satellite observations are encouraged to make their data routinely available to the international user community. In each case, procedures (and necessary protocols) for users to gain routine access to global, operational and research data sets should be identified and made available to users via links on the SSSP Web site. This will include complete listings of the data available (measurements and products), data formats, metadata and software for reading data files.

Action (to SSSP Co-Chairs)

The Co-Chairs will request information from space agencies through ITWG members (AK Sharma, Devendra Singh, Dong Chaohua, Alexander Uspensky) and provide links to the information on Web site).

2.6.4 Access to HRPT data and software from current polar satellites

Action (to SSSP Co-Chairs)

The Co-Chairs will request information from space agencies and provide links on the Web site. WG members will collect needed information on operational and research satellites and instruments for which direct broadcast (HRPT) data and associated software processing packages are available (and not currently included on the SSSP Web site). Appropriate data links will be provided to the Webmaster for inclusion in the HRPT area of the site.

Recommendation (to Satellite Agencies and HRPT Reception Stations)
It is recommended that satellite data providers and HRPT reception stations consider programs for expanded HRPT and associated imager data coverage similar to EARS, but with more complete global coverage.

2.6.5 Instrument health and future instrument status

Action (to SSSP Co-Chairs)
The Co-Chairs will request information on instrument health from satellite providers through ITWG members (Dieter Klaes, Devendra Singh, Dong Chaohua, Alexander Uspensky, Paul Menzel, Hal Bloom) to identify sources of information (e.g., Web sites) covering the health of current instruments and the status of future satellites and instruments. This information shall be provided to the SSSP Webmaster to include on the Web site.

2.6.6 Access to information on data plans for future satellites

Action (to SSSP Co-Chairs)
The Co-Chairs will request information on future satellite systems from satellite providers through ITWG members (A.K. Sharma, Dieter Klaes, Devendra Singh, Dong Chaohua, Alexander Uspensky, Hal Bloom). Information shall be provided to the SSSP Webmaster to include on the ITWG site.

2.6.7 Scientific algorithm information from global satellite providers

Action (to SSSP Co-Chairs)
The Co-Chairs will request information from satellite providers through ITWG members (Dieter Klaes, Peter Schlüssel, Thierry Phulpin, Devendra Singh, Dong Chaohua, Alexander Uspensky, Tony Reale, Walter Wolf, Tom Kleespies). They will identify sources of information (e.g., Web sites) describing the scientific methods for processing polar satellite data, beginning with measurement calibration (i.e., instrument filter functions, etc.) and including derived product algorithms. This information will be provided to the ITWG Webmaster for inclusion on the SSSP Web page.

2.6.8 Information on useful datasets for satellite data processing and simulation

Action (Lydie Lavanant)
A list of parameters and associated data atlas volumes available within the international community from operational and research satellites will be identified, and links to scientific documentation, formats and data will be established within the SSSP Web site to facilitate their access by users.

2.6.9 Global HRPT directory

Action (Lydie Lavanant, Elizabeth Sylvestre, Tom Kleespies)
WG members should seek information concerning actively working HRPT sites. Available government licensing and/or other listings will be sought to aid in creating a directory. Once established, the SSSP Co-Chairs shall contact these facilities and solicit inputs to SSSP and, where appropriate, encourage ITWG participation.

2.6.10 Collocated radiosonde and satellite observation dataset

Action (Tony Reale, Lydie Lavanant, Hank Revercomb, Mitch Goldberg, Graeme Kelly)
Efforts to compile real-time and historical datasets of collocated radiosonde (GTS and special experimental observations) and operational polar satellite (Global and HRPT) data are encouraged. The SSSP Web site will be expanded to identify groups compiling such data, and facilitate better awareness of and access to special experimental radiosondes (and other in situ ground truth observations) which are not routinely available.

2.6.11 Satellite Upper Air Network (SUAN)

Action (Tony Reale, with Guy Rochard, Don Hinsman, Peter Thorne, Mitch Goldberg, John Bates, Dave Steenbergen, Dieter Klaes)
A proposal describing the Satellite Upper Air Network will be developed and provided to the WMO for

international discussion and recommendation. This proposal would identify candidate site selection, expected benefits, network protocols (i.e., launch schedules) and resource requirements.

2.6.12 Identification of key research topics

Action (Tony Reale, Lydie Lavanant, Tony McNally, Thierry Phulpin)

SSSP WG members will establish a list of key scientific topics in conjunction with ongoing user needs. ITWG members are requested to provide inputs to the SSSP WG Co-Chairs, who will review and forward this information to the Webmaster for inclusion on the SSSP site.

2. WORKING GROUP REPORTS

2.1 RADIATIVE TRANSFER AND SURFACE PROPERTY MODELLING

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

Working Group members: R. Saunders (Co-Chair), L. Garand (Co-Chair) with F. Weng, M. Matricardi, P. Brunel, T. Kleespies, L. McMillin, J. Li, N. Jacquinet-Husson, D.S. Turner, V. Sherlock, G. Deblonde, C. Köpken, J. Grove-Rasmussen, H. Woolf, J-L. Moncet, M. Vesperini, C, Crevoisier, P. Schlüssel, D. Klaes, Y. Han, E. Weisz, M. Schwaerz, X. Wu, A. Uspensky, R. Knuteson, P. Wang, A. Dybbroe, A. Collard, T. Auligné, M. Szczech-Gajewska, D. Anselmo, L. Strow (provided inputs during ITSC-XIII).

This working group focuses on the issues related to atmospheric radiative transfer (RT) and surface property models which are relevant for radiance assimilation and atmospheric and surface retrievals from past, current and planned infrared and microwave sounder data.

2.1.1 Atmospheric profile datasets for Radiative Transfer

Radiative transfer (RT) models require a dataset of diverse profiles for training and independent validation. The group is actively using various profiles datasets whose characteristics are summarised in Table 2.1-1. A Fortran 90 code for interpolating a profile from one level to another and extrapolation above the top level has been provided to the group as an action from the last meeting. One of the developments since ITSC-XII has been the use of NWP model based profile datasets that have a more consistent treatment of humidity in the upper troposphere and lower stratosphere.

Action

Roger Saunders to post profile interpolation code on ITWG-RTWG Web page.

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

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	Raymond Armante/LMD 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[1]	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

[1]One profile in the upper levels in the UMBC set has stratospheric temperatures that are too cold.

Recent developments include a consideration of the units conversion for water vapour. A report on this is available on request from Peter Rayer (peter.rayer@metoffice.com) at the Met Office.

Action

Roger Saunders to put trace gas profiles on ITWG-RTWG Web site.

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:

• ATOVS filter responses for NOAA-N due for launch in September 2004.

Action

Tom Kleespies to inform ITWG before NOAA-N launch.

• MTSAT IR channel characteristics are available from Jeff Puschell (Raytheon) subject to approval by JMA.

• AMSR-E Paul Van Delst (NCEP) has the channel responses.

• SSMIS channel characteristics are available. S/N02 is the sensor in orbit.

Action

Tom Kleespies to provide SSMIS channel characteristics.

• WINDSAT channel characteristics are required.

Action

Tom Kleespies to obtain and provide WINDSAT measured channel responses.

2.1.3 Line by Line (LbL) model status

The status of IR LbL models used by the group is summarized below:

- **GENLN2**: No new developments were reported. **RFM** is a faster more user friendly version of GENLN2 available from Oxford University.
- **kCARTA** has been updated based on AIRS validation. Code available on UMBC Web site. (contact is Larrabee Strow at UMBC email: strow@umbc.edu).
- **LBLRTM**: A new version 8.2 is now available from AER Web site at http://rtweb.aer.com
- **4A** in its operational version is now distributed by NOVELTIS but is still free for research groups. It uses GEISA-2001 at http://ara.lmd.polytechnique.fr
- **σ -IASI** is available from EUMETSAT based on LBLRTM but optimised for IASI.
- **Hartcode** from R. Rizzi/F. Miskolczi
- **FLBL** from Shawn Turner (MSC) for research in MSC and used to train MSCFAST.

Recommendation

Infrared line by line models can now be validated using AIRS data with collocated profiles for a wide range of atmospheric situations. Model developers should be encouraged to update their models and/or spectroscopic databases in the light of this new dataset.

For microwave LbL models:

- **MONORTM** is a simplified version of LBLRTM for the microwave and can be obtained from the same Web site as LBLRTM.
- **MPM 89/92** continues to be used by many groups (i.e., basis for RTTOV and OPTRAN)
- **Rosenkranz** model last updated in 2002.

- **ATM** from Juan Pardo.
- **STRANSAC** from LMD.
- **ARTS** a model developed at Bremen University which is being extended to cover the infrared. A poster was presented on ARTS.

2.1.4 Assessment of spectroscopic databases

The performance of the new generation of high spectral resolution atmospheric sounders (e.g., AIRS, CrIS and IASI) is dependent upon the quality of the spectroscopic parameters of the active gases since these are used as input to the LbL models. The latest official releases for spectroscopic parameters are GEISA-2003 and HITRAN-2000+ and there is code available to convert from GEISA into HITRAN format. It was noted that there are plans to change the format of HITRAN in the future. A warning about the treatment of CFCs in HITRAN was discussed where all the negative absorption values have been suppressed. Nicole Jacquinet-Husson (LMD) reported on the draft of a 'road map' for the HITRAN and GEISA databases.

Action

Nicole Jacquinet-Husson to send Roger Saunders copy of 'road map' document for distribution to the group.

LMD has also continued support for the aerosol dataset for IASI.

The role of this group to help provide information through the Web site of useful validation datasets (e.g., ground based, airborne, satellite) was proposed.

Action

All members of the group to send information on validation datasets to RTWG Co-Chairs for posting on the ITWG-RTWG Web site on a new validation page.

2.1.5 Fast RT models

The working group noted the continuing progress on fast RT models, especially for simulating AIRS data. The group reviewed the status of fast models:

OPTRAN: Version 6 is available and is the operational code. Version 7 uses a corrected transmittance term in place of the effective transmittances. Version 8 is under development and uses a polynomial fit to represent the coefficients along the absorber path. The point of contact is Yong Han (NESDIS). Plans are to merge versions 7 and 8 and to use it for cloudy radiance simulations. Other plans include additional variable gases. Papers on OPTRAN have been submitted to Applied Optics.

RTTOV: Version 7.1 is the latest version. Version 8 will be released in Feb 2004 and the paper in the proceedings by Saunders *et. al.* gives more details. Users were reminded to feedback any problems to rttov.nwpsaf@metoffice.com. RTTOV-71 can simulate cloudy radiances.

GASTROPOD: An AIRS fast model based on kCARTA. This is an open source project and code can be downloaded from gastro.sourceforge.net. Regression coefficients for pre-launch and the latest post-launch AIRS ISRF are available.

OSS: The code is working for AIRS, CrIS, NAST-I, AMSU and CMIS. The training on LBLRTM and possibly kCARTA will be redone to include the CFCs. Cloudy radiance simulation is planned. The code may be available on request to Jean-Luc Moncet (AER).

MSCFAST: The code is being used at Met. Service Canada for GOES radiance assimilation. It also

supports AIRS, but currently only the 324 channel subset.

LMD fast models: A Neural Net model has been developed for AIRS and IASI simulations. A Jacobian model has also been developed for AIRS. A poster on the LMD fast models was presented at the conference. In addition, the 3R and 3R-NN models from LMD have demonstrated their capability in simulating TOVS channels (Chédin *et al.* JQSRT, **77**, 2003).

SARTA: AIRS fast RT model from UMBC based on kCARTA.

PLOD/PFAAST: Hal Woolf has developed code for HIRS, MODIS, GOES and other IR sensors. It is trained on the UMBC 48 profiles with LBLRTM. Plans are to update with cleaned up training set and latest version of LBLRTM.

RTIASI: Fast RT model for simulating IASI radiances. Version 4 is available from EUMETSAT with variable trace gases and reflected solar radiation. Version 5 will be released in June 2005 with scattering, aerosols and clouds.

Issues for fast models

• Trace gases

Fast models are now beginning to have the capability to treat trace gases as variable in the same way as water vapour and ozone have been in the past. This allows for retrieval of trace gas concentrations. However a trace gas climatology is still required for retrievals which require a climatological first guess. The models should have the ability not to compute trace gas transmittances if they are not required.

• Number of levels and predictors

Increasing the number of layers for fast models may be required for advanced sounders but it also slows the model run times for ATOVS. Fast models need to be flexible to allow different number of levels for different sensors as required. Increasing the number of predictors for higher accuracies needs to be balanced against the increased model run times. It was thought 40-50 levels is enough for ATOVS but ~90 levels may be needed for AIRS simulations.

• Broad channels

Broadband channels can be difficult to simulate with fast models as one central frequency is not a good approximation for the whole channel. Planck weighted transmittances have been used in the past (e.g., Weinreb and Hill, *NOAA Technical Report NESS* **80**, 1980) with some success and more recently with RTTOV (see poster at ITSC-XIII by Pascal Brunel and Shawn Turner). Also a Planck function correction which uses the central frequency as a free parameter rather than setting it to the mean value can extend the range over the usual 2 parameter (band correction factors) solution.

• Model diagnostics

Several users asked for the option to be able to output profile layer mean quantities which were used in the regression. Outputting the various emission terms (surface, upwelling, and downwelling) was also requested.

• Fast model testing for Tangent Linear and Adjoint codes.

This is an area where it was felt some guidance to the users is required. Both Tom Kleespies and Paul van Delst have some lecture notes on TL/AD testing. They made the point each module should be tested individually. Vanessa Sherlock noted inner products could be used to test tangent linear and adjoint codes.

Action

Tom Kleespies and Roger Saunders to collect notes on this topic and post a summary on

the ITWG-RTWG Web site.

2.1.6 AIRS RT model comparison

At the workshop for Soundings from High Spectral Resolution Observations in May 2003, an AIRS radiative transfer model comparison was proposed and Roger Saunders is now coordinating this activity under the auspices of the ITWG. Results from 9 models have already been submitted and about 15 participants have indicated they will provide results. An initial analysis of the differences was presented as a poster at ITSC-XIII. It was emphasised the importance of having results from the LbL model dependent set for each of the fast models so that the difference between the LbL models can be excluded from the analysis. Error correlations from the model differences were also requested to be documented in the results. Larabee Strow offered to provide profiles from the ARM W. Pacific site, together with AIRS data to provide a comparison between the models and measurements. The method of Louis Garand will be adopted to assess the Jacobian differences. A reference Jacobian will have to be selected which could be the dependent set, where possible, for each fast model. It was agreed any comparison of model run times (e.g., for 1000 profiles) would only be approximate but it was felt this was still useful information. To summarise the aim of the first phase is:

- 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.
- To estimate model error covariances.
- Assess the Jacobians from each model using the Garand measure of fit for a limited selection of channels.
- Document the time taken to run each model.

The plan is to have all the results submitted by January 2004 and provide a report by April 2004. The results would be posted on the RTWG Web site at:
http://cimss.ssec.wisc.edu/itwg/groups/rtwg/rtairs.html

As a second phase it was suggested to provide a line by line transmittance dataset to all participants for training so the uncertainties due to the different profiles and spectroscopy could be eliminated. However data volumes may make this difficult to achieve at least for all the AIRS channels. It was also suggested to do studies on the impacts on AIRS retrievals of the RT model errors derived from phase one. Vanessa Sherlock will address this by assessing how the RT errors feed through to the retrievals using a 1D-Var code. The response of the models to surface emissivity was also a parameter of interest which may be added.

Recommendation

All AIRS RT modellers should be encouraged to participate in the AIRS RT model comparison to assist in the estimation of forward model error covariances.

Action

Roger Saunders to obtain profiles and AIRS data from Larrabee Strow and provide to modellers.

2.1.7 Surface property models

2.1.7.1 Microwave emissivity

Ocean surface
FASTEM-2 is being updated by Stephen English (Met Office) to improve the simulations and add a polarimetric capability so all 4 components of the Stokes vector are computed. It will be released as part of RTTOV-8.

NRL is developing a polarimetric model for WINDSAT.

Paul Chang at NESDIS is preparing a field campaign during 2004 to make microwave sea surface measurements at high wind speeds to validate the models.

Land surface
A new snow model by Fuzhong Weng (NESDIS) will soon be tested on AMSU channels. Stephen English presented results showing that data assimilation trials using the microwave surface emissivity atlas had not been successful suggesting an implicit retrieval of surface emissivity might be more successful.

2.1.7.2 Infrared emissivity

Ocean surface
The sea surface emissivity model from Wu and Smith (*Applied Optics*, **36**, 1997) is now being used for developing fast IR surface emissivity models (e.g., at NCEP) due to the more complex treatment for larger viewing angles and higher wind speeds although their results agree with Masuda et. al. for normal wind speeds and close to nadir view angles.

For RTIASI an alternative to the Cox and Munk slope variance for the ocean surface has been developed using a surface wave model in an attempt to provide more realistic computations of reflected downwelling radiation. This allows the emissivity model to be initialised by a wave model in an NWP system. Shaw and Churnside (*Applied Optics*, **36**, 1997) have published measured statistics of sea-surface slope. In the era of advanced sounders it would be worth updating the IR sea surface emissivity models with newer datasets.

Land surface
Several talks were presented during the conference on this topic. There are now several MODIS atlases of land surface emissivity and in a few years there will be global atlases of surface emissivity in all the AIRS window channels. Retrievals of surface emissivity have been demonstrated from AIRS over the ARM Oklahoma site. There is a University of Washington study making measurements over snow. The current efforts in NWP centres to use more IR radiances over land should encourage more research into land surface emissivity.

2.1.8 Review of group Web page

The Web pages will be updated to include the new information provided during ITSC-XIII.

Action

Co-Chairs to update Web pages and ITWG-RTWG to propose additions and improvements.

2.2 TOVS/ATOVS DATA IN CLIMATE

Working Group members: P. Thorne (acting Co-Chair) with T. Achtor, S. Ackerman, G. Aumann, P. Ciren, E. Fishbein, L. Horrocks, M. McCarthy, C. Mears, G. Rädel, B. Rossow, S. Serrar, L. Zhou, [in absentia: M. Goldberg, G. Kelly, T. Reale]

2.2.1 Introduction

Weather satellites can be useful for climate monitoring purposes and, as an example satellite climate datasets from MSU have been used in a number of recent papers, including two in *Science*. However, recent developments in our understanding of the MSU calibration have highlighted the requirement for caution in interpretation of satellite climate records, and for Global Climate Observing System (GCOS) climate monitoring principles to be adhered to. Satellites will always require a degree of surface and satellite based validation, and this could and should be better optimised and targeted in space and time. The relative cost of such a program is small and the potential benefits significant for climate applications. TOVS data continue to be used in reanalysis products and provide very useful information, particularly over otherwise data-sparse ocean and high latitude regions.

NOAA NESDIS has recently published a white paper relating to future plans for its polar orbiting satellites under the Climate Change Science Program. This Paper is available for comment on the ITWG Web site. Mitch Goldberg can provide further details regarding the review process. The working group broadly supports this paper which builds on recommendations from previous ITSC meetings and external bodies such as GCOS. However, the WG believes that the paper could be improved in certain respects. Individual members of the Working Group (and ITWG more generally) can make comments on different aspects of the white paper. Feedback from this group on the white paper is welcomed. In particular there was concern voiced that the definition of "Climate Data Record" within the white paper was not specific enough. We hope to pool together the feedback from this group via Mitch Goldberg and John Bates as we feel that feedback as a group would be more powerful than as individuals.

Recommendation

We recommend that ITWG broadly supports the white paper.

Action

The NOAA NESDIS white paper is available on the ITWG Web site. All members of the Climate Working Group (and other interested parties) should provide feedback and comments on the white paper to Mitch Goldberg and John Bates.

Action

Mitch Goldberg and John Bates to provide summary of responses and report back via the ITWG email list.

Rather than repeat the ground covered by the white paper, we have chosen to concentrate on other work not explicit in it for the remainder of this WG report. Furthermore we concentrate entirely on applications from the (A)TOVS MSU and HIRS sounders as these are the areas of group expertise.

2.2.2 Recent advances in the use of TOVS / ATOVS data in climate studies

Since ITSC-XII a number of peer-reviewed climate datasets have been constructed and / or documented:

- 2 new realisations of the long-term (A)MSU tropospheric record from Channel (5)2 and an update to the previously published version.
- A HIRS based CO_2 dataset.
- Potential new datasets and transfer capability from AIRS.

MSU, HIRS UTH, and SST datasets continue to be widely used in climate research applications. The MSU record is being used to try to help evaluate the causes of recently observed changes in the vertical structure of atmospheric temperatures. This is an important topic in climate change studies and MSU data have the potential to contribute to understanding physical processes. In particular, the MSU record is truly global in coverage whereas available radiosonde data are primarily a Northern Hemisphere continental record. The change in frequency of channel 12 on HIRS with the ATOVS platform instrumentation means that the UTH product has been discontinued from 1998 onwards.

Work also continues to be undertaken by investigators in the WG to prepare other climate-quality satellite datasets.

2.2.3 Issues related to long-term homogeneity

Ensuring long-term homogeneity in satellite datasets is essential for climate studies, and the group noted lessons learned from a number of instruments (HIRS, CERES). In this report we use the example of MSU to highlight some of the key issues, which are generic to all satellite instruments if they are to be useful in climate research.

Discrepancies between three independently produced MSU datasets (Christy *et al. J. Atmos. and Oceanic. Tech.* **20** 613-629, 2003; Mears *et al. J. Clim.* **16** 3650-3664, 2003; Vinnikov and Grody, *Science* **302**, 269-272, 2003) have raised serious concerns regarding long-term homogeneity of satellite-based climate records. Pessimistically, they can imply that satellite data may not be useful for climate change studies at all (although they are useful for climate variability) as in terms of global-mean trends these three datasets do not overlap within their respective published uncertainty estimates. Alternatively, one or more of the datasets might be physically unrealistic. Each group has tried to minimise errors associated with satellite platform changes, diurnal drift etc. Although the likely sources of non-climatic noise in the MSU measurements are generally agreed upon, the groups undertake very different approaches to correct for these. In the absence of an agreed transfer standard it is difficult to conclude unambiguously which approach is more likely to be correct. Tony Reale presented in the climate session a potential radiosonde baseline network (SUAN). An agreed transfer standard should be put in place for future reference to reduce uncertainty in the size and pattern of non-climatic effects for both MSU and other satellite datasets. SUAN would provide such a standard at relatively small cost and have potential benefits operationally as well as for climate monitoring. However efforts should explicitly be made to minimise the impact on records from long-term stations, especially from the GUAN (150 stations) and Lanzante *et al.* (87 stations) datasets, which can provide a complimentary viewpoint and extend back further than the satellite period.

Action

Tony Reale to pursue SUAN funding and agreement through relevant bodies (NOAA, NASA, WMO, GCOS etc.). This needs to be effectively targeted which will require research and further collaboration with interested parties before being presented.

Key in establishing and maintaining a climate data record using spaceborne sensors is the regular intercomparison between the sensors on different satellites in a statistically representative sample of global positions. An inter-calibration satellite (ICS) in a medium earth orbit (MEO) at 10,000 Km altitude can be useful in supporting this requirement, when equipped with suitable high spatial and spectral resolution VIS, IR and MW radiometers. The MEO concept is being evaluated at NASA and NOAA. Having two independent sources of calibration for polar orbiters (ground based SUAN and a suitable MEO) would greatly enhance our understanding of non-climatic noise characteristics in their products. An additional benefit of such a MEO instrument would be the accurate characterization of the diurnal cycle in the IR and MW. The diurnal cycle is currently not well-represented in polar satellite and radiosonde observations, due primarily to coarse spatial/temporal sampling, or in NWP/climate models.

Recommendation

ITWG encourages an inter-calibration sensor to be considered for the first medium earth orbit evaluation payload.

It has been found that most of the discrepancy in trends between the MSU time series relates to a single platform - NOAA-9 and the treatment of its overlap periods, particularly that with NOAA-6. The periods of overlap are very short and so the choice of an inter-satellite bias correction approach has a disproportionately large effect. Carl Mears' analysis shows that this single satellite's transitions account for approximately half of the long-term trend difference between two of the datasets. This highlights the importance of future satellite missions adhering to the GCOS observing system principles as articulated in the white paper and elsewhere.

Future planned NOAA platforms will be different from the (A)TOVS systems. There will be a critical need to maintain backward compatibility with existing records to ensure continuity in climate data records. New instruments should explicitly demonstrate that they maintain this backward compatibility. Climate monitoring considerations should be borne in mind whenever instruments are modified or replaced. There is a climate requirement for a cross-track MW scanner with the same channels as AMSU going forward into the future. Similarly, HIRS channel 12 frequency should be returned to the original specification - allowing for a continuation of the UTH series, albeit with an undesirable break of several years. Alternatively such a channel should be reconstituted from high resolution sounder data. The combination of AMSU and HIRS can provide information on changes to the hydrological cycle, an area of uncertainty in climate model predictions. If climate models can be shown to capture observed changes in the hydrological cycle, then we will have greatly increased confidence in their projections of future climate change.

Recommendation

ITWG should promote the GCOS observing principles to satellite agencies.

Recommendation

When changing instrumentation satellite agencies should try and ensure that the new sensor has backward compatibility to ensure long-term climate monitoring can continue.

The effect of uncertainties in the MSU dataset is important as the choice of climate data record version can fundamentally affect our understanding of climate change. We need to understand the true evolution of the MSU time series and the reasons for discrepancies between the current versions. This is likely to provide lessons for other satellite based climate record construction. The continuing uncertainty about the trend greatly reduces confidence of the climate community in the veracity and value of satellite based climate records.

Recommendation

ITWG members should help to resolve the observed MSU dataset trend discrepancy for the climate community by providing their expertise and guidance gleaned from other applications of MSU.

There are a number of additional issues relating to long-term satellite dataset consistency which are likely to become increasingly important in the future for all TOVS products:

- Re-examination of calibration on long time-scales to identify and remove seasonal and interannual effects not evident in real-time quality control.
- Better metadata availability (addressed through CLASS - see white paper).
- More complete sampling of the diurnal cycle.

A major consideration regarding sampling of the diurnal cycle is the choice of equator crossing times for future polar-orbiters. If at all possible, consistency of crossing times both in-orbit, and with previous

platforms would be advantageous. NOAA plans for NPOESS have specified crossing times of 1030, 1330, and 1730LT.

Action

Evan Fishbein and Carl Mears to assess the optimal choice of equator crossing times for climate applications and report back to ITWG.

2.2.4 Reanalysis datasets

ECMWF have recently completed a new ERA-40 reanalysis product that has directly assimilated radiances from (A)TOVS. Initial analysis and comparison with observed ground-based and satellite datasets suggests that this is an improvement over the previous much shorter ERA-15 product, both at the surface and aloft. The reanalysis provides us with tools to assess satellite climate datasets. However, the timing of model stream start dates has been unfortunate with regard to the NOAA-9 MSU problem. A stream started in 1987 when only NOAA-9 data were available shows an initial 0.5K warm bias in its MSU2 brightness temperature.

Recommendation

ITWG to ask ECMWF to try rerunning a 2-year segment from early 1986 to remove the early NOAA-9 platform warm bias and allow potential analysis of true NOAA-9 platform bias in MSU2.

With each generation of reanalysis, lessons are learned which increase the physical realism of the next generation product. However, there is little money currently available to either ECMWF or NCEP to undertake such work. Continued development of high quality reanalyses may be useful in guiding choices required in homogenising long-term satellite records (and surface based records) to construct climate quality datasets.

Recommendation

ITWG should reaffirm to funding bodies the potential benefits of new high quality reanalysis products.

2.2.5 Relations to international climate programs and other bodies

Individuals from within ITWG continue to interact with other groups and programs on an ad hoc basis. This collaboration is likely to increase in the coming years as satellite records are better exploited by both the satellite and climate communities.

Mitch Goldberg has received a formal request from AOPC (WMO Atmospheric Observation Panel for Climate) for information as to what the key IR and MW frequencies are which need to be maintained for continuity. There were no members of the group who felt qualified to address this at the meeting.

Action

ITWG climate group to form a sub-group to discuss this issue and report back.

Given plans for polar orbiting satellites from agencies other than NOAA/NASA/EUMETSAT, it is felt that it would be useful to place AMSU and HIRS sensors on some of these platforms. This would permit a better characterisation of the diurnal cycle and more robust coverage.

Recommendation

ITWG to promote using standardised sensors on non-NOAA platforms as a way to increase spatial and temporal coverage for climate records.

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

Working Group members: C. Chouinard (Chair), J. Derber (Co-Chair), S. English (Co-Chair), with B. Amstrop, N. Atkinson, T. Auligné, N. Baker, P. Dahlgren, G. Deblonde, M. Gang, E. Gérard, B. Harris, R. Hess, C. Köpken, M. Kazumori, A. Korpela, Z. Liu, S. Macpherson, T. Montmerle, F. Rabier, R. Randriamampianina, D. Singh, C. Tingwell, M. Uddstrom, G. Verner, W. Wolf, J. Xue

2.3.1 Introduction

There were many substantive presentations at this meeting that indicated very positive results using satellite data from different instruments. There continues to be a move towards the use of level 1b sounder and imager radiances. Observing System Experiments (OSEs) presented at this meeting demonstrate that satellite data have 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 currently produce most of the impact. More centres that were previously using processed level-1d radiances have now started to use raw level-1b radiances with very positive results.

At this meeting, first impact experiments of high spectral resolution instruments (i.e., AIRS) were shown. As expected by NWP centres, the conservative use of these has produced at best small positive impact. However, in the development of the systems to assimilate these data, many innovative improvements at the various centres have been introduced. These improvements have positioned the centres to begin experimentation on additional improvements directed towards extracting more information from the high resolution data.

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 now assimilated at a majority of NWP centres and with reports of various levels of positive impacts particularly on the moisture fields and precipitation. At the last ITWG meeting, the AMSU-B data were only assimilated operationally at a few centres with experimental use of AMSU-B data at several others. This widespread use of the AMSU-B data is representative of the general increase in the use of satellite radiance data among the various centres.

The use of satellite radiances in Limited Area Models continues to progress and some groups have now successfully implemented the use of radiances with similar results as observed in global systems. 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 Data Assimilation/NWP

The use of satellite data remains very dependent on the monitoring and evaluation procedures for the satellite data. Prior to the use of the data it is important to diagnose the significant biases between

background and radiances (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.

Recommendation (to DA/NWP Centres)

The Working Group recommends the continued exchange of monitoring results and encourages each centre to develop their own Web page to post their results. A master document linking all Web pages has been developed and linked on the NWP SAF site and a similar link will be set on the ITWG Web site to enable easy examination and comparison of results between groups. Centres are encouraged to share pre-submitted papers and any valuable material on the following topics:

1. **Bias correction procedures for regional and global systems**
2. **Scan-dependent biases**
3. **Thinning procedures for regional and global systems**
4. **Background error correlation and variance studies**
5. **Mesoscale verifications**

Action

C. Chouinard will coordinate the development of the NWP Web page until June 2004 after which S. English will take responsibility.

The Working Group further recognizes the importance of day-to-day monitoring procedures in rapidly identifying problems related to the data particularly when they originate from instrument problems and there is need to intervene quickly.

Recommendation (to DA/NWP Centres)

That an e-mail list be set up and used to quickly alert each other of potential problems and their severity so actions can be taken in a timely manner. (Action: J. Derber to setup the e-mail list) Note: this e-mail list is intended as an informal exchange between NWP centres not a formal communication with data providers. The original list is made up of NWP WG members but will likely be extended to others.

The Working Group further recognizes that the specification of background and observational errors is critical for optimal assimilation of any data type and in particular radiances. Most DA/NWP Centres continue to update their background and observational error covariances and the Working Group encourages exchanging these results so as to better understand the impact of the a-priori statistics on TOVS data assimilation.

Recommendation (to DA/NWP Centres)

The Group recognizes the difficulty in implementing and validating radiance/retrieval data in a DA/NWP system and recommends that those that have prepared so-called single observation experiments in the development of their assimilation system post them on their Web page with sufficient details on the Web site for another to replicate these independently.

The WG recognizes the importance of Observing System Experiments (OSEs) to quantify the impact of individual sources of data. The results of OSEs are also useful in the decision making process in

agencies. Some centres have presented recent OSEs at this meeting with their systems and continue to update these when their analysis systems undergo critical updates.

Recommendation (to DA/NWP Centres)

Encourage the production of OSEs at various NWP centres to be presented at the next meeting and most importantly post these results on the ITWG Web site.

The results of the ITWG survey presented at this meeting and reproduced in 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.

Recommendation (to ITSC)

The Group recommends that the McNally survey summary grid be continued and posted on the ITWG Web site. When changes are made at various NWP centres on the use of data, that McNally be advised, the grid updated accordingly, and the changes be logged on the ITWG Web site. The WG noted that the table and survey should be expanded and include more information on how the data are prepared and used at various centres. This would be reflected by a more complete summary with additional columns and/or notes. (Action: T. McNally to coordinate).

The results of the survey indicate that the majority of DA/ NWP centres still rely upon processed level-1b and level-1d data and retrieved products for their operational forecasting systems. The Group wishes to acknowledge this fact and support the continuing efforts of NOAA/NESDIS and EUMETSAT in their crucial role in providing these products. This inter-agency collaboration has been very beneficial. The WG wants to commend the progress at NESDIS in change notification and monitoring of the data and the recent detection of the problems with NOAA-17.

Recommendation (to NOAA/NESDIS and EUMETSAT)

The Group recommends that the data providers should continue to improve the quality assurance of all data, including level 1b and level 1d. The quality of the data (e.g., including navigation) should be monitored at all stages including the final stage, which may have been reformatted. The provider should attempt to identify and flag questionable or poor quality data. Data providers, e.g. EUMETSAT and NOAA/NESDIS, are encouraged to use NWP monitoring results to help them in diagnosing data problems. The Group recognizes that it is easy to identify gross errors, while subtle errors are more difficult to detect. Action: NESDIS, EUMETSAT

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.

Recommendation

To document, evaluate and improve the current procedures to convert antenna temperatures to brightness temperatures. (NESDIS and DoD)

Action

To collect documentation of the current status of antenna correction procedures for current microwave instruments from DoD, NESDIS, EUMETSAT and NASA and present at next ITSC meeting. (G. Deblonde)

Table 2.3-1. Use of satellite data in operational NWP (ITWG survey of systems at 01 / 09 / 2003)

Institute	Retrievals in Global NWP	Retrievals in Regional NWP	Radiances in Global NWP	Radiances in Regional NWP	external WWW DATA MON
Australia			YES-NP (1DVAR)	YES-NP (1DVAR)	NO
Canada	NESDIS (ensemble)		YES-1B (3DVAR)	YES-1B (3DVAR)	YES
ECMWF			YES-1B (4DVAR)		YES
France			YES-1B (4DVAR)		NO
Germany	NESDIS				NO
India	NESDIS				NO
Japan		NESDIS + LOCAL	YES-NP (3DVAR)		NO
Denmark				YES-1B (3DVAR)	NO
UK			YES-1B (3DVAR)	YES-1B (3DVAR)	YES
USA (NCEP)			YES-1B (3D SSI)	YES-1B (3D SSI)	YES
USA (NRL)	NESDIS	NESDIS			NO

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.

2) Blacklisting of data results in 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 internal Web services, but many are still not posted on the external (WWW) Web.

4) The ITWG needs to decide what to do with (i.e., how to document) the (sometimes very comprehensive) responses from each NWP centre. (e.g., upload to Web site?). They are a valuable reference for users.

2.3.3 Forward modelling

The WG is concerned with the development of RT code for new instruments. The RTM codes developed by each group (e.g., IASI/AIRS) does not follow the universal interface policy of RTTOV and its predecessors. The Working Group is worried that these RTM may be difficult to use at DA/NWP centres. The use of

different RT codes in NWP models for different satellites is a serious maintenance issue.

Recommendation

We encourage the developers of new instruments to either expand or enhance current RT models, or develop general codes applicable to all instruments and make them available.

2.3.4 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 are 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 was reported at this meeting that the use of 3 polar satellites has been shown to provide better and more extensive cover of satellite radiances which increases the impact in NWP models. There was also a report on improvement with a fourth sounder on the Aqua platform.

Recommendation

That satellite agencies and the WMO GOS WG consider 3xAMSU or equivalent in orthogonal orbits as minimum requirement to maximize global coverage for operational NWP.

NWP Centres spend a large part of unproductive and duplicative effort on data formatting and management. The group is worried that rather than converging on the use of a single WMO standard format some agencies are proposing new data formats complicating the use of the data and unnecessarily increasing the cost of the development.

Recommendation

That satellite agencies support the use of the WMO standard and produce data in a common format (e.g., BUFR). Also, the agencies should collaborate early and often on definitions and provisions of test data sets.

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

That EARS be continued and where possible, extended to include more of NH and possibly SH.

Recommendation

The data providers should continue to strive to speed up delivery of data and eliminate blind orbits. (Action EUMETSAT, NESDIS)

The use of research satellites in operational NWP centres has been increasing. The availability of these 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.

Recommendation

Real-time access to the observations by NWP centres should be considered for all satellite observation programs which may be useful for NWP. (All satellite agencies)

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 the NWP centres to begin early development of the infrastructure necessary to use the data.

Recommendation

Both operational and research programs should develop collaborative efforts with NWP centres to evaluate the new data and allow the earliest possible access to the data for the NWP centres.

The WG is concerned that the instrument specification for ATMS channel noise exceeds current AMSU performance.

Recommendation (NOAA, EUMETSAT)

Specification for future instruments at least matches or improves upon the capabilities of current instruments.

2.4 ADVANCED SOUNDERS

Working Group members: W. Smith (Co-Chair), A. Huang (Co-Chair) with T. Auligné, P. Antonelli, H. Bloom, D. Chaohua, A. Collard, C. Crevoisier, D. Crain, R. Dedecker, E. Fishbein, A. Gasiewski, M. Goldberg, L. Horrocks, G. Kelly, D. Klaes, T. Kleespies, B. Knuteson, B. Lambrigtsen, A. Larar, J. Li, X. Liu, M. Matricardi, M. Pavolonis, J. Predina, J. Puschell, Y. Qu, F. Rabier, T. Reale, G. Rochard, F. Romero, H. Roquet, P. Schlüssel, M. Schwaerz, A. Sharma, V. Sherlock, D. Singh, A. Uspensky, E. Weisz, F. Weng, W. Wolf, H. Woolf, X. Wu, D. Zhou

2.4.1 Review of the scope of the Advanced Sounder Working Group

Meetings of the Advanced Sounder working group will focus on scientific issues affecting the optimal performance of advanced satellite sounder systems. The working group will review the status of the development of advanced sounder systems and recommend changes regarding to instrument specification, performance, data processing, and utilization where necessary. For the purpose of this working 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.

2.4.2 Status of plans for advanced sounding instruments

The working group noted the successful implementation of the first U.S. advanced Atmospheric Infrared Sounder (AIRS) and significant progress on the development of the IASI (Infra-red Atmospheric Sounding Interferometer), CrIS (Cross-track Infrared Sounder), IRFS-2 (Infra-Red Fourier transform Spectrometer), and the GIFTS (Geosynchronous Imaging Fourier Transform Spectrometer) advanced sounding instruments. Table 2.4-1 summarizes characteristics of these instruments, and Figure 2.4-1 summarizes their planned operating periods. The characteristics of these instruments are described in more detail on the ITWG Web site. The working group also noted progress on plans for advanced microwave sounders and their characteristics are listed on the ITWG Web site.

Action

J. Eyre to update IR and MW sounder tables on ITWG Web site before ITSC-XIV.

Action

A. Huang to implement a Web page for the Advanced Sounders Working Group on the ITWG Web site.

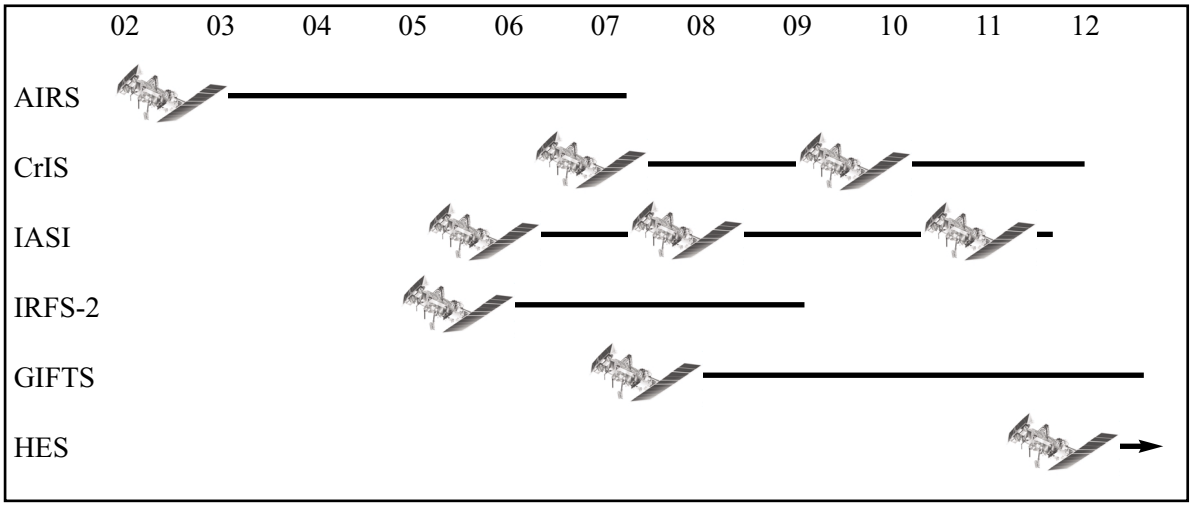


Figure 2.4-1. Current and Future Advanced IR Sounder Timeline.

Table 2.4-1. Advanced Infrared Sounding Instrument Characteristics

Name	IMG	AIRS	IASI	CrIS	IRFS-2	GIFTS	HES
Orbit (km)	800	705	833	824 (NPP) 828 (NPOESS)	850	Geo-synchronous	Geo-synchronous
Instrument	FTS	Grating	FTS	FTS	FTS	FTS	TBD
Agency and Producer	MITT JAROS	NASA JPL BAE	EUMETSAT/ CNES Alcatel	IPO (DoD/NOAA/ NASA), ITT	Russian Aviation & Space Agency	NASA/NOAA/ Navy Space Dynamics Lab (Utah St. U.)	NOAA/ NASA
Spectral range (cm^{-1})	700-3000	649-1135 1217-1613 2169-2674	645-2760	650-1095 1210-1750 2155-2550	665-2000	685-1130 1650-2250	650-1200 1650-2150 or 1210-1740 2150-2250
Unapodized spectral resolution (cm^{-1})	0.05	0.5-2.25	0.35-0.5	0.625 1.25 2.5	0.6	0.6	0.6-2.5
Field of view (km)	10	13 x 7	12	14	35	4	4-10
Sampling density/50 km square	1	9	4	9	1	144	25-156
Power (W)	150	256	200	124	50	325	TBD
Mass (kg)	115	156	230	152	45-50	135	TBD
Platform	ADEOS -1	Aqua	METOP-1, 2,3	NPP and NPOESS C1	METEOR 3M N2	Geostationary	GOES R+
Launch date	1996	2002	2005	2006 for NPP 2009 for C1	2005	2008-2010	2013

2.4.3 New initiatives for geostationary sounding

The working group discussed developments since ITSC-XII in sensors for sounding of the atmosphere from geostationary orbit.

Recommendation (to Space Agencies)

The ITWG recommends that system design simulations and other studies be completed for the purpose of identifying optimized performance/cost/risk/benefit approaches for candidate geostationary and MEO microwave sensors. This microwave system would supply data for temperature and moisture soundings and time-resolved precipitation mapping.

2.4.4 The use of the NPOESS requirements change process

Recommendations for NPOESS requirements updates or changes can be facilitated through a U.S. Dept. of Defense (DOD) process. This process requires members to make a performance/cost/benefit presentation to the Joint Agency Requirements Group (JARG) which may be an interactive process. Users are then polled to determine if the proposed requirement change is beneficial to their respective agency. Once consensus is reached, JARG members from NOAA and DOD ask their respective agency

to fund the change. Once funding has been identified and the requirements approval by the JARG and the Senior Users Requirements Group (e.g., weather and oceanography service directors from agencies), the proposed change is handed to the NPOESS executive committee for approval. Once approved, the NPOESS IPO executes the change. Recommendations for NPOESS requirements changes or updates should use the above process, which for the ITWG can be facilitated by Mitch Goldberg, the NESDIS liaison to the JARG.

Recommendation to ITWG

Any recommendation concerning NPP and NPOESS advanced sounding instruments' requirements change should use this process by presenting the relevant study results to the JARG through Mitch Goldberg.

2.4.5 Implementation of advanced sounders

The working group discussed improvements which could be made to the CrIS instrument on NPOESS. Several recommendations are made below:

Recommendation (to NPOESS Joint Agency Requirements Group (JARG))

ITWG recommends that the entire interferogram be sampled and transmitted to the ground for all three spectral bands of the NPOESS CrIS instrument. This will allow full spectral resolution to be achieved for the midwave and shortwave N_2O/CO_2 bands as well as for the longwave bands. Full spectral resolution in all three bands is important for improving boundary layer temperature and upper tropospheric water vapor sounding as well as for extraction of trace gas profiles for climate data records. In addition the longwave extent of the shortwave band of the CrIS should be extended to include the 4.7 μm band of CO lines. Measurement of tropospheric CO is important for monitoring and forecasting air quality and for associated impacts to atmospheric chemistry climate.

Recommendation (to NPOESS Joint Agency Requirements Group (JARG))

ITWG recommends that the 0530LT and 1330LT NPOESS platforms retain full CrIS and ATMS measurement capability. These two satellites together with the 0930 METOP satellite will be able to provide 4-hour frequency high resolution soundings that are important for improved global weather predictions (see recommendation in 2.3.4 related to this).

Recommendation (to NASA)

ITWG recommends that the orbit of the NPP satellite be changed from 1030 to a time that better complements the 0930 orbit of the METOP satellite. This is important to improve the global sampling of high vertical resolution soundings for global weather prediction.

Experience with AIRS data has revealed that 90% of the AIRS 15 km FOVs contain cloud which limits the accuracy and vertical resolution of tropospheric soundings. The proper combination of instantaneous FOV and radiometric sensitivity should be defined so as to optimize CrIS sounding performance for the most generally occurring partly cloudy scene condition. Specifically, FOVs with a linear dimension of 8 km, or smaller (as suggested by the Huang et al. study presented at ITSC-XIII) should be considered after investigation of the spatial sampling impacts of the smaller FOV sizes on the accuracy of the retrieval results.

Recommendation (to NPOESS Joint Agency Requirements Group (JARG))

The Field-of-View size for CrIS should be redefined so as to optimize sounding performance under partly cloudy sky conditions.

2.4.6 Data processing, inversion and assimilation

NOAA has started to make available some of the NPOESS documentation to selected members of the ITWG for review. This is to be welcomed. However, further documents for all sensors are still required. Several recommendations and actions given below were agreed during these discussions.

Action (Hal Bloom)

ITWG requests that the user communities be provided with, and invited to review, the draft specifications (content and format) for the raw data records (RDRs) and sensor data records (SDRs) for NPOESS/NPP instruments.

Recommendation (to IPO and NPOESS Joint Agency Requirements Group (JARG))

ITWG recommends that the user communities be invited to assess and comment on the performance of NPOESS/NPP sensors and processing algorithms, especially calibration data and algorithms, in a timely fashion to enable suitable preparation for processing and interpretation of data from the flight mission.

Action (Allen Larar / Chair of SOAT)

Interact with the NPOESS IPO to facilitate a mechanism for ITWG members to obtain NPOESS ground processing and field terminal design parameters, including draft input data file formats, draft processing design documents, draft interface control documents and draft hardware specification documents through collaborations with the NPOESS SOAT.

Recommendation (to CGMS)

ITWG recommends that responsible agencies establish focal points to ensure that ingest and pre-processing code for future advanced sounders (and their complementary imagers) is provided, in a form suitable for use with locally-received direct read-out data, and yielding output consistent with globally processed data. Furthermore, activities are to be undertaken to integrate this code into processing packages available for international distribution in a timely manner.

Recommendation (to IPO and NASA)

ITWG recommends that ingest code for NPP instruments (CrIS, ATMS and VIIRS) be made available by IPO to the external scientific community, and that such algorithms should be integrated into a processing package for locally received data available for international distribution.

2.4.7 Characterization of spatial response

The spatial responses of some sensor fields of view are still not being measured pre-launch to the required accuracy.

Recommendation (to Space Agencies)

ITWG recommends that the spatial responses of advanced sounders should be characterized to a level at which the associated error does not cause the total noise budget of the instrument to be exceeded, and, where achievable at reasonable cost, to a level at which the associated error is a negligible contribution to the total system noise.

2.4.8 Validation of data and products

To accelerate the full and early utilization of advanced sounders' data and products, validation of both data and products must be made as soon as possible. High quality global in-situ measurements are

required to help achieve this goal.

Recommendation (to NOAA and NASA)

The Advanced Sounder working group strongly supports the Satellite Upper Air Network (SUAN) initiative proposed by the Satellite Sounder Science and Products working group (see action in 2.6.11).

The SUAN effort will provide a large quantity of in-situ measurements early in the lives of these satellite missions, potentially shortening validation times and accelerating the utilization of validated data and products.

2.4.9 Workshop for Soundings from High Spectral Resolution Sounders

A 3-day workshop for soundings from High Spectral Resolution Sounders was recently hosted by ITWG members from University of Wisconsin-Madison and demonstrated useful scientific exchanges and established shared resources and knowledge that may enable the optimal processing and future utility of advanced sounding data. These more in-depth workshops than are possible during the ITSC meetings would aim to accelerate the use of, and optimize the information provided by, high spectral resolution measurements from advanced sounders. The workshops would actively seek to involve young scientists in the field.

Recommendation (to ITWG)

The Advanced Sounders working group recommends that ITWG organize periodic Advanced Sounding workshops to be held independently of the main ITSC meetings and plans should be made to hold a workshop in Europe before ITSC-XIV.

2.4.10 Glossary of instruments

ABI	Advanced Baseline Imager (for GOES-R+)
AIRS	Atmospheric Infrared Sounder
AMSR	Advanced Microwave Scanning Radiometer
AMSU-A	Advanced Microwave Sounding Unit - A
AMSU-B	Advanced Microwave Sounding Unit - B
ATMS	Advanced Technology Microwave Sounder
AVHRR	Advanced Very High Resolution Radiometer
CMIS	Conical-scanning Microwave Imager/Sounder
CrIS	Cross-track Infrared Sounder
GIFTS	Geosynchronous Imaging Fourier Transform Spectrometer
GLOBUS	Multi-channel scanning radiometer
HES	Hyperspectral Environmental Suite (for GOES-R+)
HSB	Humidity Sounder - Brazil
IASI	Infra-red Atmospheric Sounding Interferometer
IRAS	Infra-red Atmospheric Sounder
IRFS-2	Infra-Red Fourier-transform Spectrometer
MHS	Microwave Humidity Sounder
MODIS	MODerate-resolution Imaging Spectroradiometer
MTVZA-OK	Module for atmospheric temperature and humidity sounding - oceans
MWTS	MicroWave atmospheric Temperature Sounder
MWHS	MicroWave atmospheric Humidity Sounder
VIIRS	Visible/Infrared Imager Radiometer Suite

2.5 INTERNATIONAL ISSUES AND FUTURE SYSTEMS

Working Group members: G. Rochard (Acting Chair) with T. Achtor, E. Borbas, A. Dybbroe, G. Fournier, A. Gasiewski, D. Griersmith, D. Klaes, B. Lambrigtsen, T. Reale, R. Saunders, P. Schlüssel, D. Steenbergen and A. Uspensky (with additional inputs from D. Hinsman and J. Eyre after the meeting).

2.5.1 Introduction

Working Group discussions included the following topics: data access and dissemination; timeliness of satellite data; software and documentation, equator crossing times; frequency protection; education, training and promotion; GPS/RO; and the satellite upper air network (SUAN).

Due to the absence of Don Hinsman, Paul Menzel and John Eyre from ITSC-XIII, it was agreed that the report should be reviewed by them as well as Bill Smith, Jim Purdom and the ITWG Co-Chairs before the final preparation of the report.

2.5.2 Data access and dissemination

Concerning data access, ITWG recognized the outstanding efforts by space agencies to provide access to satellite data and encourages all space agencies to continue such efforts. Access to satellite data had been instrumental in the major improvements in weather forecast, synoptic meteorology, meso-scale modelling and climate monitoring as described by the other ITSC Working Groups.

The Working Group agreed it was essential for both operational NWP centres and research users to have access to global, real-time, satellite data in a timely and efficient manner. The Working Group acknowledged the efforts by satellite operators to provide these data to the global user community through direct broadcast as well as accessible databases. Maintaining data access standards and principles had resulted in improved utilization of satellite data at enormous cost benefit to many user communities, e.g., agriculture, industry and transportation.

The Working Group noted the recent incorporation of appropriate Research and Development (R&D) satellite missions into the space-based component of the Global Observing System (GOS). This was seen as a new mechanism to further enhance access to satellite data in order to meet the requirements of international users including National Meteorological and Hydrological Services and at NWP centres. Many of those requirements had not previously been totally met by the operational meteorological satellite systems. Hence, continuing efforts to add further R&D satellites to the GOS were encouraged. While it was too early to assess the full impact of enhanced access to R&D satellite data, the Working Group expressed its strong support for the initiative and efforts of satellite operators to make their data more available, especially for real-time or operational users and by direct broadcast where possible. ITWG also noted the expansion of the CGMS membership to include R&D space agencies contributing to GOS.

2.5.3 Timeliness of satellite data

ITWG recalled that the WMO timeliness goal for global NWP was at present 1 hour with a threshold within 4 hours of observation. It noted that the new EUMETSAT EARS provided data nominal within 30 minutes and most all data within 1.5 hours. ITWG recognized that the goal for global NWP would most probably become 30 minutes in the near future.

Recommendation (to WMO/CGMS)

It was recommended that WMO review the requirement for timeliness of satellite data for global NWP in the light of NWP centres changing requirements.

The Working Group was of the opinion that in the near future timely access to both global and local direct readout data would be required for the NWP assimilation systems, at least for regional and fine mesh/short range models. Pre-processing software should be made available by the satellite operators where possible, such as software packages for new satellites (NPP, NPOESS, METOP, FY-3, METEOR-3M etc.) to the same pre-processed level as made by NASA, NOAA, EUMETSAT, CMA/NSMC, PLANETA etc. for the global data.

2.5.4 Software and documentation

The Working Group noted that software and its associated documentation was becoming increasingly critical for efficient and accurate data processing, including the need for instrument and measurement metadata as well as software for direct broadcast processing from the raw signal (level 0) to calibrated, navigated radiances (level 1b).

Recommendation (to Space Agencies)

The Working Group recommended that the satellite operators continue their excellent efforts to provide documentation and software to support optimal use of environmental satellite data with the view to have complete compatibility between global and local geophysical parameters (at least to level 1b).

In the same way, the Working Group encouraged comparisons between fast radiative transfer models not only for scientific progress but also to encourage the use of common software to achieve fully compatible use of radiances.

The Working Group noted that the software pre-processing topic would also be discussed in the Working Group on Advanced Sounders (see section 2.4.6).

2.5.5 Equator crossing time

The Working Group noted that CGMS currently maintained a list of equator crossing times for all sun-synchronous satellites and that it would be useful to maintain a link to the table on the ITWG Web site. The Working Group reaffirmed the need to maintain a robust system in both AM and PM orbits optimally spaced including minimal drift for preservation of long time series of observation for climate monitoring.

Action (D. Hinsman)

Provide link to CGMS table to ITWG Webmaster.

2.5.6 Frequency protection

With regard to frequency protection, the Working Group agreed that one priority was to finalise the WMO draft table for users' needs between 1 to 1000 GHz and also to consider 1000 to 3000 GHz. The WMO draft table is available on the ITWG Web site at: (http://cimss.ssec.wisc.edu/itwg/groups/frequency/). The table will be updated by December 2003 and the complete update of the WMO draft table should be accomplished before mid 2004. The Working Group noted the considerable information already contained on the WMO Satellite Activities Web site and in the CEOS/WMO database. The Working Group noted that work remained to define the Delta T for noise not attributed to man-made interference.

Recommendation (to National Radiofrequency Agencies)

Given the current levels of uncertainty in the studies for potential interference to EESS applications within the 23.6-24.0 GHz band by proposed automobile collision avoidance radars it was recommended that:

1) automobile radar manufacturers make efforts to develop systems that operate outside this band
2) any interference study of the impact of automobile radars on EESS applications using this band incorporate margins of at least 13 dB (20x) below the necessary EESS sensitivity levels to account for the uncertainties.

2.5.7 Education, training and promotion

The Working Group noted the extensive international efforts, particularly through WMO, concerning education and training in satellite meteorology. It recognized that these efforts were contributing greatly to better utilization and impact of satellite data on countries throughout the world. The Working Group therefore encouraged participants at ITSC-XIII and their associated agencies to provide resources and information or Web site links that may contribute to the WMO-coordinated efforts in education and training including the Virtual Laboratory concept to utilize resources globally.

Action (to ITWG)
All members of ITWG to consider contributing to ITWG training Web page.

2.5.8 GPS/RO

The WG reviewed recent progress to investigate the complementary information content of data from passive (IR and MW sounders) and active (GPS/RO) systems on tropospheric temperature and moisture profiles. Studies confirm that the two systems are indeed highly complementary, with the GPS/RO data providing improved temperature information near the tropopause and improved moisture information in the lower troposphere.

2.5.9 Satellite Upper Air Network

The Working Group noted a proposed approach to monitoring data from polar orbiting satellites with radiosondes. In particular, the Working Group reviewed the proposal to establish a satellite upper air network (SUAN) in order to provide monitoring of operational polar orbiting satellites through a carefully defined network of reference coincident radiosondes with polar satellite overpass. The Working Group also noted the ongoing activities within WMO/CBS on the redesign of the GOS in which the radiosonde networks and their launch times for the whole range of applications for which WMO was responsible were under discussion. The Working Group was of the opinion that as those WMO activities evolved one possible outcome could be the need for a network such as SUAN. Thus, the Working Group encouraged continued development of the SUAN concept. The Working Group also noted that the need for collocated data was not universally accepted for all applications and that continued investigations in this area were still required. Additionally, the Working Group also suggested that it would be appropriate to carefully evaluate the scientific justifications for SUAN taking into consideration the existing requirements for the GCOS Upper Air Network (GUAN).

2.6 SATELLITE SOUNDER SCIENCE AND PRODUCTS

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

Working Group members: T. Reale (Co-Chair), L. Lavanant (Co-Chair) with T. Achtor, L. Avila, E. Borbas, M. Chalfant, D. Chaohua, I. Dyras, I. Galindo, D. Griersmith, V. John, B. Lambrigsten, S. Lee, J. Li, G. Radel, F. Romano, M. Schroedter-Homscheidt, S. Serrar, A. Sharma, D. Singh

2.6.1 Introduction

The Working Group (WG) on Satellite Sounder Science and Products (SSSP) discussions focused on the role of the SSSP to facilitate the access to data by users (global and HRPT) of current operational and research satellites, and information concerning planned data access capabilities for future satellites (over the next two years). It was agreed that the SSSP page on the ITWG Web site should be expanded to provide information on research satellite health, and the status of pending, future satellite preparation and launch schedules (out to two years), in addition to the current operational satellite health (which is already provided).

Discussion also addressed topics such as the role of the SSSP Web site to provide information (via Web site links) concerning current and planned scientific algorithms from satellite providers (i.e., NOAA, EUMETSAT, NSMC, etc.) for global and local processing systems. The group discussed the possibility of developing user surveys on current and future uses of the data. Participants also agreed that it was important for the WG to define key areas of research concerning current and future data processing and applications, and to facilitate validation studies involving the various satellites, instruments, scientific products and algorithms available from the scientific community.

It was agreed that the current Web site structure has progressed significantly and provides a strong resource for users to access information on international scientific activities involving polar satellite data. For example, over the past 18 months the site has matured to provide categorization of products, applications, and facilities, resulting in efficient and user-friendly access to information from over 40 individual contributors who provide scientific input. Possible areas of expansion, in addition to those discussed earlier, include the addition of a global data and HRPT information directory, and of course the continued solicitation of scientific inputs from users both within and outside the ITSC community. Ms. Leanne Avila, the ITWG Webmaster, is recognized for her outstanding support in this area.

Finally, the WG acknowledged and encouraged activities to provide historical data sets of raw satellite (TOVS and ATOVS) and radiosonde (GTS and Special) collocated observations, and the need to expand current operational systems to provide such data routinely. The WG endorsed plans for a dedicated Satellite Upper Air Network (SUAN) to provide coincident satellite and reference radiosonde observations in support of current and future validation of polar satellite, radiosonde, and associated scientific applications, acknowledging the evolving requirements for such data in the processing, validation and utilization of (past, present and future) global satellite data. The success of this project will eventually need broad agency support that can best be focused through the WMO.

2.6.2 Working Group interaction and scientific contributions

The WG on Satellite Sounder Science and Product's primary function is to demonstrate the scientific achievements and current developments in our field, both within ITWG, and from the international scientific community. Unlike other ITWG Working Groups that were formed to address specific scientific issues, an important function of SSSP is to interact with the other groups and support their efforts to inform our user community about what they are doing. This is achieved through interactive links between the SSSP Web site and the other WGs, and most importantly, through the individual scientific contributions by individuals to the SSSP site.

Action (all WG Members)

The WG Co-Chairs and individual members will promote the synergy between SSSP and other ITWG Working Groups, continue to seek scientific contributions from members and from the international community, and enhance the SSSP and ITWG Web site to meet these goals. The group will also seek to identify sources of information on the use of sounding data through questionnaires.

2.6.3 Access to global data from current polar satellites

Improved access to global satellite data and products in real-time and for historical data is needed from current operational and research satellites operated by NOAA (U.S.), NASA (U.S.), NSMC (China), METEOR (Russia) and IRI (India). It is understood that routine access to all observations is not always feasible; however, in many cases routine data access appears unduly limited (to selected portions of the data stream) and/or cumbersome.

Recommendation (to Satellite Agencies)

All satellite operators providing global polar satellite observations are encouraged to make their data routinely available to the international user community. In each case, procedures (and necessary protocols) for users to gain routine access to global, operational and research data sets should be identified and made available to users via links on the SSSP Web site. This will include complete listings of the data available (measurements and products), data formats, metadata and software for reading data files.

Action (to SSSP Co-Chairs)

The Co-Chairs will request information from space agencies through ITWG members (AK Sharma, Devendra Singh, Dong Chaohua, Alexander Uspensky) and provide links to the information on Web site).

2.6.4 Access to HRPT data and software from current polar satellites

Documentation and information concerning the availability and access to direct broadcast (HRPT) data from operational and research polar satellites is often not readily available to users. Software packages to ingest and process the data are also needed by the user community to create navigated, calibrated data sets. Programs such as the EUMETSAT ATOVS Retransmission Service (EARS), which provide expanded coverage of level 1a and 1c HRPT sounding data, represent an improvement to user access to such data, albeit for a limited area. A more complete approach is needed to create a near-global, real-time data set of polar HRPT data, along with associated software packages for global and regional processing.

Action (to SSSP Co-Chairs)

The Co-Chairs will request information from space agencies and provide links on the Web site. WG members will collect needed information on operational and research satellites and instruments for which direct broadcast (HRPT) data and associated software processing packages are available (and not currently included on the SSSP Web site). Appropriate data links will be provided to the Webmaster for inclusion in the HRPT area of the site.

Recommendation (satellite agencies and HRPT reception stations)

It is recommended that satellite data providers and HRPT reception stations consider programs for expanded HRPT and associated imager data coverage similar to EARS, but with more complete global coverage.

2.6.5 Instrument health and future instrument status

The SSSP Web site currently provides operational polar satellite instrument health status for NOAA operational satellites. Similar information is needed for the other operational and available research satellites, including those operated by China, India and Russia. Similarly, access to information on the status of preparations for near-term future satellites, for example, NOAA-N, NPP/NPOESS, METOP and EOS-3, is also needed to facilitate timely planning for processing these data.

Action (to SSSP Co-Chairs)

The Co-Chairs will request information on instrument health from satellite providers through ITWG members (Dieter Klaes, Devendra Singh, Dong Chaohua, Alexander Uspensky, Paul Menzel, Hal Bloom) to identify sources of information (e.g., Web sites) covering the health of current instruments and the status of future satellites and instruments. This information shall be provided to the SSSP Webmaster to include on the Web site.

2.6.6 Access to information on data plans for future satellites

Users need to be better informed about satellite provider plans concerning access to global and direct broadcast data from future weather satellites. In particular those U.S. missions planned within the next few years (e.g., NOAA-N, EOS-3 and NPP/NPOESS) and from other nations, including Europe (METOP), China (FY), India and Russia, who plan to operate polar satellites.

Action (to SSSP Co-Chairs)

The Co-Chairs will request information on future satellite systems from satellite providers through ITWG members (A.K. Sharma, Dieter Klaes, Devendra Singh, Dong Chaohua, Alexander Uspensky, Hal Bloom). Information shall be provided to the SSSP Webmaster to include on the ITWG site.

2.6.7 Scientific algorithm information from global satellite providers

Improved information dissemination concerning the current scientific algorithms being used by government agencies that are processing operational and experimental satellite data is needed. We believe users are not aware of the details surrounding such processing and thus cannot use the data most effectively. This information should include the uncertainty about the measurements and processed data.

Action (to SSSP Co-Chairs)

The Co-Chairs will request information from satellite providers through ITWG members (Dieter Klaes, Peter Schlüssel, Thierry Phulpin, Devendra Singh, Dong Chaohua, Alexander Uspensky, Tony Reale, Walter Wolf, Tom Kleespies). They will identify sources of information (e.g., Web sites) describing the scientific methods for processing polar satellite data, beginning with measurement calibration (i.e., instrument filter functions, etc.) and including derived product algorithms. This information will be provided to the ITWG Webmaster for inclusion on the SSSP Web page.

2.6.8 Information on useful datasets for satellite data processing and simulation

Access to training datasets for new platforms 1-2 years before launch (e.g., METOP, NPP) such as the simulated orbit available for AIRS before launch will facilitate the preparation of new processing chains and this activity should be encouraged.

The mapping of global parameters such as SST, albedo, terrain types, surface elevation, emissivity, etc have become widely produced from polar satellites, serving as important input parameters for users who

are processing satellite data. For example, a fine description of the land surface emissivity IR spectrum depending on a land surface classification will enable the use of more tropospheric sounding channels from IR hyperspectral sounders. Also, the use of information for cloud top emissivities allows the simulation of cloudy spectra. Efforts to identify such data products and to facilitate access to them on the SSSP Web site should be pursued.

Action (Lydie Lavanant)

A list of parameters and associated data atlas volumes available within the international community from operational and research satellites will be identified, and links to scientific documentation, formats and data will be established within the SSSP Web site to facilitate their access by users.

2.6.9 Global HRPT directory

A directory of HRPT facilities worldwide that are actively receiving, ingesting, processing and archiving polar satellite data is recognized as a potentially valuable mechanism for identifying system and scientific processing methodologies across the international community. Such a directory could help broaden participation in ITWG. For example, individuals from each facility could be solicited for information concerning their work (i.e., register on the SSSP Web site) and future participation in ITWG.

Action (Lydie Lavanant, Elizabeth Silvestre, Tom Kleespies)

WG members should seek information concerning actively working HRPT sites. Available government licensing and/or other listings will be sought to aid in creating a directory. Once established, the SSSP Co-Chairs shall contact these facilities and solicit inputs to SSSP and, where appropriate, encourage ITWG participation.

2.6.10 Collocated radiosonde and satellite observation dataset

Real-time and historical datasets of collocated radiosonde and polar satellite observations have been compiled by a number of agencies and provide important information to monitor the radiosondes, satellite measurements and products, and ultimately to validate and “tune” the underlying scientific algorithms and applications. However, existing strategies for their compilation typically do not include “special” experimental radiosondes, and often lack sufficient raw data (i.e., level-1a and 1b observations) and meta-data (i.e., quality control, data adjustments, etc.) which can compromise their usefulness. It is critical that all strategies for compiling collocation data sets, for example, the processing stage(s) of the data, spatial and temporal windows, QC, etc., be clearly documented. Those groups identified will be encouraged to provide access to their data and metadata via the SSSP Web site, for example, to facilitate inter-comparison studies across various scientific algorithms and satellites (i.e., AIRS vs. ATOVS).

Action (Tony Reale, Lydie Lavanant, Hank Revercomb, Mitch Goldberg, Graeme Kelly)

Efforts to compile real-time and historical datasets of collocated radiosonde (GTS and special experimental observations) and operational polar satellite (Global and HRPT) data are encouraged. The SSSP Web site will be expanded to identify groups compiling such data, and facilitate better awareness of and access to special experimental radiosondes (and other in situ ground truth observations) which are not routinely available.

2.6.11 Satellite Upper Air Network (SUAN)

Since the onset of polar satellite operational systems in 1979 (TIROS -N) and through the current ATOVS sensors, the problem of monitoring satellite radiometers and derived weather products from satellite to satellite has been a major problem for the climate community. This has resulted in a less than optimal impact of these data, particularly on climate applications. A standard reference set of ground

truth (i.e., radiosonde) measurements launched close to satellite overpass times as proposed through the Satellite Upper Air Network (SUAN) would help to minimize such problems. Such a network and ensuing historical record would potentially benefit all applications that depend on satellite and radiosonde observations.

Action (Tony Reale, with Guy Rochard, Don Hinsman, Peter Thorne, Mitch Goldberg, John Bates, Dave Steenbergen, Dieter Klaes)

A proposal describing the Satellite Upper Air Network will be developed and provided to the WMO for international discussion and recommendation. This proposal would identify candidate site selection, expected benefits, network protocols (i.e., launch schedules) and resource requirements.

2.6.12 Identification of key research topics

The international research community conducts research investigations and develops scientific algorithms in support of a broad spectrum of user requirements. Although it is never the intention of this WG to downplay the importance of any particular scientific development activity, it is recognized that certain issues, given their immediate potential impacts, have significant potential impact. Identifying a list of key topics relevant to ATOVS and advanced sounder applications that is consistent with ongoing and expected research and development programs can play an important role in scientific planning and resource allocation.

Action (Tony Reale, Lydie Lavanant, Tony McNally, Thierry Phulpin)

SSSP WG members will establish a list of key scientific topics in conjunction with ongoing user needs. ITWG members are requested to provide inputs to the SSSP WG Co-Chairs, who will review and forward this information to the Webmaster for inclusion on the SSSP site.

3. TECHNICAL SUB-GROUP REPORTS

3.1 ATOVS AND AVHRR PROCESSING PACKAGE (AAPP)

3.1.1 Background

AAPP was created through the joint development of a number of European institutions, under co-ordination of EUMETSAT, for the pre-processing of HRPT direct readout data from NOAA polar orbiting satellites. AAPP produces, in a suite of processing steps, level 1b, level 1c and level 1d output files. The AAPP level 1d file is the interface to numerous level 2 processing packages, which are available and used world wide.

3.1.2 Status

AAPP has been distributed world wide by EUMETSAT and installed successfully by more than 200 users. The current version is AAPP 4.0 and is being shipped to users at the time of writing this report. This version includes all upgrades up to V3.7 which have been provided via ftp. AAPP V4.0 is compatible with Fortran90. New modules were included and perform the handling of moon contamination of the space views from ASMU-A.

3.1.3 Bugs and problems

No major bugs or problems have been reported.

3.1.4 Information exchange

The current scheme for the exchange of information between involved parties was considered as sufficient.

- New releases (Vn.0) of AAPP are distributed on CD-ROM on an 18 month cycle basis. Temporary updates (Vn.i) are distributed via ftp-server (ftp.eumetsat.de). Users are informed about new releases and updates and any other AAPP related subject via the AAPP internet forum: L-AAPP@eumetsat.de
- The Users can pass requests and information via EUMETSAT's user service (ops@eumetsat.de) or the AAPP helpdesk (aapp.nwpsaf@metoffice.com).
- The AAPP Internet Forum allows users to communicate to each other via e-mail and automatically addresses all forum participants.

NOTE: Beginning with the initial operations phase (IOP) planned for April 2004, the NWP SAF will take over the distribution of AAPP, i.e., from V5.0 AAPP will be delivered by the NWP SAF.

Four links were provided from the AAPP Web page to the NWP SAF home page.

3.1.5 New developments

Three major upgrades are planned for AAPP in the future:

1. Upgrade of AAPP to process the data of NOAA-N and N'. This requires the development of modules for

- The processing of MHS,
- A new level 1b format for MHS (as defined by NESDIS),
- The calibration of HIRS/4 data, and updated level 1b format.

2. Navigation update, including ability to use 2-line element orbital prediction data.

The target date for developments 1 and 2 is summer 2004.

3. Extension of AAPP to process HRPT data from Metop. The level 1 processing of IASI data will be incorporated as a new feature. Development is required for the following modules:

- Software to process IASI level 1 data. It is planned to use the operational IASI Level 1 software, developed by CNES, for this purpose. The software will be made available to Météo-France.
- Additional orbit propagation software. The AHRPT from Metop provides an ADMIN message, which includes the orbit information in the form of TBUS elements and in the form of 13 SPOT orbit parameters.
- The data provided from the spacecraft are instrument source packets (ISP) in the CCSDS (Consultative Committee for Space Data Systems) packetised format. An interface needs to be provided.

The target date for this development is summer 2005.

A Working Group has been set up between the NWP SAF and the EPS Project to co-ordinate the development and to ensure as much as possible the compatibility between the global operational products and the local products. This group has met twice and has triggered a fruitful information exchange. A draft work-plan has been established (it contains essentially the steps listed above).

3.1.6 New platforms

AAPP has been installed successfully on SUN, HP, SGI, DEC and IBM platforms. No new platforms were identified. The Group noted that the Finnish Meteorological Institute (FMI) has established a version of AAPP adapted for Linux, for use with the GNU Fortran Compiler. Some modules needed to be rewritten for this purpose. Note: This version is not part of the official release. After a short discussion whether the development should include Linux with GNU Fortran the group concluded that it was better to use the official release, since GNU Fortran is not further developed via Fortran90.

3.1.7 AAPP License

Users can request a license for AAPP via EUMETSAT's Web page:
http://www.eumetsat.de/en/area4/aapp/get-aapp/get-aapp.html

3.1.8 Actions

All actions from the last meeting were closed or overtaken by events.

3.2 INTERNATIONAL ATOVS PROCESSING PACKAGE (IAPP)

Although there was no formal meeting of the IAPP Technical Sub Group, there were useful conversations with several users. They are generally satisfied with the performance of the package, but did raise some issues that, when resolved, will definitely enhance the utility - and appeal - of the IAPP.

One user expressed quite a bit of frustration at the difficulty in adapting the output of his agency's numerical model output to the format of the ancillary files required by the IAPP. This issue has arisen in email and telephone consultations with other users, as well. The procedure that is contained within the IAPP is essentially "hard-wired" to the global files produced by NCEP's Aviation Forecast Model, and how one could go about modifying it to use some other type of gridded data is not at all apparent. Undertaking a major expansion of the relevant documentation will be considered in order to provide more of a "cookbook" that would enable users to make such an adaptation relatively straightforward. This will not be a trivial task, but the issue should be addressed.

Another major concern is the lack, within the IAPP, of any procedures for evaluating the output of the retrieval process - e.g., plotting of data values and construction of contour analyses. In this instance, the inclusion of an interface, in the form of utility software to read the retrieval netCDF output file, that could be used to present data to a FORTRAN or IDL graphics package will be explored.

The lack of an up-to-date radiance bias adjustment procedure is also a concern; users were informed that this issue will be addressed in the near future.

3.3 INTERNATIONAL MODIS/AIRS PROCESSING PACKAGE (IMAPP)

The International MODIS (Moderate Resolution Imaging Spectroradiometer) and AIRS (Atmospheric Infrared Sounder) Processing Package (IMAPP) is a NASA funded, freely distributed software package which allows any ground station capable of receiving direct broadcast from Terra or Aqua to produce calibrated and geo-located radiances, and a variety of environmental products. The versions of the IMAPP software released to date have proven to be highly effective tools for the global EOS direct broadcast community, enabling users to receive and process raw data in real-time (i.e., as observations are acquired) and generate environmental products as needed.

To date, the University of Wisconsin SSEC has released IMAPP software for MODIS Level 1 calibrated and geo-located radiances, and a selection of MODIS Level 2 geophysical products including cloud mask, cloud top properties, cloud phase, atmospheric profiles and total precipitable water vapor. Working in conjunction with the AIRS Team at NASA JPL, SSEC received the first post-launch delivery of the AIRS/AMSU/HSB (AMSU- Advanced Microwave Sounding Unit; HSB - Humidity Sounder Brazil) Level 1 software, and released the first version of the AIRS/AMSU/HSB Level 1 IMAPP software on 5 November 2003. The current IMAPP product algorithms, along with those planned for production during the next three years are listed in Table 3.3-1.

Table 3.3-1. Summary of current and planned IMAPP MODIS and AIRS product algorithms.

	MODIS	AIRS/AMSU/HSB
Current	Geo-location/Navigation Cloud Mask Cloud Phase Cloud Top Property Clear T/Q Sounding Total Precipitable Water	Geo-location/Navigation
Planned	Cloud Particle Size Cloud Optical Thickness Aerosol Optical Thickness Surface Reflectance Sea Surface Temperature Snow Detection Sea Ice Detection Scene Classification (Clouds and Land Surface)	Clear/Cloudy T/Q Sounding Cloud Detection Cloud Clearing Cloud Height/Emissivity Surface Skin Temperature Cloud Liquid Water AMSU Precipitation Estimate
	MODIS/AIRS Collocation	

The IMAPP software is available from http://cimss.ssec.wisc.edu/~gumley/IMAPP/ and has been ported to and tested on a variety of UNIX and PC platforms (see Web page for more details). The IMAPP MODIS is released to the international EOS direct broadcast community under the GNU General Public License. The software has been well received by a wide variety of users and is currently in use at over 75 ground stations around the world. IMAPP software is supplied as a standard feature by many ground station manufacturers including SeaSpace and Integral Systems of USA, Kongsberg Spacetec of Norway, and Environmental Systems and Services of Australia.

Examples of the IMAPP suite of direct broadcast products produced at CIMSS are shown below (Figure 3.3-1). In the future, IMAPP will evolve to incorporate, adapt, and develop new processing algorithms to meet global users' demands for regional real-time multi-disciplinary applications. IMAPP will also continue to incorporate feedback and suggestions provided by users in order to improve its functionality,

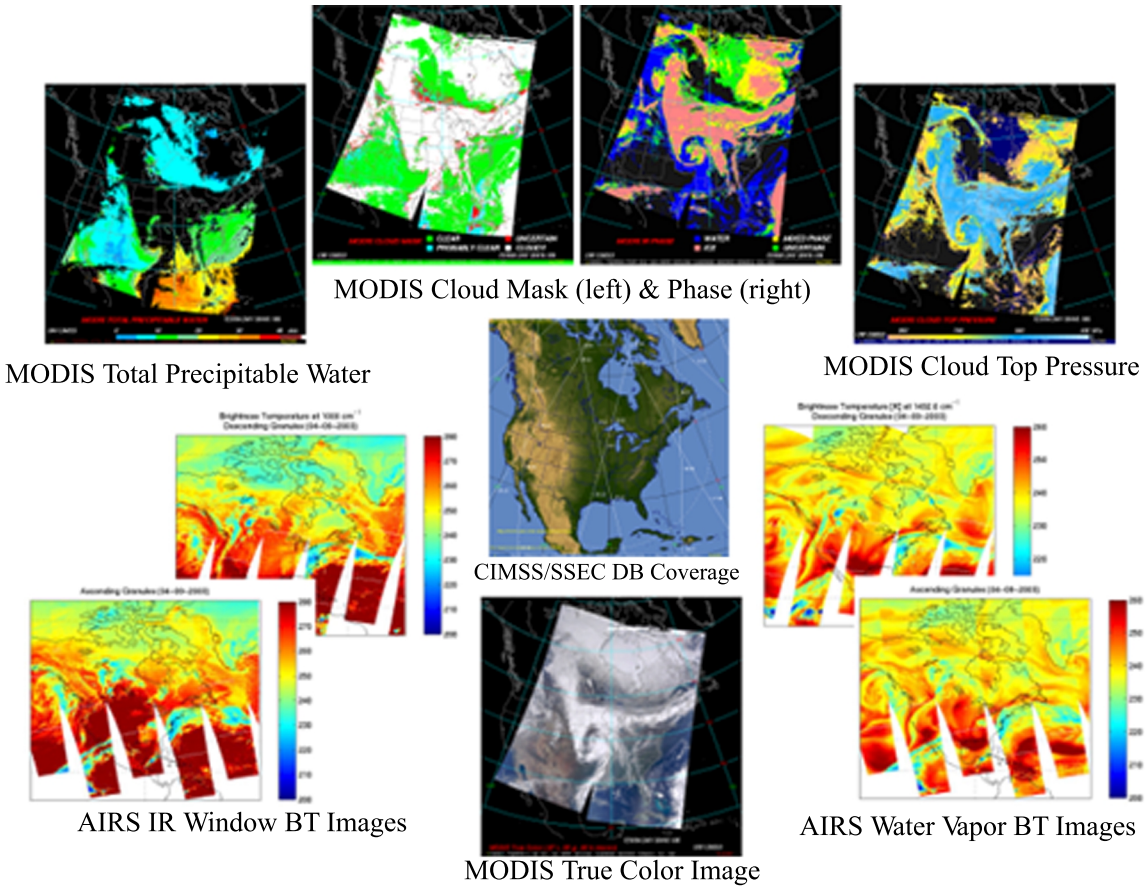


Figure 3.3-1. Examples of real-time IMAPP MODIS and AIRS imagery products generated at CIMSS.

accuracy, efficiency, and standardization. Most of all, with open source architecture and rigorous documentation standards, IMAPP can be easily implemented on almost any computing platform.

3.4 FAST RADIATIVE TRANSFER MODEL, RTTOV

A presentation on the current status of the fast radiative transfer model, RTTOV, was given during ITSC-XIII and a paper summarising the status is available in the proceedings and accessible from the ITWG Web site. The RTTOV-7 software is available to users on request from the NWP SAF (mailto:rttov.nwpsaf@metoffice.com). The RTTOV documentation can be viewed on the NWP SAF RTTOV Web site at http://www.metoffice.com/research/interproj/nwpsaf/rtm/

3.5 FREQUENCY MANAGEMENT

This technical sub-group was created at ITSC-XII with Guy Rochard (Chair), Narinder Chauhan, Steve English, John Derber, Albin Gasiewski, Roger Saunders, Jean-Noel Thepaut, Tony McNally, and John Bates. The group is open to all interested persons.

The protection of the microwave spectrum to allow scientific use for passive remote sensing of the Earth's surface and atmosphere is an important challenge, due to the huge pressure from commercial, industrial and military applications. Their "man-made" emissions in key portions of the microwave spectrum could render these bands useless for remote sensing applications. Key documents related to this issue are found on the ITWG Web site (http://cimss.ssec.wisc.edu/itwg/groups/frequency/); they include "Protection of Radio Frequencies for GEO" and "Comment to GEO Report."

At ITSC-XIII, a short meeting was held. The following summarises the discussions.

- The scientific community, including the ITWG technical sub-group do not have enough contacts and influence in the national radio communications agencies and commercial, industrial or military lobbies (see for example the 23.6-24 GHz problem in the USA and Europe).
- We have scientifically progressed to express the needs for passive microwave applications in NWP, but not in climate. We have not had enough progress for surface (land and ocean), limb sounding (more generally above 275 GHz for passive microwaves on polar or geostationary meteorological satellites) or for active bands (altimeters, scatterometers, rain radars, etc.). ITWG must help make progress on climate needs, particularly in terms of Delta T, by updating or consolidating the tables in the above-mentioned documents. These tables correspond to ITU Records 515, 1028 and 1029 (quoted below) for the passive microwave. We need an extended group to help with several other topics.
- It is critically important to extend our sub-group to other groups affected by the loss of these bands, including universities and manufacturers (e.g., MIT and Northrop Grumman Corporation), and to work together at least by correspondence. To start this expansion it was recommended to have a special session at SPIE in Denver in early August 2004, at IGARSS in Anchorage at the end of September 2004, and at SPIE Asia and Pacific in Honolulu, Hawaii in early November 2004. It is planned to have a common presentation (G. Rochard at Denver, A. Gasiewski at Anchorage and P. Menzel at Honolulu). At the Denver meeting it is planned to invite universities and manufacturers to extend our contacts to improve our presentation.
- As to linking with the ITU Working party 7C and the WMO, we should act more from inside these two organisations. For the time being only the ITU Recs 515, 1028 and 1029 exist but they have to be improved. No progress has been made on the draft WMO table. (See the WMO table either in the ITSC-XII poster of G. Rochard (http://cimss.ssec.wisc.edu/itwg/itsc/itsc12/posters/Rochard_MW_poster.doc) or Table 2 in the SPIE paper Frequency Protection for Passive Remote Sensing of the Earth, located in the Frequency sub-group Web page noted above.)
- Regarding the SFCG (Space Frequency Coordination Group: http://sfconline.org/) during the last 3 years ITWG has been a member of SFCG and has been represented at the SFCG 20 meeting in Cairns by John Le Marshall and Guy Rochard in 2000, as well as at the SFCG 21 meeting in Cayenne in 2001. This is also true for SFCG 22 in Italy in September 2002 and at SFCG 23 in September 2003 at San Diego. SFCG 24 will be in Lannion, France in September 2004, hosted by ITWG and held close to the Centre de Météorologie Spatiale of METEO-FRANCE.
- Two specific actions need to occur at SFCG-24 by G. Rochard. The first is to update the WMO/ITU handbook (see http://www.wmo.ch/web/www/TEM/SG-RFC/Handbook.htm) and the second is to provide an update of the bands, bandwidths, Delta T and % availability above 275 GHz. This second action refers to the ITU table shown in the ITSC-XII poster of Rochard

or Table 1 of the SPIE paper, Frequency Protection for Passive Remote Sensing of the Earth (both tables are the same). This corresponds to the ITU Recommendations 515, 1028 and 1029. Concerning the WMO/ITU handbook, the issue is to find a way for updating the information in agreement with the ITU and WMO. The Delta T in these tables is also the level of compatibility which must exist between worldwide (global) and direct readout (local) preprocessing to get consistent level 1b or 1c radiances. This applies for all polar orbiting meteorological satellites.

- On our sub-group Web page, three or four new documents will replace the current ones in Spring 2004.
- A report about the expected results of our sub-group and a new meeting will be held at ITSC-XIV.
- Apart from the scientific documents to justify the protection for our needs, the only other approach is for every country to lobby their national radio-communication agencies and convince them that the long term scientific needs are more important than short term economical and/or military interests.

ITSC-XIII AGENDA

Wednesday 29 October 2003

8:00	Registration (continues til 15:00)	
9:00-9:30	Welcome	Co-Chairs Tom Achtor, Roger Saunders Dave Steenbergen
	Local Arrangements	Louis Garand
	Review of Agenda	

9:30-10:30

Session 1: Operational Use of ATOVS — Chair: Bill Smith

1.1	**Clement Chouinard**	The assimilation of AMSU-B radiance data in the Canadian Meteorological Centre global data assimilation system; their difficulties relative to the assimilation of AMSU-A radiances
1.2	**Stephen English**	Current status and future plans for assimilation of passive microwave measurements at the Met Office
1.3	**Graeme Kelly**	Use of satellite radiances in the operational ECMWF system
1.4	**Elisabeth Gerard**	Use of ATOVS raw radiances in the operational assimilation system at Météo-France

10:30-11:00 BREAK

11:00-12:30

Session 1: Operational Use of ATOVS — Chair: Clement Chouinard

1.5	**Jishan Xue**	Development of 3D Variational Assimilation System for ATOVS Data in China
1.6	**Masahiro Kazumori**	Operational use of the ATOVS radiances in global data assimilation at the JMA
1.7	**Christopher Tingwell**	Locally Received and Processed ATOVS Radiances in the Australian Region LAPS Data Assimilation and Prediction System
1.8	**John Derber**	Enhanced use of radiance data in NCEP data assimilation systems
1.9	**Devendra Singh**	Recent Improvements in Temperature and Moisture Profiles Using NOAA Satellites AMSU Data and Their Impact on NWP Model Over Indian Ocean
1.10	**Louis Garand**	Dynamic inference of background error correlation between surface skin and air temperature

12:30-14:00 LUNCH

14:00-15:30

Session 2: New Applications for NWP — Chair: Stephen English

2.1	**Thomas Auligne**	First results of the assimilation of AIRS data in METEO-FRANCE NWP model
2.2	**Tony McNally**	The assimilation of AIRS radiance data at ECMWF
2.3	**Brett Harris**	A Model Based Bias Correction Scheme for AIRS at the Met Office
2.4	**Andrew Collard**	Assimilation of AIRS radiances into the Met Office's Global NWP Model
2.5	**Lydie Lavanant**	Use of MODIS imager data to help dealing with AIRS cloudy radiances

2.6	**Zhiquan Liu**	Potential of high density observations on Numerical Weather Prediction: A study with simulated observations

15:30-16:00 BREAK

16:00-17:00
Session 2: New Applications for NWP — Chair: Tony McNally

2.7	**Steve English (for Brett Candy)**	The Use of AMSU data in the Met Office Mesoscale Model
2.8	**Vanessa Sherlock**	Use and impact of satellite data in the NZLAM-VAR mesoscale model
2.9	**Al Gasiewski**	Prospects for All-Weather Microwave Radiance Assimilation
2.10	**Mitch Goldberg (for John Bates)**	NOAA's Satellite and Information Stewardship Program and Plans

17:00-18:00 BREAK

18:00 Icebreaker

Thursday 30 October 2003

8:30-10:15
Session 2: New Applications for NWP — Chair: Godelieve Deblonde

2.11	**Chris O'Dell (for Ralf Bennartz)**	Fast passive microwave radiative transfer in precipitating clouds: Towards direct radiance assimilation
2.12	**Tony McNally (for Frédéric Chevallier)**	Variational Cloud and Rainfall Data Assimilation at ECMWF
2.13	**Michèle Vesperini**	Contribution of POLDER to water vapour observation
2.14	**Herschel L. Mitchell**	Assimilation of AMSU-A Microwave Radiances with an Ensemble Kalman Filter
2.15	**Ma Gang**	A Research of Four-dimension Variational Data Assimilation with ATOVS Clear Data
2.16	**Thibaut Montmerle**	Impact of the assimilation of MSG/SEVIRI radiances in a mesoscale NWP model
2.17	**Roger Randriamampianina**	Impact of the ATOVS data on the Mesoscale ALADIN/HU Model

10:15-10:45 BREAK

10:45-11:15
Session 3: Instrument Studies — Chair: Dieter Klaes

3.1	**Thomas Kleespies**	Preparations for NOAA N and N'
3.2	**Pubu Ciren (for Changyong Cao)**	Operational High Resolution Infrared Radiation Sounder Calibration Algorithms and Their Effects on Calibration Accuracy

11:15-12:15
Session 4: Radiative Transfer and Surface Modeling — Chair: Larrabee Strow

4.1	**Roger Saunders**	Status of RTTOV-7 and plans for RTTOV-8
4.2	**John Derber (for Paul van Delst)**	NCEP infrared sea surface emissivity model

4.3	**Fuzhong Weng**	A New Microwave Snow Emissivity Model
4.4	**Nicole Jacquinet-Husson**	The 2003 Edition of the GEISA spectroscopic database system for the second generation vertical sounders radiance simulation

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

13:45-15:30
Session 4: Radiative Transfer and Surface Modeling — Chair: Tom Kleespies

4.5	**David Shawn Turner**	An Alternate Approach to Modelling the Reflected Downward Flux Term
4.6	**Jean-Luc Moncet**	Infrared radiative transfer modeling using the Optimal Spectral Sampling (OSS) method
4.7	**Malgorzata Szczech-Gajewska**	Spectral surface emissivity for use in assimilation of IR radiance data over land
4.8	**L. Larrabee Strow**	Atmospheric Spectroscopy with AIRS: Validation of the AIRS Forward Model
4.9	**Robert Knuteson**	Validation of Satellite AIRS LST/LSE Products Using Aircraft Observations
4.10	**Larry McMillin**	Advances in the Use of Super Channels for Processing High Spectral Resolution Satellite Measurements
4.11	**Marco Matricardi**	RTIASI-4 - An improved version of the ECMWF fast radiative transfer model for the Infrared Atmospheric Sounding Interferometer

15:30-16:00 BREAK

16:00-17:00 ITSC-XII Action Items presented by WG Chairs — Moderators: Tom Achtor/ Roger Saunders

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

17:00-17:15 Working Group Formation — Chairs: Roger Saunders and Tom Achtor

17:15-18:00 BREAK

18:00-19:30 Poster Session A

Friday 31 October 2003

8:30-10:30
Session 5: Retrieval of Atmospheric Parameters — Chair: Allen Huang

5.1	**David Anselmo**	Comparison of the CMC analyzed fields of Integrated Water Vapour with those retrieved from the SSM/I
5.2	**Kung-Hwa (Peter) Wang**	The AMSU Observation Bias Correction and its Application on 1-Dvar Retrieval Scheme and Typhoon Monitoring
5.3	**George Aumann (for Thomas S. Pagano)**	Level 1B Products from the Atmospheric Infrared Sounder (AIRS) on the EOS Aqua Spacecraft

5.4	**Sung-Yung Lee**	AIRS Retrieval System
5.5	**Mitch Goldberg**	Atmospheric Soundings of Temperature, Moisture and Ozone from AIRS
5.6	**Elisabeth Weisz**	AIRS Real-Time Sounding Profile Retrieval for IMAPP (International MODIS/AIRS Processing Package) Users
5.7	**John Blaisdell**	Current Results from AIRS/AMSU/HSB
5.8	**Soumia Serrar**	First global measurement of mid-tropospheric CO2 from NOAA polar satellites: The tropical zone

10:30-11:00 BREAK

11:00-12:45

Session 5: Retrieval of Atmospheric Parameters **Chair: Guy Rochard**

5.9	**Cyril Crevoisier**	Mid-tropospheric CO2 retrieval in the tropical zone from AIRS observations
5.10	**Bjorn Lambrigsten (for Eric J. Fetzer)**	Validation of AIRS Retrievals
5.11	**Hank Revercomb**	Validation of Atmospheric InfraRed Sounder (AIRS) Spectral Radiances with the Scanning High-resolution Interferometer Sounder (S-HIS) aircraft instrument
5.12	**Allen Larar**	Validation Studies Using NAST-Interferometer Field Measurements
5.13	**Paolo Antonelli**	Validation and Comparison of S-HIS and NAST-I Retrievals for THORPEX 2003
5.14	**William L. Smith**	Validation of Satellite AIRS Retrievals With Aircraft NAST-I Observations - Implications for Future Satellite Sounding Capabilities
5.15	**Eva Borbas**	Effects of GPS/RO refractivities on IR/MW retrievals

12:45-14:00 Lunch (Plus poster session preparation)

14:00-15:15

Session 6: Satellite Agency and Status Reports **Chair: Peter Schlüssel**

6.1	**Alan Lipton**	Characterization of troposphere and land surface properties from CMIS
6.2	**Dong Chaohua (for Wenjian Zhang)**	The sounding instruments on second generation of Chinese national meteorological satellites FY-3
6.3	**Devendra Singh (for R. C. Bhatia)**	India Meteorological Department Report
6.4	**Alexander Uspensky**	Scientific Research Center “Planeta” Report
6.5	**Dieter Klaes**	EUMETSAT Plans

15:15-15:45 BREAK

15:45-17:00

Session 6: Satellite Agency and Status Reports **Chair: Alexander Uspensky**

6.6	**Guy Rochard**	Update about frequency protection: Results from WRC 2003 and SFCG 23… What to do now?
6.7	**A. K. Sharma**	NESDIS ATOVS Operational Sounding Products Processing and Distribution
6.8	**Tony Reale**	NESDIS ATOVS Operational Sounding Products
6.9	**Nigel Atkinson**	Further development of the ATOVS and AVHRR Processing

		Package (AAPP), including an initial assessment of EARS radiances
6.10	**Hal Bloom**	The National Polar-orbiting Operational Environmental Satellite System: Future U.S. Operational Earth Observation System

17:00-17:30 BREAK

17:30-19:00 Poster Session B

19:00 Group Dinner

Saturday 1 November 2003

Working Groups
9am-11am (or as arranged by chairmen)

Sunday 2 November 2003

Working Groups
9am-11am/6-8pm (or as arranged by chairmen)

Monday 3 November 2003

8:30-9:15

Session 7: Retrieval of Surface Parameters — Chair: Louis Garand

7.1	**William Smith (for John Le Marshall)**	Preparations for the Geostationary Imaging Fourier Transform Spectrometer
7.2	**Xuebao Wu**	Retrieving Infrared Land Surface Emissivity With AIRS Observations
7.3	**Youri Plokhenko**	Surface effects in hyperspectral infrared measurements from the AIRS instrument of the Aqua satellite

9:15-10:00

Session 8: Retrieval of Cloud Parameters — Chair: Mike Uddstrom

8.1	**Michael Chalfant**	Advanced TOVS (ATOVS) Cloud Products Using HIRS/3 and AMSU-A Measurements
8.2	**Filomena Romano**	Cloud Parameters from a Combination of Infrared and Microwave Satellite Measurements
8.3	**Gaby Rädel**	Cirrus microphysical properties from TOVS observations

10:00-10:30 BREAK

10:30-11:30

Session 8: Retrieval of Cloud Parameters (continued)

8.4	**Hung-Lung Allen Huang**	Synergistic Cloud Clearing and Cloud Property Retrieval Using Aqua Sounding and Imaging Infrared Measurements
8.5	**Evan Fishbein**	Characteristics of the Cloudy Atmosphere Observed the Atmospheric Infrared Sounder (AIRS)

8.6	**Jun Li**	Synergistic use of high spatial resolution imager and high spectral resolution sounder for atmospheric and cloud retrievals
8.7	**Ignacio Galindo**	Estimates of the dynamics of volcano eruption column using real-time AVHRR

12:00-13:30 Lunch

13:30-15:15
Session 9: Use of ATOVS for Climate Studies — Chair: Carl Mears

9.1	**Bill Rossow**	What has the climate been doing for the last 20 years and why?
9.2	**Mark McCarthy**	Climate variability and change of tropical tropospheric humidity as observed by HIRS
9.3	**Graeme Kelly**	Use of radiances data in ERA-40
9.4	**Carl Mears**	Understanding the difference between the UAH and RSS retrievals of satellite-based tropospheric temperature estimates
9.5	**Peter Thorne**	Monitoring Climate Change using Satellites: Lessons from the MSU
9.6	**Tony Reale**	Plans for a Collocated Radiosonde and Satellite Upper Air Network (SUAN)

15:15-15:45 BREAK

15:45-17:30
Session 10: Future Systems and Processing — Chair: Dong Chaohua

10.1	**Bjorn Lambrigtsen**	GeoSTAR - A New Approach for a Geostationary Microwave Sounder
10.2	**Jeffrey Puschell**	NPOESS VIIRS sensor design and performance
10.3	**Xu Liu**	Overview of the CrIMSS (CrIS/ATMS) retrieval algorithm
10.4	**Thierry Phulpin**	IASI on Metop : an Advanced Sounder for Operational Meteorology and Climate studies
10.5	**Peter Schlüssel**	The Operational IASI Level 2 Processor
10.6	**Marc Schwaerz**	Joint Temperature, Humidity, Ozone, and SST Retrieval from IASI Sensor Data
10.7	**Dong Chaohua**	Dust Storm Monitoring and Quantitative Prediction Experiment with NWP in Northeast Asian

17:30-19:00 BREAK (Working Group Meetings to finish reports)

19:00 Banquet

Tuesday 4 November 2003

9:00-9:30
Session 10: Future Systems and Processing — Chair: Thierry Phulpin

10.8	**George Aumann (for Thomas Kampe)**	SIRAS-G, The Spaceborne Infrared Atmospheric Sounder: The potential for high-resolution infrared imaging spectrometry from geosynchronous orbit
10.9	**Jun Li (for Tim Schmit)**	Introduction of the Hyperspectral Environmental Suite (HES) on GOES-Rand beyond

9:30-9:45 BREAK

9:45-11:45	Working Group reports and actions summary • Radiative Transfer and Surface Property Modeling (Roger Saunders) • ATOVS/TOVS in Climate Studies (Peter Thorne) • ATOVS/TOVS in NWP (Clement Chouinard) • Advanced Infrared Sounders (Allen Huang) • International Issues and Future Systems (Guy Rochard) • Satellite Sounder Science and Products (Tony Reale)	
11:45-12:00	Plans for next meeting and closing remarks	Co-Chairs Tom Achtor, Roger Saunders
12:00-13:00	Lunch	
13:30	Bus departs for Montreal Dorval airport	
14:30	Bus arrives at Montreal Dorval airport	

Poster Session A: Thursday

A01 **Michael Chalfant:** Advanced TOVS (ATOVS) Cloud Products Using HIRS/3 and AMSU-A Measurements

A02 **Izabela Dyras:** Meteorological Products Generation Using Combined Analysis of ATOVS and AVHRR Data

A03 **Aarno Korpela:** Multi-spectral rain-rate retrieval from AMSU and AVHRR

A04 **Ma Gang:** A Research of Four-dimension Variational Data Assimilation with ATOVS Clear Data

A05 **Nancy Baker:** Variational retrievals within the summertime eastern Pacific environment using ATOVS with the COAMPS™ mesoscale forecast system

A06 **Nancy Baker:** The Assimilation of Satellite Observations for the U.S. Navy's Operational Forecast Models

A07 **Mitch Goldberg:** Long-Term Temperature Time Series Constructed from "Morning" Satellites

A08 **Carl A. Mears:** Progress towards a climate-quality data set from MSU channel 1

A09 **Viju Oommen John:** Comparison of AMSU-B Brightness Temperature with Simulated Brightness Temperature using Global Radiosonde Data

A10 **Leanne Avila:** The ITWG Web Site: Creating a Useful Forum for the Community

A11 **Tom Achtor:** The International ATOVS Processing Package (IAPP)

A12 **Tom Achtor:** The International MODIS/AIRS Processing Package (IMAPP)

A13 **Hung-Lung Allen Huang:** Re-examining the Requirements on Field-Of-View Size for CrIS

A14 **Steve Ackerman:** MODIS Cloud Mask: Results and Validation

A15 **Clemence Pierangelo:** Measurements of Stratospheric Volcanic Aerosol Optical Depth from NOAA/TOVS Observations

A16 **Clemence Pierangelo:** Retrieving dust aerosol optical depth and altitude using AIRS data

A17 **Walter Wolf:** A Fully Operational Near Real-Time AIRS Processing and Distribution System: Level 2 Products

A18 **Lihang Zhou:** Application of Principal Component Analysis to Near Real-Time AIRS Channel Monitoring, Data Compression, Noise Filtering, and Atmospheric Retrievals

A19 **Pubu Ciren:** First Comparison of Radiances Measured by AIRS/Aqua and HIRS/NOAA-17

A20 **Pascal Brunel:** On the use of Planck-weighted transmittances in RTTOV

A21 **Stephen English:** A comparison of RTTOVSCATT and ARTS with AMSU-B observations using Met Office mesoscale model short range forecasts of ice water profiles

A22 **Stephen English:** How good are current emissivity models?

A23 **Cyril Crevoisier (for Sylvain Heilliette):** Two fast forward radiative transfer models dedicated to the AIRS instrument and comparison to AIRS observations

A24 **Roger Saunders:** Intercomparison of fast radiative transfer models for AIRS simulations

A25 **Youri Plokhenko:** Observation of Solar radiation reflected by land surfaces from the GOES-8

sounder IR spectral measurements over continental USA

A26 **Albin Gasiewski:** Estimation of Coupling Between Mobile Vehicular Radars and Satellite Radiometers

A27 **Albin Gasiewski:** Geosynchronous Microwave Observation System Simulation

A28 **Jeffrey Puschell:** Japanese advanced meteorological imager (JAMI): design, characterization and expected on-orbit performance

A29 **John Galantowicz:** Optimization and evaluation of interpolated ATMS and CMIS data

Poster Session B: Friday

B01 **Adam Dybbroe:** An operational AVHRR cloud top temperature and height retrieval and its validation

B02 cancelled

B03 **Dieter Klaes:** The ATOVS and AVHRR Product Processing Facility for EPS

B04 **Tony Reale:** ATOVS Operational Products and the Satellite Upper Air Network (SUAN)

B05 **Tony Reale:** WG On SSSP Activities

B06 **Ralf Bennartz:** Satellite-based Precipitation Analysis in Support of Nowcasting Applications

B07 **Peter Thorne:** The use of MSU in climate change studies

B08 **Per Dahlgren:** Ongoing and planned activities in the usage of ATOVS AMSU A/B in the HIRLAM 3DVAR system at SMHI

B09 **Jakob Grove-Rasmussen:** Use of ATOVS in the DMI-HIRLAM regional weather model

B10 **Marion Schroedter:** Use of ATOVS data for operational atmospheric correction and surface irradiance calculations

B11 **Soumia Serrar:** Simultaneous determination of continental surface emissivity and temperature from NOAA- 10/HIRS observations. Analysis of their seasonal variations

B12 **Michael Pavolonis:** A comparison of AVHRR and HIRS Global Cloud Types

B13 **Eva Borbas:** Comparison of IAPP and ICI Sounding Products at CIMSS

B14 **Harold Woolf:** Influence of the first guess on mesoscale IAPP retrievals

B15 **Nicolas Wagneur:** Operational assimilation of GOES water vapor imager channel at MSC

B16 **Frédéric Chevallier:** Global maps of microwave land surface emissivities for weather forecast

B17 **Frédéric Chevallier:** RTTOV_SCATT, a fast radiation model that includes scattering at microwave
frequencies

B18 **Yong Han:** An Improved OPTRAN Algorithm

B19 **Jean-Luc Moncet:** Preliminary validation of the CrIMSS (ATMS/CrIS) retrieval algorithm

B20 **Jean-Luc Moncet:** Infrared radiative transfer modeling using the Optimal Spectral Sampling (OSS) method

B21 **Florence Rabier:** Cloud characteristics and channel selection for IASI radiances in the meteorological
sensitive areas

B22 **Florence Rabier:** Application of an objective error variance tuning method to satellite radiances observational errors

B23 **Alexander B. Uspensky:** Can a statistical regression be a valuable tool for advanced IR-sounders data inversion?

B24 **Ralph Dedecker:** A System Design for Storing, Archiving, and Retrieving Hyperspectral Data

B25 **Thierry Phulpin:** Potential use of IASI for volcanic clouds detection and monitoring

B26 **(Hilary E. Snell):** The Infrared Ozone Retrieval Algorithm for NPOESS-OMPS

B27 **Guy Rochard:** Update about frequency protection: Results from WRC 2003 and SFCG 23… What to do now?

B28 **Daniel Zhou:** Tropospheric CO Observed with NAST-I: Retrieval Algorithm, First Results, and Validation

B29 **Lawrence Larrabee Strow:** Observations of dust emission/absorption by AIRS

ITSC-XIII ABSTRACTS

SESSION 1

1.1 The assimilation of AMSU-B radiance data in the Canadian Meteorological Centre global data assimilation system: their difficulties relative to the assimilation of AMSU-A radiances

Presenter: Clement Chouinard

C. Chouinard and J. Hallé
Meteorological Service of Canada

The assimilation of AMSU-A data is now used routinely at most national NWP Centres, and their impact, as demonstrated at most Centres, is now recognized as the most important source of data in the SH and in some systems, it represents the most important source of data in the NH.

AMSU-A radiances are ideal data for any assimilation system, and particularly for a variational system such as the Canadian Meteorological Centre (CMC) 3D-var. The radiative transfer model required to simulate AMSU-A radiance from an atmospheric state vector is a linear operator which depends mainly on the atmospheric temperature. Consequently, the impact of a radiance datum will impact mostly the temperature profile and not the moisture. On the other hand, the radiative transfer for AMSU-B is a complex nonlinear operator which depends strongly on moisture and temperature, consequently a radiance datum will apply a correction in both these fields. Background error statistics of temperature and moisture then become important critical parameters controlling the flow of radiance information to the atmospheric temperature and moisture profiles.

A series of tests prepared with AMSU-B radiances will highlight the difficulties with the data and how these were resolved in order to positively impact on all analysis variables. It will be shown that the quality control (QC) and the data selection are critical, and how small differences in a problematic atmospheric profile can lead to major differences in the simulated radiance using RTTOV-7. These large differences between simulated and observed then produce large corrections to the initial guess temperature and humidity of the 3D-var. When all difficulties were resolved, the impact of AMSU-B data on the analyses and forecasts were very significant as will be demonstrated from 2-month summer and winter assimilation cycles. The impact on moisture are very large improving precipitation forecasts up to and beyond 4 days. The use of AMSU-B radiance data was implemented in the 3D-var at CMC on June 19, 2003.

1.2 Current status and future plans for assimilation of passive microwave measurements at the Met Office

Presenter: Stephen English

Stephen English, Andrew Smith, Fiona Hilton, William Bell, Brett Candy and Nigel Atkinson
Met Office, United Kingdom

The use of passive microwave instruments such as AMSU and SSM/I is now well established at the Met Office, both for global and regional NWP. In this paper current operational use of ATOVS and SSM/I data will be summarised. Results from recent pre-operational trials will be presented, including results using data from three satellites, use of RTTOV-7 and a new bias correction scheme. Work has been continuing on use of ATOVS over land. It is being found that providing detailed first-guess information for emissivity is having little impact, and effort is focusing on robust methods for analysing emissivity in 1D-var. Work has also begun on comparing model NWP background fields of ice and liquid water with passive microwave measurements. For an in-depth analysis of the use of AMSU in mesoscale assimilation see the paper by Candy et al.

The major scientific challenges facing us for processing future passive microwave systems such as CMIS will be examined, and work underway to test and develop the necessary science will be presented.

1.3 Use of satellite radiances in the operational ECMWF system

Presenter: Graeme Kelly

Graeme Kelly
ECMWF, United Kingdom

Currently 70 million satellite radiances are presented to the operational 4D-VAR analysis at ECMWF and about 3.5 million radiances are used in the 4D-VAR minimisation. The paper will summarise the calculations of surface emissivity and the screening for cloud and rain for each sensor. Also the assimilation and forecast impact from the sensors HIRS, AMSUA, AMSUB, and SSMI will also be discussed.

1.4 Use of ATOVS raw radiances in the

operational assimilation system at Météo-France

Presenter: Elisabeth Gérard
Elisabeth Gérard, Florence Rabier, Nadia Fourrié, Delphine Lacroix
Météo-France/CNRM/GMAP, Toulouse, France

The use of raw radiances became operational at Météo-France on 22nd of October 2002 and the use of NOAA-17 data in addition to NOAA-15 and NOAA-16 data on 17th of December 2002. Only AMSUA data have been used in the operational model as a first step.

The purpose of this presentation is to document the developments associated with the operational modifications to follow: improvement of the precipitation mask for a better usage of AMSUA data, use of HIRS data and use of locally received Lannion and EARS AMSUA data in addition to the currently used NESDIS/Bracknell data in short cutoff time analyses where largest impact is expected. Results of Observing System Experiments will also show the benefit of AMSUA data in our operational model.

1.5 Development of 3D Variational Assimilation System for ATOVS Data in China

Presenter: Xue Jishan

Xue Jishan, Zhang Hua, Zhu Guofu, Zhuang Shiyu
Chinese Academy of Meteorological Sciences

Zhang Wenjian, Liu Zhiquan, Wu Xuebao, Zhang Fenyin
National Satellite Meteorological Center, China

In order to alleviate the problem of sparseness of conventional observational data in some key areas for numerical weather prediction, a new 3D variational data assimilation system (GRAPES-3Dvar) with stress on effective usage of satellite data has been developed. This is a grid point analysis system. Recursive filter or spectral transformation is used for preconditioning of control variables during minimization of cost function depending on the domain of analysis (either limited area or global). The forward observational operator and its tangent linear and ajoint for satellite irradiances are adopted from the software package RTTOV developed by ECMWF. A bias correction scheme for input irradiances data is also developed. At present only AMSU-A and AMSU-B data over the oceans are used to avoid the influences of inaccurate computation of surface emissivity and erroneous first guess in higher levels.

In addition to satellite irradiances and conventional rawinsonde observations, satellite derived winds from geostationary satellite and surface winds from QUIKSCAT are also ingested by the assimilation system. The results of preliminary experiments are very encouraging. In the experiments with typhoon cases, the use of ATOVS microwave irradiances from NOAA-16 obviously improves the numerical prediction of both track and intensity of the typhoon. Further investigation shows that without satellite information, the large scale flow pattern are usually poorly defined due to the lack of observations and some bogus model must be adopted for defining the inner structure of the typhoon. The assimilation of satellite irradiances results in better analyses of both the inner structure of the typhoon and the large scale environment. The latter is crucial for the prediction of the track and the former is an important factor determining if the typhoon will develop or decay. The wind information is also an important complementary data source, especially for reducing the positioning error of the typhoon in the analyses. The assimilation of irradiances at microwave channels over land and at infrared channels will be tested in the near future with new scheme of surface emissivity to be introduced. The assimilation system will also be tested in the operational environment.

1.6 Operational use of the ATOVS radicances in global data assimilation at the JMA

Presenter: Masahiro Kazumori

Masahiro Kazumori, Kozo Okamoto, Hiromi Owada

In the presentation, current status of the direct assimilation of ATOVS radiances at the Japan Meteorological Agency (JMA) and the results of some experiments are shown.

Since 1982, JMA had operationally used the temperature profile retrieved by NOAA/NESDIS. As the accuracy of humidity product is not sufficient, only temperature and thickness had been used. There was few observed information of atmospheric humidity in JMA global analysis: JMA uses only radio-sonde-observed humidity profiles and statistically derived profiles from Geostationary Meteorological Satellite (GMS-5) brightness temperature. Since 3D-Var data assimilation system was introduced in the operational global analysis system, ATOVS radiance assimilation has been being developed. As cycle experiments showed many good results, it became operational in 28 May 2003. In the experiments, level 1D ATOVS radiances data are assimilated directly in place of retrievals, and the

statistical humidity retrievals from GMS-5 were discontinued. Moreover new cumulus parameterization scheme of global model was jointly used.

The direct assimilation of ATOVS data expanded moisture observation coverage and improved the analyzed quality of temperature field and humidity, which will lead to higher performance of the prediction globally. The experiments have demonstrated positive impacts on forecast skills for the geopotential height at 500 hPa in the southern hemisphere and in the tropical region. The forecast scores of the temperature at 850 hPa, wind speed at 250 hPa and sea level surface pressure were similarly good. The improvement of short-term forecast was remarkable. The temperature profiles in the upper stratosphere and the global humidity field in the troposphere were also improved. The initial fields of temperature and humidity showed higher accuracy verified against radio-sonde observation and the total precipitable water from SSM/I. And better results on the typhoon track prediction and the global monthly mean 24-hour rainfall were also found out.

Though JMA has achieved considerable progress in ATOVS data assimilation, some un-preferable features are seen: anomalous change of temperature at some levels in the stratosphere and the excessive concentration of rainfall in 6-hour forecast. To solve these problems, we continue to carry out some experiments and improve the global model and bias correction scheme of ATOVS brightness temperature. Moreover, we are going to assimilate ATOVS Level 1B and SSM/I data operationally in 2003 and a preparation on AIRS data assimilation is proceeding.

1.7 Locally Received and Processed ATOVS Radiances in the Australian Region LAPS Data Assimilation and Prediction System

Presenter: Christopher Tingwell

C. Tingwell, B. Harris, W. Bourke and J.Paevere
Bureau of Meteorology Research Centre
Commonwealth Bureau of Meteorology
Melbourne, Australia

The use of 1DVAR retrievals of ATOVS radiances in the Australian Bureau of Meteorology Local Assimilation and Prediction System (LAPS) has produced a modest improvement in forecast skill over that obtained with NESDIS retrievals and represents an important step towards the unification of the data assimilation schemes employed by the Bureau's local NWP system (LAPS) and global system (GASP). The 1DVAR retrieval scheme was implemented in the 29-level operational LAPS system in September 2002, with 1DVAR retrievals used over the sea and below 100 hPa. NESDIS retrievals are used to extend the first guess profiles above the top of the model (50 hPa).

An extended 50-level version of LAPS, with the model top raised to 0.1 hPa and nested within a similarly extended GASP, is being used to test the 1DVAR assimilation of locally received ATOVS radiances, processed via the AAPP package. The timeliness of local reception and processing should improve the amount of ATOVS data available to the LAPS system which, operationally, employs an early data cut-off. The vertical extension of both models eliminates the need for NESDIS retrievals and promises a fully unified local/global data assimilation system able to handle radiance data, whether received and processed locally or sent from overseas centres via the GTS, equivalently. The results of experiments conducted to date will be presented.

1.8 Enhanced use of radiance data in NCEP data assimilation systems

Presenter: John Derber

John C. Derber, Paul VanDelst, XiuJuan Su, Xu Li, and Russ Treadon
NOAA/NWS/NCEP/EMC, Camp Springs, MD, USA

Since ITSC-12, there have been significant changes in the use of radiance data at NCEP. These changes include the improvement and standardization of the radiative transfer system, new surface emissivity formulations, enhanced data selection algorithms, improvements in the quality control, reformulated bias correction techniques, refined data assimilation techniques, improved forecast models and the inclusion of new data sources. These changes will be briefly described with an emphasis on investigations directed towards testing of three new data sources. These data sources (EOS AIRS and AMSU-A, GOES imager, and AVHRR imager) each present different challenges and have different strengths. The EOS data have required the development of the capability of using large numbers of channels into the data assimilation systems. The inclusion of this capability has driven several changes to the radiative transfer calculations and quality control procedures. The inclusion of the GOES imager data was primarily directed towards the improvement of the definition of the upper level moisture fields. The use of these data has presented unique quality control problems. To begin development of enhanced surface temperature analyses, we have also begun evaluating the use of

AVHRR imager data. These data have shown significant potential for improving the specification of the sea surface temperature within our analysis system. Data impact experiments for these three data sets will be presented.

1.9 Recent Improvements in Temperature and Moisture Profiles using NOAA Satellites AMSU data and their impact on NWP model over Indian region

Presenter: Devendra Singh

Devendra Singh, Y. V. Rama Rao, and R. C. Bhatia
India Meteorological Department
New Delhi-10003, INDIA

India Meteorological Department, New Delhi receives and process NOAA TOVS and ATOVS data in real time. The physical and neural network approaches have been used to retrieve atmospheric temperature and moisture profiles from NOAA-16 satellite AMSU data over Indian region. The earlier training data set based on global data only for two seasons used in neural network technique has been replaced by new training data set based on regional data over land and ocean for all the seasons. The new training data set has improved the temperature and moisture profiles accuracy retrieved using neural network approach compared to physical method. The detail validation and inter comparisons of temperature and moisture profiles have also been carried out with ECMWF analysis over sea and land separately for different seasons for the year 2002-2003. The performance of neural network technique is found to be superior compared to physical method.

Recently, temperature and moisture profiles retrieved from NOAA-16 ATOVS data over Indian region have been used in regional NWP model for the impact study. The operational NWP system of India Meteorological Department is based on a Limited Area Analysis and Forecasting System (LAFS), which consists of real time processing of data received on Global Telecommunications System (GTS), objective analysis by 3-D multivariate optimum interpolation (OI) scheme and a multi-layer primitive equation model. Several experiments were performed using temperature and moisture profiles retrieved from NOAA-16 ATOVS data. The preliminary studies reveal that these additional data have a positive impact on geopotential height and rainfall prediction of the limited area model. A case study pertaining to monsoon over India has also been worked upon using the same data. The results will be presented in detail during the workshop.

1.10 Dynamic inference of background error correlation between surface skin and air temperature

Presenter: Louis Garand

Louis Garand, Mark Buehner and Nicolas Wagneur
Meteorological Service of Canada

One neglected component of background vertical error correlations necessary for data assimilation is that between surface skin and air temperature. This component is of interest, in particular, for the assimilation of radiances which are sensitive to the surface, as it impacts on the retrieved boundary layer structure. One difficulty is that this correlation, most often strong, can also be weak or even negative depending on the meteorological situation. Here, we explore the avenue of mapping globally this correlation using an ensemble of forecasts valid at the same time from differences of each member with the ensemble mean. This method appears very promising as it uses flow dependent background error syatistics. An impact study involving the assimilation of infrared window channels of the GOES imager will be presented.

SESSION 2

2.1 First results of the assimilation of AIRS data in METEO-FRANCE NWP model

Thomas Auligne

Thomas Auligne, Florence Rabier, Meteo-France, CNRM/GMAP
Lydie Lavanant, Meteo-France, CMS
and Mohamed Dahoui, DNM Morocco

A subset of channels from AIRS (Atmospheric InfraRed Sounder) aboard AQUA satellite is provided operationally by NOAA/NESDIS to NWP centres. Studies have been carried out to assimilate this data in the METEO-FRANCE NWP suite. They require good monitoring and bias correction of the observations. The impact of the early assimilation of AIRS on numerical weather forecast is presented.

Infra-red radiances are contaminated by clouds in most cases. Therefore, there is a need for a cloud detection scheme. We focus on the McNally and Watts method that has been validated in a comparison study by Lavanant and Dahoui. In order to take more advantage of the available data, the assimilation of cloudy radiances is studied, using a radiative transfer model in cloudy conditions (RTTOV-Cld). Results

from monitoring and 1D-Var assimilation experiments are shown.

2.2 The assimilation of AIRS radiance data at ECMWF

Presenter: Tony McNally

Tony McNally, Phil Watts, Jonathan Smith, Richard Engelen, Graeme Kelly, and Jean-Noel Thepaut

A limited amout of radiance data from the AIRS instrument on AQUA are assimilated into the ECMWF operational analysis/forecasting system. The key elements of the assimilation system will be described (e.g., cloud detection and handling of systematic errors) and the results of impact experiments performed prior to operational implementation will be presented. Finally the areas currently under development will be discussed together with some plans for the future.

2.3 A Model Based Bias Correction Scheme for AIRS at the Met Office

Presenter: Brett Harris

Brett Harris[1], Andrew Collard[2], Roger Saunders[2] and James Cameron[2]
[1]Bureau of Meteorology Research Centre, Melbourne, Australia
[2]The Met Office, Bracknell, United Kingdom

The Atmospheric Infrared Sounder (AIRS) is a high resolution spectrometer with 2378 channels in the range of 640 - 2700 cm^{-1} of the infrared spectrum. The instrument is onboard NASA's AQUA earth observing satellite launched on 4 May 2002. The Met Office receives brightness temperatures for a subset of 324 channels, in near real-time, from NESDIS. The radiances are then passed through a cloud detection algorithm, to determine the clear soundings. The RTTOV-7 forward model is used to simulate background radiances from the Met Office NWP system. As for ATOVS, the observed minus background radiances have systematic biases, which must be removed before the radiances may be assimilated in a variational data assimilation system. In this study, a model based bias correction scheme, based on the Harris and Kelly (2001) approach, is used with various combination of background predictors, to find the optimal combination which removes the biases, both globally and locally for a small subset of channels. The results of various predictor combinations for different channels will be presented.

2.4 Assimilation of AIRS radiances into the Met Office's Global NWP Model

Presenter: Andrew Collard

Andrew Collard (Met Office), Roger Saunders (Met Office), James Cameron (Met Office), Yoshiaki Takeuchi (JMA), Brett Harris (BoM), John Eyre (Met Office) and Lisa Horrocks (Met Office)

The Atmospheric Infrared Sounder (AIRS), launched on NASA's polar-orbiting Aqua satellite in May 2002, is the first in the next generation of high spectral resolution infrared sounders. These advanced sounders are designed to measure atmospheric temperature and humidity with much better vertical resolution than has previously been possible from satellite instruments. With 2378 channels in the 3.7-15.4 micron range, perhaps the greatest challenge presented by AIRS is the efficient assimilation of measured radiances into NWP models for maximum benefits in improved temperature and humidity profiles.

A subset of 324 AIRS channels has been received in near-real time at the Met Office since October 2002. We use a 1D-Var pre-processing step to perform quality control, variational cloud detection, channel selection, bias correction and monitoring. Our routine data monitoring provides comparisons of AIRS radiances with Met Office 6-hour forecast fields: results and selected spectra are updated daily on the WWW. 3D-Var is then used to assimilate clear fields-of-view into the Met Office NWP model. We will provide an overview of the processing system in place at the Met Office. Areas for future improvement and first results from assimilation trials will be discussed.

2.5 Use of MODIS imager data to help dealing with AIRS cloudy radiances

Presenter: Lydie Lavanant

Mohamed Dahoui, Lydie Lavanant**, Florence Rabier***, Thomas Auligne****
** Moroccan Meterological Service*
*** Météo-France/DP/CMS/R&D*
**** Météo-France/CNRM/GMAP*

The atmospheric Infrared Sounder (AIRS) was launched in May 2002 on board the AQUA platform. This new high spectral resolution instrument provides 2378 channels covering the spectral range between 3,7 mm to 15 mm. Even with a much lower spectral

resolution, the impact of ATOVS data on numerical weather prediction forecasts is positive and consistent. Consequently it is anticipated that additional positive impact will occur with the successful exploitation of AIRS data.

For the time being, in most operational analysis systems, the assimilation of the satellite radiances is limited to the cloud-free pixels. This is mainly due to the deficiencies in the representation of clouds processes within atmospheric models. As a consequence clouds are considered as a source of noise and any unfiltered cloud affected pixels could have a large detrimental impact on the quality of NWP products. It is then crucial to be confident in the quality of the cloud detection schemes used in the assimilation systems. Several approaches are used to detect and characterize clouds from AIRS radiances. Most algorithms are based on threshold techniques and radiative transfer calculations. The main goal of this study is to the different cloud-detection/characterization schemes, applied to AIRS data, by using the MF/CMS cloud detection scheme based on collocated MODIS imager data. Four AIRS cloud-detection schemes have been tested: the NOAA/NESDIS, ECMWF schemes for the cloud detection and the CO2-slicing and Minimum Local Emissivity Variance (MLEV) methods that make cloud detection and characterization.

Previous AIRS cloud information is then used to allow the retrieval of the atmospheric profile in cloudy conditions from AIRS/AMSU channels. In this study, only low-level cloud situations are considered. The cloud top pressure and effective cloud amount are used as background or first guess of the 1DVar method.

Status on the development and validation on a 10 days dataset in North Atlantic of mapped MODIS/AIRS observations collocated with ECMWF NWP forecast profiles are presented.

2.6 Potential of high density observations on Numerical Weather Prediction: A study with simulated observations

Presenter: Zhiquan Liu

Zhiquan LIU, National Satellite Meteorological Center, Beijing, China
and Florence RABIER, Centre National de Recherches Météorologies, Toulouse, France

The skill of numerical weather prediction depends to a large extent upon the quantity of globally available observations. Especially for high density observations, only a fraction of observations is used in current assimilation systems. In this presentation, the potential of high density observations is studied in a practical 4DVAR assimilation context. Two individual meteorological situations are used to examine the impact of different observation densities on the analysis and the forecast. A series of observing-system simulation experiments (OSSEs) are performed. Both direct observations (temperature and surface pressure) and indirect observations (radiance), with uncorrelated and correlated errors, are simulated. In general, it is verified that a small reduction (increase) of the initial error in the sensitive area can produce a considerable improvement (degradation) of the targeted forecast. In particular, the results show that increasing the observation density for the uncorrelated-error case can generally improve the analysis and the forecast. However, for correlated observation error and using a diagonal observation error covariance matrix in the assimilation, increasing the observation number in such a way that the error correlation between two adjacent observations becomes greater than a threshold value (around 0.2), will degrade the analysis and the forecast. In any case, it would seem that artificially increasing the observation error would allow to use dense observations even if their error is spatially correlated.

2.7 The Use of AMSU data in the Met Office Mesoscale Model

Presenter: Steve English (for Brett Candy)

Brett Candy, Stephen English, Richard Renshaw & Bruce Macpherson

Following on from the positive benefit of using AMSU radiance information in the Met Office Global Model we have recently investigated the use of such data in the Met Office UK Mesoscale Model. In this paper we shall give an overview of the implimentation of AMSU radiances into the Mesoscale Model data assimilation scheme and highlight some problems encountered regarding consistency with existing observational types that are used outside of the variational framework. A general problem regarding the assessment of impact for a new data type in a model with a small domain is the ability to obtain reliable statistics of forecast change. In this paper we attempt to address this by two methods, firstly by running an impact study for an extended period encompassing several weather types and secondly by validating precipitation forecasts using the UK weather radar network.

2.8 Use and impact of satellite data in the

NZLAM-VAR mesoscale model

Presenter: Vanessa Sherlock

V. Sherlock, P. Andrews, A. Korpela, H. Oliver and M. Uddstrom
NIWA, Wellington, New Zealand

We provide a summary of the current use of satellite data in the NZLAM-VAR mesoscale model for the New Zealand region. The accuracy of forecasts using global and mesoscale models are presented for a one month case study period. Results from mesoscale model runs without and with data assimilation are compared, and the impact of assimilation of ATOVS data is examined specifically. Future developments are described briefly.

2.9 Prospects for All-Weather Microwave Radiance Assimilation

Presenter: Albin Gasiewski

Albin J. Gasiewski[1], Alexander Voronovich[1], Bob L. Weber[2], Boba Stankov[1], Marian Klein[3], Reginald J. Hill[1], and Jain-Wen Bao[1]

[1] NOAA/Environmental Technology Laboratory, 325 Broadway, Boulder, CO, USA
[2] Science and Technology Corporation and NOAA/ETL, Boulder, CO, USA
[3] University of Colorado/NOAA-CIRES, Boulder, CO, USA

Microwave radiometric data from satellite sensors is an extremely valuable source of information for temperature and moisture profiling and radiance assimilation over regions that are either cloud-free or covered by mostly thin non-scattering clouds. However, regions for which assimilation of microwave data would be most valuable include frontal zones where rapidly evolving heavy cloud cover and/or precipitation is present. Although scattering at microwave band above ~50 GHz can be strong in such regions the ability to probe deeply using microwaves can still provide important information on the amount and type of hydrometers and latent heating profiles. Time-resolved observations of cloud and precipitation dynamics can facilitate further inference of moisture and heat fluxes.

Direct radiance assimilation provides an optimal framework by which to utilize such information, however, the use of microwave data in radiance assimilation for all weather conditions remains limited due to several factors, including: 1) the need to rapidly and accurately compute the incremental response functions over heavy clouds and precipitation, and 2) time-sampling limitations of polar-orbiting microwave sensors, 3) microphysical precipitation process model limitations, including lack of appropriate error covariance models, and 4) fast and self-consistent assimilation update techniques. While each of these obstacles is formidable, we discuss in this talk potential solutions currently under study. Specifically, we demonstrate a new discrete-ordinate technique for rapid numerical calculation of the incremental brightness temperature profiles (Jacobian) for a layered scattering atmosphere. Applying this method to simulated data using the MM5 mesoscale atmospheric model of NCAR for Hurricane Bonnie (1998) we illustrate the potential for satellite microwave observations to be used to “lock” the state of a numerical weather model onto observed precipitation dynamics. Both low-Earth orbiting and geosynchronous microwave radiance fields are considered, and ramifications for the prospects of such all-weather assimilation using the proposed Global Precipitation Mission (GPM) and Geosynchronous Microwave (GEM) Sounder/Imager systems are discussed.

2.10 NOAA’s Satellite and Information Stewardship Program and Plans

Presenter: Mitch Goldberg (for John Bates)

John Bates, Chief Remote Sensing Applications Division, National Climatic Data Center, NOAA/NESDIS

NOAA/NESDIS is implementing a concept of a stewardship umbrella for its new and old satellite data sets and for the processing of satellite data for climate. The elements of this stewardship program include:

1. Careful monitoring of observing system performance for long-term applications
2. Generation of authoritative long-term records through validation of the calibration process, reprocessing, product generation and the blending of in situ and satellite measurements
3. Provide state of the environment information for decision makers and place the current state in its historical context
4. Archive and access to fundamental measurements, products and metadata
5. Data rescue for past satellite data sets

This talk will provide an overview of NESDIS progress and plans for stewardship.

2.11 Fast passive microwave radiative transfer in precipitating clouds: Towards direct radiance assimilation

Presenter: Chris O'Dell for Ralf Bennartz

Ralf Bennartz
Atmospheric and Oceanic Sciences
University of Wisconsin, Madison, Wisconsin, USA

Tom Greenwald
Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin, Madison, Wisconsin, USA

Andrew Heidinger
NOAA/NESDIS

Peter Bauer
ECMWF

Radiative transfer models for global data assimilation purposes have to fulfill stringent requirements in terms of computation speed, memory usage, and accuracy. In a new project supported by the Joint Center for Satellite Data Assimilation (JCSDA) we investigate different options for fast radiative transfer models in the microwave spectral range. 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. In precipitating situations, scattering by large particles becomes important and must be adequately considered in the radiative transfer. We will give an outline on the status of the development and test of the fast microwave radiative transfer models for clouds and precipitation and show results of Monte-Carlo simulations that illustrate the number of scattering events experienced by a photon for different types of precipitation and different frequencies.

2.12 Variational Cloud and Rainfall Data Assimilation at ECMWF

Presenter: Tony McNally for Frédéric Chevallier

Frédéric Chevallier, Peter Bauer, Angela Benedetti, Marta Janiskova, Philippe Lopez, Emmanuel Moreau, Adrian M. Tompkins

4D-Var assimilation schemes assume the linearity of their forward model in the vicinity of prior information and consequently do not properly handle variables that have fine temporal and spatial scales compared to the forward model. Hence cloud- and rain- affected satellite radiances are discarded from numerical weather prediction 4D-Var systems despite the critical need of observations within the cloudy regions.

To circumvent that limitation, a '1D-Var+4D-Var' approach has been developed at ECMWF, where 4D-Var assimilates 1D-Var retrievals of temperature and moisture profiles in rain-affected areas. The 1D-Var method is applied either to rain-rate retrievals obtained from satellite observations or directly to satellite brightness temperatures. This paper will present the methodology and will describe the meteorological impact on the forecast system.

Further, we suggest the possibility of assimilating some of the satellite radiances directly in 4D-Var further to achieving improvements in the modelling of clouds: for instance the 6.3 microns channel on-board all the geostationary satellites. The ECMWF 4D-Var system is being modified so as to assimilate such observations and first results may be presented.

2.13 Contribution of POLDER to water vapour observation

Presenter: Michèle Vesperini

Michèle Vesperini
Laboratoire d'Optique Atmosphérique, UMR CNRS 8518, Université de Lille 1, 59655 Villeneuve d'Ascq, France

The POLDER instrument onboard ADEOS (Nov 1996 - June 1997) provided the first opportunity to apply the two-channel ratio technique in the near infrared to retrieve atmospheric water vapor content at the global scale. It revealed very valuable data over continents, where radiosonde measurements are very sparse and where inversion of InfraRed and microwave measurements is very unprecise due to surface emissivities. The total column water vapor content (TCWV) is retrieved in clear-sky conditions from two channels located beside and in an H2O gaseous absorption band (respectively 865 and 910 nm). Assuming that the surface reflectance variation is small between these two close bands, the 910 to 865 nm reflectance ratio is a function of the atmosphere transmission which is related to the water vapor content. The second POLDER mission onboard ADEOS-2 launched late 2002, will use an updated retrieval algorithm. The relation between TCWV and reflectance ratio is parameterized with a polynomial fit, whose coefficients are determined by using SSM/I

TCWV collocated observations over ocean. Spectral variations of the land surface reflectivity are accounted for by a correction factor using the atmospheric window 765 and 865 nm reflectances. Water vapor retrieval are performed for all clear-sky pixels over land and for clear-sky and specular reflexion (glint) situations over ocean. Comparisons with meteorological analyses showed large discrepancies over Africa and southern America. Differences appear mainly off the maximum intensity of the ITCZ showing a problem of the forecasting system in positioning the convectiveactivity when not forced by appropriate observations.

2.14 Assimilation of AMSU-A Microwave Radiances with an Ensemble Kalman Filter

Presenter: Herschel Mitchell

Herschel L. Mitchell, P.L. Houtekamer, Gerard Pellerin, Mark Buehner, and Bjarne Hansen
Meteorological Service of Canada (MSC), Dorval, Quebec, Canada

The ensemble Kalman filter (EnKF) is a 4-d data assimilation method. On the one hand, it is an approximation to the standard Kalman filter that improves as the ensemble size increases; on the other hand, it is a nonlinear extension of the standard Kalman filter. The EnKF is well-suited for parallel computation and, on today's computers, can be run at resolutions that can yield operationally interesting results. An interesting aspect of the EnKF is that it does not require tangent linear or adjoint operators either for the forecast model or for the (forward) interpolation operators from the model state to the observations.

An EnKF has been developed to provide initial conditions for the Canadian Meteorological Centre (CMC) operational medium-range ensemble prediction system. The EnKF is currently undergoing pre-operational testing. It uses a version of the CMC operational forecast model having a global 240x120 grid and 28 levels in the vertical. Many different types of meteorological observations, including microwave radiances from the AMSU-A instrument on the NOAA polar orbiters, are assimilated by the EnKF. At the present time, the EnKF relies on the quality control and bias correction procedures performed by the CMC operational 3-d variational (3d-Var) analysis for these latter observations. For the calculation of simulated radiances from a model state vector, the EnKF (like the operational 3d-Var procedure) uses the RTTOV radiative transfer model developed by the NWP Satellite Application Facility.

The way in which the AMSU-A radiances are assimilated in the EnKF will be described. Results showing their overall impact will be presented and compared with corresponding results for the operational 3d-Var procedure.

2.15 A Research of Four-dimension Variational Data Assimilation with ATOVS Clear Data

Presenter: Ma Gang

Ma Gang
National Satellite Meteorological Center, Beijing 100081
Wang Yunfeng
LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing 100029
Fang Zongyi
National Satellite Meteorological Center, Beijing 100081

Satellite vertical sounding data, which represent the three-dimension distribution of atmospheric state at that time, are based on infrared and microwave observations of meteorological satellite. Nowadays more and more deducing atmospheric parameters from satellite vertical sounding data and other satellites data are applicated in numerical weather forecast. In order to use as many as these data high spatial resolution, a four-dimension data assimilation scheme is developed to introduce them into a numerical weather prediction model. Then the quality of model's initial field is therefore improved. And the model physical parameters such as wind and water vapor become more rational.

In this paper a variational assimilation method is used. In this method, a MM5 mesoscale model and its adjoint model that are used as dynamic restriction. As well as conventional sounding data, ATOVS radiance data from satellite and retrieved air temperature and water vapor profiles from ATOVS data are introduced into our system by an observational operator and its adjoint operator simultaneously. While the initial variables (approximate atmospheric situation) in the model domain are given, upwelling-radiance on the top of atmosphere for each channel of ATOVS will be calculated by the integral of a fast radiation transfer model (RTTOV). Therefore the ATOVS data are integrated into the four-dimension mesoscale variational data assimilation system for both analyzing and forecasting. Then a more precise initial model input and thus a more accurate forecast can be obtained by these coherent variables of atmospheric situation.

In order to check the impact of ATOVS data on model

forecast, data from T106 and ATOVS during 19-26, July, 2002 are used. First we get the impact from the initial model field only with the conventional sounding data variational assimilation on the predicted atmospheric state and the temporal and spatial precipitation distribution. Then the ATOVS clear-radiance is introduced into the assimilation system to get the impact on the model prediction. At last the impact of retrieved profile from ATOVS data is performed. To confirm these impacts we design three tests. At first we assimilate the model initial filed only with air temperature and no atmospheric moisture; and in the second test the assimilation of the model initial fields only with the moisture and without air temperature is proved to have positive effect on the simulated precipitation. In the last one both the air temperature and water vapor from ATOVS clear-radiance is assimilated to see how it improves the model prediction.

2.16 Impact of the assimilation of MSG/SEVIRI radiances in a mesoscale NWP model

Presenter: Thibaut Montmerle

Thibaut Montmerle and François Bouttier (Météo-France)
(This work is financed by Alcatel Space)

In the context of high-resolution weather forecasting, the high horizontal and temporal resolutions of measurements performed by geostationary satellites are an asset compared to polar satellites, despite their weaker spectral and vertical resolutions. The SEVIRI radiometer onboard MSG (Meteosat Second Generation) provides a complete set of radiance observations in the visible and the infrared spectrum every 15 min with an approximate spatial resolution of 3 km over Europe. Those measurements therefore seem to be particularly well adapted for weather prediction at convective-scale, since they allow continuous access to information about the variation rates of temperature and humidity fields in space and time.

In order to quantify the impact of the assimilation of SEVIRI radiances in the mesoscale analysis of those meteorological quantities, the ALADIN model and its variational assimilation scheme have been used. ALADIN is an operational limited area NWP model coupled with the global model ARPEGE developed at Météo-France, that uses a horizontal resolution of 10 km and a stretched vertical grid composed of 41 levels. In its research version, a 3D-Var analysis can be applied in order to assimilate different kinds of meteorological observations. Radiances observed by 8 channels of SEVIRI radiometers in the infrared and water vapor absorption spectrum have been assimilated in this framework. All the radiances that have not been contaminated by clouds are taken into account, and a bias correction scheme has been applied.

A noticeable positive impact has been observed in the analysis of the vertical structure of the specific humidity in the middle troposphere. The poor vertical resolution of the channels that are sensitive to temperature variations implies however a very weak reduction of the error in the analysis of this quantity. 24 hours prediction that have been undertaken from this analysis shows more realistic cloud cover patterns in the mid and high troposphere than the prediction performed without any data assimilation. It is also showed that these results are highly dependent on the formulation of the background error covariance matrix (or B matrix) that allows to filter and spread spatially the information contained in the radiances. To maximize their potential effect during the assimilation step, the B matrix should indeed take into account the vertical stratification of the forecast errors of the humidity field which are the errors that spatial instruments should strive to observe. Different formulations and their effect on the analysis of the humidity field and on the forecast are presented here.

2.17 Impact of the ATOVS data on the Mesoscale ALADIN/HU Model

Presenter: Roger Randriamampianina

Roger Randriamampianina and Regina Szotak

At the Hungarian Meteorological Service for the last few years we have been investigating the three-dimensional variational (3D-Var) data assimilation technique in the limited area model ALADIN (ALADIN/HU).

Our main objective is to change the so-called dynamical adaptation (that takes initial file from the French global model ARPEGE) that is recently in operational use, to a 6-hour data assimilation cycling. Other important task is to use as more observations as possible. Data from radiosonde and surface observations are already prepared for data assimilation. At present, we are investigating the use of data from aircraft (AMDAR) and satellite (ATOVS) observations. Two resolutions (80 and 120km) are considered in the study of the impact of ATOVS data.

We got promising results when assimilating ATOVS data at both resolutions.

SESSION 3

3.1 Preparations for NOAA-N

Presenter: Thomas Kleespies

Thomas. J. Kleespies
NOAA/NESDIS
Camp Springs, MD 20746

NOAA-N is presently scheduled for launch in the summer of 2004. This satellite will carry somewhat different instrumentation from the NOAA-KLM series. The Microwave Humidity Sounder will replace the Advanced Microwave Sounding Unit-B. The MHS has some different frequencies from the AMSU-B. The High Resolution Infrared Sounder/3 will be replaced by the HIRS/4, which has a smaller field of view. This paper will discuss these changes and some changes to the level 1B processing at NOAA/NESDIS that will accompany the launch of NOAA-N. It will also discuss some of the planned On-orbit Verification activities for NOAA-N and review some results of the successful OV for NOAA-17.

3.2 Operational High Resolution Infrared Radiation Sounder Calibration Algorithms and Their Effects on Calibration Accuracy

Presenter: Pubu Ciren (for Changyong Cao)

Changyong Cao

The High Resolution Infrared Radiation Sounder (HIRS) calibrates once every 40 scan-lines using a blackbody and space view. As a result, the calibration coefficients between the calibration cycles have to be interpolated. In the history of operational HIRS calibration, several interpolation methods have been used and unfortunately, depending on which method is used, these algorithms can produce HIRS level 1b radiance data with significant differences in scene brightness temperature. Although the effect on weather applications is relatively small, it is significant for long term climate studies where high calibration accuracy is required. In this study, the operational HIRS calibration algorithms are evaluated, and sample test data sets are analyzed to quantify the effects. A new algorithm is proposed to reduce the calibration biases caused by the previous calibration algorithms.

SESSION 4

4.1 Status of RTTOV-7 and plans for RTTOV-8

Presenter: Roger Saunders

Roger Saunders, Stephen English, Peter Rayer (Met Office),
Pascal Brunel (MeteoFrance),
Frederic Chevallier and Marco Matricardi (ECMWF)

The fast radiative transfer model, RTTOV-7, was released in Feb 2002 and has since been distributed to many users worldwide. The capabilities of RTTOV-7 will be recalled and some statistics on its use will be presented. The next update to RTTOV is RTTOV-8 planned for release in early 2004. The main technical and scientific upgrades to RTTOV-8 will be described.

4.2 NCEP infrared sea surface emissivity model

Presenter: John Derber (for Paul van Delst)

Paul van Delst
CIMSS@NOAA/NCEP/EMC

An infrared sea surface emissivity model for use in the NCEP Global Data Assimilation System (GDAS) has been completed. The model is based on fitting specific sensor channel emissivities derived from high resolution sea surface emissivities computed using the Wu-Smith model. The emissivity fit accuracy and the impact on radiative transfer calculations and GDAS statistics will be discussed.

4.3 A New Microwave Snow Emissivity Model

Presenter: Fuzhong Weng

Fuzhong Weng and Banghua Yan
Joint Center for Satellite Data Assimilation

This study presents a new microwave snow emissivity model which is empirically derived from satellite retrievals and ground-based measurements. This model produces a variety of snow emissivity spectra at microwave frequencies according to snow types. As part of this model, an algorithm is also developed to classify snow type using the Advanced Microwave Sounding Unit (AMSU) measurements at 23.8, 31.4, 50.3, 89 and 150 GHz. It is shown that the global snow emissivity simulated with this model agrees well with that retrieved from satellite measurements.

4.4 The 2003 Edition of the GEISA spectroscopic database system for the second generation vertical sounders radiance

simulation

Presenter: Nicole Jacquinet-Husson

N. Jacquinet-Husson, N.A. Scott, A. Chédin, K. Garceran, R. Armante
LMD, Ecole Polytechnique, 91128 Palaiseau, FRANCE

The GEISA (Gestion et Etude des Informations Spectroscopiques Atmosphériques: Management and Study of Atmospheric Spectroscopic Information) computer accessible database system, in its former 1997 and 2001 versions, has been updated in 2003 (GEISA-03). It is developed by the ARA (Atmospheric Radiation Analysis) group at LMD (Laboratoire de Météorologie Dynamique, France) since 1974. This early effort implemented the so-called "line-by-line and layer-by-layer" approach for forward radiative transfer modelling action.

The GEISA 2003 system comprises three databases with their associated management softwares:
· a database of spectroscopic parameters required to describe adequately the individual spectral lines belonging to 42 molecules (96 isotopic species) and located in a spectral range from the microwave to the limit of the visible. The featured molecules are of interest in studies of the terrestrial as well as the other planetary atmospheres, especially those of the Giant Planets.
· a database of absorption cross-sections of molecules such as chlorofluorocarbons which exhibit unresolvable spectra.
· a database of refractive indices of basic atmospheric aerosol components.

Illustrations will be given of GEISA-03, data archiving method, contents, management softwares and Web access facilities at:
http://ara.lmd.polytechnique.fr

The performance of instruments like AIRS (Atmospheric Infrared Sounder; http://www-airs.jpl.nasa.gov) in the USA, and IASI (Infrared Atmospheric Sounding Interferometer; http://smsc.cnes.fr/IASI/index.htm) 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. Its content, will be described, as well.

This work is ongoing, with the purpose of assessing the IASI measurements capabilities and the spectroscopic information quality, within the 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 (EPS) project, by simulating high resolution radiances and/or using experimental data. EUMETSAT will implement GEISA/IASI into the EPS ground segment.

The IASI soundings spectroscopic data archive requirements will be discussed in the context of comparisons between recorded and calculated experimental spectra, using the ARA/4A forward line-by-line radiative transfer modelling code in its latest version.

4.5 An Alternate Approach to Modelling the Reflected Downward Flux Term

Presenter: David Shawn Turner

D.S. Turner
Meteorological Service of Canada

Most current fast forward models simulate the attenuated reflected downward flux as the attenuation of the reflection of a downward radiance evaluated along a path defined by the secant of a mean emergent angle, the diffussivity factor. Models assume the diffusivity factor to be constant or the secant of the satellite zenith angle, and assume that the spectral mean of the RDF term can be decomposed into the product of the specral means of its components. This article considers the inadequacies of these assumptions and proposes an alternate method for evaluating this term.

4.6 Infrared radiative transfer modeling using the Optimal Spectral Sampling (OSS) method

Presenter: Jean-Luc Moncet

By Jean-Luc Moncet, Gennadi Uymin, Xu Liu and H. Snell

The OSS method is a simple and flexible approach to radiance modeling originally developed for the real-time processing of NPOESS/CrIS data. OSS-based models have been produced for the airborne NAST-I and AIRS instruments as well as for microwave sensors. The monochromatic treatment of the radiative transfer in OSS confers the ability to directly model non-positive ILS (such as interferometric functions)

and to accommodate different observer altitudes (for airborne applications). In addition, it greatly simplifies the computation of analytical Jacobians and makes it possible to model scattering effects in an accurate and computationally efficient way. An overview of the theoretical basis and examples of applications of the OSS method will be presented. More details will be given in a companion poster.

4.7 Spectral surface emissivity for use in assimilation of IR radiance data over land

Presenter: Malgorzata Szczech-Gajewska

Malgorzata Szczech-Gajewska, IMWM, Krakow, POLAND
Florence Rabier, Meteo-France, Toulouse, France

The interest of the usage of the very high spectral resolution satellite measurements, as from AIRS or IASI instruments, over land will certainly be growing in the next few years. Preparatory studies have begun with the creation of appropriate "climatological" maps for surface spectral emissivity (SSE), based on new Ecoclimap (Masson et al.2002) vegetation and land cover types and infrared SSE values from spectral libraries (MODIS, ASTER and JPL) compiled with the ones modelled by Snyder et al. (1998). Separated emissivity maps were created for 18 wavebands in the infrared spectral range and for each month. The final maps were validated with MODIS channel 31 and 32 land surface emissivity products based on the split-window method. Currently new SSE is tested in the radiative transfer model RTTOV7 with HIRS channel 8 and AIRS data.

4.8 Atmospheric Spectroscopy with AIRS: Validation of the AIRS Forward Model

Presenter: L. Larrabee Strow

L. Larrabee Strow

The high spectral resolution radiances measured with the Atmospheric Infrared Sounder (AIRS) launch on NASA's AQUA platform in May 2002 are providing a unique data set for improving our understanding of atmospheric emission spectra, which will hopefully lead to improved weather and climate products without the need for empirical tuning of these products. We have compared radiances observed with AIRS to radiances computed from ECMWF analysis/forecast products, and computed from a wide range of radiosonde measurements recorded coincident with an AIRS overpass. Our analysis of these results concentrate on clear, night, ocean conditions where the surface emissivity should be well known, and the detection of cloud-free fields-of-view is most accurate. We now have a dataset that includes large numbers of nominally clear observations over many months, allowing accurate statistical analysis, at least for the ECMWF comparisons. Results assessing the accuracy of various formulations for the water vapor continuum will be discussed, both in the atmospheric windows and inside the strong water band centered at 6.7 microns. In addition we will present analysis of the validation of the temperature sounding channels that are influenced by carbon dioxide emission.

4.9 Validation of Satellite AIRS LST/LSE Products Using Aircraft Observations

Presenter: Robert Knuteson

Robert Knuteson, Brian Osborne, Henry Revercomb, and David Tobin
University of Wisconsin, Madison, Wisconsin

William Smith
NASA Langley Research Center, Hampton, VA

Weather satellites have shown positive impact on forecast models for data collected over the world's oceans. However, the use of weather satellite data over land areas has been limited. One of the problems faced by users of broadband infrared measurements is the inability to separate the effect of land surface temperature (LST) from natural variations in land surface emissivity (LSE). A new generation of infrared sounders has been developed for obtaining improved profiles of atmospheric temperature, water vapor, and trace gas concentrations. A characteristic of these advanced sounders is the use of spectrometers with nearly continuous coverage of the 8-14 micron infrared window region with resolving powers of 1000 or greater. These high spectral resolution sounders have the advantage of being able to resolve individual absorption lines of water vapor and carbon dioxide and thereby provide a number of transparent "microwindows" that require a smaller atmospheric correction than broad-band instruments. In addition, it has been recognized that high spectral resolution infrared observations have another important advantage over broad band measurements in that they allow an effective surface temperature to be determined simultaneously with an effective land surface emissivity. A method for emissivity - temperature separation using high spectral resolution infrared observations will be presented using data from the NASA Atmospheric InfraRed Sounder (AIRS) satellite instrument. The satellite measurements will be compared with subpixel

observations at high spectral resolution from a high altitude aircraft over a ground truth site in North Central Oklahoma, USA. The techniques used in this analysis have implications for the future operational use of data from the NPOESS CrIS and the METOP IASI sensors.

4.10 Advances in the Use of Super Channels for Processing High Spectral Resolution Satellite Measurements

Presenter: Larry McMillin

Larry McMillin and Yong Han, NOAA/NESDIS

High spectral resolution instruments provide the resolution necessary to optimize the vertical resolution of the measurements. They also provide a very large number of channels, and processing all the channels is beyond the processing capabilities of current computers. As a result, various procedures are used to decrease the processing burden. These are using a subset of channels, using eigenvectors, and using super channels. Using a subset does not take advantage of the noise reduction that is possible. Using eigenvectors is difficult because current rapid transmittance algorithms cant be applied. These leaves the super channel approach as the one solution that can use all the information and make the calculations rapidly. The super channel approach consists of picking channels that have similar spectral properties and averaging them. To obtain the speed benefits, two parts are required. These are a fast radiative transfer model, and a Planck calculation. These have been done for broad band instruments such as HIRS, but super channels differ in that the wavelength intervals are wider than a typical broad band instrument and the fact that discrete wavelengths are selected. The solutions that have been applied to AIRS data will be presented and the information content will be compared to the original data.

4.11 RTIASI-4 - An improved version of the ECMWF fast radiative transfer model for the Infrared Atmospheric Sounding Interferometer

Presenter: Marco Matricardi

Marco Matricardi, ECMWF, Reading, UK

An improved version of RTIASI, the ECMWF fast radiative transfer model for IASI, has been developed with EUMETSAT. The new version of the model, RTIASI-4, features a number of significant upgrades. Regression coefficients are generated from a database of line-by- line transmittances that uses the year 2000 version of the HITRAN molecular database and the number of gases included in the line-by-line computations has been increased to include HNO3, CCL4, OCS and CF4. The accuracy of radiance computation has been improved by dividing the atmosphere into 89 fixed pressure layers that extend from 1050 to 0.005 hPa. To improve the prediction of the water vapour optical depths, a single algorithm for water vapour has been introduced with the data being weighted prior to performing the regression and the computation of the optical depth due to the water vapour continuum absorption has been performed using a separate fast transmittance model. RTIASI-4 also features a revised set of predictors for ozone. As a result, a significant reduction of the fast model fitting errors in the 6.7 mm water vapour band and in the 9.8 mm ozone band has been achieved. Including CO, CH4, N2O and CO2 as profile variables has also enhanced the capability of the model that can be exploited for environment related studies to be carried out at ECMWF. The radiative transfer equation used in RTIASI-4 includes the effect of solar radiance reflected over a land or water surface. For the case of solar radiance reflected over a land surface, the reflecting surface is treated as a perfect diffuser following the Lambert law whereas for a full-gravity-capillary wave surface the reflective characteristics of the surface are described by the Gaussian-Joint North Sea Wave project model. Finally, in RTIASI-4 the viewing angle of the detector and the zenith angle of the sun are converted into a local path angle that varies with altitude because of the curvature of the Earth and its surrounding atmosphere.

SESSION 5

5.1 Comparison of the CMC analyzed fields of Integrated Water Vapour with those retrieved from the SSM/I

Presenter: David Anselmo

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

On June 19th, 2003 the Canadian Meteorological Centre (CMC) began assimilating AMSU-B brightness temperatures and GOES-9 radiances in its 3D-Var global data assimilation system. These new satellite data join the AMSU-A brightness temperatures that are already assimilated (Channels 3-10 over the oceans) at CMC since June 7th, 2001. To prepare for the assimilation of SSM/I (Special Sensor Microwave Imager) brightness temperatures, the CMC analyzed IWV (Integrated Water Vapor) fields are evaluated by comparing them with SSM/I retrieved IWV. Two

comparisons are performed. Firstly, SSM/I IWV fields are compared against analyzed fields to measure the impact of assimilating AMSU-A Channel 3 (50.3 GHz) which has a non-negligible humidity dependence. Analyses prior to the addition of AMSU-B and GOES data are used for this purpose. Two assimilation cycles are executed: one assimilating AMSU-A Channels 3-10 and the other only Channels 4-10. Secondly, SSM/I IWV is compared with analyzed fields of IWV that are derived with and without the additional AMSU-B and GOES data over the same period. The results of these two comparisons will be presented.

5.2 The AMSU Observation Bias Correction and Its Application on 1-Dvar Retrieval Scheme and Typhoon monitoring

Presenter: Kung-Hwa Wang

Kung-Hwa Wang, Chien-Ben Chou
Central Weather Bureau, Taipei, Taiwan

The Advanced Microwave Sounding United-A (AMSU-A) on NOAA series after NOAA-15 is the new generation of microwave sounders for providing information on the vertical profiles of atmospheric temperature and humidity. Since most of AMSU channels have beam position-dependent bias, therefore it is crucial to remove such bias for providing useful profiles of atmosphere. The measurement errors are estimated from the differences between satellite observations and the simulated satellite observations which were obtained from a radiative transfer operator with 12-hours forecasts as their input. The measurement errors estimated in this way will contain the forecast error of 12 hours forecast. The NMC method assume that the statistics of difference between forecasts at different ranges valid at the same time are the representative of forecast error statistic. The differences used in NMC method have been transfer to brightness temperature in each AMSU channels with the radiative transfer operator. This data can be used to obtain the value of 12 hours forecast error in brightness temperature for each AMSU channels. So that the effect from the 12 hours forecast errors in each AMSU channels can be removed when the measurement errors are estimated as mentioned above. In this study, we carefully examined the AMSU beam near Taiwan area. A bias correction method which concerns about the beam position-dependent bias and the effect of 12 hours forecast error used on the regression equations has been built. A data reitrieval method based on one-dimensional variational schemed has also been developed. Through the comparison of the retrieved profiles and the background fields, we found that the method worked well near Taiwan area. Even with quite accurate background fields, the retrieved profiles profiles have show positive impact to improve the fields, The result show that the improvement made in the retrieval scheme over background error is about 0.45K in the temperature profiles above 780 hPa. So as the temperature anomalous of typhoon is improved.

5.3 Level 1B Products from the Atmospheric Infrared Sounder (AIRS) on the EOS Aqua Spacecraft

Presenter: George Aumann for Thomas Pagano

Thomas S. Pagano
Jet Propulsion Laboratory, California Institute of Technology
Pasadena, CA

The Atmospheric Infrared Sounder (AIRS) was launched May 4, 2002 on the EOS Aqua Spacecraft. AIRS is the first high spectral resolution infrared imaging sounder with 2378 infrared channels ranging from 3.7 - 15.4 microns and a spectral resolution of 1200. A discussion of the objectives of the AIRS experiment including requirements on the data products is given. We summarize the instrument characteristics including sensitivity, noise and spectral response and preflight calibration results leading to the estimate of the calibration accuracy. We show the in-flight behavior and stability of the instrument and steps taken to mitigate the effects of icing and radiation effects. Indications are that the radiometric accuracy of AIRS is better than 0.2K for all frequencies at a scene temperature of 250K, and stability better than 0.2K as well. Spectral stability is shown to be better than 2ppm of the center frequency. The Level 1B calibration algorithm will be presented as well as the results of in-flight stability and sensitivity measurements.

5.4 AIRS Retrieval System

Presenter: Sung-Yung Lee

By Sung-Yung Lee, Evan Manning, and Ed Olsen
Jet Propulsion Laboratory
Pasadena, California.

The AIRS Team Leader Facility at JPL is developing software to process AIRS data. The software will be run at NASA GSFC DAAC in Greenbelt Maryland. The retrieval algorithm, which generates atmospheric and surface parameters from radiance products, is called the Unified Team Algorithm. Many science

team members are responsible for various parts of the retrieval algorithm. They test their software at their home institution and integrate it into the AIRS level 2 software. Major software changes to the Unified Team Algorithm are reviewed by the science team.

The AIRS project has the goal of temperature retrieval accuracy of 1K in 1 km thick layers in the troposphere. For water vapor profiles, the accuracy goal is 10% relative accuracy in 2 km thick layers in the troposphere. We are also planning to retrieve surface and cloud parameters as well as minor gases like O3, CH4 and CO.

JPL is preparing to deliver the first working version of the level 2 software in July 2003. The output from this version will be released to the public in August. Many AIRS products from this provisional version of retrieval software will be presented.

5.5 Atmospheric Soundings of Temperature, Moisture and Ozone from AIRS

Presenter: Mitch Goldberg

M.D. Goldberg, C.D. Barnet, L. McMillin, L. Zhou
M. Divakarla, W. Wolf
NOAA/NESDIS/STAR, Camp Springs, MD, USA

The Atmospheric InfraRed Sounder (AIRS) is the first of a new generation of high spectral resolution infrared sounder with 2378 channels measuring outgoing radiance between 650 cm-1 and 2675 cm-1. The improved vertical resolving power of the AIRS is expected to greatly improve the accuracy of temperature and moisture soundings. AIRS soundings of atmospheric temperature, moisture and ozone are being generated in near real-time at NOAA/NESDIS. These products are currently being validated, and distribution of these retrievals to the community is expected by the end of 2003. The soundings are compared with radiosondes, model analyses and NOAA-16 retrievals. Both the algorithms and the validation results are discussed in detail.

The next advanced sounders to be processed at NESDIS will be the Infrared Atmospheric Sounding Interferometer (IASI) and the Cross-track Infrared Sounder (CrIS). If launch schedules are maintained, IASI and CrIS radiance and sounding products are expected no earlier than 2006 and 2007, respectively. Our plans for providing IASI and CrIS products are also discussed.

5.6 AIRS Real-Time Sounding Profile Retrieval for IMAPP (International MODIS/AIRS Processing Package) Users

Presenter: Elisabeth Weisz

Elisabeth Weisz, Hung-Lung Huang, Jun Li, Suzanne Seemann, Eva Borbas, Liam Gumley
Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison, U.S.A

The high-spectral-resolution Atmospheric Infrared Sounder (AIRS) is part of the core payload of NASA's Earth Observing System (EOS)-Aqua platform. AIRS, together with the Advanced Microwave Sounding Unit (AMSU) and the Humidity Sounder Brazil (HSB), provides measurements of atmosphere, clouds, land and ocean surface properties with high accuracy.

Current work at CIMSS includes the development of a real-time processing algorithm to retrieve atmospheric temperature and humidity profiles in the troposphere and lower stratosphere as part of the International MODIS/AIRS Processing Package (IMAPP). The first version of the clear statistical retrieval approach includes the use of a training database accounting for viewing angle, surface emissivity, surface skin temperature, surface pressure, and forward model bias. The global training dataset utilizes single window channel classification procedure providing six classes of regression coefficient sets to optimize retrieval performance. To identify clear scenes 1km-MODIS cloudmask has been adapted for AIRS footprints. We present retrieval methodology, and discuss associated aspects including training database setup, noise characterization/filtering, channel selection, and synthetic principal component regression. Results are discussed by means of performance and error characterizations.

We anticipate the first release of this processing algorithm before the ITSC-XIII.

5.7 Current Results from AIRS/AMSU/HSB

Presenter: John Blaisdell

Joel Susskind(a), Christopher D. Barnet(b), John M. Blaisdell(c), Lena F. Iredell(c), Fricky Keita(c), Louis C. Kouvaris(c)

(a) NASA Goddard Space Flight Center
(b) NOAA/NESDIS
(c) Science Applications International Corporation

AIRS was launched on EOS Aqua on May 4, 2002, together with AMSU-A and HSB, to form a next generation polar orbiting infrared and microwave atmospheric sounding system. The primary products

of AIRS/AMSU/HSB are twice daily global fields of atmospheric temperature-humidity profiles, ozone profiles, sea/land surface skin temperature, and cloud related parameters including OLR. The sounding goals of AIRS are to produce 1 km tropospheric layer mean temperatures with an rms error of 1K and layer precipitable water with an rms error of 20%, in cases with up to 80% effective cloud cover. Pre-launch simulation studies indicated that these results should be achievable. Minor modifications have been made to the pre-launch retrieval algorithm now that a full year of data has been collected, and these recent modifications are discussed. Sample fields of parameters retrieved from AIRS/AMSU/HSB data are presented and validated as a function of retrieved fractional cloud cover. As in simulation, the degradation of retrieval accuracy with increasing cloud cover is small. Select fields are also compared to those contained in the ECMWF analysis, done without the benefit of AIRS data, to demonstrate information the AIRS can add to that already contained in the ECMWF analysis.

5.8 First global measurement of mid-tropospheric CO2 from NOAA polar satellites: The tropical zone

Presenter: Soumia Serrar

A. Chédin, S. Serrar, N.A. Scott, C. Crevoisier, R. Armante
Laboratoire de Météorologie Dynamique, Institut Pierre-Simon Laplace,
Ecole Polytechnique, 91128 Palaiseau, France

Mid-tropospheric mean atmospheric CO2 concentration is retrieved from the observations of the NOAA series of polar meteorological satellites, using a non-linear regression inference scheme. For the four years of the present analysis (July 1987 - June 1991), monthly means of the CO2 concentration retrieved over the tropics (20N-20S) from NOAA-10 show very good agreement with recent in situ observations (properly equipped commercial airliners). The annual trend inferred corresponds to the known increase in the concentration of CO2 as a result of human activities. Also, the impact of El Nino Southern Oscillation (ENSO) events is clearly seen and confirms in situ observations or model simulations. A rough estimate of the method-induced standard deviation of these retrievals (resolution of 15x15° and one month) is of the order of 3.6 ppmv (around 1%). The coming analysis of the almost 25 years of NOAA archive should contribute to better an understanding of the carbon cycle.

5.9 Mid-tropospheric CO2 retrieval in the tropical zone from AIRS observations
Presenter: Cyril Crevoisier

Cyril Crevoisier, Alain Chédin, Sylvain Heilliette, Noëlle A. Scott, Soumia Serrar and Raymond Armante

The new 2378 channel high spectral resolution NASA/Aqua/Atmospheric Infrared Sounder (AIRS) launched in May 2002 is used to retrieve mean concentration of atmospheric carbon dioxide (CO2). A reduced set of AIRS channels, presenting a high sensitivity to variations of the atmospheric CO2 and reduced sensitivities to variations of other atmospheric components, and well covering the mid-troposphere (from 700 hPa to the tropopause), is first selected using the Optimum Sensitivity Profile (OSP) method (Crevoisier et al 2003). A cloud elimination procedure based on AIRS and Atmospheric Microwave Sounding Unit (AMSU) observations is then performed to detect clear fields of view. The resulting AIRS and AMSU measurements, the latter being not sensitive to CO2 variations, are used in a neural network inference procedure. This non-linear regression scheme has already proved its efficiency in the retrieval of mid-tropospheric CO2 from NOAA polar satellites (Chédin et al 2003). The first results obtained with AIRS give hope to improve the accuracy of the retrieval. Maps of monthly mean mid-tropospheric CO2 concentration are finally obtained for a few months in the tropics [20S;20N].

5.10 Validation of AIRS Retrievals

Presenter: Bjorn Lambrigsten (for Eric Fetzer)

By Eric J. Fetzer, Edward T. Olsen, Luke L. Chen, Denise Hagan, Evan Fishbein, and Frederick W. Irion
Jet Propulsion Laboratory, California Institute of Technology

The Atmospheric Infrared Sounder (AIRS) spectrometer and companion instrument the Advanced Microwave Sounding Unit have operated simultaneous since 31 August 2002. Collocated observations from the Humidity Sounder for Brazil were also available until 5 February 2003. Geophysical products are generated from directly observed radiances using a retrieval algorithm that is an integral part of the observing system. Retrieved products include cloud cleared radiance, surface temperatures, cloud properties, profiles of temperature and water vapor, and column and profile abundances of ozone and other trace gases. These quantities are being validated by comparison with observations

taken in situ and by other satellite sensors. Retrievals are also compared with general circulation model reanalyses. All retrieved products are scheduled for public release in August 2003. Validation analyses for this data release are limited to open ocean conditions in the latitude band from 40 S to 40 N, however. The AIRS retrieval algorithm is scheduled for update in February 2004, and the associated products will be validated over the entire 40 S to 40 N band, including nighttime land. Subsequent releases will address increasingly complex observing conditions, including daytime land and polar conditions. We describe here the validation of cloud cleared radiances, sea surface temperatures, profiles of water vapor and temperature, and ozone. Comparisons are currently being made with assimilation model reanalyses, operational buoys and radiosondes, and dedicated radiosondes and ozonesondes. Results are presented for retrievals over ocean, appropriate to the August data release. Some preliminary comparisons over land are also shown.

5.11 Validation of Atmospheric InfraRed Sounder (AIRS) Spectral Radiances with the Scanning High-resolution Interferometer Sounder (S-HIS) aircraft instrument

Presenter: Hank Revercomb

Henry E. Revercomb, David C. Tobin, Robert O. Knuteson, Fred A. Best, William L. Smith, Paul van Delst, Daniel D. LaPorte, Scott D. Ellington, Mark W.Werner, Ralph G. Dedecker, Ray K. Garcia, Nick N. Ciganovich, H.Benjamin Howell, and Steven Dutcher*

University of Wisconsin-Madison, Space Science and Engineering Center
1225 West Dayton Street, Madison Wisconsin, 53706
** NASA Langley Research Center*

The ability to accurately validate high spectral resolution IR radiance measurements from space using comparisons with aircraft spectrometer observations has been successfully demonstrated. The demonstration is based on a 21 November 2002 under-flight of the AIRS on the NASA Aqua spacecraft by the S-HIS on the NASA ER-2 high altitude aircraft and resulted in brightness temperature differences approaching 0.1K for most of the spectrum!

Aircraft comparisons of this type provide a mechanism for periodically testing the absolute calibration of spacecraft instruments with instrumentation for which the calibration can be carefully maintained on the ground. This capability is especially valuable for assuring the long-term consistency and accuracy of climate observations, including those from the NASA EOS spacecrafts (Terra, Aqua and Aura) and the new complement of NPOESS operational instruments. The validation role for accurately calibrated aircraft spectrometers also includes application to broadband instruments and linking the calibrations of similar instruments on different spacecraft.

Both the AIRS and the S-HIS calibrations are expected to be very accurate (formal 3-sigma estimates are better than 1 K brightness temperature for a wide range of scene temperatures), because high spectral resolution offers inherent advantages for absolute calibration and because they make use of high emissivity cavity blackbodies as onboard radiometric references. AIRS has the added advantage of a cold space view, and the S-HIS calibration has benefited from the availability of a zenith view from high altitude flights on the Proteus aircraft. The S-HIS has also benefited from calibration techniques developed over many years in conjunction with the original HIS aircraft instrument and with the Atmospheric Emitted Radiance Interferometer (AERI) instruments developed for the DOE ARM Program. The absolute radiometric calibration is traceable to NIST, and in the future, we plan to check the calibration directly by inter-comparison to a NIST-maintained sensor (the TXR radiometer).

It is expected that aircraft flights of the S-HIS and its close cousin the NPOESS Atmospheric Sounder Testbed (NAST) will be used to check the long-term stability of AIRS over the life of the mission.

5.12 Validation Studies Using NAST-Interferometer Field Measurements

Presenter: Allen Larar

Allen M. Larar[a], William L. Smith[a], Daniel K. Zhou[a], and Stephen Mango[b]
[a]NASA Langley Research Center, Hampton, VA 23681
[b]NPOESS Integrated Program Office, Silver Spring, MD 20910

The Integrated Program Office (IPO) developed and supports high-altitude aircraft flights of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Airborne Sounding Testbed (NAST) as part of risk mitigation activities for future NPOESS sensors. The NAST-Interferometer (NAST-I) is a high spectral and spatial resolution (0.25 cm-1 and 0.13 km nadir footprint per km of aircraft altitude, respectively) cross-track scanning (2 km swath width per km of altitude) Fourier Transform Spectrometer

(FTS) observing within the 3.7 - 15.5 micron spectral range. NAST-I infrared spectral radiances are used to characterize the atmospheric thermodynamic state and provide information on radiatively active trace gases (e.g., O3 & CO), clouds, and the terrestrial surface during experimental campaigns. These direct and derived NAST-I data products greatly contribute toward instrument and forward model pre-launch specification optimization and will enhance post-launch calibration/validation activities for the Cross-track Infrared Sounder, CrIS, to fly on NPP and NPOESS (as well as for other advanced atmospheric spaceborne sensors). In this paper we address some of the challenges associated with validating infrared spectral radiances obtained from such high spectral resolution remote sensing systems. This will include comparison of NAST-I infrared spectral radiances measured during recent field experiment campaigns with other radiance measurements as well as radiance calculations performed using Line-by-Line (LBL) and "Fast" forward radiative transfer models based on independent, nearly-coincident observations of atmospheric state.

5.13 Validation and Comparison of S-HIS and NAST-I Retrievals for THORPEX 2003

Presenter: Paolo Antonelli

Paolo Antonelli, Hank Revercomb, Robert Knuteson, Dave Tobin, and Steve Dutcher
University of Wisconsin, Madison, Wisconsin
William Smith and Daniel Zhou
NASA Langley Research Center, Hampton, VA

The Scanning High-resolution Infrared Sounder (S-HIS) and the NPOESS Aircraft Sounding Test-bed Interferometer (NAST-I) have flown simultaneously on the same platform during the 2003 THORPEX Observing System Test campaign. Both the instruments are Michelson interferometers and possess very high spectral and spatial resolution. The results of several airborne missions exploited in the past years have shown that the absolute accuracy of the spectral radiances measured with these instruments is excellent. This paper aims to take advantage of the simultaneous observations collected by the two instruments to show: a) the relative spectral accuracy, b) the differences in the noise levels between the two instruments c) the differences in the vertical and horizontal structure of the retrieved temperature and water vapor fields.

5.14 Validation of Satellite AIRS Retrievals With Aircraft NAST-I Observations - Implications for Future Satellite Sounding Capabilities

Presenter: William Smith

William Smith and Daniel Zhou
NASA Langley Research Center, Hampton, VA
Paolo Antonelli, Hank Revercomb, Robert Knuteson, and Allen Huang
University of Wisconsin, Madison, Wisconsin

The airborne NPOESS Aircraft Sounding Test-bed Interferometer (NAST-I) has flown on numerous flights under the Aqua satellite in order to validate AIRS radiance measurements and profile retrievals. The NAST-I is an excellent AIRS airborne validation tool since it possesses very high spectral and spatial resolution. The results of these airborne missions have shown that there is excellent absolute accuracy of the spectral radiances measured with the NAST-I and AIRS instruments. However, the vertical resolution of the derived profile is shown to be highly dependent on the "effective" noise level of the spectrum used for the retrieval process. The "effective" spectrum noise level is a function of the single spectral sample radiance measurement noise, the number of spectral channels used for the retrieval, and the number of spatial samples averaged to produce the final profile result. For the NAST-I aircraft instrument, the effective spectrum noise level is extremely small after reducing the horizontal linear resolution to that of the satellite AIRS instrument (i.e., ~14 km for AIRS as opposed to ~2km for NAST-I) and as a result its relatively large spectral range and high spectral resolution (i.e., NAST-I possess nearly four times the number of spectral channels as does the AIRS). Retrieval results for various spectral and spatial resolutions are shown to demonstrate the dependence of retrieved vertical profile resolution on the effective spectrum noise levels. For example, it is shown that spatial averaging of the AIRS data, which increases signal to noise, can be used to improve the vertical resolution of the retrieved profiles. Implications for future METOP IASI, NPP/NPOESS, and EO-3 GIFTS spectral resolution, spatial resolution, and instrument noise characteristics are discussed.

5.15 Effects of GPS/RO refractivities on IR/MW retrievals

Presenter: Éva Borbás

Éva Borbás [1], W. Paul Menzel [2], Jun Li [1], and Harold M. Woolf [1]
[1]Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin/Madison
[2]NOAA/NESDIS Office of Research and

Applications

We examined whether the GPS/RO measurements of the tropopause region are able to improve tropospheric profile retrievals from IR and MW radiometric measurements with the ATOVS (Advanced TIROS Operational Vertical Sounder) on current NOAA polar orbiting satellites and with the future high spectral resolution infrared measurements from the Cross-track Infrared Sounder (CrIS) planned for the NOAA Polar Orbiting Environmental Satellite Suite (NPOESS).

First a simulation study will be presented wherein a statistical regression is used to get temperature and moisture retrievals from the combination of the ATOVS (CrIS) brightness temperatures and GPS/RO refractivity data. The ATOVS/CrIS and GPS/RO combination is found to yield tropospheric profiles in better agreement with those from radiosondes than profiles inferred from either system alone. A sensitivity test was also performed to investigate how large GPS/RO refractivity errors can be and still improve the radiometric temperature or moisture retrievals. Second, the associated study conducted with real GPS/RO (CHAMP) and sounder (ATOVS) data will also be shown.

SESSION 6

6.1 Characterization of troposphere and land surface properties from CMIS

Presenter: Alan Lipton

Jean-Luc Moncet and Alan Lipton
AER Inc.

The NPOESS Conically-scanning Microwave Imager/Sounder (CMIS) will provide polarimetric measurements in the range 6-183 GHz. CMIS will combine capabilities of AMSR, WindSat and SSMIS, in that it will enable the retrieval of soil moisture, ocean surface wind direction, and mesospheric temperature, in addition to the more traditional microwave land/surface environmental variables. The combination of sounding and imaging channels on the CMIS instrument will be exploited to enhance both surface and lower atmosphere characterization and maintain physical consistency between the atmosphere and surface variables. In particular, the presence of vertically and horizontally polarized channels near 23 GHz and in window regions, together with the presence of sounding channels, will open the door to significant advances in assimilation or retrieval of lower atmosphere data over land. In addition, there are plans to quantify the impact of incorporating the information provided by VIIRS and CrIS, on the same platform, on the system performance over land and on the EDR quality control.

6.2 The sounding instruments on second generation of Chinese national meteorological satellites FY-3

Presenter: Dong Chaohua (for Wenjian Zhang)

Wenjian ZHANG
National Satellite Meteorological Center, China Meteorological Administration,
Beijing 100081, P.R. CHINA

FY-3 is the second generation of Chinese national polar-orbiting meteorological satellite series. According to the current plan, the year 2006-2010 is the FY-3 Research and Development (R&D) phase with two satellites and followed by operational phase with five satellites. The FY-3 series will be equipped with both sounding and imaging payload, enabling more powerful observations, with the main objectives of providing global sounding of 3-dimensional thermal and moisture structures of the atmosphere parameters to support global and regional numerical weather prediction, providing global imaging to support short range weather forecasting and real time monitoring of meteorological/hydrological disasters and surface environment anomaly, as well as providing necessary data for deriving important geophysical parameters to support researches on global change and climate change.

In partnership with the China Aerospace Science and Technology Corporation (CASC), the first satellite of this series, FY-3A satellite, is scheduled to be available in 2006. Now the FY-3A and associated instruments are under manufacturing. FY-3A will carry more than ten remote sensing instruments and four of them related to atmospheric sounding. These instruments are: Infrared atmospheric sounder, Microwave atmospheric temperature sounder, Microwave atmospheric humidity sounder and Ozone profiler. This paper will give a brief introduction to the FY-3A, including the manufacturing progress of the satellite platform, the manufacturing progress FY-3A instruments, as well as the planning of FY-3 ground segment.

6.3 India Meteorological Department Report

Presenter: Devendra Singh (for R. C. Bhatia)

An update on the India Meteorological Department.

6.4 Scientific Research Center "Planeta" Report

Presenter: Alexander Uspensky

An update on the Scientific Research Center "Planeta."

6.5 EUMETSAT Plans

Presenter: Dieter Klaes

K. Dieter Klaes
EUMETSAT, Darmstadt, Germany

EUMETSAT is currently developing, jointly with ESA the EUMETSAT Polar System (EPS) and commissioning the first Meteosat Second Generation Satellite(MSG-1). MSG-1 has been successfully launched in 2002 and will start to provide validated observations from the Earth/Atmosphere system end of 2003. 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 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. The launch of the first Metop satellite is planned for September 2005. Three Metop spacecraft are foreseen within EPS.

6.6 Update about Frequency Protection: Results of WRC 2003 and SFCG 23… What to do now?

Presenter: Guy Rochard

Guy Rochard
Meteo-France

This paper will report on results from the WRC 2003 and SFCG 23 meetings. Additional information about frequency protection can be found on these web sites:

http://cimss.ssec.wisc.edu/itwg/groups/frequency/
and
http://guy.rochard.free.fr/meteo/

6.7 NESDIS ATOVS Operational Sounding Products Processing and Distribution

Presenter: A. K. Sharma

A. K. Sharma
NOAA/NESDIS
Washington DC 20233

Since 1979 the National Oceanic and Atmospheric Administration National Environmental Satellite, Data, and Information Service (NOAA/NESDIS) has been providing the operational sounding products from the polar orbiting satellites continuously with a suite of infrared and microwave radiation sounder measurements, and derived temperature and moisture sounding products on a global scale. NOAA's primary mission for sounding data products represents a unique source of global, atmospheric, weather information, with a demonstrated positive impact on Numerical Weather Prediction (NWP) forecasts. Current polar orbiting satellites provide measurements from the HIRS/3, AMSU-A and AMSU-B sounder instruments on board NOAA-15, NOAA-16 and NOAA-17. Advanced TIROS (Television and Infrared Observation Satellite) Operational Vertical Sounding (ATOVS) sounding products from NOAA-15 were operationally implemented by NESDIS in April 1999 and AMSU-B processing was delayed until May 2000. NOAA-16 and NOAA-17 were made operational in March 2001 and October 2002 respectively. There are over 500,000 soundings made every day from the ATOVS on aboard NOAA-15, 16 and 17 series of Polar Orbiting Environmental Satellites (POES). Monitoring sounding data products generation systems on a 24 hours basis is important. A web-based user interface has been developed and implemented for monitoring the products generation systems. Quality of the data products and timeliness for processing and distribution are extremely important factors in designing the operational systems at the NESDIS. This presentation will include the discussion on the improvements on the quality and timeliness and the operational changes required by the systems to accommodate the future instruments data processing such as pipeline processing for granules instead of orbits. The processing changes required for the upcoming launches of the NOAA satellites NOAA-N and NOAA-N' and the European Organization for the Exploitation of Meteorological (EUMETSAT) satellites, Meteorological Operational Satellite (MetOp)-1 and MetOp-2 will be discussed. Re-hosting of operational systems from a slower processor CRAY machine to a faster processor IBM machine will also be discussed.

6.8 NESDIS ATOVS Operational Sounding Products

Presenter: Tony Reale

Tony Reale
NOAA/NESDIS
Washington DC 20233

The National Oceanic and Atmospheric Administration, National Environmental Satellite Data and Information Service (NESDIS) operates a fleet of civilian, polar orbiting environmental satellites which provides users and researchers with a suite of operational atmospheric and environmental data. The current operational configuration consists of three polar satellites, NOAA-15, 16, and 17, each deploying the Advanced TIROS Operational Vertical Sounder (ATOVS) instrument configuration. ATOVS consists of the 15-channel Advanced Microwave Sounding Unit-A (AMSU-A), the 5-channel AMSU-B, the 20-channel High-resolution Infrared Radiation Sounder (HIRS/3), and the 6-channel Advanced Very High Resolution Radiometer (AVHRR/3).

The following report summarizes the current status of the operational ATOVS (and AMSU-B) instruments and derived sounding products distributed by NESDIS to national and international users. This is done through a brief review of instrument health, the scientific processing algorithms, statistical results, and a series of examples of data requests (on a global and regional scale) that have been received from the user community over the past 18 months. It is through such requests and feedback back from users that NESDIS is able to gauge the usefulness of these data, the scope of the information they provide and areas of concern. For example, the application of derived soundings for arctic polar winter cases, tropical moisture, and global temperatures in the middle and upper stratosphere are just a few examples of user requests received and discussed. Ongoing internal review by NESDIS scientists has also resulted in a number of interesting cases, for example, during the recent winter period (2003), the weather pattern over a large portion of the United States featured a persistent lower level inversion associated with cold air overridden by warm moist air from the Gulf of Mexico and South Atlantic, and an associated signature error characteristic in the derived sounding products. Such features represent one of the foremost challenges for satellite meteorologists as they are essentially invisible to the current generation of satellite atmospheric radiometers, yet can be reliably identified through comparisons against short-term numerical weather prediction forecasts.

The report concludes with a discussion of derived satellite product error characteristics, how the current scientific algorithms meet (or not) the current user requirements in this area for the variety of numerical weather prediction and climate applications these data entertain, and how future upgrades planned by NESDIS during the Year 2004 (including significant advances in scientific validation) will better meet these needs. Also discussed is the role of the radiosonde network in defining error characteristics, their explicit use in "tuning" the scientific algorithms to derive products, current strengths and weaknesses, and how future plans to dedicate a small global network of reference sondes to provide ground truth coincident with polar satellite overflights could better meet the needs of numerical weather prediction and climate application users.

6.9 Further development of the ATOVS and AVHRR Processing Package (AAPP) including an initial assessment of EARS radiances

Presenter: Nigel Atkinson

Nigel Atkinson and Keith Whyte (Met Office), Tiphaine Labrot (Météo-France)

The various changes to AAPP for the recent V4.0 release will be discussed. These include rationalisation of the documentation, Fortran90 compatibility and the addition of code to detect and correct for occurences of the moon in the AMSU-A space view. The requirements for AAPP V5.0 will be examined, in particular the changes necessary for processing NOAA-N data. Finally the future of AAPP in the Metop era will be addressed.

Examples of the implementation of AAPP in an operational setting, particularly the routine processing of data from the Eumetsat ATOVS Retransmission Service (EARS), will be included.

6.10 The National Polar-orbiting Operational Environmental Satellite System: Future U.S. Operational Earth Observation System

Presenter: Hal Bloom

By Hal J. Bloom and Peter Wilczynski

Over the last decade, the tri-agency Integrated Program Office (IPO), comprised of the National Oceanic and Atmospheric Administration (NOAA), the Department of Defense (DoD), and the National Aeronautics and Space Administration (NASA), has been managing the development of the National Polar-orbiting Operational Environmental Satellite System (NPOESS). NPOESS will replace the current military and civilian polar-orbiting environmental satellites. The IPO, through its Acquisition and Operations

(A&O) contractor, Northrop Grumman, will begin in 2009 to launch NPOESS spacecraft into three orbital planes to provide a single, national system capable of satisfying both civil and national security requirements for space-based, remotely sensed environmental data.

In 1997, the IPO initiated a robust sensor risk reduction effort that was focused on early development of the critical sensor suites and algorithms necessary to support NPOESS. In 2001, preliminary design efforts were completed for the last of five critical imaging/sounding instruments for NPOESS. Three of these sensors are scheduled to fly on the joint NASA/IPO NPOESS Preparatory Project (NPP) mission in 2006. Early flight-testing of instruments will reduce development risk and demonstrate and validate global imaging and sounding instruments, algorithms, and pre-operational ground processing systems prior to delivery of the first NPOESS spacecraft.

To meet user-validated requirements for 55 geophysical parameters, NPOESS will deliver global Stored Mission Data (SMD) to four U.S. centers for processing and distribution, with 95% of the data being delivered in less than 28 minutes from the time of collection. Global SMD will be down-linked to 15 globally distributed ground stations at Ka-band frequencies and will be the complete, full resolution data set containing all sensor data and auxiliary data necessary to generate all NPOESS Environmental Data Records. NPOESS spacecraft will also simultaneously broadcast two types of real-time data to suitably equipped ground stations. The NPOESS High Rate Data broadcast (X-band frequencies) will be a complete, full resolution data set and is intended to support users at regional hubs. The NPOESS Low Rate Data broadcast (L-band frequencies) will be a subset of the full data set and is intended for U.S. and worldwide users of remote/mobile field terminals.

The advanced technology visible, infrared, and microwave imagers and sounders that will fly on NPOESS will deliver higher spatial and temporal resolution atmospheric, oceanic, terrestrial, climatic, and solar-geophysical data, enabling more accurate short-term weather forecasts and severe storm warnings, as well as serving the data continuity requirements for improved global climate change assessment and prediction.

SESSION 7

7.1 Preparations for the Geostationary Imaging Fourier Spectrometer

Presenter: William Smith (for John Le Marshall)

J.F. Le Marshall, R.G. Seecamp, A. Rea
Bureau of Meteorology, Australia

W.L. Smith
Langley Research Center, NASA, USA

L.M. Leslie
University of Oklahoma, Norman, Oklahoma, USA

M. Dunn
Latrobe University, Melbourne, Australia

The Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) will be completed in late 2005, to support a 2006 or later launch. The GIFTS will be orbited as NASA's New Millennium Program Earth Observing-3 (EO-3) Mission and GIFTS will serve as a prototype of sounding systems to fly on future operational geostationary satellites.

The first year of operation of GIFTS will support the infusion of new technologies and data processing techniques into future geostationary operational satellite systems. The mission will validate the GIFTS measurement concept for altitude-resolved (water vapour observation based) winds, provide high temporal and spatial resolution soundings of the atmosphere for temperature and absorbing species and demonstrate new technologies for future research and operational systems.

We describe some of the development activity in support the application of GIFTS data over continental USA and also describe preparations for the collection and utilisation of this data when the GIFTS is stationed over the Indian Ocean. This activity includes preparation for providing radiance products for NWP, altitude resolved, error characterised winds, temperature and moisture profiles, product imagery (stability fields, water vapour fields, etc.), sea and land surface temperatures with attendant emissivities, ozone and CO amounts and cloud properties. This activity has involved use of aircraft ultra spectral observations, AIRS data and also synthetic GIFTS data. Examples of this activity will be shown at the meeting. Overall it is clear the program indicates significant potential benefit from the high temporal, spectral and spatial resolution ultra spectral observations provided by this instrument and encourages further preparation for their exploitation.

7.2 Retrieving Infrared Land Surface Emissivity With AIRS Observations

Presenter: Xuebao Wu

Xuebao Wu[1], Jun Li[2], Yuanjing Zhu[1], Paul Menzel[2], and Wenjian Zhang[3]
[1] Department of Atmospheric Science, Peking University, Beijing, China
[2] CIMSS/SSEC/UW-Madison, USA
[3] National Satellite Meteorological Center, Beijing, China

This report reviews briefly the characteristics of high spectral resolution observations. The paper describes the use of EOS-Aqua AIRS measurements over China to characterize the surface properties important for IR thermal emission. Infrared rapid transmittance model is used for the sensitivity study of surface parameters and the atmospheric parameters from lower troposphere. An experiment is carried out to retrieve the land surface emissivity and temperature. The MLEV (Minimum Local Emissivity Variance) retrieval method is implemented in this study. The atmospheric profiles of the ECMWF NWP model are utilized to simulate the satellite measurements. Preliminary retrieval results are given out.

7.3 Surface effects in hyperspectral infrared measurements from the AIRS instrument of the Aqua satellite

Presenter: Youri Plokhenko

Youri Plokhenko[#] and W. Paul Menzel[&]
[#]Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin-Madison, 1225 W. Dayton St., Madison WI 53706
(608) 262-7287 , (608) 262-5974 (FAX), YouriP@ssec.wisc.edu
[&]Office of Research and Applications , NOAA/ NESDIS, Madison WI

The surface emissivity (SE) variations cause measurable changes in infrared radiances. To improve the accuracy of vertical temperature-moisture profiles retrieved from AIRS sounder infrared measurements, the surface emissivity must be accounted for in the solution of the inverse problem. The accuracy of atmospheric parameters retrieved from IR measurements depends on the measurement accuracy and accurate definition of measurement model. The associated inverse problem based upon the numerical solution of the radiative transfer equation (RTE) is ill posed. Disregarding the spectral-spatial variations of SE in the RTE magnifies the errors. Different types of surface cover, with different surface optical properties and extremely high spatial and temporal variations, restrict the use of a priori estimates of SE. The direct evaluation of SE is an effective approach for modeling. A model accounting for the surface reflection and an algorithm of solution are presented. The solution includes the surface emissivity, the surface temperature, and the temperature-moisture profile. The RTE equation is solved using method of least squares in coordinate descent on basis of a Gauss-Newton numerical schema. Results of SE estimation are demonstrated. The SE estimates over land show significant spectral-spatial variability. Accounting for the emissivity positively changes the atmospheric temperature-moisture profiles estimate.

SESSION 8

8.1 Advanced TOVS (ATOVS) Cloud Products Using HIRS/3 and AMSU-A Measurements

Presenter: Michael Chalfant

Michael W. Chalfant
Office of Research and Applications / NESDIS / NOAA, Washington DC

Franklin H. Tilley
ITSS Division / Raytheon Corporation, Lanham MD

The National Oceanic and Atmospheric Administration (NOAA) , National Environmental Satellite Data and Information Service (NESDIS) currently produces a suite of operational quality cloud products from the Advanced TIROS Operational Vertical Sounder (ATOVS) system using the High-resolution Infrared Radiometer Sounder (HIRS/3) and Advanced-Microwave Sounding Unit (AMSU-A) instruments onboard the NOAA polar orbiting satellites. These global products include Cloud Top Temperature, Cloud Top Pressure and Cloud Amount, in support of NESDIS' commitment to improve Short Term Warnings and Forecasts. The ATOVS cloud products are dependent upon the generation of accurate temperature and moisture retrievals for both the generation of a correction for the attenuation of radiances above the cloud tops as well as the determination of cloud top pressure.

The ATOVS cloud products are generated using the CO2 Slicing technique, at each HIRS/3 Field-of-View (FOV). These products are also output to 1 X 1 degree gridded fields, for ascending and descending orbital passes and separated into Total, High, Medium and Low pressure layers, where the parameters are calculated as a function of the Effective Cloud Fraction. The ATOVS cloud products, at the sounding location are being archived and distributed via

AWIPS, to NWS field forecast offices. Two cloud product statistical tables are generated globally and updated daily on the NESDIS web site, for comparison with other cloud product systems as well as assessing the performance of the ATOVS cloud product system.

The ATOVS cloud products have been undergoing extensive evaluation by NESDIS and National Weather Service (NWS) personnel for possible use in regional and global Numerical Weather Prediction (NWP) forecasts. Comparisons of the ATOVS Cloud products with several other cloud product generation systems such as the ATOVS temperature retrieval Cloud Mask; the AVHRR/3 based CLAVR-x and UK Meteorological Office's Clear Fraction; GOES and the USAF RTNEPH, have resulted in substantial improvement in the coverage of retrieved marine stratus plus providing for an independent quantative verification of the ATOVS cloud parameter values. This paper describes the algorithms for deriving these cloud products as well as the scientific and system upgrades which have resulted in significant increases in both cloud product accuracy and coverage.

8.2 Cloud Parameters from a Combination of Infrared and Microwave Satellite Measurements

Presenter: Filomena Romano

F. Romano, V. Cuomo* and R. Rizzi°*
** Istituto di Metodologie per l'Analisi Ambientale, IMAA/CNR, Potenza, Italy*
° ADGB - Dip. Fisica, viale Berti Pichat 6/2, Bologna, Italy

Clouds are both absorbers of outgoing longwave radiation and reflectors of incoming solar radiation. Due to their crucial role, the knowledge of the horizontal and vertical distribution and the optical properties of globally distributed clouds are of fundamental importance to the understanding of the radiation and heat balance, weather and climate of the earth and the atmosphere. Measurements of radiation from space can play a big role in helping us to understand how radiation depends on cloud properties. They can also help us to identify which are the most critical cloud properties to measure. The goodness of satellite-based measurements is that they offer the only practical way of making cloud measurements over the entire global. In the next future, many of new satellite sensors will be available for cloud observation. The improvement of spatial resolution and spectral characterisations allow us to apply sophisticated retrieval procedure, which will provide new cloud products with enhanced accuracy.

Although radiometers have been used to derive cloud cover, study of the quantitative estimate of the vertical cloud composition and structure by means of passive remote satellite sounding has been extremely limited because of the complexity of the cloud interactions with the radiation field of the atmosphere. Since clouds are practically opaque in the infrared sounding frequencies and since the majority of the clouds are transparent in the microwave regions, it would appear that a proper combination of infrared and microwave measurements could be useful and significant data to determine the cloud coverage, the vertical cloud structure and composition in all weather conditions.

In this paper we wish to demonstrate the feasibility of utilizing a combination of infrared and microwave sounding data for the estimation of the cloud parameters. Theoretical calculation are used to examine the spectral characteristics of microwave (AMSU) and infrared brightness temperature values for non-precipitating clouds in order to improve the retrieval of cloud parameters.

8.3 Cirrus microphysical properties from TOVS observations

Presenter: Gaby Rädel

G. Rädel , C. J. Stubenrauch, and F. Eddounia
CNRS/IPSL, Laboratoire de Météorologie Dynamique, Ecole Polytechnique, France

The Improved Initialization Inversion (3I) algorithm converts TIROS-N Operational Vertical Sounder (TOVS) observations from the NOAA Polar Orbiting Environmental Satellites into atmospheric temperature and water vapor profiles, as well as into cloud and surface properties at a spatial resolution of 1°. Within the framework of the NOAA/NASA Pathfinder Program, eight years (1987-1995) of TOVS data have been processed. Cloud-top pressure and effective IR cloud emissivity are computed from the CO_2-band radiances by a weighted χ^2 method.

We already retrieved the mean effective ice crystal sizes e) for large-scale cirrus clouds with an IR emissivity between 0.3 and 0.85 by using their dependance on the difference between cloud emissivities at 8 μm and 11 μm for NOAA10 data. Look-up tables were constructed assuming homogeneous clouds of 1km thickness, consisting of randomly oriented planar polycrystals (Rädel et al., 2003). In addition the ice water path (IWP) is determined from the emissivity at 11 μm and the retrieved D_e. We find that on average effective ice crystal diameters lie between 30 and 60 μm and ice water paths lie between 20 and 35 g/m^2, depending on

season and latitude.

Correlations between these micro- and macrophysical properties and the state of the atmosphere, as described by the ECMWF ERA-40 reanalysis, have been established by collocating the two data sets. A parameterization of D_e as function of wind and water vapour content, as well as cloud top temperature and ice water path from TOVS will be presented.

This study is part of the European project CIRAMOSA (CIrrus microphysical properties and their effect on RAdiation: survey and integration into climate MOdels using combined SAtellite observations).

Rädel, G.; Stubenrauch, C. J.; Holz, R.; Mitchell, D. L.: Retrieval of effective ice crystal size in the infrared: Sensitivity study and global measurements from TIROS-N Operational Vertical Sounder, *J. Geophys. Res.* Vol. **108** No. D9, 10.1029/2002JD002801, 2003.

8.4 Synergistic Cloud Clearing and Cloud Property Retrieval Using Aqua Sounding and Imaging Infrared Measurements

Presenter: Hung-Lung (Allen) Huang

Hung-Lung Huang[1], Kevin Baggett[1], Elisabeth Weisz[1], Jun Li[1], and William L. Smith[2]
[1]Cooperative Institute of Meteorological Satellite Studies, University of Wisconsin - Madison
[2]Langley Research Center, NASA

High spectral resolution (~0.5 cm-1) infrared sounding and high spatial resolution (~1 km) infrared imaging measurements on board the NASA EOS Aqua satellite provide an unprecedented opportunity to characterize the full clear and cloudy sounding and cloud property retrieval capability that no single instrument has been able to achieve, up to now.

The Atmospheric Infrared Sounder (AIRS) has single field of view resolution at sub satellite point (i.e. nadir) of about 14 km. The clear sounding sampling probability is less than 10%. It requires the use of infrared measurements from multiple AIRS field of views and co-located microwave measurements to improve the yield of high performance clear sounding retrieval. Unfortunately, this procedure reduces the spatial resolution (from one single to 3 by 3 field of views, for example) and is also limited by the inhomogeneity (different types, phases, and heights) and contrast (difference of cloud fraction within each field of view) of the clouds within the processing footprint.

As part of International MODIS and AIRS Processing Package (IMAPP), AIRS sounding and cloud property retrieval will be demonstrated by the fusion of 1-km MODIS infrared radiances with the derived cloud mask and phase products. We will present the details of this synergistic procedure, performance of the cloud cleared radiances and the associated sounding and cloud property retrievals.

8.5 Characteristics of the Cloudy Atmosphere Observed the Atmospheric Infrared Sounder (AIRS)

Presenter: Evan Fishbein

By Evan Fishbein, Luke Chen and Sung-Yung Lee
Jet Propulsion Laboratory, California Institute of Technology

The Atmospheric Infrared Sounder (AIRS) derives surface and profiles quantities under partial cloudy conditions by estimating the clear sky component of the observed radiances. The procedure uses microwave and infrared radiances to provide independent estimates of the clear component. It also assumes variability at scales less than 50 km occurs only in the cloudy component. We are validating both the assumptions and results of the procedure. We compare clear sky radiances produced from forecasts with those from our algorithms. We compute the spatial coherency of the cloudy component and are examining its daily and seasonal variability.

8.6 Synergistic use of high spatial resolution imager and high spectral resolution sounder for atmospheric and cloud retrievals

Presenter: Jun Li

Jun Li, Timothy, J. Schmit@, Fengying Sun*, W. Paul Menzel@*

**Cooperative Institute for Meteorological Satellite Studies (CIMSS)*
University of Wiscon-Madison
Madison, WI 53706, U.S.A.

@NOAA/NESDIS, Office of Research and Applications
Madison, WI 53706, U.S.A.

High spatial resolution imager and high-spectral resolution sounder radiance measurements from

geostationary orbit will allow for monitoring the evolution of atmospheric profiles and clouds. Advanced baseline imager (ABI) and Hyperspectral Environmental Suite (HES) on GOES-R in 2012 and beyond will provide enhanced spatial, temporal and vertical information for atmospheric soundings and clouds operationally. ABI provides better information on cloud types and phase with high spatial resolution, while HES provides better information on cloud-top and emissivity. Combination of data from both instruments will provide improved cloud property retrievals than that from either alone. The Moderate-Resolution Imaging Spectroradiometer (MODIS) and Atmospheric Infrared Sounder (AIRS) measurements from EOS Aqua platform are used for the atmospheric and cloud property retrievals. The retrievals from combination of MODIS and AIRS data are compared with retrievals from either MODIS or AIRS alone, as well as the forecast analysis, to demonstrate the advantages on the atmospheric and cloud retrieval using combined high spatial and spectral imaging and sounding radiance measurements.

8.7 Estimates of the dynamics of volcano eruption column using real-time AVHRR

Presenter: Ignacio Galindo

Ignacio Galindo

Centro Universitario de Investigaciones en Ciencias del Ambiente (CUICA)
UNIVERSIDAD DE COLIMA,
Colima, México
galindo@ucol.mx

The physical properties of eruption plumes are studied for the eruption of Popocatépetl volcano which occurred on July 19, 2003 at 9:20 local time coincident with the NOAA-15 satellite pass. Computations are made using the AVHRR brightness temperature and radiance data obtained from the plume and the nearby environment. The results show besides the distribution of mass and the energy of the plume the thermal flux and the variation of velocity with height in the eruption column and the variation of the radial expansion velocity with radial distance according with Sparks (1986) and others. We believe that the introduction of AVHRR data into these calculations produces more reliable results.

SESSION 9

9.1 Diagnosing the Global Energy-Water Cycle with Satellite Observations

Presenter: William Rossow

William B. Rossow

As part of the World Climate Research Program, the Global Energy and Water Experiment (GEWEX) is, as its name suggests, attempting to diagnose the atmospheric energy-water cycle and its variations. Note that this cycle is central to determining the climate's sensitivity (feedbacks) to forced changes and plays a role in determining unforced climate variations by connecting all of the other components of the climate system. To achieve this, the GEWEX Radiation Panel (GRP) is working to assemble a complete diagnostic dataset that describes the main components of the energy-water cycle and its weather-scale variations over a period of a few decades to support research on these topics. Some of these datasets are ready now and appear to be of useful accuracy, some exist but their accuracy is not well known and some do not exist at all. The rationale for assembling this data collection and a summary of the current status will be presented. Since these data are now being used for climate research, the GRP is proposing that a careful assessment of their quality be carried out to: (1) set the stage for re-processing (if needed) to improve quality, (2) provide a better understanding of these data when used for analyses of the energy-water cycle and (3) to support the next IPCC assessment, which will focus on water. Given the expertise in the ITWG, GRP proposes to partner with ITWG for the assessment of satellite-based tropospheric water vapor data products. It might make sense for this task to be combined with a complete assessment of tropospheric and surface temperature measurements from satellites as well.

9.2 Climate variability and change of tropical tropospheric humidity as observed by HIRS

Presenter: Mark McCarthy

Mark McCarthy[1] & Ralf Toumi[2]
[1]Hadley Centre of Climate Prediction and Research, Met Office, UK
[2]Imperial College, London, UK

We review some of our results from analysing the Upper Tropospheric Relative Humidity (UTRH) product of J.Bates et al. (2001) from the High Resolution Infra-Red Sensor (HIRS) for the period 1979-98.

The only mode of interannual variability that can be identified in the HIRS record are UTRH variations following patterns of anomalous convection associated with El Nino and the Southern Oscillation (ENSO).

We describe the seasonal pattern of this variability and show that extremes in UTRH during the northern hemisphere winter of an ENSO event are dominated by regional changes in tropospheric temperatures. Atmosphere-ocean dynamics coupled with the seasonal cycle in UTRH can result in regional UTRH anomalies during the following summer season. We further discuss the importance of being able to simultaneously diagnose temperature and humidity products in climate research, and radiosonde data are used to highlight differences in temperature-humidity relationships over a range of space and time scales.

The HIRS dataset contains significant regional trends characterised by increasing humidity over Africa, the West Indian ocean and the Amazon, and decreasing humidity over the southern hemisphere convergence zones and subtropics. We show that changes in ENSO, or a simple intensification of the Hadley circulation are inadequate to describe these observations, a number of alternative scenarios are discussed, including the suitability of the current version of the HIRS dataset for trend analysis.

The results are presented with comparison to those produced by the atmosphere only model HadAM3 forced with observed SSTs for the same period.

9.3 Use of radiances data in ERA-40

Presenter: Graeme Kelly

Graeme Kelly
ECMWF, United Kingdom

At ECMWF a re-analysis has been completed using all available satellite and conventional data from 1967 to 2002. A reduced resolution version of the ECMWF operational IFS system (3D-VAR at 60 levels and horizontal resolution of TL 159 (120 km) was used for the data assimilation system. The use of satellite radiances started with VTPR radiances in 1973 and radiances were used directly in the assimilation from VTPR, HIRS, MSU, SSU, and AMSU. SSMI radiances where input to a pre-processing 1D-VAR and the retrieved products of total precipitable water and wind speed were then assimilated in the 3D-VAR analysis. Some of the difficulties that arose with the satellite data during the re-analysis discussed. The re-analysis was highly successfully but it is clear that further re-analyses could be further improved with the knowledge obtained from ERA40 about the performance of the satellite sensors.

9.4 Understanding the difference between the UAH and RSS retrievals of satellite-based tropospheric temperature estimates

Presenter: Carl Mears

Carl Mears and Frank J. Wentz
Remote Sensing Systems

Abstract not available.

9.5 The use of MSU in climate change studies

Presenter: Peter Thorne

Peter Thorne, Simon Tett, & David Parker
Hadley Centre for Climate Prediction and Research, Met Office, UK

We briefly summarise our recent research using two independently produced MSU climate timeseries.

We illustrate the use of MSU products in attempts to resolve the observed discrepancy between a significant surface warming and little tropospheric temperature change within the tropics over the satellite period. This is contrary to climate model predictions of increasing warming aloft under anthropogenic forcings. We use MSU data both to inform and to test our hypothesis that this disagreement occurs because tropical tropospheric temperature evolution on climate timescales is a two-boundary problem with both surface and stratospheric constraints.

We also show how MSU data can be usefully used to inform us as to the potential causes of recent climate change. Space-time global optimal detection studies using a climate-model yield significant both natural and anthropogenic climate change signals within tropospheric MSU timeseries. This result is shown to be insensitive to the choice of MSU dataset within the mid to upper troposphere. For stratospheric temperatures our analyses imply that the model significantly overestimates the response - most likely because it has too much ozone reduction in comparison to recent observations.

9.6 Plans for a Collocated Radiosonde and Satellite Upper Air Network (SUAN)

Presenter: Tony Reale

Tony Reale
NOAA/NESDIS
Washington DC 20233

The problem of absolute scientific calibration and

validation of polar satellite radiometers, and the lack of a dedicated global program to provide such data since the onset of the TOVS operational series satellites in 1979, has resulted in a serious problem concerning the identification and removal of systematic bias and uncertainty in the long-term record of satellite data. This has turned out to be a major problem particularly for climate applications where such errors or jumps in the long term record of measurements and/or derived products can easily overwhelm the sensitive climate signals being sought, as well as for shorter term numerical weather prediction (NWP) applications for which such differences can introduce measurements bias and/or increased noise mitigating their impact.

Over the past year or so several user groups from the climate, NWP and satellite community have recognized this inherent weakness and have recommended that the requirements for the global radiosonde network be expanded to include polar satellite scientific calibration and validation. During January, 2003, the NOAA Council on Long-term Climate Monitoring (CLTCM) forwarded several carefully worded recommendations for establishing a small network of reference radiosondes coincident with overflying (polar) satellites for absolute calibration of global atmospheric temperature and moisture, citing the specific need for long-term planning to obtain accurate global temperature and moisture measurements via integrated global observing systems which include redundant data platforms.

Later in March, 2003, a "Workshop to Improve the Usefulness of Operational Radiosonde Data" was held at the National Climatic Data Center (NCDC) in Asheville, North Carolina. Recommendations from this diverse group of radiosonde users and experts from the NWP, climate and satellite community formally recognized that the requirements for global radiosondes clearly extend to the satellite community, citing the need for absolute scientific calibration of satellite measurements, products and scientific algorithms (i.e., radiative transfer fast codes) against "reference" radiosondes. Similar to CLTCM, the Workshop recommend that a small network of global (reference) radiosondes coincident with operational (and research) polar satellite overpass be established. However, the Workshop went on to recommend basic guidelines for selecting candidate sites, for example, that selected sites not interfere with established climate records and NWP requirements for synoptic observations. The group also noted the problem of radiosonde measurement errors, their association with the various radiosonde instrument types, changes that have occurred over time, and the potential importance of past and future collocations with satellite overpass to resolve these errors. Finally the Workshop recommended that the International TOVS Study Conference be consulted in setting up this Satellite Upper Air Network (SUAN).

The following report summarizes activities over the past several months to establish a preliminary network of candidate SUAN sites, including site selection based on previous climate and NWP requirements, the radiosonde type flown and adequate global distribution.

SESSION 10

10.1 GeoSTAR - A New Approach for a Geostationary Microwave Sounder

Presenter: Bjorn Lambrigsten

Bjorn Lambrigtsen
Jet Propulsion Laboratory

The Geostationary Synthetic Thinned Aperture Radiometer (GeoSTAR) is a microwave atmospheric sounder, with capabilities similar to those of the AMSU-A/B system, and is intended for deployment in geostationary orbit - where it will complement future infrared sounders to enable all-weather temperature and humidity soundings. It also has the capability of mapping rain rates, and it can be deployed in medium earth orbits as well. GeoSTAR is based on spatial-interferometric principles and uses a stationary array of a large number of individual receivers to synthesize a large aperture and achieve the required spatial resolution, an approach that has significant advantages over conventional real-aperture systems - such as full-disk scanning with no moving parts. GeoSTAR will implement the same tropospheric sounding channels as AMSU-A (temperature) and AMSU-B (humidity) and will achieve an initial spatial resolution of 25-50 km. Future versions will have significantly higher spatial resolution. The required technology is currently being developed at the Jet Propulsion Laboratory and other collaborating organizations, under NASA's Instrument Incubator Program, and a ground based demo system will be ready in 2005.

10.2 NPOESS VIIRS sensor design and performance

Presenter: Jeffrey Puschell

Carl F Schueler, Jeffery J. Puschell, J. Edward Clement, et al.
Raytheon Santa Barbara Remote Sensing

This presentation summarizes the anticipated performance of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Visible Infrared Imaging Radiometer Suite (VIIRS) sensor. Predictions are generated from models and demonstration hardware based on the design. VIIRS risk-reduction will continue as the Engineering Development Unit (EDU) is assembled and tested over the next year facilitating performance verification and lowering flight unit development risk.

10.3 Overview of the CrIMSS (CrIS/ATMS) retrieval algorithm

Presenter: Xu Liu

Xu Liu and Jean-Luc Moncet,
AER, Inc

AER is the retrieval algorithm developer for the Cross Track Infrared and Microwave Sounder Suite (CrIMSS), which will fly onboard of NPP and NPOESS platforms. The infrared component of the CrIMSS is an interferometer-based Cross-Track Infrared Sounder (CrIS). The microwave component is an Advance Technology Microwave Sounder (ATMS). The radiative transfer forward model uses an innovative parameterization, which models both radiances and weighting functions accurately and efficiently. The inversion algorithm uses a physical retrieval method to retrieve atmospheric and surface properties from both microwave and infrared sensors. Different strategies for dealing with clouds will be discussed. Some results of applying the CrIMSS algorithm to real data will be presented.

10.4 IASI on Metop : an Advanced Sounder for Operational Meteorology and Climate studies

Presenter: Thierry Phulpin

T. Phulpin, G. Chalon and D. Blumstein
Centre National d'Etudes Spatiales, 18 avenue E. Belin, 31401 Toulouse cedex 9 - France

IASI is a new generation infrared vertical sounder developed jointly by CNES and EUMETSAT that will be embarked on METOP 1 to 3. 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 instrument is composed of a Fourier transform spectrometer and an associated infrared imager. The optical configuration is based on a Michelson interferometer and the interferograms are processed by an on-board digital processing subsystem, which performs the inverse Fourier transforms and the radiometric calibration. The infrared imager co-registers the IASI soundings with AVHRR imager (AVHRR is another instrument on the Metop satellite).The first flight model has just been delivered by the prime Alcatel to be integrated in the next months on METOP 1. Its radiometric performances are compared to its specifications.

The operational software for level 1 and level 2 is currently under development respectively under CNES and Eumetsat responsibility. The Level 1 processing is devoted to deliver to end users very well calibrated and located radiance spectra. Its functions and parameters will be established , monitored and updated by the TEC. A calibration/validation plan to ascertain level 1 data quality has been defined.

Based on actual current instrument performances, simulations performed in the framework of preparatory studies by the IASI sounding study working group (ISSWG) show that with the current assimilation or inversion techniques, mission requirements are met.

10.5 The Operational IASI Level 2 Processor

Presenter: Peter Schluessel

Peter Schluessel
EUMETSAT

The operational IASI (Infrared Atmospheric Sounding Interferometer) Level 2 processor will be part of the EPS (EUMETSAT Polar System) Core Ground Segment). Starting with Level 1c data the IASI Level 2 processor generates vertical profiles of temperature and humidity, ozone columns of deep layers, and columnar amounts of carbon monoxide, nitrous oxide, and methane, as well as surface temperature, surface emissivity, cloud amount, cloud height, and cloud phase. The processor not only makes use of IASI data but also utilises information from the companion instruments AVHRR (Advanced Very High Resolution Radiometer), AMSU-A (Advanced Microwave Sounding Unit A), and MHS (Microwave Humidity Sounder), as well as Level 2 products from the Advanced TIROS Operational Vertical Sounder (ATOVS).

The processor functionality can be broadly broken down into three parts, the pre-processing, the cloud-detection, and the retrieval step. In the pre-processing all data are checked for availability and are validated against valid thresholds and co-located with IASI by interpolation or nearest match-up. Land-sea mask and surface topography distribution are generated for each IASI instantaneous field of view (IFOV) and weighted with the corresponding point spread function. Depending on user-configuration and data availability a number of cloud detection tests are executed, based on IASI data alone, or using IASI in combination with AVHRR and/or ATOVS. The AVHRR scenes analysis is used to determine cloud amount, cloud height distribution, and the number of cloud formations within an IASI IFOV. Different retrieval types are foreseen. In the cloud-free case the parameters to be derived are temperature and water-vapour profiles, ozone amounts in deep layers, columnar amounts of carbon monoxide, methane, and nitrous oxide, surface temperature, and surface emissivity at different wavelengths. In cloudy situations, the number of retrieved parameters can change according to cloud amount and user choice. It is foreseen that parameters are derived above clouds only, or in case of low cloud amounts, that a cloudy retrieval or a variational cloud clearing is performed. The retrieval techniques implemented are statistical retrievals based on EOF regression and artificial neural network methods for the first retrieval, and a variational Marquardt-Levenberg method employing IASI super-channels and/or AMSU-A and MHS channels. The result from the first retrieval can constitute the final product, or it can be fed as initial guess into the simultaneous iterative retrieval. The final product will be accompanied by a compressed error covariance matrix.

10.6 Joint Temperature, Humidity, Ozone, and SST Retrieval from IASI Sensor Data

Presenter: Marc Schwaerz

Marc Schwaerz and Gottfried Kirchengast, Institute for Geophysics, Astrophysics, and Meteorology (IGAM), Graz, Austria

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 2005). 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 and climate change and variability studies (e.g., of the El Nino phenomenon) will benefit from these improvements. The aim of our data analysis preparation 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 discuss a joint retrieval algorithm of temperature, humidity, ozone, and SST (more precisely, the latter is the surface skin temperature of the ocean), which we developed based on optimal estimation methodology and which we carefully tested under 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% only (~250), which are subsequently used in the retrieval processing. We show that this reduction is possible without any performance decrease compared to using many more (order 1000) channels. The clearly improved performance of the joint algorithm compared to more specific retrieval setups is exemplified as well. Finally, the application of the algorithm to AIRS (Advanced Infrared Sounder) data, a next step planned, is addressed.

10.7 Dust Storm Mornitoring and Quantitative Prediction Experiment with NWP in Northeast Asian

Presenter: Dong Chaohua

DONG Chaohua

From spring to early summer, dust storms frequently occur in Northeast Asian (in some places throughout the year). Northern China was seriously affected by the dust storm and dust weather system in spring. These dust storm and dust weather systems are generally generated in the droughty and part droughty area of middle latitudes, which just have a rare vegetation coverage, as strong winds entrain large quantities of dust particles into the atmosphere and carry them over large distances downstream. These dust storms have a severe impact upon the air quality in regions downwind of the dust sources. The real-time monitor and prediction of dust storms therefore are highly desirable as a meteorological service to the public.

Payload of meteorological satellites has several spectral regions locating at visible, near infrared,

infrared and microwave bands. So the satellite sensors can receive reflection, emission and absorption from the observed targets, such as aerosol, clouds, and earth's surface. Based on different spectrum performance, the geophysical parameters can be obtained.

As the meteorological satellites have a wide monitoring scale, good time frequency and spatial resolution, high precision, it is the most effective way for monitoring dust storms. A 24-hour operational dust storm monitoring system by using both geostationary and polar orbiting satellite data was established in NSMC/CMA on March 1, 2001. With this system, we can dynamically monitor dust storm, analyze dust storm sources and transport paths, as well as calculate dust storm influencing range and aerosol strength.

The form of dust storm is a very complicated physical process, such as atmospheric movement, type of land surface, dust emission etc. The prediction model of dust activities must involve the key processes of dust emission, dust transport and dust deposition. It requires the coupling of the dust emission scheme with an atmospheric model, supported by other modules and adequate land-surface parameter, i.e., the establishment of an integrated modeling system.

In order to test the integrated modeling system, a joint working group in which the scientists are from the different parts, suth as the CMA, the Chinese Academy of Science and City university of Hong Kong, China, did 24, 48 and 72hr forecasts of Northeast Asian dust events for march and April, 2002. The results are validated with synoptic records from the meteorological network and dust concentration measurements at 12 stations in China, Japan and Korea. The predicted spatial patterns and temporal evolution of dust events and the predicted near-surface dust concentrations are found to agree well with the observations. The successive forecasts of near surface dust concentration for the 10-day period between 15 and 24 March 2002 are compared with observations. It demonstrates that the modeling system well predicted the spatial distributions and temporal evolutions of all dust events in this period of time.

We have determined the total dust emission, total dust deposition and total dust load for the entire domain of simulation and have found that the total dust emission is on average 11.5 $x10^6$ tn day^{-1} (maximum 65.7 $x10^6$ tn day^{-1}); total dust deposition is 10.8 $x10^6$ tn day^{-1} ((maximum 51.4 $x10^6$ tn day^{-1}) and total dust load is 5.5 $x10^6$ tn with a maximum of 15.9 $x10^6$ tn.

10.8 SIRAS-G, The Spaceborne Infrared Atmospheric Sounder: The potential for high-resolution infrared imaging spectrometry from geosynchronous orbit

Presenter: George Aumann (for Thomas Kampe)

Thomas U. Kampe
Ball Aerospace & Technologies Corp., Boulder Colorado, USA

Thomas S. Pagano
NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA

The Spaceborne Infrared Sounder for Geosynchronous Earth Orbit (SIRAS-G) represents a new approach to infrared imaging spectrometry suitable for Earth observation from geosynchronous orbit. SIRAS-G, selected for development under NASA's 2002 Instrument Incubator Program (IIP-4), is an instrument concept with lower mass and power requirements than contemporary instruments while offering enhanced capabilities for measuring atmospheric temperature, water vapor, and trace gas column abundances in a compact package. SIRAS-G utilizes grating spectrometers to provide the high spectral resolution, building off the experience of AIRS. The SIRAS-G concept is adaptable to airborne, low-Earth orbit and geosynchronous deployment. The flight instrument concept is designed to measure infrared radiation in 2048 spectral channels with a nominal spectral resolution $(\Delta\lambda/\lambda)$ of between 700 and 1100. SIRAS-G employs a wide field-of-view hyperspectral infrared optical system that splits the incoming radiation to four separate grating spectrometer channels. Combined with large 2-D focal planes, this system provides simultaneous spectral and high-resolution spatial imaging. In 1999, the SIRAS team built and tested SIRAS spectrometer No. 4 (12.3 - 15.4μm) under NASA's Instrument Incubator Program (IIP-1). SIRAS-G builds on this experience with a goal of producing a laboratory demonstration instrument including the scan assembly, telescope, a single spectrometer channel, focal plane and active cooling subsystem. In this paper, we describe planned development activities, including the fabrication and testing of the demonstration instrument. Performance predictions for several candidate future scientific missions are presented and the potential benefits to science retrievals due to enhanced spatial resolution are discussed.

10.9 Introduction of the Hyperspectral Environmental Suite (HES) on GOES-R and beyond

Presenter: Jun Li (for T. Schmit)

Timothy J. Schmit[#], and James Gurka[@]

[#]Office of Research and Applications
NOAA/NESDIS
1225 West Dayton Street
Madison, WI 53706
[@]Office of System Development
NOAA/NESDIS
Suitland, Maryland

The Hyperspectral Environmental Suite (HES) on GOES-R in 2013 will provide high spatial (better than 10 km), high temporal (better than 1 hour), high spectral resolution (single wavenumber), measurements with rapid coverage rate for observing the evolution of atmosphere and clouds. The HES has been expanded to include other capabilities for environmental monitoring of the ocean and land. HES, together with the Advanced Baseline Imager (ABI), will provide visible, near-infrared and infrared radiance measurements for improving weather monitoring and forecasting. The requirement for HES disc sounding (DS) and severe weather/meso-scale (SW/M) modes are introduced in this talk, and various simulations are carried out to demonstrate the superiority of HES over the current GOES sounder system. Atmospheric Infrared Sounder (AIRS) measurements are also used for the HES performance studies.

POSTER SESSION A: THURSDAY

A01: Advanced TOVS (ATOVS) Cloud Products Using HIRS/3 and AMSU-A Measurements

Presenter: Michael Chalfant

Michael W. Chalfant
Office of Research and Applications / NESDIS / NOAA, Washington DC

Franklin H. Tilley
ITSS Division / Raytheon Corporation, Lanham MD

The National Oceanic and Atmospheric Administration (NOAA) , National Environmental Satellite Data and Information Service (NESDIS) currently produces a suite of operational quality cloud products from the Advanced TIROS Operational Vertical Sounder (ATOVS) system using the High-resolution Infrared Radiometer Sounder (HIRS/3) and Advanced-Microwave Sounding Unit (AMSU-A) instruments onboard the NOAA polar orbiting satellites. These global products include Cloud Top Temperature, Cloud Top Pressure and Cloud Amount, in support of NESDIS' commitment to improve Short Term Warnings and Forecasts. The ATOVS cloud products are dependent upon the generation of accurate temperature and moisture retrievals for both the generation of a correction for the attenuation of radiances above the cloud tops as well as the determination of cloud top pressure.

The ATOVS cloud products are generated using the CO2 Slicing technique, at each HIRS/3 Field-of-View (FOV). These products are also output to 1 X 1 degree gridded fields, for ascending and descending orbital passes and separated into Total, High, Medium and Low pressure layers, where the parameters are calculated as a function of the Effective Cloud Fraction. The ATOVS cloud products, at the sounding location are being archived and distributed via AWIPS, to NWS field forecast offices. Two cloud product statistical tables are generated globally and updated daily on the NESDIS web site, for comparison with other cloud product systems as well as assessing the performance of the ATOVS cloud product system.

The ATOVS cloud products have been undergoing extensive evaluation by NESDIS and National Weather Service (NWS) personnel for possible use in regional and global Numerical Weather Prediction (NWP) forecasts. Comparisons of the ATOVS Cloud products with several other cloud product generation systems such as the ATOVS temperature retrieval Cloud Mask; the AVHRR/3 based CLAVR-x and UK Meteorological Office's Clear Fraction; GOES and the USAF RTNEPH, have resulted in substantial improvement in the coverage of retrieved marine stratus plus providing for an independent quantative verification of the ATOVS cloud parameter values. This paper describes the algorithms for deriving these cloud products as well as the scientific and system upgrades which have resulted in significant increases in both cloud product accuracy and coverage.

A02: Meteorological Products Generation Using Combined Analysis of ATOVS and AVHRR Data

Presenter: Izabela Dyras

Izabela Dyras, Danuta Serafin-Rek, Zofia Adamczyk
Institute of Meteorology and Water Management, P. Borowego 14, 30-215 Kraków

The satellite observations in different waveband ranges provide the important information on the state of the atmosphere that is used for weather analysis and forecast. Combining these data into one system encounters problems due to the data various range as

well as temporal and spatial resolution. On the other hand such system is a useful tool for the data analysis and presentation.

The paper presents the progress in the cloud analysis on NOAA AVHRR images as well as in algorithms allowing the retrieval of various parameters from NOAA AMSU data in the Satellite Research Department, Institute of Meteorology and Water Management in Poland. The combined analysis maps are created and then disseminated via Intranet to the regional forecasting offices. Such satellite maps enhance the ability to diagnose the meteorological parameters e.g., precipitation using satellite imagery.

The prepared meteorological products for Poland include several thematic layers such as precipitation intensity and range, convective clouds' detection, Total Precipitable Water estimation. A case study from 12th of August, 2002 will be included to present the system's functionality.

The GIS technology is used for preparation and visualisation of the products and allow to overlay data derived from various other sources including ground measurements, NWP analysis and forecast, lightning system, geographical data and administrative boundaries.

A03: Multi-spectral rain-rate retrieval from AMSU and AVHRR

Presenter: Aarno Korpela

A.V. Korpela, M.J. Uddstrom
National Institute of Water and Atmospheric Research (NIWA)
Private Bag 14 901
Wellington
New Zealand

We have previously described the development of NIWA ATOVS Collocation Archive (NACA) at ITSC-X and ITSC-XI. The archive collocates AMSU level 1d AAPP data and AVHRR locally derived products with Doppler weather radar data, at high spatial accuracy (1 km) and temporal resolution (7.5 min), preserving information at sub-AMSU instantaneous field of view scale. The relationship between AMSU observations and rain-rate, including beam-filling effects is investigated through analysis of the NACA archive, identifying rain signatures. For the development of rain retrieval algorithm, those AMSU-B ifovs that contain no precipitation are used to derive a relationship between the 89 and 150 GHz data in the absence of scattering. Scattering index can then be defined as the difference between the modelled (scatter free) 150 GHz brightness temperature and the measured 150 GHz brightness temperature. Rain-rate scattering algorithm from NACA is based on rain signal in the scattering index. By combining the AMSU data with the AVHRR derived within-ifov cloud data, characterizing the rain processes, it is possible to further refine the accuracy of the scattering index method, leading to rain-rate retrievals with $R^2 > 0.69$. The details of the method and validation results will be presented, demonstrating the capability of the combined microwave, infrared, and visible rain-rate algorithm to produce spatially accurate rainfall estimates of value in nowcasting, rain-process studies, and the identification of radiative contaminants in the observations used in numerical weather prediction models (e.g., the New Zealand Limited Area Model, NZLAM-VAR).

A04: A Research of Four-dimension Variational Data Assimilation with ATOVS Clear Data

Presenter: Ma Gang

Ma Gang
National Satellite Meteorological Center, Beijing 100081
Wang Yunfeng
LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing ,100029
Fang Zongyi
National Satellite Meteorological Center, Beijing 100081

Satellite vertical sounding data, which represent the three-dimension distribution of atmospheric state at that time, are based on infrared and microwave observations of meteorological satellite. Nowadays more and more deducing atmospheric parameters from satellite vertical sounding data and other satellites data are applicated in numerical weather forecast. In order to use as many as these data high spatial resolution, a four-dimension data assimilation scheme is developed to introduce them into a numerical weather prediction model. Then the quality of model's initial field is therefore improved. And the model physical parameters such as wind and water vapor become more rational.

In this paper a variational assimilation method is used. In this method, a MM5 mesoscale model and its adjoint model that are used as dynamic restriction. As well as conventional sounding data, ATOVS radiance data from satellite and retrieved air temperature and water vapor profiles from ATOVS data are introduced into our system by an observational operator and its adjoint operator simultaneously. While the initial

variables (approximate atmospheric situation) in the model domain are given, upwelling-radiance on the top of atmosphere for each channel of ATOVS will be calculated by the integral of a fast radiation transfer model (RTTOV). Therefore the ATOVS data are integrated into the four-dimension mesoscale variational data assimilation system for both analyzing and forecasting. Then a more precise initial model input and thus a more accurate forecast can be obtained by these coherent variables of atmospheric situation.

In order to check the impact of ATOVS data on model forecast, data from T106 and ATOVS during 19-26, July, 2002 are used. First we get the impact from the initial model field only with the conventional sounding data variational assimilation on the predicted atmospheric state and the temporal and spatial precipitation distribution. Then the ATOVS clear-radiance is introduced into the assimilation system to get the impact on the model prediction. At last the impact of retrieved profile from ATOVS data is performed. To confirm these impacts we design three tests. At first we assimilate the model initial filed only with air temperature and no atmospheric moisture; and in the second test the assimilation of the model initial fields only with the moisture and without air temperature is proved to have positive effect on the simulated precipitation. In the last one both the air temperature and water vapor from ATOVS clear-radiance is assimilated to see how it improves the model prediction.

A05: Variational retrievals within the summertime eastern Pacific environment using ATOVS with the COAMPS™ mesoscale forecast system

Presenter: Nancy Baker

Grant A. Cooper[123], Nancy L. Baker[2], and Philip A. Durkee[3]

[1]U.S. Navy Fifth Fleet, Bahrain
[2]Naval Research Laboratory, Monterey, CA
[3]Department of Meteorology, Naval Postgraduate School, Monterey, CA

A one-dimensional variational (1DVAR) retrieval scheme has been used to investigate the complex relationship between satellite-derived information and a priori constraint. Specifically, we investigate the ability of the Advanced TIROS Operational Vertical Sounder (ATOVS) to contribute information within the summertime eastern Pacific (EPAC) environment to a mesoscale numerical weather prediction system (the Coupled Ocean - Atmosphere Mesoscale Prediction System (COAMPS™) and the Naval Research Laboratory (NRL) Atmospheric Variational Data Assimilation System (NAVDAS)).

Analyses of information content and theoretical retrieval performance show that, when treated optimally, significant humidity and temperature information can be derived from ATOVS infrared and microwave retrievals within the clear and cloudy sky summertime EPAC environment. A study of theoretical retrieval error sensitivity to representative EPAC background state vector elements and associated errors was also conducted to establish the a priori elements critical for successful 1DVAR retrievals.

1DVAR profile temperature and humidity retrievals were generated using both simulated and actual ATOVS observations constrained by the COAMPS 6-hr forecasts and a synoptically relevant background error covariance matrix. The time period of interest coincides with the Dynamics and Chemistry of Marine Stratocumulus (DYCOMS) Phase II field study. The 1DVAR results are consistent with the theoretical information content study and indicate that these satellite observations can provide information that, when used in concert with a reasonable first-guess background (i.e., from COAMPS), reduce the retrieval error and adjust the retrieval within the shallow boundary layer toward the designated “true” profile.

The generally good agreement between theoretical retrieval errors and the error statistics calculated using non-linear Newtonian iteration demonstrates consistency and reliability of the NRL 1DVAR retrieval scheme.

COAMPS is a trademark of the Naval Research Laboratory.

A06: The Assimilation of Satellite Observations for the U.S. Navy’s Operational Forecast Models

Presenter: Nancy Baker

Nancy L. Baker[1], Clay Blankenship[1], Bill Campbell[1], Rolf Langland[1], Steve Swadley[2]*
[1]Naval Research Laboratory, Monterey, CA
[2]METOC Consulting, Monterey, CA

Scientists at the Marine Meteorology Division of the Naval Research Laboratory have recently developed a new three-dimensional variational system NAVDAS (NRL Atmospheric Variational Data Assimilation

System). NAVDAS is slated to replace the multivariate optimum interpolation analysis system this fall for both the global and mesoscale atmospheric forecast models run operationally at the U.S. Navy's Fleet Numerical Meteorology and Oceanography Center.

NAVDAS is designed to assimilate a variety of satellite observations, including visible and infrared cloud-tracked and water vapor winds, scatterometer winds, radiances or retrievals for polar orbiting sounders, and the Special Sensor Microwave Imager (SSM/I) surface wind speed and total precipitable water. In addition, the adjoints of global forecast model (NOGAPS) and NAVDAS are used to compute the sensitivity of the forecast error to the observations and to the assigned observation error, and to estimate the impact of the observations on the forecast error. These statistics may be used to tune NAVDAS.

This presentation will describe assimilation details and results from AMSU-A and AMSU-B radiance assimilation tests. Observation impact statistics compiled from several months of assimilation/adjoint runs will also be presented and discussed. Finally, results from data assimilation runs where the observation usage has been modified as suggested by the adjoint calculations are presented.

A07: Long-Term Temperature Time Series Constructed from "Morning" Satellites

Presenter: Mitch Goldberg

M.D. Goldberg and Zhaohui Cheng
NOAA/NESDIS/STAR, Camp Springs, MD, USA

There has been much debate about the magnitude of decadal temperature trends in the mid troposphere derived from the MSU. Temperature trends from Christy and Spencer, and Wentz et al. at RSS are derived by combining all observations from "morning" and "afternoon" satellites to a given local time. In addition to computing offsets between the different satellites (i.e. intercalibration), special attention is needed to account for the drift in the equator crossing times (i.e. changes in the diurnal cycle), which can be quite large for the "afternoon" satellites. These adjustments of course are not perfect and will result in uncertainty in the trends. Our approach is to avoid these adjustments by constructing MSU/AMSU time series from "morning" satellites (NOAA-10 , NOAA-12 and NOAA-15). The drift of the morning satellites is very small (within 1 hour) and can be ignored completely when constructing ocean-only time series. Another feature of using "morning" satellites is that the data can be separated into ascending and descending orbits allowing time series to be generated for two nominal local times - 7:30 AM and 7:30 PM. We find that the trend at 7:30 AM is larger than 7:30 PM. Details of our methodology and results for different regions are discussed.

A08: Progress towards a climate-quality data set from MSU channel 1

Presenter: Carl Mears

Carl A. Mears, Matthias C. Schabel, and Frank J. Wentz
Remote Sensing Systems
438 First Street, Suite 200
Santa Rosa, CA 95401 USA

Climate monitoring research using the MSU and AMSU instruments has focused on direct measurements of the middle troposphere and lower stratosphere using MSU channels 2 and 4, and their (nearly) corresponding channels on AMSU1,2 as well as indirect measurements of the lower troposphere obtained by differencing measurements from different incidence angles to obtain the synthetic '2LT' channel1. Analysis of MSU channel 1, which has a atmospheric vertical weighting function that peaks near the surface, is complicated by the large contribution of surface emission to the measured brightness temperatures. Over land, the extraction of a climate quality data set may be impossible due to the large diurnal cycle in surface temperature, as well as large changes in surface emissivity as soil moisture, vegetation extent, and snow cover on a variety of time scales. Over the ocean, the situation is significantly better, since the oceanic emissivity is both lower and much better characterized. In this presentation, we summarize our progress towards a climate quality data set over the oceans. We are currently using our comprehensive ocean surface model (which we also use to retrieve ocean surface winds from SSM/I, TMI and AMSR) to remove the effects of surface emission from the MSU channel 1 data, and CCM3 model output to remove the effects of the diurnal cycle.

1. Christy, J.R., et al., "Error Estimates of Version 5.0 of MSU/AMSU Bulk Atmospheric Temperatures." *Journal of Atmospheric and Oceanic Technology*, 2003. In Press.
2. Mears, C.A., M.C. Schabel, and F.J. Wentz, "A reanalysis of the MSU channel 2 troposperic temperature record." *Journal of Climate*, 2003. In Press.

A09: Comparison of AMSU-B Brightness Temperature with Simulated Brightness

Temperature using Global Radiosonde Data

Presenter: Viju Oommen John

By V. O. John, S. A. Buehler, and M. Kuvatov, IUP, University of Bremen, Germany

We present a comparison of brightness temperature measured by AMSU to radiative transfer model calculations based on radiosonde data. The forward model used is the stable version of the Atmospheric Radiative Transfer Simulator (ARTS), a general purpose radiative transfer model which can handle many different remote sensing instruments in the millimeter to infrared spectral region. The atmospheric profiles used are the Met Office - Global Radiosonde Data taken from the British Atmospheric Data Centre (BADC). The comparison is done for 82 stations from 15 European countries, the countries participating in COST Action 723.

As the forward model ARTS has already been validated against AMSU brightness temperatures using high resolution radiosonde data from Lindenberg which is a reference station for German Weather service (DWD), the main aim of this comparison is to check the quality of the radiosonde data from the different stations. The poster will present the methodology of the comparison, final results of the forward model validation, and how the quality check is made for the radiosonde stations.

A10: The ITWG Web Site: Creating a Useful Forum for the Community

Presenter: Leanne Avila

Leanne Avila
CIMSS/University of Wisconsin-Madison

Following the election of the new Co-Chairs, Roger Saunders and Tom Achtor, maintenance of the ITWG web site was transferred to the webmaster at CIMSS (home institution of Tom Achtor - http://cimss.ssec.wisc.edu/itwg/). Working closely with the Co-Chairs, the new ITWG webmaster undertook the task of redesigning the site to create not only a more aesthetically pleasing page, but also to create a more useful forum for the ITWG community. News and Highlights have been added to provide a more dynamic element to the site. Numerous updates, including practical information, regarding this ITSC conference have been posted to the ITWG web site to encourage users to continue to visit. We will continue to find ways to enhance the usefulness of the site with input from the community.

A11: The International ATOVS Processing Package (IAPP)

Presenter: Tom Achtor

Thomas Achtor, Jun Li, and Hal Woolf
Cooperative Institute for Meteorological Satellite Studies (CIMSS)
University of Wisconsin-Madison

The International ATOVS Processing Package (IAPP) has been developed to retrieve the atmospheric temperature profile, moisture profile, total ozone and other parameters in both clear and cloudy atmospheres from ATOVS radiance measurements. The IAPP algorithm retrieves the parameters in 4 steps: 1) cloud detection and removal; 2) bias adjustment; 3) regression retrieval; and 4) nonlinear iterative physical retrieval. A publication by Li, Wolf, Menzel, Zhang, Huang and Achtor, Journal of Applied Meteorology (August 2000) provides details on the algorithms. This poster will describe in detail the ITPP processing technique with examples of output products. Information on how to obtain the ITPP is also available.

A12: Software Packages for Direct Broadcast Data Processing of EOS MODIS and AIRS/Microwave Radiances

Presenter: Tom Achtor

Allen Huang, Thomas Achtor, Liam Gumley
Cooperative Institute for Meteorological Satellite Studies (CIMSS)
University of Wisconsin-Madison

The Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison, USA, has a long history of software development to acquire and process radiances measurements from polar orbiting and geostationary weather satellites. Since 1983, CIMSS has worked with the International TOVS Working Group (ITWG) to create the International TOVS/ATOVS Processing Packages (ITPP/IAPP). CIMSS has also worked with NASA and the Earth Observing System (EOS) direct broadcast community to create the International MODIS/AIRS Processing Package (IMAPP). This paper describes these software packages and their products.

INTERNATIONAL MODIS/AIRS PROCESSING PACKAGE (IMAPP)
Within the NASA Earth Observing System (EOS) program, a direct broadcast capability was created for MODIS and AIRS radiance measurements. The

NASA Earth System Enterprise provided support to the University of Wisconsin CIMSS to develop processing software for MODIS and AIRS. The objective is to develop a software package for international distribution which allows any ground station capable of receiving EOS direct broadcast data to produce a suite of geophysical products in near real-time (within 1 hour of satellite overpass). This objective will allow NASA to directly involve the international community in the use and validation of EOS data sets.

The International MODIS/AIRS Processing Package (IMAPP) allows any ground station capable of receiving direct broadcast from Terra or Aqua to produce calibrated and geolocated MODIS or AIRS radiances (Level 1), along with a select group of science products (Level 2). IMAPP is derived from the operational MODIS processing software developed at NASA GSFC, and is modified to be compatible with direct broadcast data.

The most recent version of IMAPP MODIS Level-1 software supporting Terra and Aqua (v1.4) was released to the international EOS direct broadcast community in September 2002. The initial release of IMAPP MODIS Level 2 science products occurred in May 2002, and the current version (v1.4) was released in September 2003. The MODIS Level 2 products currently include cloud mask, cloud top properties, and atmospheric profiles, using the same science algorithms as the operational NASA versions. However a simplified input/output interface allows the software to run on all supported IMAPP platforms, and also allows both IMAPP and NASA MODIS Level-1B HDF formats to be used as input.

IMAPP is supported on the following UNIX platforms and operating systems:
SGI MIPS, IRIX 6.5
Sun Ultra, SunOS 5.7
IBM RS/6000, AIX 4.3
HP PA-RISC, HP-UX B.10.20
Intel Pentium, Linux 2.2.12-20 (with gcc)
Intel Pentium, Solaris x86 2.5.1 (with gcc)
The IMAPP source code distribution is at:
http://cimss.ssec.wisc.edu/~gumley/IMAPP/

The MODIS cloud mask indicates the probability that a given view of the earth surface is unobstructed by clouds or optically thick aerosol, and whether that clear scene is contaminated by a shadow. The cloud mask is generated at 1000 and 250 meter spatial resolution. It is more than a simple yes/no decision. The cloud mask includes four levels of confidence indicating whether a pixel is clear (bits 1 and 2) as well as the results from different spectral tests. An individual confidence flag is assigned to each single-pixel test and is a function of how close the observation is to the threshold. The individual confidence flags are combined to produce the final cloud mask flag for the output file. The algorithm is further divided into several conceptual domains (e.g., daytime ocean) according to surface type and solar illumination. Each domain defines a processing path through the algorithm, which in turn defines the spectral tests performed and associated thresholds. Different cloud conditions are detected by different tests. Spectral tests which find similar cloud conditions are grouped together. The groups are arranged so that independence between them is maximized (Ackerman, et. al., 1998)

The MODIS cloud top properties algorithm retrieves cloud top pressure, temperature, effective emissivity, and thermodynamic phase. The CO2 slicing algorithm (pressure, temperature, emissivity) uses the differences in longwave infrared (> 13 microns) cloud absorption, while the phase algorithm component utilizes differences in ice and water absorption between 8 and 12 microns. Utilizing the 8-11 micron and 11-12 micron brightness temperature differences, cloud phase can be discerned based upon the magnitude of the differences (Frey, et. al., 1999).

The MODIS atmospheric profiles algorithm retrieves vertical profiles of temperature and moisture, total column water vapor and ozone, and surface skin temperature. The algorithm is regression-based and uses clear-sly radiances measured by MODIS in day and night conditions over land and water. The regression coefficients are derived from a fast radiative transfer model with input profiles obtained from a global database of radiosonde measurements of temperature, moisture, and ozone (Seemann, et. al., 2003).

AIRS/AMSU/HSB Level-1 processing software is undergoing final beta testing at CIMSS in preparation for release in November, 2003. Combined MODIS/AIRS retrieval algorithms are being prototyped and tested. They will be available in a later release.

During the next year of IMAPP activities, the following work is planned:
Port new MODIS Level 2 science products to IMAPP including SST, Land Surface Reflectance, Aerosol Optical Depth, Cloud Optical Properties, Snow/Ice Detection
Release first version of AIRS/AMSU/HSB Level-1 processing software (in conjunction with NASA JPL).
Release AIRS Level 2 retrieval algorithm for combined AIRS/MODIS observations.

References:

Ackerman, S. A., K. I. Strabala, W. P. Menzel, R. A. Frey, C. C. Moeller, and L. E. Gumley, 1998: Discriminating clear sky from clouds with MODIS. *J. Geophys. Res.*, **103**, D24, 32141-32157.
Frey, R. A., B. A. Baum, W. P. Menzel, S. A. Ackerman, C. C. Moeller, and J. D. Spinhirne, 1999: A comparison of cloud top heights computed from airborne lidar and MAS radiance data using CO2 slicing. *J. Geophys. Res.*, **104**, 24547-24555.
Seemann, S. W, J. Li, W. P. Menzel, and L. E. Gumley, 2003: Operational Retrieval of Atmospheric Temperature, Moisture, and Ozone from MODIS Infrared Radiances. *J. Appl. Meteorol.*, **42**, 1072-1091.

A13: Re-examining the Requirements on Field-Of-View Size for CrIS

Presenter: Hung-Lung Allen Huang

Hung-Lung Huang, Richard Frey, CIMSS, University of Wisconsin-Madison, W. L. Smith, Langley Research Center, NASA, and H. Bloom, Integrated Program Office, NOAA

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) is expected to become a vital part of the long-term global earth-atmosphere observing system. The NPOESS's advanced infrared sensor, the Cross-track Infrared Sounder (CrIS) will provide most of the atmospheric profile information on temperature and water vapor, under both clear and cloudy conditions, for the next twenty years.

One of the recommendations of the advanced sounders group within the International TOVS Working Group (ITWG) at 12th International TOVS Study Conference (ITSC) states, "ITWG encourages NOAA to re-examine the requirements on field-of-view size of CrIS." It is this recommendation that provides the motivation for the work presented here.

Currently the CrIS field-of-view (FOV) size requirement is set at approximately 14 km at satellite nadir view. The current Atmospheric InfRared Sounder (AIRS), aboard NASA's polar-orbiting EOS-Aqua satellite, has a 13.6 km nadir FOV. At this FOV size, using AIRS as an example, more than 90% of measurements will be cloud contaminated and major processing efforts will involve not only time consuming cloud detection and cloud clearing, but will also degrade measurement performance (higher data noise) and lose valuable spatial resolution.

Theoretically, a finer spatial resolution (smaller FOV size) will enable improved sounding through broken clouds. In this paper we use sounding and imaging data from NPOESS' surrogate, AIRS and MODIS, to demonstrate that a smaller CrIS FOV can achieve improved sounding performance and also reduce processing demands. Based on our findings we will be recommending a 8 km or smaller CrIS FOV (at satellite nadir) to the advanced sounder working group during the 13th ITSC meeting.

A14: MODIS Cloud Mask: Results and Validation

Presenter: Steve Ackerman

S.A. Ackerman[1], R. Frey[1], W. P. Menzel[2], K. Strabala[1], C. Moeller[1], J. Key[1], L. Gumley[1] and D. Tobin[1]

[1]CIMSS
University of Wisconsin-Madison
1225 West Dayton St.
Madison WI, 53704
[2]NOAA/NESDIS/ORA, University of Wisconsin-Madison, Madison, Wisconsin.

Clouds are a crucial component in all meteorological and climate models. MODIS makes it possible to improve upon the existing remote sensing studies by identifying clouds more reliably with a multi-spectral approach at high spatial resolution. The MODIS Cloud Mask aims to minimize the potential errors in retrieval algorithms resulting from cloud contamination by labeling every pixel of data as either *confident clear, probably clear, uncertain*, or *cloudy*. Cloud masking from the MODIS observations are produced routinely and distributed to the earth system scientists.

The MODIS cloud mask classifies each pixel as either *confident clear, probably clear, uncertain*, or *cloudy*. The cloud mask algorithm (Ackerman et al, 1998) uses a series of threshold tests to detect the presence of clouds in the instrument field-of-view. Designed to operate globally during the day and night, the specific tests executed are a function of surface type, including land, water, snow/ice, desert, and coast, and solar illumination. Each cloud detection test returns a confidence level that the pixel is clear ranging in value from 1 (high confidence clear) to 0 (low confidence clear). Tests capable of detecting similar cloud conditions are grouped together and a minimum confidence is determined for each group as follows:

$$G_j{=}1,N = \min[F_{i,j}]i{=}1,m,$$

where F_i is the confidence level of an individual spectral test, m is the number of tests in a given group, and N is the number of groups (e.g., five). The final cloud mask (Q) is then determined from the

product of the results from each group,

$$Q = \sqrt[N]{\prod_{i=1}^{N} G_j}$$

This approach is clear-sky conservative in the sense that if any test is highly confident that the scene is cloudy (Fi = 0), the final clear sky confidence is 0. The four confidence levels included in the cloud mask output are: (1) confident clear (Q > 0.99); (2) probably clear (Q > 0.95); (3) uncertain (Q > 0.66); and (4) cloudy (Q = 0.66). For many regions of the globe, the uncertain classification can be considered probably cloudy. For comparison with the expert analysis, confident clear and probably clear are considered clear pixels and the uncertain and cloudy confidences are labeled as cloudy.

The paper will present the latest updates to the MODIS cloud mask, results from this cloud detection algorithm, and along with validation using ground based, aircraft and other satellite instruments.

A15: Measurements of Stratospheric Volcanic Aerosol Optical Depth from NOAA/TOVS Observations

Presenter: Clémence Pierangelo

Clémence PIERANGELO[1], Alain CHEDIN[1], Patrick CHAZETTE[2]
[1]LMD-IPSL, Palaiseau, France,
[2]LSCE-IPSL, Gif-sur-Yvette, France

We show that infrared optical depth of stratospheric volcanic aerosols produced by the eruption of Mount Pinatubo in June 1991 may be retrieved from the observations of the High resolution Infrared Radiation Sounder (HIRS-2) onboard the polar meteorological satellites of the National Oceanic and Atmospheric Administration (NOAA).

Evolution of the concentration in time and in space, in particular the migration of the aerosols from the tropics to the Northern and Southern Hemispheres are found consistent with our knowledge of the consequences of this eruption. The method relies on the analysis of the differences between the satellite observations and simulations from an aerosol-free radiative transfer model using collocated radiosonde data as the prime input. Thus, aerosol optical depths are retrieved directly without making assumptions about the aerosol size distribution or absorption coefficient.

A reanalysis of the almost 25 years archive of NOAA/TIROS-N Operational Vertical Sounder (TOVS) observations has considerable promise for an improved knowledge of the atmosphere loading in volcanic aerosols.

A16: Retrieving dust aerosol optical depth and altitude using AIRS data

Presenter: Clémence Pierangelo

Clémence PIERANGELO, Alain CHEDIN, Cyril CREVOISIER, Sylvain HEILLIETTE, Raymond ARMANTE, Claudia STUBENRAUCH, Noëlle A. SCOTT
LMD-IPSL, Palaiseau, France

We show that the recently launched Advanced InfraRed Sounder (AIRS) is able to retrieve both the optical depth and the altitude of dust aerosols over ocean. The very high resolution of AIRS channels (about 1cm-1) requires a line-by-line radiative transfer code, and the presence of the aerosol requires to consider scattering effects. Therefore, we developed a radiative transfer code coupling a line-by-line model (Automatized Atmospheric Absorption Atlas : 4A) and a discrete ordinate method (DISORT). Simulations show that the decrease in brightness temperature may reach 10 K for some channels. This effect increases with the aerosol optical depth and altitude of the layer. As these variations depend on the channel considered, we aim at retrieving both the altitude and the optical depth, using a well-chosen subset of ten to twenty channels and Look-up-Tables. Dust events over the ocean have already been detected and first retrievals will be presented at the time of the meeting. Further studies are being undertaken to retrieve separately dust loading and spectral infrared optical depths. Through the variations of spectral infrared optical depths, we should improve our knowledge of the spectroscopy and chemical composition of the dust aerosol.

A17: A Fully Operational Near Real-Time AIRS Processing and Distribution System: Level 2 Products

Presenter: Walter Wolf

W. Wolf(1), M. Goldberg(2), and L. Zhou(1)

(1) QSS Group Inc, Lanham, MD, USA
(2) NOAA/NESDIS/STAR, Camp Springs, MD, USA

A near real-time AIRS/AMSU/HSB processing and distribution system is fully operational at NOAA/NESDIS/STAR. Level 1B radiances and brightness temperatures have been distributed to

Numerical Weather Prediction Centers since October, 2002. These data have been placed into BUFR format and distributed through the NOAA CEMSCS server. The AIRS Level 2 products, temperature, water vapor, ozone, and surface products, are planned to be released to the public during late summer or early fall of 2003. NOAA plans to place the Level 2 products into BUFR format and distribute this data to the user community. Details of the data formats, along with the processing and distribution of the AIRS products will be presented.

A18: Application of Principal Component Analysis to Near Real-Time AIRS Channel Monitoring, Data Compression, Noise Filtering, and Atmospheric Retrievals

Presenter: Lihang Zhou

L. Zhou (1), M. Goldberg(2), and W. Wolf(1)

(1) QSS Group Inc, Lanham, MD, USA
(2) NOAA/NESDIS/STAR, Camp Springs, MD, USA

The Atmospheric InfraRed Sounder (AIRS) is the first high spectral resolution infrared sounder that provides accurate atmospheric soundings at high vertical resolution. Principal component analysis (PCA) has been used as an effective tool to store the information from the 2000 plus AIRS channels in a compressed format. AIRS individual channels can be reconstructed with minimal signal loss, using about 80 eigenvectors. A web site has been developed where the quality of the AIRS reconstructed radiances can be monitored in conjunction with the individual channel quality information. Details on the application of PCA to AIRS data, including the generation and application of eigenvectors, the use of PCA for data compression, quality control, noise filtering and estimation, and the PCA monitoring web site will be presented. The use of PCA for the regression retrieval of atmospheric parameters, such as temperature, moisture and ozone profiles, and surface skin temperature, surface emmisivity, etc., will also be discussed.

A19: First Comparison of Radiances Measured by AIRS/AQUA and HIRS/NOAA-17

Presenter: Pubu Ciren

Pubu Ciren, QSS GROUP Inc. Maryland, U.S.A. and Changyong Cao, NOAA/NESDIS/STAR, U.S.A.

The operational High Resolution Infrared Radiation Sounder (HIRS) has been flown on all NOAA satellites for more than two decades. An independent and objective evaluation of its calibration accuracy is highly desirable for both weather and climate applications. The Atmospheric Infrared Sounder (AIRS) onboard the recently launched AQUA satellite, with hyper-spectral resolution covering most of the HIRS spectral channels, provides such a unique opportunity for evaluating the calibration accuracy of HIRS. In this study, we present for the first time the comparisons of radiances measured by HIRS with those convolved from coincidental AIRS measurements on both collocated pixel level and grid level. The study is based on publicly released AIRS data from March to July, 2003. Preliminary results, including agreements and discrepancies between the measurements from these two instruments are presented.

A20: On the use of Planck-weighted transmittances in RTTOV

Presenter: Pascal Brunel

P. Brunel, F. Chevallier, D.S. Turner and M. Szyndel

Several fast radiative transfer models including RTTOV assume that the Planck function does not depend on wave number when integrating over the width of a satellite filter function. This approximation is less valid for wide spectral bands, like the Meteosat water vapour channel. In the operational weather centres, that error is partly corrected downstream in a bias-correction scheme.

This paper presents an alternative approach, where the model regression predicts convolved transmittances that are weighted by the Planck function. The method is applied to RTTOV. Results are presented comparing the performance of the model to reference line-by-line computations and to real satellite observations.

A21: A comparison of RTTOVSCATT and ARTS with AMSU-B observations using Met Office mesoscale model short range forecasts of ice water profiles

Presenter: Stephen English

T. R. Sreerekha, Claudia Emde, Stefan Buehler, Univ. of Bremen, Germany and
Una O'Keeffe, Stephen English
Met Office, United Kingdom

Modelling of emission from liquid water and

precipitation has made significant progress in recent years, but the errors of scattering models for ice clouds are not well documented. In this paper the ability of two independent models, ARTS and RTTOVSCATT to simulate AMSU-B is examined. RTTOVSCATT uses a simple delta-Eddington solution to the radiative transfer equation, whereas ARTS uses a successive order of scattering method in discrete ordinates, with a full treatment of polarisation. NWP background fields of temperature, humidity, cloud water and ice are taken from very short range forecasts (less than six hours) of the Met Office mesoscale model. These are colocated in time and space to the AMSU-B measurements for a number of case studies. Initial results are encouraging with similar broadscale features in the ARTS simulations and AMSU-B observations, although very large ice crystals need to be assumed to be present in significant numbers to explain the magnitude of observed brightness temperature depression for AMSU-B. The poster will present latest results of the intercomparison.

A22: How good are current emissivity models?

Presenter: Stephen English

Stephen English
Met Office, United Kingdom

It is generally agreed that assimilation of radiances which are sensitive to the surface (ocean, land, ice) requires knowledge of surface emissivity. This can either be provided by a model relating emissivity to geophysical variables, or an atlas of emissivity itself at relevant frequencies. But how good does this emissivity need to be? How does this match up to current model performance (and how do we validate this)? What implications does this have for use of ATOVS in NWP? In this poster an analysis of emissivity errors derived from AMSU observations (compared to NWP background) will be presented, using RTTOV/Fastem. It is concluded that Fastem-1 has an surface brightness temperature error equivalent to an error in emissivity of 1.5% over the ocean, which is not good enough to extract useful temperature information from AMSU channels 4 and 5, except near the edge of the scan. The major sources of error are discussed. A similar analysis is shown for other surface types.

A23: Two fast forward radiative transfer models dedicated to the AIRS instrument and comparison to AIRS observations.

Presenter: Cyril Crevoisier (for Sylvain Heilliette)

Sylvain Heilliette, Alain Chedin, Noëlle Scott, Raymond Armante and Cyril Crevoisier
Laboratoire de Météorologie Dynamique
Ecole Polytechnique- 91128 Palaiseau Cedex (France)

The launch of the high spectral resolution Advanced Infrared Sounder (AIRS) on board of EOS-Aqua opens promising perspectives for remote sensing applications as the improvement of temperature and water vapor profile retrieval or retrieval of greenhouse gases (CO2, N2O and CH4 for example). The availability of a forward radiative transfer model is the key to all these applications. Fast line-by-line models like the Automatized Atmospheric Absorption Atlas (4A) model are able to produce accurate results but remain too slow for the treatment of huge amount of data from this new instrument. In order to fill this gap, we have developed two hyperfast codes devoted to the simulation of a reduced set of 324 AIRS channels distributed by NESDIS. These two models rely on the availability of the TIGR-AIRS dataset of brightness temperatures, transmission functions, temperature and gas mixing ratio analytical Jacobians, calculated for all the atmospheric situations of the TIGR thermodynamic database using our fast line-by-line model 4A. The first model is based on a multilayer perceptron trained using supervised learning techniques on the TIGR-AIRS database as the learning set. The second model is based on thermodynamic profile pattern recognition in the TIGR database and linearization of the radiative transfer equation. Computation time is of the order of 0.02 sec/atmosphere for the neural network approach and of 0.2 sec/atmosphere for the pattern recognition approach. The advantages and drawbacks of these two different approaches are presented. As an example of application, we show bias calculations between real AIRS observations and simulated brightness temperatures using ECMWF analyses and radiosonde measurement as input thermodynamic profiles.

A24: Intercomparison of fast radiative transfer models for AIRS simulations

Presenter: Roger Saunders

Roger Saunders, Met Office,
Jean-Luc Moncet, AER and
Vanessa Sherlock, NIWA

Since the launch of Aqua in May 2002 several fast radiative transfer models have been developed to rapidly compute AIRS radiances and their jacobians

for data assimilation and retrieval applications. At the Workshop on Sounding from High Spectral Resolution Infrared Observations at Madison, Wisconsin on 6-8 May 2003 it was agreed to set up an intercomparison under the ITWG of RT models which can simulate AIRS radiances. This paper presents some initial results from at least 3 models. Both forward model computations for all AIRS channels and calculations of Jacobians for a selection of AIRS channels will be presented. It is hoped that more models will be included in the intercomparison in time.

A25: Observation of Solar radiation reflected by land surfaces from the GOES-8 sounder IR spectral measurements over continental USA

Presenter: Youri Plokhenko

Youri Plokhenko[#] and W. Paul Menzel[&]

[#]Cooperative Institute for Meteorological Satellite Studies
University of Wisconsin-Madison, 1225 W. Dayton St., Madison WI 53706
(608) 262-7287 , (608) 262-5974 (FAX), YouriP@ssec.wisc.edu
[&]Office of Research and Applications , NOAA/ NESDIS, Madison WI

The quantitative estimation of temperature and moisture vertical profiles is based upon the numerical solution of the radiative transfer equation (RTE). The associated inverse problem is ill posed. The accuracy of atmospheric parameters retrieved from IR measurements depends on the measurement accuracy and accurate definition of the measurement model.

The effect of surface emissivity (SE) on IR broad band spectral measurements (GOES-8) is discussed. SE variations cause measurable changes in infrared radiances. Disregarding the spectral-spatial variations of SE in the RTE magnifies the errors. Different types of surface cover, with different surface optical properties and extremely high spatial and temporal variations, restrict the use of a priori estimates of SE. A model accounting for SE and an algorithm of solution are presented. The solution includes SE, the surface temperature, and the temperature-moisture profile. Results over land (continental USA) are discussed. Spatial-temporal distributions of SE estimates in longwave and shortwave spectral bands are presented.

For daytime the solar reflected component in the 3.8 - 4.6μ band (5 channels) is estimated for cloud free conditions using a priori SE estimates (nighttime) and surface temperature, atmospheric temperature-moisture profiles estimates derived from spectral measurements in longwave band 6.5-7.5 μ (3 channels) and 11-14.7 μ(8 channels). A ratio of the bi-directional reflection function for a 1-hour time increment (variable solar angle under fixed satellite measurement geometry) for each pixel of the measurement matrix (195*315) is estimated. The temporal-spatial analysis of the bi-directional reflection function ratio indicates a significant anisotropy in the spatial-angle distribution of surface reflection for broad band spectral measurements with spatial averaging about 900-2500 km*km: forward scattering is significantly larger than back scattering; scattering is an increasing function of solar altitude angle in the back plain and a decreasing function of solar altitude angle in the forward plain.

Results show that in satellite remote sensing the applicability of the Lamberthian surface to model the downwelling IR flux reflection of real land surface will be very limited.

A26: Estimation of Coupling Between Mobile Vehicular Radars and Satellite Radiometers

Presenter: Albin Gasiewski

Albin J. Gasiewski and Valery U. Zavorotny
NOAA Environmental Technology Laboratory, Boulder, CO USA

It has recently been proposed by the automotive industry that wideband vehicular collision avoidance radar be developed at a frequency centered at approximately 24 GHz. Coupling of emissions from such radar systems into passive microwave satellites can impart significant interference to earth remote sensing applications in the bands between 22 and 27 GHz, and in particular in the 23.6-24.0 band allocated on a primary basis to the passive Earth Exploration Satellite Service (EESS) [1]. One of the most obvious coupling mechanisms between mobile vehicular radar and a satellite radiometer is reflection of the main lobe of the radar by another directly-illuminated vehicle toward the main lobe of the radiometer. Since vehicular radars will commonly illuminate another close-in leading vehicle it is believed that such scattering scenarios will be commonplace.

In order to estimate the interference from a collection of such vehicular radars to a passive microwave satellite (such as the NOAA AMSU or future NPOESS ATMS and CMIS sensors) we performed both numerical simulations to determine the system coupling coefficient C_{sm}, defined as ratio of the angular power density at the radiometer for the

reflected beam to the main lobe angular power density on the axis of the vehicular radar. The single reflection mechanism taken into account is that from the rear window of the leading vehicle, suspected to be the primary element that would provide interference at the angles of the radiometer receiving antenna.

The cases we consider show that reflection of radiation from vehicular radars from the rear windows of automobiles can impart a significant degree of coupling (-10 to -20 dB) with space-borne radiometers. Additional scattering can be expected from other nearby objects such as trees and the tilted roofs of buildings. Discussed will be the expected impact on satellite radiometry for weather and climate observation.

References [1] A. J. Gasiewski, W. Wiesbeck and C. S. Ruf, "Impact of mobile radar and telecommunications systems earth remote sensing in 22-27 GHz range," Technical Assessment by the IEEE GRSS Technical Committee on Frequency Allocation in Remote Sensing (FARS), April, 2002.

A27: Geosynchronous Microwave Observation System Simulation

Presenter: Albin Gasiewski

Albin J. Gasiewski[1], Boba Stankov[1], Alexander Voronovich[1], Bob L. Weber[2], Marian Klein[3], and Jai-Wen Bao[1]

[1]NOAA/Environmental Technology Laboratory, 325 Broadway, Boulder, CO, USA
[2]Science and Technology Corporation and NOAA/ETL, Boulder, CO, USA
[3]University of Colorado/NOAA-CIRES, Boulder, CO, USA

Passive microwave sounding and imaging from geosynchronous orbit was first studied in the mid-1970's, although initial proposals using microwave channels at ~183 GHz and lower frequencies required prohibitively large antennas. In 1992 it was proposed that submillimeter-wavelength channels could be used for many of the sounding and cloud/precipitation imaging applications that previously were believed to require the use of microwave channels. The capabilities of submillimeter-wave channels for precipitation imaging were further demonstrated in 1994 using airborne imagery of clouds at the 325 GHz water vapor band. These studies suggested that the antenna costs for geosynchronous microwave precipitation imaging and temperature and moisture sounding can be significantly reduced while retaining good spatial resolution by using key submillimeter-wavelength water vapor and oxygen bands. Accordingly, the current Geosynchronous Microwave (GEM) Sounder/Imager concept is based on a ~2-3 meter center-fed reflector antenna and fast-scanning subreflector. An alternate concept for gesynchronous microwave sounding and imaging (GeoSTAR) has been proposed based on synthetic aperture techniques, and would ostensibly be able to provide similar resolution using bands at 50-56 and 183 GHz.

In this poster we illustrate a means for assessing the precipitation retrieval capabilities of GEM vis-à-vis GeoSTAR using an observation system simulation for a landfalling hurricane event (Hurricane Bonnie, August 1998). The system simulations are based on 6-km resolution, 50-level microphysical cloud data obtained from MM5 model runs for Hurricane Bonnie using the Reisner five-phase microphysical cloud model. A unique fast forward radiative transfer model based on the discrete-ordinate (DO) method and incorporating both scattering effects and fast calculation of the Jacobian of the forward transfer model is used to compute observed brightness temperature fields and their derivatives. Discussed will be the accuracy of rain rate and cloud liquid and ice water content retrievals.

A28: Japanese advanced meteorological imager (JAMI): design, characterization and expected on-orbit performance

Presenter: Jeffrey Puschell

Jeffery J. Puschell et al.
Raytheon Santa Barbara Remote Sensing

The Japanese Advanced Meteorological Imager (JAMI) was developed by Raytheon and delivered to Space Systems/Loral as the Imager Subsystem for the Japanese MTSAT-1R system. Detailed characterization tests show JAMI meets all MTSAT-1R requirements with margin using a compact, efficient instrument architecture.

A29: Optimization and evaluation of interpolated ATMS and CMIS data

Presenter: John Galantowicz

John Galantowicz, Alan Lipton, and Jean-Luc Moncet
AER Inc.

Interpolation of microwave sensor data is needed both to create effective footprint shapes that match other

channels and sensors (e.g., ATMS to Crosstrack Infrared Sounder, CrIS, field-of-regard) and to collocate sample centers. In many cases--for example, when the interpolation increases footprint size relative to the native sensor footprint--the process may also produce composite samples with lower effective radiometric noise than the sensor. Optimal interpolation methods like those derived from the Backus-Gilbert approach provide various mechanisms through which the user tries to control the composite sample effective shape, location, and noise properties. It is left to the user, however, to judge the qualities of the results and use them to make the necessary trade-offs regarding spatial sampling and radiometric noise. Using results from footprint matching exercises for CMIS (Conical Microwave Imager Sounder) and ATMS (Advanced Technology Microwave Sounder), we will describe techniques for defining this trade-space and evaluating composite sample spatial and radiometric qualities. Considerations include sub-resolution horizontal scene variability and spatial noise, vertical profile retrieval resolution, geolocation accuracy, and the costs of artificial resolution enhancement.

POSTER SESSION B: FRIDAY

B01: An operational AVHRR cloud top temperature and height retrieval and its validation

Presenter: Adam Dybbroe

Adam Dybbroe (SMHI), Sauli Joro (FMI), Aarno Korpela (NIWA), Anke Thoss (SMHI)

Within the Eumetsat Satellite Application Facility (SAF) project to support Nowcasting and Very Short Range Forecasting (NWCSAF) SMHI has developed algorithms and software to extract four cloud and precipitation products from AVHRR data. A cloud top temperature and height (CTTH) product from polar satellite data is useful in aviation forecasting and in the early warning of thunderstorm development. But in addition to Nowcasting the AVHRR CTTH will also be used for climate applications through the Climate Monitoring SAF.

The CTTH is derived in both opaque and semi transparent cloudiness. The opaque retrieval assumes the cloud to be black and is using a colocated NWP model profile and forward radiative transfer model calculations to compensate for absorption above the cloud. The semi-transparency retrieval uses a histogram correction method using the AVHRR 11 and 12 micron window channels, based on the work of Inoue (1985) and Derrien et al. (1988).

The objective validation of satellite derived cloud top height is a challenging task. Direct measurements require expensive measurement campaigns using aircrafts, and are thus scarce. In addition the often used ground based remote sensing techniques as provided by Lidars usually have difficulty detecting high thin cirrus and also requires the cloudfield to be single layered.

In our attempt to objectively validate the NWCSAF AVHRR based CTTH retrieval we have used operational radar data from a network of C-band weather radars over Finland, capable of giving reliable estimates of the height of ice clouds, including thin cirrus. A significant advantage of weather radars are their good areal coverage (at least in Scandinavia) and their high temporal and spatial resolution. Weather radars provide the possibility for a large validation dataset, and data can be collocated in time and space with the satellite data with a high accuracy avoiding the necessity for critical assumptions to account for possible deviations.

B02: cancelled

B03: The ATOVS and AVHRR Product Processing Facility for EPS

Presenter: Dieter Klaes

Dieter Klaes, Jörg Ackermann, Rainer Schraidt, Tim Patterson, Peter Schlüssel, Pepe Phillips, Arlindo Arriaga, and Jochen Grandell

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. The specification of the PPF is based on two well-known and well-established software packages, which have been used by the international community for some years: The AAPP (ATOVS and AVHRR Pre-processing Package) and ICI (Inversion Coupled with Imager). The PPF is able to process data from instruments flown on the Metop and NOAA satellites. For the level 1 processing of the sounding instruments' data (HIRS, AMSU-A and MHS), the basic functionality of AAPP has been kept; however, the individual chains for each instrument have been separated and additional functionality has been integrated. For HIRS a global calibration, as performed by NOAA/NESDIS today, has been

included. For AMSU-A and MHS the moon contamination of the calibration space view can be corrected for. Additional functionality has also been included in the AVHRR processing. In particular, an enhanced navigation by landmark processing has been implemented to ensure accurate geo-location. Additionally, the PPF can digest and process the global AVHRR data either at full pixel resolution (1 km at nadir), which is the nominal mode for the Metop processing, or at the reduced resolution of the NOAA/GAC (Global Area Coverage) data (about 4 km resolution at nadir). For the level 2 processing the ICI had to be modified to include the most recent improvement in fast radiative transfer modelling as included in the RTTOV-7. As a first step towards the realisation of the PPF a prototype has been generated for the purpose to help specifying the details of the PPF, and for verification of the latter by generation of reference and test data. The prototype is able to process HRPT data, GAC data from the NOAA satellite active archive (SAA), and also Local Area Coverage (LAC) data. GAC data processing means that the processing of whole orbits is possible. Current work is aimed to assess the quality of the Level 2 retrievals and to generate reference test data for the operational PPF.

B04: ATOVS Operational Products and the Satellite Upper Air Network (SUAN)

Presenter: Tony Reale

Tony Reale
NOAA/NESDIS
Washington DC 20233

The current configuration of NOAA operational polar satellites consists of NOAA-15, 16, and 17, each deploying the Advanced TIROS Operational Vertical Sounder (ATOVS) instrument configuration. ATOVS which consists of the 15-channel Advanced Microwave Sounding Unit-A (AMSU-A), the 5-channel AMSU-B, the 20-channel High-resolution Infrared Radiation Sounder (HIRS/3), and the 6-channel Advanced Very High Resolution Radiometer (AVHRR/3). The following poster summarizes the current status of the operational ATOVS (and AMSU-B) derived sounding products distributed by NESDIS to national and international users. This is done through a brief review of the scientific processing algorithms, statistical results, and a series data cases based on requests that have been received from the user community over the past 18 months. Planned upgrades of the scientific algorithms and products to better meet current and future user requirements particularly in the areas of numerical weather prediction and climate are also presented.

One of the major areas of concern for users that has evolved with the more widespread use of these data particularly is the problem of absolute scientific calibration and validation of polar satellite radiometers and derived products, and the lack of a dedicated global program to provide such data. This has resulted in a serious problem concerning the identification and removal of systematic bias and uncertainty in the long-term record of satellite data, as well as with the current data measurements being received. Over the past year or so several user groups from the climate, NWP and satellite community have acknowledged this problem and have recommended that the requirements for the global radiosonde network be expanded to include a subset or radiosondes coincident with satellite overpass. Such groups include the NOAA Council on Long-term Climate Monitoring (CLTCM) in January 2003, and later in March a “Workshop to Improve the Usefulness of Operational Radiosonde Data” was held at the National Climatic Data Center (NCDC) in Asheville, both forwarding specific recommendations for establishing special radiosonde sites to provide reference radiosondes coincident with overflying (polar) satellites for absolute scientific calibration of global satellite measurements, atmospheric temperature and moisture, and associated scientific algorithms. The poster concludes with a summary of recent activities to establish a preliminary network of candidate Satellite Upper Air Network (SUAN) sites.

B05: Working Group for Satellite Sounding Science and Products (SSSP)

Presenter: Tony Reale

Tony Reale
NOAA/NESDIS
Washington DC 20233

Lydie Lavannant
Meteo-France/DP/CMS
Lannion, France

Leanne Avila
CIMSS
Madison, WI

At the 11th International TOVS Study Conference (ITSC-XI, Budapest, 2000), the Working Group (WG) on Satellite Sounder Science and Products (SSSP) was formed to promote the importance and continued development of scientific techniques for deriving environmental products from operational (and research) weather satellites. The focus of the WG is mainly on polar orbiting satellites (given their global coverage), but combined polar and other (i.e., GOES,

GPS) platforms are also of interest. The primary objective is to facilitate better communication and collaboration among scientists within the international research and operational communities by providing a central location for information dissemination and exchange, thus creating a forum for addressing scientific algorithms and products from operational and research weather satellites, and to promote scientific exchange among the international group of researchers and product developers.

One action of the ITWG/SSSP was to create a new SSSP web site now available through the ITWG web site (http://cimss.ssec.wisc.edu/itwg/sssp/) to serve as the focal point for promoting correspondence and comparisons among scientists working in the product derivation area. The site provides users the opportunity to register their work by actively seeking scientific product developer inputs to register their work by providing to us a brief summary (or abstract), associated graphic, and web site link (if available). Topics for contributions include Products and Science (ie, soundings, wind, clouds...Level 1,2,3...), Scientific Processing Packages (ie, AAPP, OPTRAN, 1DVAR, etc), Satellite Instrument Health, and Direct Broadcast issues.

The longer term goals of the WG/SSSP will be to report to the ITWG on the current status of derived products and scientific algorithms, the progress made since the last ITSC meeting, perceived areas of strengths and weaknesses, and recommended actions.

The poster presents the SSSP web site, current contributions and ongoing issues.

B06: Satellite-based Precipitation Analysis in Support of Nowcasting Applications

Presenter: Ralf Bennartz

Ralf Bennartz
Atmospheric and Oceanic Sciences
University of Wisconsin, Madison, Wisconsin, USA

Anke Thoss, Adam Dybbroe, Daniel B. Michelson
Swedish Meteorological and Hydrological Institute (SMHI)
Norrköping, Sweden

Within the framework of EUMETSAT's Nowcasting Satellite Active Facility (SAF) new satellite-based applications for nowcasting and very short range forecasting are being developed. We describe a method to remotely sense precipitation and classify its intensity over water, coasts, and land surfaces. This method is intended to be used in an operational nowcasting environment. It is based on data obtained from the Advanced Microwave Sounding Unit (AMSU) onboard NOAA-15/16/17. Each observation is assigned a probability of belonging to four classes: precipitation-free, risk of precipitation, precipitation between 0.5 and 5 mm/h and precipitation higher than 5 mm/h. Since the method is designed to work over different surface types, it relies mainly on the scattering signal of precipitation-sized ice particles received at high frequencies.

With the successful launch of Meteosat Second Generation (MSG) additional opportunities in precipitation nowcasting arise from the combination of multispectral MSG observations with polar orbiting passive microwave sensors. We will present first results of precipitation classifications using combined AMSU/MSG-SEVIRI observations.

B07: Monitoring Climate Change using Satellites: Lessons from the MSU

Presenter: Peter Thorne

Simon Tett & Peter Thorne
Hadley Centre for Climate Prediction and Research, Met Office, UK

Monitoring climate change from an in situ network is difficult due to instrument changes, random errors, and other inhomogeneities. Doing so from satellites is much more difficult. Experience with in-situ networks implies that for observational error to be neglected it should be less than 10% of the expected climate signal. Errors of more than about 50% are too large to sensibly validate model predictions. An error analysis of deep-layer temperatures produced by University of Alabama, Huntsville (UAH) from the MSU instruments flown on several operational weather satellites shows that the largest contribution to observational error for the 21-year trend arises from inter-satellite bias adjustment. However, uncertainties in the corrections arising from the temperature of the instrument were non-negligible.

Recently Remote Sensing Systems (RSS) have produced an alternative analysis to that of UAH. Differences between the two for the "MT" product exceed their respectively estimated error bounds and arise mainly from differences in the corrections for instrument body temperature associated with NOAA-9. The availability of two independently produced versions permits study as to the sensitivity to processing choices. Clearly for other products this may not be possible so it is important that we fully investigate the causes of differences to learn lessons

for future climate satellite applications.

These findings support the recommendations of several published reports (e.g., NRC2001) which address the use of satellite data for climate research:
(1) Satellite overlaps should be a minimum of two years in length, implying "launch-on-schedule" rather than "launch on failure"
(2) Instruments require extensive and better pre-launch calibration at a level which can support climate trend evaluation for example to avoid corrections for the instrument body temperature
(3) On-board monitoring of instrumentation
(4) Minimal east-west spacecraft drift to avoid aliasing the diurnal cycle
(5) Maintenance of spacecraft altitude with on-board propulsion.
If since 1979 AMSU instruments had been flown with two-year overlaps, an instrument lifetime of five years and stable orbits then the error in tropical deep-layer temperatures would be about 0.02 K/decade. This is a considerable reduction in the approximate error of 0.1 K/decade from the instruments actually flown.

B08: Ongoing and planned activities in the usage of ATOVS AMSU A/B in the HIRLAM 3DVAR system at SMHI

Presenter: Per Dahlgren

Per Dahlgren
SMHI, Sweden

AMSU-A radiances over sea are soon to be operationally assimilated at SMHI. The effects of more carefully selected data for bias correction are therefore important to study. One of our plans is to select bias correction data in the vicinity of soundings only. A further development in the use of AMSU-A data is to assimilate radiances over ice and land. Due to the importance and the non linear properties of surface skin temperature and surface emissivity, we will perform tests where these variables are included in the control vector. We also plan to use AMSU-B in our 3DVAR. So far, we have only done a literature survey in the matter. The first practical experiments are planned to the autumn of 2003.

B09: Use of ATOVS in the DMI-HIRLAM regional weather model

Presenter: Jakob Grove-Rasmussen

Jakob Grove-Rasmussen, DMI, and
Bjarne Amstrup (bja@dmi.dk), DMI

For years the positive impact of (A)TOVS measurements in global weather models has been well established, but the usefullness of the data in regional short range models has not been fully exploited.

The aim of this study is to explore the impact of AMSU-A data from NOAA16 and NOAA17 on the DMI-HIRLAM (Danish Meteorological Institute - HIgh Resolution Local Area Model), covering Europe, North America and the Atlantic Ocean. This study has become more relevant with the established EARS (EUMETSAT ATOVS Retransmission System) which enables the EUMETSAT member countries to receive ATOVS data within 30 minutes of observation over a large fraction of the DMI-HIRLAM region.

B10: Use of ATOVS data for operational atmospheric correction and surface irradiance calculations

Presenter: Marion Schroedter-Homscheidt

Marion Schroedter-Homscheidt, Thomas Holzer-Popp, Padsuren Tungalasaikhan
Deutsches Zentrum für Luft- und Raumfahrt (DLR) e.V.
Deutsches Fernerkundungsdatenzentrum (DFD)
Oberpfaffenhofen, D-82234 Weßling, Germany
phone: ++49 8153 282896, fax: ++49 8153 281363
e-mail: Marion.Schroedter@dlr.de

The German Remote Sensing Data Center (DFD) processes TOVS and ATOVS temperature and water vapour profiles on a routinely basis for all NOAA passes received by its facilities in Oberpfaffenhofen. TOVS profiles are retrieved with ITPP5.21 and ATOVS profiles with a combination of AAPP3.0 and IAPP2.0. All data sets are made available within the frame of the ISCU World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT, http://wdc.dlr.de).

From these level 2 data, value added products like gridded water vapour vertical column maps over Europe are generated operationally for different times of the day.

European maps of water vapour column are used at DFD mainly for atmospheric correction of remote sensing sensors measuring in the Visible and Near-Infrared like NOAA-AVHRR, IRS-LISS, Landsat7-ETM, and MODIS.

A new application serving the renewable energy industry is currently under development in the EC funded HELIOSAT-3 project: Solar irradiances are

calculated from measurements of the SEVIRI instrument onboard the Meteosat Second Generation satellite. The retrieval of spectrally resolved products and the separation into the direct and diffuse radiation is aimed at. These data will be used for an optimized siting of concentrating solar thermal power plants and performance checks of solar energy systems. To describe atmospheric extinction, water vapour measurements from ATOVS are used during the development phase. Later it is aimed at using MSG derived water vapour directly, but ATOVS will still be used for quality checks and cross-comparisons.

B11: Simultaneous determination of continental surface emissivity and temperature from NOAA-10/HIRS observations. Analysis of their seasonal variations

Presenter: Soumia Serrar

A. Chédin, E. Péquignot, N. A. Scott, S. Serrar

Laboratoire de Météorologie Dynamique, Institut Pierre-Simon Laplace,
Ecole Polytechnique, 91128 Palaiseau, France

Continental surface infrared emissivity strongly depends on the frequency and on the type of the surface. Emissivity values as low as 0.7 may be observed around 8-10 μm or, at shorter wavelengths around 4 μm, particularly over desert regions. Satellite observations are very sensitive to emissivity variations, up to 0.5 K in brightness temperature at 11 μm for a variation as small as 0.01 of the emissivity. An accurate and coherent (simultaneous) determination of surface temperature and emissivity is essential to greatly improving the estimation of the longwave surface energy budget and, consequently, improving the performance of surface-atmosphere interaction models. Based on a space-differential approach and a non-linear regression inference method, 4 years of NOAA-10 observations (July 1987 to June 1991) over northern Africa (5N-30N and 20W-60E) have been interpreted in terms of surface emissivity at three wavelengths (channel 8 at 11.1 μm, channel 10 at 8.3 μm, and channel 18 at 4 μm) and surface temperature. Maps at the resolution of 1°x1° and one month will be shown. Time series of zonal means bring into evidence important seasonal variations. They are compared to time series of precipitations and Normalized Difference Vegetation Index (NDVI).

B12: A Comparison of AVHRR and HIRS Global Cloud Types

Presenter: Michael Pavolonis

Michael J. Pavolonis, CIMSS/SSEC/UW and Andrew K. Heidinger, ORA/NOAA/NESDIS

In this study, global-scale radiometric cloud types from an extended version of the Clouds from AVHRR (Advanced Very High Resolution Radiometer) (CLAVR-x) software suite will be examined as they relate to low, mid, and high level cloud amounts derived from High Resolution Infrared Radiation Sounder (HIRS) measurements. The CLAVR cloud types include warm liquid water clouds, supercooled water clouds/mixed phase clouds, opaque ice clouds, non-opaque ice clouds, and multi-layered clouds. Monthly frequencies for each cloud type will be shown for the months of January and July. Of particular interest are regions containing multiple cloud layers since the presence of cloud overlap can greatly alter the retrieval of cloud top height and hence the derived low, mid, and high cloud amounts from the HIRS data. The cloud overlap algorithm employed in CLAVR has been shown to be capable of accurately classifying regions of cloud overlap on a global-scale.

B13: Comparison of IAPP and ICI Sounding Products at CIMSS

Presenter: Eva Borbas

Harold M. Woolf, Eva Borbas, Jun Li, Thomas Achtor
Cooperative Institute for Meteorological Satellite Studies
Space Science and Engineering Center, University ofWisconsin-Madison
Madison, Wisconsin 53706, USA

Lydie Lavanant and Guy Rochard
Meteo-France, SCEM, CMS, Lannion, France

The International ATOVS Processing Package (IAPP) and its predecessor, the International TOVS Processing Package (ITPP), have been developed at SSEC/CIMSS to retrieve atmospheric temperature and moisture profiles and other parameters in both clear and cloudy atmospheres from (Advanced) TIROS Operational Vertical Sounder (ATOVS/TOVS) radiance measurements. The software has been run operationally for NOAA TOVS and/or ATOVS Global Area Coverage data and direct broadcast (DB) data since the early 1990's. Meanwhile, another ATOVS/TOVS DB processing package, called Inversion Coupled with Imager (ICI), was developed by Meteo-France.

At SSEC/CIMSS the DB ATOVS data have been processed operationally in near real-time by both IAPP and ICI, since February 2001. The products are monitored on a daily basis and validated on the web site

http://cimss.ssec.wisc.edu/iapp_ici/

The poster will present comparisons, in both graphical and numerical forms, of the products of the two software packages.

B14: Influence of the first guess on mesoscale IAPP retrievals

Presenter: Harold Woolf

Harold M. Woolf, Wayne F. Feltz, and Thomas H. Achtor

The International ATOVS Processing Package (IAPP) has been run operationally since early 2002 for small areas (approximately +/- 4 degrees of latitude and longitude) centered on the Atmospheric Radiation Measurement (ARM) program Clouds and Radiation Testbed (CART) sites at Lamont, Oklahoma (36.6N 97.5W); Barrow, Alaska (71.3N 156.8W); and Nauru (0.5S 166.9E). These sites are customarily denoted Southern Great Plains (SGP); North Slope of Alaska (NSA); and Tropical Western Pacific (TWP), respectively. The retrievals are done twice, using (1) the built-in regression guess, and (2) profile information obtained from the National Centers for Environmental Prediction (NCEP) Aviation Model global analysis-forecast system.

Because of the extensive amount and variety of instrumentation operating at the SGP site, there is ample “ground truth” available, making it an ideal location for evaluation of retrieval methodology.

The poster will present comparisons of retrievals made with and without numerical weather prediction (NWP) first-guess information, and independent estimates of atmospheric state obtained from other sensors at the site.

B15: Operational Assimilation of GOES Water Vapor Imager Channel at MSC

Presenter: Nicolas Wagneur

Nicolas Wagneur and Louis Garand
MSC, Dorval, Quebec, Canada

The assimilation of radiance imager data at 6.7 micron (channel 3) was made operational in the Canadian Meteorological Center global 3Dvar analysis system in June 2003. The MSCFAST (Garand, 1999) physical radiative transfer model is used as forward operator. This addition was made concurrently with new AMSUB data. The improvement of adding independently GOES imager channel 3 on moisture analysis and forecasts is shown.

The monitoring suite of data treatment shows stable cardiograms of innovations. Also geographical maps of monthly averages of innovations show no viewing angle bias problems. These data are to be implemented in regional system as the new main frame computer will become operational. Work is under way in order to include recently activated GOES-12 satellite.

B16: Global maps of microwave land surface emissivities for weather forecast

Presenter: Frédéric Chevallier

Catherine Prigent, Frédéric Chevallier, Peter Bauer and Jean-Noel Thépaut

Significant uncertainties still affect the estimation of microwave surface emissivity over land and hamper the assimilation of surface-sensitive microwave channels. Several approaches are being investigated for AMSU-A and are presented. On the one hand, top-down methods estimate the emissivity based on independent (i.e. not assimilated) satellite measurements, for instance SSM/I data over land or past data. On the other hand, bottom-up approaches are based on land surface and surface emissivity modelling. These various methodologies are discussed and results in the ECMWF assimilation system are presented.

B17: RTTOV_SCATT, a fast radiation model that includes scattering at microwave frequencies

Presenter: Frédéric Chevallier

Emmanuel Moreau, Peter Bauer and Frédéric Chevallier

For simulating the radiative transfer in clouds and precipitation for large data volumes, a radiation model has been developed based on the fast modeling framework RTTOV. Multiple scattering contributions are implemented through the Eddington’s second approximation. This poster describes the model and illustrates its validation. Based on ECMWF model

cloud and precipitation profiles a relative comparison of RTTOV_SCATT and of a doubling-adding model reveals that apart from situations with excessive amount of snow (snow paths > 1kg/m2) both models agree within radiometer noise, i.e, within 0.5K. An intercomparison with radiative transfer codes from independent research groups also reveals the good performance of the model. However the treatment of subgrid-scale cloud variability is identified as an important source of uncertainty.

B18: An Improved OPTRAN Algorithm

Presenter: Yong Han

Yong Han, Larry M. McMillin, Yoshihiko Tahara, Thomas J. Kleespies, Xiaozhen Xiong, and Paul van Delst

Presented here is an improved algorithm for the fast and accurate transmittance-calculation procedure, optical path transmittance (OPTRAN). This algorithm combines two techniques developed separately at the NOAA NESDIS and NCEP and implemented in OPTRAN version 7 and 8, respectively. The first technique applies a correction term to account for the differences between the total transmittances averaged over spectral response function (SRF) and the transmittances that are the product of the SRF-averaged transmittances of individual gases. The correction term is estimated from a given atmospheric state in a similar way as that to predict transmittances for each gas. The motivation for developing the technique is to eliminate the use of the effective transmittances, a technique difficult to apply in situations when transmittances are estimated for four or more gases. The second technique is developed in order to reduce the number of regression coefficients used to predict the transmittances. It is especially useful for hyper-spectral sensors, such as AIRS, for which the number of coefficients is reduced to 183,106 from 4,280,400 in the previous versions. The technique applies a polynomial function with the gas amount as a dependent variable to estimate the vertical variations of the coefficients, rather than having a separate set of regression coefficients for each vertical layer. We will present some technique details of how the two techniques are implemented in the new algorithm, and the results of the algorithm validations against both dependent and independent data sets.

B19: Infrared radiative transfer modeling using the Optimal Spectral Sampling (OSS) method

Presenter: Jean-Luc Moncet

Jean-Luc Moncet, Gennadi Uymin, Xu Liu and H. Snell

The OSS method is a simple and flexible approach to radiance modeling originally developed for the real-time processing of NPOESS/CrIS data. OSS-based models have been produced for the airborne NAST-I and AIRS instruments as well as for microwave sensors. The monochromatic treatment of the radiative transfer in OSS confers the ability to directly model non-positive ILS (such as interferometric functions) and to accommodate different observer altitudes (for airborne applications). In addition, it greatly simplifies the computation of analytical Jacobians and makes it possible to model scattering effects in an accurate and computationally efficient way. An overview of the theoretical basis and examples of applications of the OSS method will be presented. More details will be given in a companion poster.

B20: Preliminary validation of the CrIMSS (ATMS/CrIS) retrieval algorithm

Presenter: Jean-Luc Moncet

Jean-Luc Moncet, Xu Liu and Richard Lynch AER, Inc.

Pre-NPP tuning and validation of the NPOESS/CrIS algorithm involves testing activities on real data from the AMSU/AIRS instruments on the EOS/AQUA platform. The future CrIS algorithm is being adapted to regularly process data from AIRS. Preliminary results of this validation effort will be presented. Key areas investigated includes removal of cloud effects and quality control of temperature and moisture profile EDRs.

B21: Cloud characteristics and channel selection for IASI radiances in the meteorological sensitive areas

Presenter: Florence Rabier

Nadia Fourrié and Florence Rabier, Météo-France, CNRM/GMAP

The cloudiness in simulated IASI (Infrared Atmospheric Sounding Interferometer) pixels deduced from AVHRR (Advanced Very High Resolution Radiometer) satellite imager is studied more especially in the meteorological sensitive areas during FASTEX (Front and Atlantic Storm Track Experiment). It is found that few clear AVHRR

observations are located in the IASI pixels in these regions, which are covered by high-level and low-level clouds. The IASI channel selection is then studied in the context of the sensitive areas for the pixels with low-level clouds. The Entropy Reduction (ER) method of Rabier et al (2002) which was previously studied in a general context is compared with two other channel selection methods using selection criteria based on the adjoint sensitivity: the sensitivity to observation and the so-called Kalman Filter sensitivity. It is found that even though the "sensitive" methods give slightly better results than the ER one, this latter performs quite robustly and at a lower computational cost. The robustness to the specification of the background error covariance matrix is then studied. It is shown that the channel selection based on the ER method is particularly robust to this specification but the analysis step itself requires an accurate determination of the background error covariance matrix. In addtion it is shown that an independently computed constant channel set gives comparable results to the optimal channel set.

B22: Application of an objective error variance tuning method to satellite radiances observational errors

Presenter: Florence Rabier

Bernard Chapnik, Gérald Desroziers, Florence Rabier, Météo-France, CNRM/GMAP and Olivier Talagrand, Laboratoire de Météorologie dynamique

Desroziers and Ivanov (2001) have proposed an objective variance tuning algorithm based on an optimality diagnosis in a variational data assimilation framework. In this poster, some interesting properties of this method are provided, an application of the algorithm to the tuning of satellite radiance observational error are shown and discussed.

References

G. Desroziers and S. Ivanov. Diagnosis and adaptive tuning of information error parameters in a variational assimilation. *Quart. J. Roy. Meteor. Soc.*, **127**:1433-1452, April 2001.

B23: Can a statistical regression be a valuable tool for advanced IR-sounders data inversion?

Presenter: Alexander Uspensky

A.B.Uspensky, S.V.Romanov***

**Scientific Research Center "Planeta" B.Predtechensky, 7, 123242 Moscow, Russia*
***Russian Research Center Kurchatov Institute, Kurchatov sq., 123182, Moscow, Russia*

The paper summarizes the performance characteristics of statistical regression approach for the inversion of advanced IR-sounders data or, in other words, for the retrieval of atmospheric temperature (T), humidity (q), ozone concentration (Q) profiles. The new-generation space-borne IR-sounders on board future operational satellites (IASI/MetOp, CrIS/NPOESS, IRFS/Meteor) will provide high resolving power (0.25 - 0.6 cm-1) spectral radiance measurements of continuous or quasi-continuous coverage from 3.7 (5.0) to 15.5 mm. Because of highly increased satellite data volume and large number of sought variables the application of traditional inversion methodology, in particular, "physical" inversion algorithms or standard regression technique may cause significant problems. The authors have developed and examined statistical regression algorithms for the retrieval of atmospheric T-, q-, Q- profiles from IASI measurements that are capable to give rather accurate results at a "reasonable" cost. The proposed retrieval algorithms are constructed on the basis of linear statistical eigen-vector regression that have been refined through the introduction of generalized empirical orthogonal functions both in measurement and state spaces. Contrary to other approaches the "optimal" number of predictor and predictand variables is specified "theoretically" using the consistency check between data information content and compression ratio. The problem of compilation the representative training datasets is considered from the point of view of sampling effects reducing and selection the limited numbers of profiles. A simulation study has been performed to demonstrate the capabilities of proposed techniques in the retrieval of T-, Q - profiles from synthetic IASI measurements. The application of developed algorithms enables to achieve the reasonable accuracy of T-, Q- profile retrievals as well as to reduce slightly the mean RMS errors (defined via averaging over atmosphere layers) comparing to standard eigen-vector regression .

B24: A System Design for Storing, Archiving, and Retrieving Hyperspectral Data

Presenter: Ralph Dedecker

Ralph G. Dedecker, Tom Whittaker, Ray K. Garcia, Robert O. Knuteson
University of Wisconsin-Madison, Space Science and Engineering Center

Hyperspectral data and products derived from

instrumentation such as AIRS, CrIS, GIFTS and HES will impose storage and data retrieval requirements that far exceed the demands of earlier generation remote sensing instrumentation used for atmospheric science research. Efforts at the University of Wisconsin - Space Science and Engineering Center (UW-SSEC) are underway to develop a new architecture designed to address projected real time and research needs.

The large volume of data collected and products produced from hyperspectral instrumentation will require large distributed storage devices employing several servers. The hardware infrastructure must be implemented to allow component augmentation, replacement, and maintenance without undue demands to modify user applications. User applications will need tools to simplify the location of data files. User data selection facilities for retrieving specific information from storage devices for calibration, analysis, instrument inter-comparison, or reference purposes will also be necessary due to the large data volume and standardized data formats and data delivery schemes will be important.

This poster will outline a prototyped infrastructure for data archiving and cataloging, data storage, metadata search and query, and retrieved data delivery schemes to be utilized for real time operations and by research users.

B25: Potential use of IASI for volcanic clouds detection and monitoring

Presenter: T. Phulpin

T.Phulpin and M. Dana, Centre National d'Etudes Spatiales, 18 avenue E. Belin, 31401 Toulouse cedex 9 - France

Volcanic emissions and resulting stratospheric aerosols are acknowledged to have a strong effect on climate. They must be detected and monitored routinely on a global scale. Volcanic clouds are also a danger for aeronautics and are for this reason monitored through a global operational system widely based on satellite data. GOES, AVHRR, HIRS and TOMS are currently used in the Volcanic Ash Advisory Centers (VAAC). Current techniques for volcanic cloud monitoring allow with a relatively good reliability detection, sizing and mass estimate of aerosol. But composition and altitude retrieval remain difficult. AIRS and MODIS data now available are also bringing some useful information. The Infrared spectrometer IASI (onboard METOP in 2005) which will provide continuous spectra from 660 to 2740 cm-1 exhibits characterisics potentially interesting for tracking volcanic clouds. A simulation based on 4A radiative transfer model show that IASI combined with AVHRR will permit to dicriminate ice clouds, ash and sulfate aerosols, to determine accurate SO2 column, and have a good estimate of the SO2 level.

B26: The Infrared Ozone Retrieval Algorithm for NPOESS-OMPS

Presenter: (for Hilary E. Snell)

Hilary E. Snell, Edward J. Kennelly and Courtney J. Scott (AER, Inc.)
Juan Rodriguez, Quinn Remund and Roger Scarlotti (Ball Aerospace)
Jack Larsen (Raytheon ITSS)

The Ozone Mapping and Profiler Suite (OMPS) was the first sensor suite selected to fly on the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) spacecraft. OMPS consists of a UV-visible limb-viewing sensor and a UV nadir-viewing sensor. OMPS will also use data from another NPOESS sensor, the Cross-Track Infrared Sounder (CrIS), to provide total column ozone measurements primarily under nighttime conditions. This poster will provide an overall description of the OMPS with emphasis on the design and capabilities of the IR ozone retrieval algorithms.

B27: Update about Frequency Protection: Results of WRC 2003 and SFCG 23… What to do now?

Presenter: Guy Rochard

Guy Rochard
Meteo-France

This poster will report on results from the WRC 2003 and SFCG 23 meetings. Additional information about frequency protection can be found on these web sites:

http://cimss.ssec.wisc.edu/itwg/groups/frequency/
and
http://guy.rochard.free.fr/meteo/

B28: Tropospheric CO Observed with NAST-I: Retrieval Algorithm, First Results, and Validation

Presenter: Daniel Zhou

Daniel K. Zhou, William L. Smith*, Jun Li†, and Stephen A. Mango‡*

*NASA Langley Research Center, Hampton, VA 23681
†University of Wisconsin, Madison, WI 53706
‡NPOESS Integrated Program Office, Silver Spring, MD 20910

A methodology of retrieving tropospheric CO from remote sensed infrared (IR) spectral data has been developed. Tropospheric CO profiles, together with the thermodynamic properties, are determined using a three-stage approach that combines the algorithms of physical-based statistical eigenvector regression, simultaneous non-linear radiance inversion, and CO enhancement physical iterative retrieval. The NPOESS Airborne Sounder Testbed-Interferometer (NAST-I) aboard a high altitude aircraft with a spectral coverage of 650-2700 cm^{-1} and a spectral resolution of 0.25 cm^{-1} has been successfully collecting the data during many field campaigns. The retrieval methodology is described and demonstrated by simulations. Detailed CO retrieval error analyses based on NAST-I instrument and the retrieval uncertainties of the other parameters are discussed. Results from several NAST-I field campaigns are presented including those from observations over the western Pacific Ocean made in conjunction with airborne truth atmospheric chemistry profiles. Retrievals from both simulations and measurements illustrate that tropospheric CO profile can be obtained from remote sensed IR spectral data (such as NAST-I data) with accurate thermodynamic properties.

B29: Observations of dust emission/absorption by AIRS

Presenter: L. Larrabee Strow

L. Larrabee Strow

The impact of atmospheric dust on the high spectral resolution radiances observed with the Atmospheric Infrared Sounder (AIRS) will be presented. We have observed dust absorption/emission and scattering for a number of large dust events originating in the Sahara, the Gobi desert, and in Syria. In addition, we have observed large dust clouds emitted by the Mt. Etna eruption. The semi-continuous high-spectral resolution radiances recorded by AIRS may allow automated detection of dust contamination in the AIRS spectra, which may be important for both data assimilation of AIRS radiances for forecasting applications and for production of climate products with AIRS. Using a scattering version of the AIRS forward model, we have determined the dust cloud optical depths and mean particle sizes for several of these events. Intercomparisons with MODIS observations of these events will also be presented.

APPENDIX A: ITSC-XIII ATTENDEE MAILING LIST

Tom ACHTOR
SSEC/CIMSS / University of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
tom.achtor@ssec.wisc.edu
608-263-4206

Steven A. ACKERMAN
CIMSS / University of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
stevea@ssec.wisc.edu
608-263-3647

Bjarne AMSTROP
Danish Meteorological Institute
Lyngbyvej 100
DK-2100 Copenhagen
DENMARK
bja@dmi.dk

David ANSELMO
Meteorological Research Branch
Environment Canada
2121 Trans-Canada Hwy, Rm 505
Dorval, Quebec H9P 1J3
CANADA
david.anselmo@ec.gc.ca
514-421-7251

Paolo ANTONELLI
CIMSS/University of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
paoloa@ssec.wisc.edu
608-263-8568

Nigel ATKINSON
Met Office
FitzRoy Road
Exeter
Devon
EX1 3PB
UNITED KINGDOM
nigel.atkinson@metoffice.com
+44 1392 884528

Thomas AULIGNE
Météo-France
42 Avenue G
Coriolis
31057 Toulouse
FRANCE
thomas.auligne@meteo.fr
+33 5610 78437

George AUMANN
Jet Propulsion Laboratory (JPL)
4800 Oak Grove Drive
Pasadena, CA 91109 USA
hha@airs1.jpl.nasa.gov
818-354-6865

Leanne AVILA
CIMSS/University of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
leanne.avila@ssec.wisc.edu
608-262-0783

Nancy BAKER
Marine Meteorology Division
Naval Research Laboratory - Monterey
7 Grace Hopper Avenue
Monterey, CA 93943-5502 USA
baker@nrlmry.navy.mil
831-656-4779

John M. BLAISDELL
NASA/GSFC/SAIC
Mailcode 910.4
Greenbelt, MD 20771 USA
blaisdell@gsfc.nasa.gov
301-286-3583

Hal BLOOM
NPOESS IPO
8455 Colesville Road, Ste 1450
Silver Spring, MD 20910 USA
hal.bloom@noaa.gov
301-713-4785

Eva BORBAS
CIMSS/Univ. of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
eva.borbas@ssec.wisc.edu
608-263-0228

Pascal BRUNEL
Centre de Météorologie Spatiale
Météo-France
BP 147
22302 Lannion cedex
FRANCE
pascal.brunel@meteo.fr
+33 2 96 05 67 45

Henry BUIJS
ABB Bomem Inc.
585, boul. Charest Est
Bureau 300
Québec (Québec) G1K 9H4
CANADA
henry.l.buijs@ca.abb.com
418-877-2944

Mike CHALFANT
NOAA/NESDIS/ORA
FOB #4, Room 3208A
5200 Auth Road
Camp Springs, MD 20746-4304 USA
michael.chalfant@noaa.gov
301-457-5188 x156

Clément CHOUINARD
Meteorological Service of Canada
Data Assimilation and Satellite Meteorology Division
2121 Trans-Canada Hwy, 5th Floor
Dorval PQ H9P 1J3
CANADA
clement.chouinard@ec.gc.ca
514-421-4761

Pubu CIREN
QSS Group Inc.
NOAA/NESDIS/STAR
5200 Auth Road
Camp Springs, MD 20746-4304 USA
Pubu.Ciren@noaa.gov
301-763-8211 x317

Andrew COLLARD
Met Office
Meteorology Building
University of Reading
PO Box 243
Earley Gate, Reading
Berkshire RG6 6BB
UNITED KINGDOM
andrew.collard@metoffice.com
+44 118 378 7839

David CRAIN
Remote Sensing Systems Engineering
ITT Aerospace/Communications
1919 West Cook Road, M/S 607
Fort Wayne, IN 46801 USA
David.Crain@itt.com
260-451-6535

Cyril CREVOISIER
Laboratoire de Météorologie Dynamique
Institut Pierre Simon Laplace
Ecole Polytechnique
91128 Palaiseau cedex
FRANCE
cyril.crevoisier@lmd.polytechnique.fr
+33 1 69 33 48 19

Per DAHLGREN
Swedish Met Service (SMHI)
Folksborgsvägen 1
601 76 Norrköping
SWEDEN
Per.Dahlgren@smhi.se
+46 11 495 8312

Godelieve DEBLONDE
Meteorological Service of Canada
2121 Trans-Canada Hwy, 5th Floor
Dorval PQ H9P 1J3
CANADA
godelieve.deblonde@ec.gc.ca
514-421-4774

Ralph DEDECKER
CIMSS/Univ. of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
Ralph.Dedecker@ssec.wisc.edu
608-263-6779

John DERBER
NOAA/NWS/NCEP/EMC
W/NP2, WWB, Room 207
5200 Auth Road
Camp Springs, MC 20746-4304 USA
john.derber@noaa.gov
301-763-8000 x7740

Chaohua DONG
National Satellite Meteorological Centre (NSMC)
Beijing
Meteorological Administration
Beijing 100081
PRC
dchua@nsmc.cma.gov.cn
+86 10 68406237

Adam DYBBROE
Swedish Met Service (SMHI)
Folksborgsvägen 1
601 76 Norrköping
SWEDEN
adam.dybbroe@smhi.se
+46 11 495 8000

Izabela DYRAS
Institute of Meteorology and Water Management
Satellite Research Department
P. Borowego 14
30-215 Kraków
POLAND
Izabela.Dyras@imgw.pl
+4912 6398196

Stephen ENGLISH
Met Office
FitzRoy Road
Exeter
Devon
EX1 3PB
UNITED KINGDOM
stephen.english@meteoffice.com
+44 1392 884652

Luc FILLION
Meteorological Service of Canada
2121 Trans-Canada Hwy
Dorval PQ H9P 1J3
CANADA
luc.fillion@ec.gc.ca

Evan FISHBEIN
NASA Jet Propulsion Laboratory
M/S 169-237
4800 Oak Grove Dr.
Pasadena, CA 91109-8099 USA
Evan.Fishbein@jpl.nasa.gov
818-354-2250

Gilles FOURNIER
Meteorological Service of Canada
2121 Trans-Canada Hwy
Dorval PQ H9P 1J3
CANADA
gilles.fournier@ec.gc.ca

John GALANTOWICZ
Atmospheric and Environmental Research, Inc.
131 Harwell Avenue
Lexington, MA 02421-3126 USA
johng@aer.com
781-761-2215

Ignacio GALINDO
Director
Centro Universitario de Investigaciones en Ciencias del Ambiente
Universidad de Colima
Apartado Postal No. 44
28000 Colima, Colima
MEXICO
galindo@ucol.mx

Ma GANG
National Satellite Meteorological Center (Beijing)
Zhongguancun South
Street 46#
Beijing 100082
CHINA
magang@nsmc.cma.gov.cn
8610 68407237

Louis GARAND
Meteorological Service of Canada
Data Assimilation and Satellite Meteorology Division
2121 Trans-Canada Hwy, 5th Floor
Dorval PQ H9P 1J3
CANADA
louis.garand@ec.gc.ca
514-421-4749

Albin GASIEWSKI
NOAA Environmental Technology Laboratory
R/ET1
Room 3B-156
325 Broadway
Boulder, CO 80305 USA
al.gasiewski@noaa.gov
303-497-7275

Pierre GAUTHIER
Meteorological Service of Canada
2121 Trans-Canada Hwy
Dorval PQ H9P 1J3
CANADA
pierre.gauthier@ec.gc.ca

Elisabeth GERARD
Météo-France/CNRM/GMAP
42 Avenue G, Coriolis
31057 Toulouse Cedex
FRANCE
Elizabeth.Gerard@meteo.fr
+33 5 61 07 84 56

Mitchell D. GOLDBERG
NOAA/NESDIS/ORA
E/RA 1, Room 712-U
5200 Auth Road, WWB
Camp Springs, MD 20746-4304 USA
Mitch.Goldberg@noaa.gov
301-763-8078 x125

David GRIERSMITH
Commonwealth Bureau of Meteorology
GPO Box 1289K
Melbourne VIC 3001
AUSTRALIA
d.griersmith@bom.gov.au
61 3 9669 4594

Jacob GROVE-RASMUSSEN
Danish Meteorological Institute
Lyngbyvej 100
DK-2100 Copenhagen
DENMARK
jgr@dmi.dk
+45 3915 7427

Yong HAN
NOAA/NESDIS
WWB, Room 810
5200 Auth Road
Camp Springs, MD 20746-4304 USA
Yong.Han@noaa.gov
301-763-8136 x110

Brett HARRIS
Bureau of Meteorology Research Centre
PO Box 1289K
Melbourne VIC 3001
AUSTRALIA
B.Harris@bom.gov.au
+61-3-9669-4388

Reinhold HESS
DWD Germany
Postfach 10 04 65
D-63004 Offenbach
GERMANY
reinhold.hess@dwd.de
+49 69 8062 2723

Lisa HORROCKS
Met Office
F itzRoy Road
Exeter
Devon
EX1 3PB
UNITED KINGDOM
lisa.horrocks@metoffice.com

H. L. Allen HUANG
CIMSS/University of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
allen.huang@ssec.wisc.edu
608-263-5283

Ron ISAACS
Atmospheric and Environmental Research, Inc. (AER)
131 Harwell Avenue
Lexington, MA 02421-3126 USA
risaacs@aer.com

Nicole JACQUINET-HUSSON
Laboratoire de Météorologie Dynamique /
École Polytechnique
Route Départementale 35
91128 Palaiseau-cedex
FRANCE
jacquinet@lmd.polytechnique.fr
+33 1 69 33 48 02

Viju Oommen JOHN
Institute of Environmental Physics/Remote Sensing
University of Bremen, NW 1
Otto-Hahn-Alle 1
D-28359 Bremen
GERMANY
vojohn@uni-bremen.de
+49-421-2184520

Steve JOHNSON
ITT Aerospace/Communications
1919 West Cook Road, M/S 617
P.O. Box 3700
Fort Wayne, IN 46801 USA
steve.johnson@itt.com

Masahiro KAZUMORI
Japan Meteorological Agency
Numerical Prediction Division
1-3-4 Ote-machi, Chiyoda-Ku
Tokyo 100-8122
JAPAN
kazumori@met.kishou.go.jp
+81-3-3212-8341 x3321

Graeme KELLY
ECMWF
Shinfield Park
Reading RG2 9AX
UNITED KINGDOM
gkelly@ecmwf.int
+44 1189 499651

Dieter KLAES
EUMETSAT
Am Kavalleriesand 31
D-64295 Darmstadt
GERMANY
klaes@eumetsat.de
+49 6151 807 565

Thomas KLEESPIES
NOAA / NESDIS
E/RA 2, Room 711
5200 Auth Road, WWB
Camp Springs, MD 20746-4304 USA
Thomas.J.Kleespies@noaa.gov
301-763-8136 x126

Robert KNUTESON
CIMSS/University of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
bobk@ssec.wisc.edu
608-263-7974

Christina KÖPKEN
Deutscher Wetterdienst (DWD)
Postfach 10 04 65
D-63004 Offenbach-Main
GERMANY
christina.kopken@dwd.de
+49-69-80622800

Aarno KORPELA
National Institute of Water and Atmospheric Research
Private Bag 14901
Wellington
NEW ZEALAND
a.korpela@niwa.co.nz
+64 4 3860495

Bjorn LAMBRIGTSEN
NASA Jet Propulsion Laboratory
4800 Oak Grove Drive
M/S 169-237
Pasadena, CA 91109 USA
bjorn.lambrigtsen@jpl.nasa.gov
818-354-8932

Allen LARAR
Chemistry and Dynamics Branch
Atmospheric Sciences Competency
NASA Langley Research Center
Hampton, VA 23681-0001 USA
allen.m.larar@nasa.gov
757-864-5328

Lydie LAVANANT
Météo-France
Centre de Meteorologie Spatiale
BP 147
22302 Lannion Cedex
FRANCE
Lydie.Lavanant@meteo.fr
+33 2 96 05 67 49

Sung-Yung LEE
NASA Jet Propulsion Laboratory
4800 Oak Grove Drive
M/S 169-237
Pasadena, CA 91109 USA
Sung-Yung.Lee@jpl.nasa.gov
818-354-0645

Jun LI
CIMSS/SSEC/UW-Madison
1225 West Dayton St
Madison, WI 53706 USA
jun.li@ssec.wisc.edu
608-262-3755

Alan LIPTON
Atmospheric and Environmental Research, Inc.
131 Harwell Avenue
Lexington, MA 02421-3126 USA
alipton@aer.com
781-761-2206

Xu LIU
Atmospheric and Environmental Research, Inc.
131 Harwell Avenue
Lexington, MA 02421-3126 USA
xliu@aer.com
781-761-2204

Zhiquan LIU
National Satellite Meteorological Center
China Meteorological Administration
46, Zhong Guan Cun
South Street
100081 Beijing
CHINA
zqliu@nsmc.cma.gov.cn
+86 10 68406123

Stephen MACPHERSON
Meteorological Service of Canada
2121 Trans-Canada Hwy
Dorval PQ H9P 1J3
CANADA
stephen.macpherson@ec.gc.ca

Jean-François MAHFOUF
MRB/RPN
Meteorological Service of Canada
2121 Trans-Canada Hwy
Dorval PQ H9P 1J3
CANADA
jean-francois.mahfouf@ec.gc.ca
514-421-7268

Philippe MARGUINAUD
Meteo France
42 Avenue G, Coriolis
31057 Toulouse Cedex
FRANCE
philippe.marguinaud@meteo.fr
+33 05 61 07 82 84

Marco MATRICARDI
ECMWF
Shinfield Park
Reading RG2 9AX
UNITED KINGDOM
Marco.Matricardi@ecmwf.int
+44 118 9499109

Mark McCARTHY
Hadley Centre (H006) Met. Office
London Road
Bracknell
Berkshire RG12 2SY
UNITED KINGDOM
mark.mccarthy@metoffice.com
+44 1392 884672

Larry McMILLIN
NOAA/NESDIS/ORA
E/RA 14
5200 Auth Road
Camp Springs, MD 20746-4304 USA
Larry.McMillin@noaa.gov
301-763-8136 x127

Tony McNALLY
ECMWF
Shinfield Park
Reading RG2 9AX
UNITED KINGDOM
Anthony.McNally@ecmwf.int
44 118 949 9034

Carl MEARS
Remote Sensing Systems
438 First Street, Suite 200
Santa Rosa, CA 95401 USA
mears@remss.com
707-545-2904 x21

Herschel MITCHELL
Meteorological Service of Canada
Data Assimilation and Satellite Meteorology Division
2121 Trans-Canada Hwy, 5th Floor
Dorval PQ H9P 1J3
CANADA
Herschel.Mitchell@ec.gc.ca
514-421-4755

Jean-Luc MONCET
Atmospheric and Environmental Research, Inc.
131 Harwell Avenue
Lexington, MA 02421-3126 USA
jmoncet@aer.com
781-761-2268

Thibaut MONTMERLE
Météo-France
42 Avenue G, Coriolis
31057 Toulouse Cedex
FRANCE
thibault.montmerle@cnrm.meteo.fr
+33 5 61 07 84 70

Chris O'DELL
University of Wisconsin-Madison
1225 West Dayton St
Madison, WI 53706 USA
odell@aos.wisc.edu
608-265-1857

Michael PAVOLONIS
CIMSS/SSEC/UW-Madison
1225 West Dayton St
Madison, WI 53706 USA
mpav@ssec.wisc.edu
608-263-9597

Thierry PHULPIN
Centre National d'Etudes Spatiales (CNES)
DSO/OT/IA, bpi 2504
18 avenue E. Belin
31401 Toulouse Cedex 9
FRANCE
thierry.phulpin@cnes.fr
+33 5 61 27 39 01

Youri PLOKHENKO
CIMSS/University of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
youri@ssec.wisc.edu
608-262-7287

Saroja POLAVARAPU
Meteorological Service of Canada
2121 Trans-Canada Hwy
Dorval PQ H9P 1J3
CANADA
saroja.polavarapu@ec.gc.ca

Joe PREDINA
ITT Aerospace/Communications Division
1919 Cook Road
P.O. Box 3700
Fort Wayne, IN 46801 USA
joe.predina@itt.com
260-451-6919

Jeff PUSCHELL
Raytheon Santa Barbara Remote Sensing
75 Coromar Drive, B32/15
Goleta, CA 93117 USA
jjpuschell@raytheon.com
805-562-7053

Yanni QU
ITT Aerospace/Communications
1919 West Cook Road, M/S 609
P.O. Box 3700
Fort Wayne, IN 46801 USA
Yanni.Qu@itt.com

Florence RABIER
Météo-France/CNRM/GMAP
42 Avenue G, Coriolis
31057 Toulouse Cedex
FRANCE
florence.rabier@meteo.fr
+33 5 61 07 84 38

Gaby RÄDEL
LMD/IPSL
Ecole Polytechnique
91128 Palaiseau Cedex
FRANCE
radel@lmd.polytechnique.fr
+33 1 69 33 44 84

Roger RANDRIAMAMPIANINA
Hungarian Meteorological Service
P.O. Box 38
H-1525 Budapest
HUNGARY
roger@met.hu
+36 1 346-47-09

Tony REALE
NOAA/NESDIS
Forecast Products Development
FOB #4, Room 3210
5200 Auth Road
Camp Springs, MD 20746-4304 USA
Tony.Reale@noaa.gov
301-457-5188 x152

Hank REVERCOMB
SSEC/CIMSS
University of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
hankr@ssec.wisc.edu
608-263-6758

Guy ROCHARD
CMS
Météo-France
BP 147
22302 Lannion cedex
FRANCE
Guy.Rochard@meteo.fr
+33 2 96 05 67 48
+33 6 89 09 33 40

Filomena ROMANO
IMAA/CNR
V. S. Loya
85050 Tito Scalo (Pz)
ITALY
romano@imaa.cnr.it
+39 0971427266

Hervé ROQUET
Centre de Météorologie Spatiale
Météo-France
BP 147
22302 Lannion cedex
FRANCE
Herve.Roquet@meteo.fr

William B. ROSSOW
NASA Goddard Institute for Space Studies
2880 Broadway
New York, NY 10025 USA
wrossow@giss.nasa.gov
212-678-5567

Roger SAUNDERS
FitzRoy Road
Exeter
Devon
EX1 3PB
UNITED KINGDOM
roger.saunders@metoffice.com
+44-1392-886295

Peter SCHLUESSEL
EUMETSAT
Am Kavalleriesand 31
D-64295 Darmstadt
GERMANY
schluessel@eumetsat.de
+49 6151 807 699

Marion SCHROEDTER-HOMSCHEIDT
Deutsches Zentrum für Luft- und Raumfahrt (DLR)
Institut für Physik der Atmosphäre
Oberpfaffenhofen
Postfach 1116
D-82230 Wessling
GERMANY
Marion.Schroedter-Homscheidt@dlr.de
+49 8153 28 2896

Marc SCHWAERZ
Institute for Geophysics, Astrophysics and
Meteorology (IGAM)
University of Graz
Universitaetsplatz 5
A-8010 Graz
AUSTRIA
marc.schwaerz@uni-graz.at
+43 316 380 8591

Soumia SERRAR
Laboratoire de Météorologie Dynamique
Institut Pierre Simon Laplace
Ecole Polytechnique
91128 Palaiseau cedex
FRANCE
serrar@lmd.polytechnique.fr
+33 1 69 33 48 20

Awdhesh SHARMA
NOAA/NESDIS
FOB #4, Room 0312
5200 Auth Road
Suitland, MD 20746 USA
Awdhesh.Sharma@noaa.gov
301-457-5247 x110

Vanessa SHERLOCK
National Institute for Water and Atmospheric Research
P.O. Box 14-901
Kilbirnie, Wellington
NEW ZEALAND
v.sherlock@niwa.co.nz
+64 4 386 04 66

Devendra SINGH
India Meteorological Department
Lodi Road
New Delhi 110003
INDIA
dschahar@hotmail.com
+91 24658236

Bill SMITH
NASA Langley
21 Langley Dr. MS-400
Hampton, VA 23681 USA
bill.l.smith@larc.nasa.gov
757-864-5914

David STEENBERGEN
Meteorological Service of Canada
4905 Dufferin Street
Downsview, Ontario M3H 5T4
CANADA
dave.steenbergen@ec.gc.ca
416-739-4257

Larrabee STROW
Physics Department
University of Maryland - Baltimore County
1000 Hilltop Circle
Baltimore, MD 21250 USA
strow@umbc.edu
410-455-2528

Malgorzata SZCZECH-GAJEWSKA
Institute of Meteorology and Water Management
Ul.P.Borowego 14
30-215 Krakow
POLAND
ziszczec@cyf-kr.edu.pl
+48 12 6398301

Peter THORNE
Hadley Centre (H006) Met. Office
London Road
Bracknell
Berkshire RG12 2SY
UNITED KINGDOM
peter.thorne@metoffice.com
+44 1392 886552

Christopher TINGWELL
Bureau of Meteorology Research Center
GPO Box 1289K
Melbourne VIC 3001
AUSTRALIA
c.tingwell@bom.gov.au
+613 9669 4239

David Shawn TURNER
Meteorological Service of Canada
4905 Dufferin Street
Downsview, Ontario M3H 5T4
CANADA
shawn.turner@ec.gc.ca
416-739-4885

Michael UDDSTROM
National Institute for Water and Atmospheric Research
Private Bag 14-901
Wellington
NEW ZEALAND
m.uddstrom@niwa.co.nz
+64 4 386 0365

Alexander USPENSKY
Scientific and Research Center on Space Meteorology
PLANETA, Roshydromet
7, B.Predtechensky
123242 Moscow
RUSSIA
uspensky@planet.iitp.ru
7 09 52552137

Gilles VERNER
Canadian Meteorological Center
Meteorological Service of Canada
2121 Trans-Canada Hwy
Dorval PQ H9P 1J3
CANADA
gilles.verner@ec.gc.ga
514-421-4779

Michèle VESPERINI
Laboratoire d'optique atmosphérique
Université de Lille 1
Bâtiment P5
59655 Villeneuve d'Ascq
FRANCE
vesperini@loa.univ-lille1.fr
33 3 20 33 61 90

Nicolas WAGNEUR
Canadian Meteorological Center
Meteorological Service of Canada
2121 Trans-Canada Hwy
Dorval PQ H9P 1J3
CANADA
nicolas.wagneur@ec.gc.ca
514-421-4779

Kung-Hwa (Peter) WANG
Central Weather Bureau
Taipei
TAIWAN
peter@msc.cwb.gov.tw

Elisabeth WEISZ
CIMSS/Univ. of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
Elisabeth.Weisz@ssec.wisc.edu
608-265-3954

Fuzhong WENG
NOAA / NESDIS / ORA
5200 Auth Road, Room 712E
Camp Springs, MD 20746-4304 USA
Fuzhong.Weng@noaa.gov
301-763-8251

Walter WOLF
NOAA/NESDIS (QSS Group, Inc.)
5200 Auth Road
Camp Springs, MD 20746-4304 USA
walter.wolf@noaa.gov
301-763-8212 x328

Hal WOOLF
CIMSS/Univ. of Wisconsin - Madison
1225 West Dayton St
Madison, WI 53706 USA
halw@ssec.wisc.edu
608-262-0986

Xuebao WU
Department of Atmospheric Science
School of Physics
Peking University
Beijing 100871
P.R. CHINA
xuebao.wu@nsmc.cma.gov.cn
+86-10-68507027

Jishan XUE
Chinese Academy of Meteorological Sciences
No. 46, South Zhong Guan Cun Street
Beijing 100081
P.R. CHINA
jsxue@cams.cma.gov.cn
86 10 68408706

Dan ZHOU
NASA Langley Research Center
Mail Stop 401A
Hampton, VA 23681 USA
Daniel.K.Zhou@nasa.gov
757-864-5663

Lihang ZHOU
QSS Group Inc.
4500 Forbes Blvd., Suite 200
Lanham, MD 20706 USA
lihang.zhou@noaa.gov
301-763-8211

Shiyu ZHUANG
Chinese Academy of Meteorological Sciences
No. 46, South Zhong Guan Cun Street
Beijing 100081
P.R. CHINA
zhuangsy@cma.gov.cn