ITSC-XVI
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ABSTRACTS

ITSC-16 ORAL PRESENTATIONS

SESSION 1

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

Presenter: Kathleen Strabala

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

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

1.2: International Polar Orbiter Processing Package (IPOPP)

Presenter: John Overton

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

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

Why is IPOPP Needed?

- Meets high expectations by DB community for mission continuity from EOS to NPOESS
- Integrates Multi-disciplined science processing packages such as IMAPP (Atmosphere), SeaDAS (Ocean) and MODIS Land Rapid Response (Land)
- Provides DB community with user friendly processing packages for global as well as regional optimized value added applications
- Enables global feedback loop for NPP CAL/VAL campaigns
- Enable DB users to contribute their regional validated processing approaches/products to assist and improve global CAL/VAL efforts
- Initiates role of research to operations provider for Direct Readout Mission
- Facilitates the adoption/adaptation of DB regional optimized research/unique processing approaches to enhance functionality and capability
- Enables industry to productize government provided algorithms into commercial product lines which offer choice to all users

Who is the DB Community?

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

1.3: AAPP developments and experiences with processing MetOp data

Presenter: Nigel Atkinson

Nigel Atkinson, Pascal Brunel, Philippe Marguinaud and Tiphaine Labrot

Version 6 of the ATOVS and AVHRR Preprocessing Package (AAPP) was released in October 2006, shortly before the launch of the MetOp-A satellite. The talk will describe the capabilities of the software and give examples of its use in an operational context. Data types now processed by AAPP include: - direct broadcast HRPT from NOAA satellites - Level 0 files from MetOp AHRPT (AMSU, MHS, HIRS, AVHRR, IASI) - global level 1b ATOVS data from NOAA - global ATOVS and IASI data from EUMETSAT (BUFR format) - global MetOp and NOAA-18 AVHRR data from EUMETSAT (EPS format) - regional ATOVS data (BUFR format - e.g. EARS and RARS) During the commissioning phase of MetOp-A the Level 0 processing capabilities of AAPP were fully tested, including the IASI local processor OPS-LRS. Unfortunately the MetOp-A AHRPT primary transmitter failed on 4th July 2007, so there has been no Level 0 data since then. At the Met Office, assimilation of IASI data became operational in November 2007. This is using an AAPP-based preprocessor in which AMSU is mapped to the IASI grid and the IASI data are thinned spatially and spectrally via a channel selection. Principal Components compression is also available, and to support this an updated set of eigenvectors has been made available to users, based on 6 months of IASI data. The talk will describe the properties of these eigenvectors. Another activity in which AAPP is a key component is the WMO initiative to develop Regional ATOVS Retransmission Services (RARS). Two networks have come on-line during 2007 - the Asia-Pacific RARS and the South American RARS. These complement the EARS network established by EUMETSAT in 2002. RARS data have been operationally assimilated at the Met Office since November 2007. Also the data quality is monitored routinely by the NWP SAF and a selection of results are made available on the NWP SAF web site. Finally, the next major release of AAPP is planned to coincide with the launch of NPP (late 2009). AAPP will not process the direct broadcast data directly but the intention is that it will be able to read the level 1 ATMS/CrIS/VIIRS products from IPOPP (being developed by NASA and the University of Wisconsin), as well as the global ATMS/CrIS radiances to be distributed by NOAA.

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

Presenter: Liam Gumley

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

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

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

Presenter: Thomas Achtor

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

The Man computer Interactive Data Access System (McIDAS) project began over 30 years ago at the University of Wisconsin-Madison to analyze and visualize data from the first generation of geostationary weather satellites. McIDAS continues to provide a strong data analysis and visualization capability for the current environmental satellites. However, the next generation of operational remote

sensing instruments under development for the NPOESS and GOES-R programs require software tools with expanded capability and performance to support innovative techniques for developing algorithms, visualizing data and products, and validating results. A project is underway at SSEC to develop the fifth generation of McIDAS, a java-based, open-source system for multispectral and hyperspectral researchers and algorithm developers that will provide powerful new data manipulation and visualization tools to work in this data rich environment. NASA EOS MODIS and AIRS data as well as MSG SEVERI and METOP IASI data are now being used in conjunction with in situ and gridded data to develop new analysis and product validation techniques in the McIDAS-V environment. This new data analysis and visualization system will support both researchers and operational users of the advanced measurement systems on METOP, NPOESS and GOES R. A review of the current state of McIDAS-V will be presented as well as plans for future development to support polar and geostationary environmental satellite programs.

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

Presenter: Jean PLA

Jean PLA

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

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

Presenter: Richard Kelley

Richard Kelley

The efforts of the (international) Space Frequency Coordination Group (SFCG) and International Telecommunications Union-Radio (ITU-R) prompted the conduct of a NOAA Passive Sensing Workshop last year. The workshop's objective was to finalize the results of two previous workshops. It

also focused on the introduction and discussion of technical papers on the identification, evaluation and utilization of particular passive sensing microwave bands, emphasizing bands above 275 GHz. This paper summarizes the workshop and provides a table which is an initial guide for updating ITU-R recommendations RS.515, RS.1028, and RS.1029. Workshop attendees recommended several changes and some additions to the existing table. Variables addressed were vegetation biomass, cirrus cloud, ice water path, cloud ice, cloud liquid water, height and depth of melting layer, precipitation, soil moisture, and the water vapor profile. Observations of these variables spanned the range of 1.37 to 882 GHz. It is hoped that the presentation of these workshop results will lead to discussions of needs for additional table entries as the changes to the ITU-R recommendations go forward.

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

Presenter: Bill Bell/Nancy Baker

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

Detailed descriptions and comparisons of the observed F-16 and F-17 SSMIS radiometric calibration anomalies uncovered during the Calibration and Validation (Cal/Val) efforts are presented. As previously described for F-16, two principal anomalies were detected: an intermittent solar intrusion to the warm load calibration target; and reflector emission due to solar heating of the reflector face itself. The solar intrusion anomaly is readily evident in the time series of the individual channel radiometer gains, and can result in as much a 1.5 K peak depression in the observed scene temperatures. A Fourier based filtering mitigation strategy has been implemented to perform the gain filtering in the SSMIS ground processing software for the sensor data records (SDRs). Performance of the F-17 hardware modifications designed to inhibit the direct solar intrusions is presented. The reflector emission bias is a function of both the frequency dependent reflector emissivity and the difference between the reflector face and Earth scene temperatures. Warm biases of 1-2.5 K in the 50-60 GHz channels and up to 5 K in the high frequency channels (150-183 GHz) are observed. These anomalies correspond to reflector emissivities of ~0.015 at 50 GHz to as high as 0.07 at 183 GHz. For F-16 the reflector thermal cycle and resulting emission anomaly is driven by earth and/or spacecraft shadow, and is a maximum when the reflector face is directly illuminated by the sun. F-17 is in the terminator orbit configuration and shading due to the solar panel array dominates the thermal cycle of the SSMIS main reflector. Investigations were performed to directly measure the effective surface electrical conductivity of the main reflectors to determine the root-cause of the apparent high emissivities. Techniques were developed to perform laboratory measurements of the remaining SSMIS flight-unit reflectors have indicated the feasibility of low surface electrical conductivities of the F-16 and F-17 reflectors (i.e. less than 1.0 MS/m) compared with pure aluminum (36 MS/m). Low conductivities were also evident on the reflectors intended for use on other precision space–based microwave radiometer systems. Procedures to determine the electrical conductivity of the reflectors are now part of the pre-flight analysis for future SSMIS instruments. Methods have also been developed to strip existing coatings and re-coat the reflectors to meet the necessary electrical conductivity criteria (~18 MS/m) for a negligibly emissive reflector. The main reflector of the third SSMIS instrument (F-18) scheduled for launch in mid 2008 has been replaced with a spare reflector having significantly higher conductivity (17-18.5 MS/m) is expected to reduce the on-orbit reflector emission to a negligible level.

SESSION 2

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

Presenter: Denis Blumstein

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

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

2.2: IASI L1 data quality and NRT monitoring at EUMETSAT

Presenter: Lars Fiedler

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

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

2.3: IASI Level-2 Product Processing at EUMETSAT

Presenter: Peter Schluessel

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

The IASI (Infrared Atmospheric Sounding Interferometer) Level 1C data are processed in near real time to Level 2 (geophysical products) in the EUMETSAT Polar System's Core ground segment and disseminated to the users via the EUMETCast system. The Level-2 processor ingests the IASI data along with information from the companion instruments AVHRR (Advanced Very High Resolution

Radiometer), AMSU-A (Advanced Microwave Sounding Unit A), and MHS (Microwave Humidity Sounder). The processor functionality can be broadly broken down into three parts, the pre-processing, the cloud-detection, and the retrieval step. The level 2 processing starts with a pre-processing. The processing options are read from a user-configurable auxiliary data set. All necessary data are accepted from the input streams and are checked for availability, validated against thresholds, and co-located on IASI footprints by interpolation or nearest match-up. A radiance tuning is applied to the IASI spectra to account for biases between the natural and the modelled radiative transfer. A number of cloud detection tests are executed, based on IASI data alone, or using IASI in combination with AVHRR and/or ATOVS. The AVHRR scenes analysis is used to determine cloud amount, cloud height distribution, and the number of cloud formations within an IASI field of view. If clouds are detected, a CO2 slicing method, adapted for the use with interferometric data, is applied to determine cloud height and amount. The cloud phase is determined by applying thresholds on brightness-temperature differences in the infrared window. Flags are generated or updated to reflect the cloud situation and to modify the choice of the retrieval method accounting for the actual cloud condition. Different retrieval types are utilised, chosen according to data availability and cloud conditions. In the cloud-free case the parameters to be derived are temperature and water-vapour profiles, ozone amounts in deep layers, columnar amounts of carbon monoxide, methane, and nitrous oxide, surface temperature, and surface emissivity at different wavelengths. In cloudy situations, the number of retrieved parameters can change according to cloud amount and user choice. It is foreseen that parameters are derived above clouds only or in case of low cloud amounts, that a cloudy retrieval is performed. The retrieval techniques implemented are statistical retrievals based on EOF regression and artificial neural network methods for the first retrieval, and a variational Marquardt-Levenberg method employing a sub-set of IASI channels. It is possible that different choices can be made depending on the parameter to be derived and on cloud condition. The processor is being optimised and validated with data from short-range NWP forecast and dedicated field campaigns.

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

Presenter: N. Jacquinet-Husson

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

The principal purpose of spectroscopic parameter compilations, in spectroscopic databases, is to provide the necessary molecular absorption input for transmission and radiance codes. In this context, GEISA (Gestion et Etude des Informations Spectroscopiques Atmosphériques: Management and Study of Spectroscopic Information), initiated in 1976, is a computer-accessible spectroscopic database[1], designed to facilitate accurate forward radiative transfer calculations using a line-by-line and layer-by-layer approach. Remote sensing of the terrestrial atmosphere has advanced significantly in recent years, and this has placed greater demands on the compilations in terms of accuracy, additional species, and spectral coverage. Actually, the performance of instruments like AIRS (Atmospheric Infrared Sounder -http://www-airs.jpl.nasa.gov/), in the USA, and IASI (Infrared Atmospheric Sounding Interferometer -http://earth-sciences.cnes.fr/IASI/) in Europe, which have a better vertical resolution and accuracy, compared to the previous satellite infrared vertical sounders, is directly related to the quality of the spectroscopic parameters of the optically active gases, since these are essential input in the forward models used to simulate recorded radiance spectra. Currently, GEISA is involved in activities related to the assessment of the capabilities of IASI through the GEISA/IASI database derived from GEISA[2]. Since the Metop (http://www.eumetsat.int) launch (October 19th 2006), GEISA/IASI is the reference spectroscopic database for the validation of the level-1 IASI data, using the 4A radiative transfer model[3] (4A/LMD http://ara.lmd.polytechnique.fr; 4A/OP co-developed by LMD and NOVELTIS -http://www.noveltis.fr/) with the support of CNES (2006). The updated 2008 edition of GEISA (GEISA-08), a system comprising three independent sub-databases devoted, respectively, to line transition parameters, infrared and ultraviolet/visible absorption cross-sections, microphysical and optical properties of atmospheric aerosols, will be described with special emphasize given to GEISA/IASI. Results of critical assessments of the spectroscopic databases such as GEISA, HITRAN and MIPAS, in terms of spectroscopic line parameters archived will be presented. Spectroscopic parameters quality requirement will be discussed in the context of comparisons between observed or simulated Earth's atmosphere spectra. GEISA is implemented on the CNES/CNRS Ether Products and Services Centre WEB site

(http://ether.ipsl.jussieu.fr), where all archived spectroscopic data can be handled through general and user friendly associated management software facilities. More than 350 researchers are registered for on line use of GEISA. Refs: 1. Jacquinet-Husson N., N.A. Scott, A. Chédin, L. Crépeau, R. Armante, V. Capelle, J. Orphal, A. Coustenis, C. Boonne, N. Poulet-Crovisier, et al. THE GEISA SPECTROSCOPIC DATABASE: Current and future archive for Earth and planetary atmosphere studies. JQSRT 2008, doi:10.1016/j.jqsrt.2007.12.015 2. Jacquinet-Husson N., N.A. Scott, A. Chédin, K. Garceran, R. Armante, et al. The 2003 edition of the GEISA/IASI spectroscopic database. JQSRT, 95, 429-67, 2005. 3. Scott, N.A. and A. Chedin, 1981: A fast line-by-line method for atmospheric absorption computations: The Automatized Atmospheric Absorption Atlas. J. Appl. Meteor., 20,556-564.

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

Presenter: W. Smith Sr.

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

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

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

Presenter: Daniel K. Zhou

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

The Joint Airborne IASI Validation Experiment (JAIVEx) was conducted during April 2007 mainly for validation of the IASI on the MetOp satellite. IASI possesses an ultra-spectral resolution of 0.25 cm-1 and a spectral coverage from 645 to 2760 cm-1. Ultra-spectral resolution infrared spectral radiance obtained from near nadir observations provide atmospheric, surface, and cloud property information. An advanced retrieval algorithm with a fast radiative transfer model, including cloud effects, is used for atmospheric profile and cloud parameter retrieval. This physical inversion scheme has been developed, dealing with cloudy as well as cloud-free radiance observed with ultraspectral infrared sounders, to simultaneously retrieve surface, atmospheric thermodynamic, and cloud microphysical parameters. A fast radiative transfer model, which applies to the cloud-free and/or clouded atmosphere, is used for atmospheric profile and cloud parameter retrieval. A one-dimensional (1-d) variational multi-variable inversion solution is used to improve an iterative background state defined by an eigenvector-regression-retrieval. The solution is iterated in order to account for non-linearity in the 1-d variational solution. It is shown that relatively accurate temperature and moisture retrievals can be achieved below optically thin clouds. For optically thick clouds, accurate temperature and moisture profiles down to cloud top level are obtained. For both optically thin and thick cloud situations, the cloud top height can be retrieved with relatively high accuracy (i.e., error < 1 km). Preliminary retrievals of atmospheric soundings, surface properties, and cloud optical/microphysical properties with the IASI observations are obtained and presented. These retrievals are further inter-compared with those obtained from airborne FTS system, such as the NPOESS Airborne Sounder Testbed – Interferometer (NAST-I), dedicated dropsondes, radiosondes, and ground based Raman Lidar. The capabilities of satellite ultra-spectral sounder such as the IASI are investigated.

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

Presenter: Paolo Antonelli

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

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

2.8: Direct radiance validation of IASI - results from JAIVEx

Presenter: Stuart Newman

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

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

2.9: Retrieval algorithm using superchannels

Presenter: Xu Liu

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

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

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

Presenter: Nikita Pougatchev

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

The Infrared Atmospheric Sounding Interferometer (IASI) Level 2 products generated by Product Processing Facility (PPF) at EUMETSAT comprise retrievals of vertical profiles of temperature and water vapor. The L2 data were validated through assessment of their error covariances and biases using radiosonde data for the reference. The reference radiosonde data set includes dedicated launches as well as the ones performed at regular synoptic times. For optimal error estimate the linear statistical Validation Assessment Model (VAM) was used. The model establishes relation between the compared satellite and reference measurements based on their relations to the true atmospheric state. The VAM utilizes IASI averaging kernels and statistical characteristics of the ensembles of the reference data to allow for finite vertical resolution of the retrievals and temporal non-coincidence. The paper presents the validation results for different geographical locations and discusses potential use of the VAM estimated error covariances and biases for applications such as NWP, satellite intercalibration, and Earth System studies.

2.11: Assimilation of IASI Radiances at the Met Office

Presenter: Fiona Hilton

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

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

2.12: Monitoring and Assimilation of IASI Radiances at ECMWF

Presenter: Andrew Collard

Andrew Collard and Tony McNally

IASI data at full spatial and spectral resolution have been arriving in near real time at ECMWF via the EUMETSAT EUMETCAST system since February 2007. Real time monitoring of a subset 366 channels commenced on 8th March 2007. Monitoring of radiance departures indicates that IASI data quality is good with biases and standard deviations comparable with or better than AIRS in the longwave temperature sounding band. An initial assimilation trial with 168 channels in the 15micron CO2 band (a region considered particularly important following experience with AIRS) has yielded significant positive impact on forecast scores. Following this result the assimilation of these IASI channels became operational at ECMWF on 12th June 2007. Enhancements on this initial system including the use of the water vapour channels will be discussed.

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

Presenter: Marc Schwaerz

Marc Schwaerz and Reinhold Hess

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

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

Presenter: Thierry Phulpin

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

MetOp, the first European meteorological platform on a polar orbit was launched on October 19, 2006. The platform carries a series of instruments, including IASI, the Infrared Atmospheric Sounding Interferometer designed and built by the French spatial agency CNES. IASI consists of a Fourier transform spectrometer, which measures radiance spectra of the Earth-atmosphere system between 645 and 2760 cm-1 in the thermal infrared, at a spectral resolution of 0.5 cm-1 (apodised). The nadir-looking geometry of IASI, combined with an across-track scanning mode reaching 48° on both sides, allows global coverage to be achieved in twelve hours. The first IASI spectra were delivered from mid July 2007. This work exhibits the first results acquired by analyses of IASI spectra, using retrieval tools dedicated both to operational and scientific processing, analysis of peculiar spectra in calibration mode, or images. We show that the extended spectral coverage of IASI provides unique information on the concentration distribution of numerous tropospheric species, impacting on climate (H2O, CO2, N2O, CH4, CFCs) or on chemistry (O3, CO, HNO3). For most of these gases we demonstrate that vertical profiling is possible. IASI is showed to be very useful to monitor volcanic SO2. The emphasis of this work is put on preliminary analyses of O3, CO, CH4 distributions on local to global scales, acquired during the first months of IASI operation, and also on CFCs and SO2.

SESSION 3

3.1: Community Radiative Transfer Model (CRTM) Status

Presenters: Paul van Delst and Yong Han

Paul van Delst and Yong Han

The Community Radiative Transfer Model (CRTM) is the operational model developed jointly by the partners of the US Joint Center for Satellite Data Assimilation (JCSDA) and JCSDA-funded research groups. This talk will discuss the current status and future development plans for the CRTM. The current implementation includes modules to compute atmospheric transmittances, optical parameters for several cloud and aerosol types, surface emissivity and reflectivity for ocean, land, ice and snow surface types, and a multiple stream radiative transfer solution. The current CRTM supports many infrared and microwave sensors, including hyperspectral sensors such as AIRS and IASI. The ongoing and planned development of the CRTM includes the implementation of a transmittance model for SSU that takes the leakage of the CO2 cell pressure into account, improvements in the CompactOPTRAN transmittance model, implementation of multiple atmospheric transmittance algorithms such as those used in RTTOV and SARTA, implementation of an algorithm to add extra layers at the top-of-atmosphere (TOA) as required to prevent large valued temperature Jacobians at TOA, implementation of a new low-frequency microwave sea surface emissivity model, implementation of a fast radiative transfer model that takes the Zeeman effect into account, investigation of a new infrared land surface emissivity model from NRL, improvement of the computational efficiency of the current Advanced Doubling-Adding (ADA) radiative transfer solver, and implementation of the Successive Order of Interaction (SOI) radiative transfer solver developed at the University of Wisconsin.

3.2: What can RTTOV-9 do for me?

Presenter: Roger Saunders

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

The development of the fast radiative transfer model RTTOV, promoted by the NWP-SAF and other EUMETSAT sponsored activities, has continued since the release of RTTOV-8 in November 2004.

Over 290 users worldwide have received a copy of the RTTOV-8 code. The RTTOV model is used for radiance assimilation in NWP models, simulating current and future satellite observations and as part of a physical retrieval scheme. The new version of RTTOV is RTTOV-9 which was released recently by the NWP SAF and is available to users free on request from the NWP SAF web site at www.nwpsaf.org. The major enhancements of RTTOV-9 over RTTOV-8 are: - Inclusion of a multiple scattering parameterisation for cloudy and aerosol infrared radiance calculations - Incorporation of cloudy radiance calculations within RTTOV allowing elimination of RTTOV_CLOUD wrapper code - Linear in tau approximation for the Planck function to improve the accuracy of the radiance computation - The curvature of the earth and refraction can now be optionally included in the optical path calculation. - Include reflected solar radiation for short-wave infrared wavelengths - More 'active' trace gases (i.e. CO, CH4, N2O) - Further optimisation of optical depth computations for all gases (initially only for AIRS and IASI) - Improved microwave simulations by including updated spectroscopy in the coefficient files. - Minor improvements to RTTOV_SCATT code (new Mie tables) - Simplified interface to avoid need to specify polarisation - Change of user interface to allow profiles on user defined pressure or sigma levels and better mapping of computed jacobians on to user levels - Improved performance over RTTOV-8 on vector machines and improved memory management. The new RTTOV-9 model has been extensively validated and results of the validation will be shown. Development of the RTTOV-9 code continues and users will be invited to make comments on the plans for RTTOV-10 which will also be presented at the conference.

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

Presenter: Marco Matricardi

Marco Matricardi

The fast radiative transfer model RTTOV has been validated for the channels of the Infrared Atmospheric Sounding Interferometer (IASI). IASI radiances measured in clear sky conditions have been compared to RTTOV radiances using as state vector profiles from the ECMWF analysis. Bias calculations were performed over water and during night. Results for an earlier version of RTTOV based on the GENLN2 line-by-line model have been compared to results obtained using the most recent version of RTTOV based on the LBLRTM line-by-line model and trained using a new set of diverse atmospheric profiles using molecular parameters from different spectroscopic databases. The impact on the results of different formulations of the water vapour continuum model has also been assessed.

3.4: Microwave Radiative Transfer at the Sub-Field-of-View Resolution

Presenter: Thomas J. Kleespies

Thomas J. Kleespies

The Advanced Microwave Sounding Unit has a nadir resolution of 50 km increasing to 155x82 km at edge of scan. Modern numerical weather prediction models are or beginning to exceed this resolution. Ancillary databases, such as digital elevation maps are available with a resolution of a few meters. This paper presents a method of using the measured antenna pattern of the AMSU in conjunction with a digital elevation model to perform radiative transfer over coastlines and other inhomogeneous terrain.

3.5: Error analysis about using CO2-absorbing band for temperature retrieval

Presenter: Qi Chengli

Qi Chengli, Ma Gang, Liu Hui, Zhang Peng

In the past more than 30 years, the traditional temperature retrieval method is using the infrared channels on CO2-absorbing band, meanwhile in the current several decades, the column contents of

CO2 have noticeably increased. So in the retrieval method it is no more accurate for the forward calculation that generate fast transmittance coefficients using fixed content CO2 column contents. Using the updated CO2 column contents to calculate fast transmittance coefficients and perform the bias estimation of simulated satellite observed measurements, and derive the temperature retrieval results. Comparison between the traditional temperature retrieval results and that with adjusted satellite observed brightness temperature show the error results.

3.6: Fast Forward Modeling in Scattering Atmospheres with Optimum Spectral Sampling

Presenter: A. Lipton

Jean-Luc Moncet, G. Uymin, and A. Lipton

Assimilation of cloudy radiances and retrieval of cloud properties require a radiative transfer method that is accurate and computationally fast. An efficient treatment of scattering is one necessary element of the modeling. Another requirement is an efficient method to represent the spectral response of a channel, without resorting to numerical integration over a fine grid of monochromatic points covering the channel response function. Optimum Spectral Sampling (OSS) has been established as a very accurate and fast method to handle the spectral response and radiative transfer in clear and cloudy atmospheres. This paper describes progress in development and testing of OSS extensions to cloudy atmospheres where scattering is significant. OSS computes the radiance for a channel as a weighted average of results from radiative transfer calculations at a relatively few monochromatic points, where the points and their weights are determined by optimization. The OSS optimal selection process can be performed in a localized manner, where the search for the optimal points is restricted to the spectral range of finite response for the channel. Another mode (described at ITSC-14) is the implementation of generalized training, where the search for optimal points for a channel is bounded only by the range of spectral response of all the channels together. A clustering approach makes the search process efficient. With generalized training, only ~250 spectral points are needed for the full AIRS channel set, which is an average of ~0.1 points per channel. For cloudy skies, OSS weights derived with generalized training from clear-sky optimization are not always accurate. The optical properties of clouds may vary substantially across the range of spectral points that contribute to a channel, and the properties will vary with the microphysical properties of the clouds and their spatial distribution. A variety of cloud conditions can be mixed into the training set, to seek spectral points and weights that are accurate for cloudy and clear atmospheres, but the performance in clear atmospheres tends to be degraded by the inclusion of cloudy atmospheres. Because cloud optical properties are spectrally smoother than molecular absorption, the cloudy profiles are less demanding, and a set of weights that achieves a specified accuracy overall will not necessarily achieve that accuracy for the clear-sky subset of training cases. To address this issue, we require that the accuracy threshold be met simultaneously for each subset (clear sky, ice cloud, liquid cloud, ice+liquid cloud). In addition, we have implemented a segmented version of generalized training by breaking the spectrum into intervals of ~20 cm-1 and applying the generalized training method to the channels in each interval independently. In such intervals, the variations in cloud properties have an impact on radiances that is quasi-linear. This capability was originally introduced for land applications to handle spectral variations of surface emissivities, and for cloud it may well be that we could use wider intervals. This approach gives a lower computational gain than the fully generalized training, but gives increased robustness for clear and cloudy atmospheres. For AIRS, this method yields ~1 spectral point per channel. For an instrument with broader response functions, such as MODIS, the number of required nodes per channel can be up to about 25. In such cases, the radiative transfer integration becomes the dominant element of the computation time. An option for speeding up the OSS RT calculations in scattering atmospheres consists of predicting a multiple-scattering increment relative to non-scattering radiances. Under such a scheme, radiance calculations in non-scattering conditions (these include treatment of cloud absorption) are performed for all the nodes, which is fast, and the full scattering calculations are performed only for a few selected predictor nodes optimally selected among the original set of OSS nodes used by this channel. The difference between the monochromatic radiances obtained with scattering and without scattering for this selected subset of nodes is used to predict a scattering correction for the channel. In tests with MODIS thermal channels, the accuracy of this OSS approach can exceed the accuracy of the commonly used band-transmittance parameterization method with an average of 1.7 scattering calculations per MODIS channel. This OSS method is particularly advantageous for reflective

surfaces with low optical depths. For mini-AIRS, it is expected that this approach, combined with the generalized training, may require much less than one multiple-scattering calculation per channel.

3.7: Development of the Multilayer Cloudy Radiative Transfer Model for the GOES-R Advanced Baseline Imager

Presenter: Allen Huang

Bormin Huang, Yong-Keun Lee, Allen H.-L. Huang, and Mitchell D. Goldberg

Surface, aircraft and satellite observations show that many cloud types can appear simultaneously at the same location but at different altitudes. Furthermore, clouds may be continuous or broken at a given cloud level within a sensor's field of view. Therefore, it is desirable that a general radiative transfer model can deal with multilayer cloudy atmospheres for remote sensing applications. Multilayer cloudy systems can be complicated even for a non-scattering atmosphere. It can be shown that forming a two- and three-layer cloud system yields 10, and 218 combinations, respectively. The satellite cloud detection or cloud property retrieval algorithms (e.g. the CO2-slicing method, the N* methods) which have been widely used for a single-layer or a simple two-layer overcast cloud system are not applicable to more complicated multilayer cloudy systems. In support of GOES-R Advanced Baseline Imager (ABI) for remote sensing of cloudy atmospheres, we develop a generalized multilayer cloudy radiative transfer model. The model is not too complicated that it makes the cloudy retrieval problems unmanageable, while generalized enough to handle multilayer clouds with the definition of the effective cloud emissivity to include the multiple scattering effects. The clear-sky atmosphere is a special case of this model where the cloud fractions are reduced to zero.

SESSION 4

4.1: Retrieval of Global Hyperspectral Surface Emissivity Spectra from Advanced Infrared Sounder Radiance Measurements

Presenter: Jun Li

Jun Li and Jinlong Li

Global hyperspectral surface emissivity map has been generated using Atmospheric InfraRed Sounder (AIRS) radiance measurements. Single field-of-view physical retrieval algorithm (Li et al. 2007: Geophysical Research Letters) was used for retrieving the global hyperspectral IR emissivity product. Collocated operational MODIS (Moderate Resolution Imaging Spectroradiometer) cloud mask product with 1 km spatial resolution is used for AIRS sub-pixel cloud detection (Li et al. 2004: Journal of Applied Meteorology); only AIRS radiances from clear skies are used for the IR surface emissivity retrieval. The 8-day (01 – 08 January 2004) composite of AIRS emissivity retrievals agrees well with the operational MODIS emissivity product at a few broad spectral bands. The spatial and spectral features of the derived emissivity spectra over desert and other regions well reflect the surface property and ecosystem conditions. The method can also be applied to process IASI (Infrared Atmospheric Sounding Interferometer) radiances with full IR spectral coverage. The global hyperspectral IR emissivity map is very important for assimilating radiances over land, retrieving other products such as dust properties and cloud properties using IR radiances.

4.2: Using Hyperspectral IR Sounder Data Over Land - PC radiative transfer and 1d-Var.

Presenter: Jonathan P Taylor

Jonathan P Taylor, Stephan Havemann, Jean-Claude Thelen

The Met Office started assimilating IASI data from the Metop platform in November 2007 and trials have shown it to have a big impact on NWP skill. However, current assimilation techniques only allow 183 of the 8461 available channels on IASI to be utilised and these are only assimilated in cloud free

conditions. Over land the number of channels is reduced further to around 40 that have their peak sensitivity at altitudes above 400hPa. A novel new principal component radiative transfer scheme has been developed and coupled with a version of the UM 1d-Var code. Using this new technique we demonstrate the ability to use hyperspectral sounder data over all cloud free scenes including those over land. In this presentation results using around 4000 channels from the Airborne Research Interferometer Evaluation System (ARIES) on the FAAM BAe146 research aircraft will be presented showing the skill in retrieving temperature, water vapour and ozone profiles simultaneously with spectrally resolved land surface emissivity and land surface temperature all of which are required to utilise satellite data over land within an NWP environment. The presentation will conclude with a presentation on the future direction of this research which includes the simulation of cloud affected radiances using principal component radiative transfer.

4.3: Infrared continental surface emissivity spectra retrieved from IASI observations

Presenter: E. Péquignot

E. Péquignot, A. Chédin, N. A. Scott

Infrared Atmospheric Sounding Interferometer (IASI) is a key element of the payload onboard METOP series of European meteorological polar-orbit satellites. The first METOP satellite was successfully launched on 19th of October 2006. In this paper, IASI observations over land are interpreted in terms of surface emissivity spectra at a resolution of 0.05 µm and skin temperature. For each IASI observation, an estimation of the atmospheric temperature and water vapor profiles is first obtained through a proximity recognition within the Thermodynamic Initial Guess Retrieval (TIGR) climatological library of about 2300 representative clear sky atmospheric situations. With this a priori information, all terms of the radiative transfer equation are calculated by using the 4A line-by-line radiative transfer model. Then, surface temperature is evaluated by using a single IASI channel (channel 699 at 12.203 µm) chosen for its almost constant emissivity with respect to soil type. Emissivity is then calculated for a set of 97 atmospheric windows (transmittance greater than 0.5) distributed over the IASI spectrum. The overall infrared emissivity spectrum at 0.05 µm resolution is finally derived from a combination of high spectral resolution laboratory measurements of various materials carefully selected within the MODIS/UCSB and ASTER/JPL emissivity libraries.

4.4: Recent updates of the UW/CIMSS high spectral resolution global land surface infrared emissivity database

Presenter: Eva E Borbas

Eva E. Borbas; Robert O. Knuteson, Suzanne W. Seemann, Elisabeth Weisz, Leslie Moy

An accurate infrared land surface emissivity product is critical for deriving accurate land surface temperatures, needed in studies of surface energy and water balance. Current sensors provide only limited information useful for deriving surface emissivity and researchers are required to use emissivity surrogates such as land-cover type or vegetation index in making rough estimates of emissivity. Inaccuracies in the emissivity assignment can have a significant effect on atmospheric temperature and moisture retrievals. To accurately retrieve atmospheric parameters, a global database of land surface emissivity with fine spectral resolution is required. An accurate emissivity is also required for any application involving calculations of brightness temperatures such as the assimilation of radiances into climate or weather models. At the Cooperative Institute of Meteorological Satellite Studies (CIMSS), University of Wisconsin, the so-called UW/CIMSS Baseline Fit (BF) global infrared land surface emissivity database was developed. The monthly, global database has been available since 2006 at the http://cimss.ssec.wisc.edu/iremis/ website and includes data for each month from October 2002 at ten wavelengths (3.6, 4.3, 5.0, 5.8, 7.6, 8.3, 9.3, 10.8, 12.1, and 14.3 microns) with 0.05 degree spatial resolution. The BF approach uses selected laboratory measurements of emissivity to derive a conceptual model, or baseline spectra, and then incorporates MODIS MYD11 measurements at six wavelengths to adjust the emissivity at 10 hinge points. These wavelengths were chosen to capture as much of the shape of the higher resolution emissivity spectra as possible between 3.6 and 14.3 microns As a recent effort at the UW/CIMSS, an

algorithm was developed to derive a high spectral resolution (HSR) IR land surface emissivity from a combination of HSR laboratory measurements of selected materials, and the UW/CIMSS Baseline Fit (BF) global infrared land surface emissivity database by using a principal component analysis (PCA) regression. The first Principal Components of 123 selected laboratory spectra (in this study the wavenumber resolution between 2-4cm-1, at 416 wavenumbers) were regressed against the 10 hinge points of the monthly UW/CIMSS BF emissivity. The algorithm to extract the high spectral resolution emissivity database from the UW/CIMSS BF emissivity dataset will be available in early 2008. In the presentation, after the introduction of the emissivity database, the impacts of varying the emissivity on the calculated top-of-atmosphere BT across the infrared spectral regions are examined, then an analysis of the effects of a change in emissivity on retrieved temperature and moisture profiles will be presented. At the end this MODIS-based emissivity database will be compared to the HSR emissivity database derived from AIRS measurements.

SESSION 5

5.1: Decadal Trends in the HIRS Radiance Record

Presenter: Brian J. Soden

Brian J. Soden, Darren L. Jackson

A 25 year record of spectral radiances from HIRS has been corrected for orbital drift and satellite intercalibration biases to create a stable radiance archive suitable for quantifying decadal variability and trends. The observed trends over the period 1979-2004 are compared to radiances simulated directly from GCMs under both prescribed SST integrations and fully-coupled ocean atmosphere models subject to observed increases in greenhouse gas and aerosol forcings. Results from this comparison will be presented at the conference. Specific emphasis will be on the changes in the water vapor and carbon dioxide channels on HIRS, the ability of the climate models to reproduce the spatial pattern and magnitude of the observed trends, and the implications of these trends for global climate change.

5.2: Upper tropospheric humidity data set from operational microwave sounders

Presenter: Viju John

V. O. John, S. A. Buehler, M. Kuvatov, M. Milz, B. J. Soden, and D. L. Jackson

Microwave radiation measured around 183.31 GHz by operational weather satellites can be used to derive Upper Tropospheric Humidity (UTH). This presentation gives details of a new UTH data set derived from Advanced Microwave Sounding Unit - B (AMSU-B) instruments on board NOAA (15, 16, and 17) satellites for 8 years (2000-2007). In contrast to UTH data sets derived from infrared measurements, the new data set is less affected by clouds. The maximum uncertainty due to clouds is estimated as 10 %RH in deep convective areas. We also show that the data from the three satellites are consistent with mean relative differences less than 4+/-7%. Comparisons with Radiosonde measurements and infrared UTH measurements show consistent results with previous studies.

5.3: What can the GCOS Reference Upper Air Network do for you?

Presenter: Peter Thorne

Abstract not available.

5.4: Intersatellite Calibrated HIRS Upper Tropospheric Water Vapor

Presenter: Lei Shi

Lei Shi and John J. Bates

Intersatellite calibration is carried out for the clear-sky HIRS upper tropospheric water vapor (UTWV) channel measurement. As the intersatellite biases are scene temperature dependent, an algorithm is developed to account for the varying biases with respect to brightness temperature. The bias correction data are derived based on overlaps of monthly means of each 10-degree latitude belt. For the colder temperature range, data from the simultaneous nadir overpass observations are incorporated. The HIRS measurements from NOAA-6 to NOAA-17 are calibrated to a baseline satellite by correcting the intersatellite biases. The time series of the intersatellite calibrated HIRS UTWV data from 1979 to present is constructed and anomaly data are computed. The anomaly time series is used to track tropical waves and variabilities. The HIRS UTWV anomaly data are particularly useful in monitoring Madden-Julian oscillation and various equatorial waves.

5.5: Long-term application and evaluation of IAPP using global radiosonde and CHAMP measurements

Presenter: Marc Schröder

Marc Schröder, Jörg Schulz, Markus Jonas, Ralf Lindau

The major objective of the Satellite Application Facility on Climate Monitoring (CM-SAF) is the exploitation of satellite observations to derive information on key climate variables of the Earth system. The CM-SAF focuses on the atmospheric part of the Essential Climate Variables defined within the framework of the Global Climate Observing System (GCOS). Among other methods the CM-SAF operationally applies the International ATOVS Processing Package (IAPP) to retrieve humidity and temperature profiles from ATOVS observations onboard NOAA-15, -16, and -18. A kriging routine is applied to the swath based retrievals in order to determine daily and monthly averages on a global grid. Furthermore, the profiles are vertically integrated and averaged to provide column integrated water vapour as well as humidity and temperature values for 5 layers and at 6 layer boundaries. Currently the years 2004-2007 had been processed, and a reprocessing event will go back to 1998 in the near future. The evaluation of temperature and humidity Climate Data Records (CDRs) for the period 2004-2007 is carried out using global radiosonde observations that meet the quality standards of the GCOS Upper Air Network (GUAN). The evaluation is extended by utilising CHAllenging Minisatellite Payload (CHAMP) observations for the years 2004 and 2005. The evaluation considers biases, RMSE, and mean absolute deviations and separates between global and zonal values. The maximum average bias of column integrated and layer integrated water vapour between ATOVS and GUAN radiosondes is 0.5 kg/m2 and 0.8 kg/m2 (850-700 hPa), respectively. For the layer averaged temperatures we find a maximum bias of -1.1 K (300-200 hPa). The RMSE of water vapour exhibits an annual cycle with a maximum in summer months and a maximum of zonal RMSE around the equator with some variation depending on the month. The exemplary comparison of ATOVS and CHAMP data confirms above findings. When future progress in inter-calibration efforts leads to improved homogenised radiances, reprocessing of ATOVS observations can be carried out easily and will lead to CDRs with at least the accuracy as presented above. Currently CM-SAF is working on an automated evaluation of temperature and humidity products with radiosonde profiles from reference stations.

5.6: The Frequency of Severe Storms in the Tropical Zone and Global Warming.

Presenter: Hartmut H. Aumann

Hartmut H. Aumann

Data from the Atmospheric Infrared Sounder show that the frequency of severe storms in the tropical zone increases by 3.6% per 0.1 K of warming of the zonal mean surface temperature. With global warming at the 0.1 K/decade rate, this corresponds to an increase in severe tropical storms of 3.6% per decade. This rate is consistent with the increase in precipitation deduced from SSMI data with the assumption that 30% of the total precipitation over tropical oceans is associated with severe storms.

5.7: AIRS in Atmospheric and Climate Research

Presenter: Hartmut H. Aumann

Bjorn Lambrigtsen, Mous Chahine, Tom Pagano, Eric Fetzer

The Atmospheric Infrared Sounder (AIRS), the first of a new generation of hyperspectral infrared sounders, was launched on the NASA Aqua platform in 2002 and has operated flawlessly ever since. With its extremely high spectral resolution – 2378 channels between 3.7 and 15.4 microns – and very stable and accurate radiometric measurements it has been possible to produce atmospheric data sets of unprecedented coverage, accuracy and resolution. Assimilation of the observed radiances into numerical weather prediction models – now done on a routine basis at a number of the world's major weather prediction centers – has already had a major impact on global weather forecast accuracy and range. Now, derived data sets are also beginning to play a major role in atmospheric research, ranging from process studies related to the hydrologic cycle to climate research related to greenhouse and other trace gases. These data sets, which include global 3-dimensional temperature and water vapor fields that are as accurate as can be obtained with the highest quality radiosondes – but with daily global coverage, are enabling studies that were previously not possible. The AIRS data sets are freely available from NASA and now cover the period from September 2002 to the present. A new version of the data processing system – V5 – was recently implemented and is now used to process all current and past data to the highest quality. We describe the data sets and results of efforts to validate them and discuss research problems that they can be used to address. The work reported on here was performed at the Jet Propulsion Laboratory, California Institute of Technology under a contract with the National Aeronautics and Space Administration.

SESSION 6

6.1: Current Status: a summary of the NWP Survey

Presenter: John Derber

Abstract not available

6.2: Progress and Plans for the use of radiance data in the NCEP global and regional data assimilation systems

Presenter: J. Derber

J. Derber, R. Treadon, D. Kleist, M. Rancic

Significant changes in the use of radiance data at NCEP have been developed and are in the process of being implemented. These developments include the use of new satellite data (METOP, SSMIS), improvements in the bias correction and quality control, enhancements in the inclusion of the surface signal in the simulated radiances, the introduction of improved radiative transfer and advances in the data assimilation techniques. Details of some of these changes (e.g., new satellite data and improved radiative transfer) are covered in other talks at this meeting. This presentation will present an overview of the changes and present the impact of these changes on the overall data assimilation and forecast system. In addition, specific details of the enhancements to the bias correction technique, improvements in the incorporation of the surface signal and the significant changes in the data assimilation technique will be presented. Finally future plans for operation assimilation of satellite sounder data will be briefly discussed.

6.3: The Use of satellite data at ECMWF

Presenter: Niels Bormann

Abstract not available.

6.4: NRL Status Report

Presenter: Nancy Baker

Abstract not available.

6.5: An Update on the Operational Use of Satellite Sounding Data at the Met Office

Presenter: Brett Candy

Brett Candy, Steve English, Fiona Hilton, James Cameron, Amy Doherty, T. R. Sreerekha , William Bell and Nigel Atkinson

This talk will give a snapshot of the sounding instruments used operationally in the Met Office global model. Since the last ITSC meeting a major forecast impact has come from the use of the instruments onboard METOP-A. However several other important updates have been introduced that increase the number of observations from existing instruments. These include the use of high peaking channels from AIRS over land and the reintroduction of the HIRS instruments on NOAAs 16 & 17 and AMSU-B on NOAA-17. Channel usage and observation errors have also had to be revised following very large analysis increments in the upper stratosphere around the winter pole.

6.6: Impact of NOAA-NESDIS level 1B radiance data on Indian Summer Monsoon

Presenter: V.S. Prasad

V.S. Prasad and S. Rambabu

National Center for Medium Range Weather Forecasting is in the process of upgrading its global data assimilation and forecasting (GDAF) system from T80L18 to T254L64 based on NCEP operational GFS system. Further, it got access to the NESDIS level 1B data and thus first time started utilisation of these direct satellite radiance data sets. To test the performance of new system, impact experiments are carried out involving these data sets for a period of three months(1 June -30 September 2007). This summer monsoon period is selected because it is very important period for India and its surroundings. The experiment was carried out at T62 resolution by running GDAF system using level -1b ATOVS radiances. This was compared with a corresponding low resolution system which does not use any ATOVS data sets. In addition to this period a similar high resolution (T254) version of the experiment was carried out for April 2007. The use of level 1B data sets shows a significant positive impact on global / hemispherical scale. But the results are mixed over Indian and Tropical regions. The detail of these results will be presented in the workshop.

6.7: Recent advances in the use of satellite data in the French NWP models

Presenter: Thibaut Montmerle

Rabier, F., Auger, L., Fourrié, N., Gérard, E., Guidard, V., Karbou, F., Michel, Y., Moll, P., Montmerle, T., Payan, C., Poli, P.

The use of satellite data in the French NWP models at global and regional scales is described. In the last year, a lot of effort had been dedicated to the assimilation of data from the MetOp satellite (ATOVS, ASCAT and IASI). The operational assimilation of ATOVS and ASCAT has been performed. The assimilation of IASI data and the more extensive use of AIRS data is currently pre-operational. Another major milestone has been the operational use of GPS radio-occultation data from the COSMIC, CHAMP and GRACE satellites mid-2007. METEOSAT CSR data are also being introduced

in the global model (in the regional model ALADIN, a fine resolution radiance product provided by the CMS in Lannion is used instead). GPS ground-based data have been used in both models since 2006. In terms of algorithmic development, an improved parametrisation of microwave emissivity has allowed a better use of these data over land, as investigated in particular over Africa during the AMMA field experiment period. Another major development was the introduction of a variational bias correction algorithm based on the one developed at ECMWF, for radiance bias correction. This change was quite positive in terms of forecast scores in the global model.

6.8: Inclusion of new data types in the Canadian data assimilation system

Presenter: Godelieve Deblonde

Nicolas Wagneur, L. Garand, J. Aparicio, A. Beaulne, M. Buehner, J-M. Bélanger, D. Anselmo, G. Deblonde, J. Hallé, P. Koclas, R. Sarrazin, and G. Verner

The Canadian data assimilation system is now benefiting from several new data types: Quikscat oceanic winds, radiances from seven SSM/I channels, and 87 AIRS channels. Extreme scan angles from AMSU-A and AMSU-B are also assimilated, which increases by about 25 % the volume of these data. In addition, the radiative transfer model was upgraded to RTTOV-8 along with a new vertical interpolator. The poster will present the impact of these new data as evaluated in a parallel run which was run from January to April 2008. At the time of this writing, results are clearly positive in the Southern hemisphere and closer to neutral in the Northern Hemisphere. In the Tropics, a large improvement in the geopotential bias is noted. It is planned to continue that parallel run with the inclusion of GPS radio-occultation data assimilated up to 30 km. Results on the impact of these data should be available at the time of the conference.

6.9: Assimilating ATOVS data in numerical weather prediction model to improve Typhoon prediction in NSMC/CMA

Presenter: Lu Qifeng

Lu Qifeng, Wu Xuebao, Zhang Fengying, Zhang Peng, Dong Chaohua

Tropical cyclones form over the seas: a typical data-sparse region for conventional observations. Therefore, satellites, especially with microwave sensors, are ideal for cyclone studies. The advanced microwave sounding unit (AMSU), in addition to providing very valuable data over non-precipitating cloudy regions, can provide very high horizontal resolution of the temperature and humidity soundings. Such high-resolution microwave data can improve the poorly analyzed cyclone. In order to solve the difficult problem of typhoon track prediction due to the scarcity of conventional data over the tropical ocean, in this paper, the No. 0709 typhoon Shengpa of 12-19 August 2007 is studied and an experiment of the typhoon track prediction is made with the direct use of the Advanced TIROS-N Operational Vertical Sounder (ATOVS) microwave radiance data (AMSU) on NOAA-18 in three-dimensional variational data assimilation. The prediction result shows that the skill of the typhoon track prediction with the ATOVS microwave radiance data is much better than that without the ATOVS data. The direct assimilation of ATOVS microwave radiance data is an available way to solve the problem of the sparse observation data over the tropical ocean, and has great potential in being applied to typhoon track prediction.

6.10: Assimilation of radiance data at JMA: recent developments and prospective plans

Presenter: Kozo Okamoto

Kozo Okamoto, Hiromi Owada, Toshinobu Ishibashi, Takumu Eagawa and Masahiro Kazumori

Recent developments and prospective plans on the satellite data assimilation, especially regarding radiance data, are presented. After the last conference in October 2006, JMA introduced various data into our operational global 4D-Var data assimilation system. The data include: AP-RARS/EARS

ATOVS radiances, ATOVS radiances onboard NOAA18 and Metop, MTSAT-1R water vapor channel radiances, and refractivities of CHAMP GPS radio occultation. Above all, Metop ATOVS (AMSU-A and MHS) has the greatest positive impact on forecasts, especially on the forecast of geopotential height, in our cycle experiments. Radiance assimilation method of hyperspectral IR sounders, such as AIRS, has been developed and its encouraging results are obtained. SSMIS radiances were added to the current radiance assimilation of SSMI, TMI and AMSR-E. It was proved to improve typhoon track forecasts slightly. A new global forecast model with the resolution of TL959L60, which was implemented in November 2007, is also briefly presented.

6.11: Direct Radiance Assimilation for WRF: Implementation and Initial Results

Presenter: Thomas Auligne

Zhiquan Liu, Hui-Chuan Lin, Dale Barker, Thomas Auligne, Xiaoyan Zhang

Weather and Research Forecast (WRF) model as well as it variational assimilation system (WRF-Var) is widely used by both research community and the operational NWP centers in US (Air Force Weather Agency) as well as a number of international WRF partners in Asia, the Middle East, and Europe. A general satellite radiance assimilation framework has been developed in the WRF-Var system in the past two years. The WRF-Var radiance assimilation capability was designed for meeting requirements of both basic research and operational applications, which will be available to research community with the next WRF release. This presentation will begin with a overview of radiance assimilation capabilities in WRF-Var, including the core component -- Fast Radiative Transfer Model (RTM), air-mass dependent bias correction algorithm, quality control and observation error tuning and so on. In particularly, two widely used RTMs, RTTOV developed by EUMETSAT in Europe and CRTM developed by JCSDA in USA, are incorporated into WRF-Var system. A preliminary comparison between RTTOV and CRTM will be present. Recent results on assimilating microwave radiance data to improve Hurricanes track and intensity forecast will be also presented. Results for the Katrina case show that assimilating AMSU-A radiance improves both track and intensity forecast, even most data are discarded over Hurricane votex area. One will also present a cloud/rain affected radiance assimilation scheme, which uses total cloud water as the control variable and a warm- rain physics process to partition total water to moisture and hydrometeor increments.

6.12: The Assimilation of Clear-Sky Infrared Radiances in the HIRLAM Model

Presenter: Martin Stengel

Martin Stengel, Per Dahlgren, Magnus Lindskog, Per Unden, Nils Gustafsson

The limited-area numerical weather prediction model HIRLAM has been adjusted to make use of the infrared (IR) radiances measured by SEVIRI on-board the MSG satellites. Therefore, the HIRLAM variational data assimilation system has been modified to take advantage of this additional observation type. Especially 4D-Var frameworks, which is one option in HIRLAM's assimilation system, are assumed to be capable of utilizing the information content provided by SEVIRI with its high temporal resolution. For the time being, only the two water vapour channels are considered. Observation impact studies have been carried out for different time periods using 3D-Var and 4D-Var. For 3D-Var the nearest SEVIRI timeslot is chosen, whereas for 4D-Var SEVIRI data from six slots are used, which are equally distributed over the 6 hour assimilation window. For these experiments, all cloud contaminated pixels had been rejected. Generally, the impact studies show a neutral to slightly positive impact of SEVIRI's clear sky infrared data on analysis and forecast fields. In all studies, the system seems to be able to use SEVIRI observations to decrease an upper-tropospheric humidity bias in the NWP model, which is found when comparing model fields and colocated radiosondes. This impact is visible up to 48 hours integration time with a decreasing magnitude. In addition, we find a slight positive impact on geopotential height and mean sea level pressure forecasts. This impact is a bit more distinct for 4D-Var and during summer. These results, as well as examples of preceding data preparation steps such as spatial thinning and quality checks, will be presented.

6.13: Assimilation of AIRS Radiances at CPTEC/INPE using the LETKF system

Presenter: Jose Aravequia

Abstract not available.

6.15: Use of satellite data in ALADIN/HARMONIE-Norway

Presenter: Roger Randriamampianina

Abstract not available.

SESSION 7

7.1: Recent developments in the use of ATOVS data at ECMWF

Presenter: Niels Bormann

Niels Bormann, Blazej Krzeminski, Peter Bauer, and Tony McNally

The ATOVS family of instruments continues to provide important information for Numerical Weather Prediction. Currently, ECMWF assimilates ATOVS data from six polar orbiting satellites, with data from 5 AMSU-A, 4 AMSU-B/MHS, and 2 HIRS instruments. The talk gives an overview of some recent developments in the operational use of ATOVS data at ECMWF. These include the swift introduction of METOP ATOVS data into operations after a brief monitoring period, use of data from the Pacific-RARS system, the revision of quality control and bias corrections for HIRS data, and the upgrade of the radiative transfer model to RTTOV-9.

7.2: A Comparison of IASI water Vapour and SSMIS window channel impacts on NWP analyses and forecasts

Presenter: W. Bell

W. Bell, F. Hilton, S. English, B. Candy, S. Swadley

In order to gain insight into the complex impacts of water vapour information from microwave window channels in NWP a study was undertaken to compare the performance of clear sky IASI 6.7 μm water vapour channels with SSMIS window channels (19-37 GHz) in the Met Office global forecast model using a 4D-Var assimilation scheme. Theoretical calculations show IASI to have more skill in determining the vertical moisture structure in the atmosphere relative to the information available from microwave window channels. The proximity of MetOp-A IASI and F-16 SSMIS orbit planes allows the compilation of a dataset of co-located observations which facilitates a comparison of SSMIS and IASI driven moisture increments in 4D-Var. Qualitatively there is agreement throughout the troposphere in all latitude bands with positive correlations between IASI and SSMIS moisture increments. In terms of forecast impacts both observation types (i.e., IASI water vapour channels and SSMIS window channels) show disappointingly weak forecast impacts on large scale fields using conventional (sonde and surface) observationally based verification measures. There is evidence of more significant impacts on short range (T+24hour) precipitation fields, especially in the tropics, and these impacts have been verified subjectively using a near real time precipitation analysis generated from TRMM, AMSR-E, SSMI and AMSU-B.

7.3: Impact of combined AIRS and GPS-RO data in the new version of the Canadian global forecast model

Presenter: Louis Garand

L. Garand, J. Aparicio, M. Buehner, G. Deblonde, M. Roch, S. MacPherson, C. Charette, A. Beaulne

GEM-Strato is a new version of the global Canadian forecast model with top raised from 10 Hpa to 0.1 Hpa. This allows to assimilate 35 additional AIRS channels on top of the currently used 87 channels. As well GPS radio-occultation refractivities are assimilated up to 3 hPa (40 km). Background error statistics were revised, with added localization of the vertical correlations. The separate and combined impacts are evaluated in 3D-FGAT assimilation cycles.

7.4: The Assimilation of Cloudy Infrared Radiances in the HIRLAM Model: Initial Experiences

Presenter: Martin Stengel

Martin Stengel, Per Dahlgren, Magnus Lindskog, Per Unden, Nils Gustafsson

Efforts have been made at SMHI to examine the utilisation of measured infrared radiances in the presence of clouds in the limited-area numerical weather prediction model HIRLAM. Since a certain portion of observations are located in cloudy areas, many observations are rejected in the first place. We have started to investigate under which circumstances observations in cloudy conditions could be used. A first strategy focuses on low level clouds. Here, the assimilation of infrared sounding channels seems to be less problematic, as far as their sensitivity to the cloud layers is negligible. Nevertheless, the filtering of those cases relies on the information about the vertical location of the clouds. This can possible be optimized when providing more accurate information to keep as many useful observations as possible. Next to a fixed cloud top pressure (CTP) limit, the comparison of the derived CTP and the local Jacobians at observation point could be more effective as criteria in this context to identify such not-radiance-affecting clouds. Additionally, we consider clouds, whose effect on the radiance is small, which can possibly be parameterized properly in the observation operator by a simple cloud assumption. First assimilation experiments, using SEVIRI's water vapour channels, have been carried out and initial results will be shown. Furthermore, we investigate the feasibility to extend the observation operator to include a simplified moist physics scheme. This framework can also be used to determine the sensitivity of modelled clouds (and subsequent simulated cloudy radiances) to the model variables. Under certain conditions, this could then be used to assimilate cloud-affected infrared radiances. Statistics of these modelled clouds in NWP model space and in observation space, as well as the sensitivity of simulated cloudy radiances will be discussed. Preliminary 1D-Var studies are currently being conducted and will be presented.

7.5: Impact of VASS radiance of FY3 assimilation on numerical typhoon prediction

Presenter: Ma Gang

Ma Gang Zhang Fengying Li Xiaoqing etc.

A set of transmittance coefficients of IRAS (InfRared Atmospheric Sounder), MWTS (MicroWave Temperature Sounder) and MWHS (MicroWave Humidity Sounder) used in RTTOV7 has been build by multivariate linear regression analysis in line-by-line radiative transfer models. Comparison of 43 profiles of the channel radiance from these line-by-line models and those from RTTOV7 shows that bias are less than 0.7K for all the 20 infrared channels of IRAS and are less than 0.3K for all the 9 channels of MWTS and MWHS. With RTTOV7 and the new transmittance coefficients, a new satellite data assimilation module has been set up to directly assimilate VASS (Atmospheric Vertical Sounding System) radiance of FY3 into GRAPES 3DVar system. Because the radiance bias of infrared channels are less than 3K while those for microwave channels are less than 0.03K between ATOVS and VASS, quality control of the radiance and bias correction to simulated VASS radiance have been introduced in terms of ATOVS radiance assimilation. Radiance of ATOVS have been use to generate VASS radiance based on the spectral characteristics of the VASS instruments in a typhoon case. Then, new initial temperature, water vapor and wind fields for GRAPES model can be produced by directly assimilating these VASS radiance. Numerical tests show positive effect on typhoon track prediction by using those satellite data in GRAPES.

7.6: An Information Based Radiance Data Selection Scheme for Efficient Use of a Multi-Satellite Constellation

Presenter: Brett Harris

Brett Harris, Chris Tingwell and Peter Steinle

In this study we investigate a new data selection scheme using level-1D ATOVS radiances derived using the European ATOVS and AVHRR Processing Package (AAPP), in the Global Assimilation and Prediction (GASP) system. Using the GASP assimilation and prediction systems at a resolution of T239/L60, we investigate the most efficient way to utilise HIRS, AMSU-A and AMSU-B/MHS radiances from the NOAA-16, 17 and 18 satellites plus MetOp-A and also AMSU-A from AQUA. At present, instead of the traditional two fully operational NOAA polar orbiting ATOVS satellites, we have three partially functional platforms. Each satellite has problems ranging from very noisy HIRS on NOAA-16/18, to total sensor failure such as with AMSU-A on NOAA-17. We also have the option to use the AMSU-A instrument on the AQUA/EOS satellite as well as the full ATOVS suite from the MetOp-A satellite. While the GASP analysis assimilates retrieved profiles from a 1DVAR system, necessitating thinning to 250km, most 3D/4D-VAR systems also have to thin satellite data to a separation greater than the original footprint. A method that chooses soundings of the highest information content, will achieve the best analysis, while minimising the time taken processing the data. This data selection method utilises a ranking system that depends on the satellite characteristics, the atmospheric conditions and the surface type for each sounding. The algorithm chooses the sounding with the highest rank within a given radius, which is then presented to the assimilation system. In the current 1DVAR system, this pre-thinning algorithm is able to achieve a reduction of over 30% in total runtime, without any reduction in forecast skill. In the future, as the Bureau moves to the new Australian Community Climate Earth-System Simulator (ACCESS) regime, utilising the OPS/VAR/UM from the Met Office, we will also wish to incorporate a subset of AIRS radiances from AQUA, as well as IASI data that will be available from MetOp-A.

7.7: Use of Hyperspectral IR Data in 4D Assimilation at NRL

Presenter: Benjamin Ruston

Benjamin Ruston, Nancy Baker, William Campbell, Tim Hogan, Xu Liu

A newly developed weak-constraint 4D-Var system is in parallel pre-operational testing at the Naval Research Laboratory. The NRL Atmospheric Variational Data Assimilation System – Accelerated Representer (NAVDAS-AR) is targeted to be the next generation assimilation system for the US Navy replacing the 3D-Var NAVDAS system within the next year. In particular, NAVDAS-AR scales much better to the high data volumes encountered working with hyperspectral instruments such as AIRS and IASI. The NAVDAS-AR system has been configured to use both the JCSDA Community Radiative Transfer Model (CRTM) and RTTOV-8.7 and a brief comparison of the two will be presented. The adjoints of NAVDAS-AR and the Navy Operational Global Atmospheric Prediction System (NOGAPS) are used to produce observation sensitivities for all simulated channels allowing for additional guidance in channel selection for assimilation. Primary channel selection begins by identifying the spectral region of interest for assimilation. The assimilation has focused initially on the longwave CO2 channels in the 13-15 micron range. Further channel selection is done by leveraging advice from other modeling centers (UK-Met Office and ECMWF), examining Jacobians for sensitivity above the model top, and the use of the NAVDAS-AR and NOGAPS adjoint sensitivities. Quality control is being done primarily by the NWP-SAF released cloud detection package for high resolution infrared sounders. Results of the assimilation runs will present standard diagnostics including the 500hPa anomaly correlations from the Northern and Southern hemispheres, vector wind RMS from 850 hPa, and tropical cyclone tracks from the 2007 season for AIRS assimilation only. Lastly, Xu Liu, a visitor from NASA Langley has incorporated the principle component version of the CRTM (pCRTM) to be used with NAVDAS-AR and IASI data. This allows direct assimilation of principle components rather than individual channels. These results are contrasted with the results from the conventional channel style assimilation runs in both computational efficiency and most importantly in NWP performance.

7.8: Intercomparison of the Cross-Track and Conical Scanning

Presenter: Banghua Yan

Banghua Yan, Fuzhong Weng, and John Derber

The NOAA Advanced Microwave Sounding Unit (AMSU) and DMPS Special Sensor Microwave Imager/Sounder (SSMIS) instruments have similar temperature and water vapor sounding channels but different cross-track and conical scan geometries. For cross-track scanning, the angle of earth incidence varies, resulting in angle-dependent weighting function and satellite measurements for a given frequency. For conical scanning, a fixed angle of incidence and a vertical axis of rotation are used, in which the viewing area and slant path remains nearly constant. The differences in this scan geometry can result in differences in impacts on model forecasts. Distinct bias correction and quality control schemes also must be utilized for AMSU and SSMIS data due to differences in error characteristics of the satellite data. These error characteristics and different bias correction and quality control schemes associated with AMSU and SSMIS data can further result in different impacts on Numerical Weather Prediction (NWP). To quantify characteristics of cross-track and conical scanning satellite microwave sounding impacts, AMSU and F16 SSMIS measurements are assimilated separately into National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) associated with Gridpoint Statistical Interpolation (GSI) subsystem. In this process, the current bias correction and quality control schemes for AMSU and SSMIS data in GSI are assessed, and the data usage in GSI and impacts of each instrument of measurements on various analysis variables and forecast score in GFS are estimated by carrying out a set of assimilation experiments for both winter and summer seasons. Since the original F16 SSMIS atmospheric sounding channels display persistent radiance anomalies, the F16 SSMIS data used in this study is corrected using both the Calibrated Temperature Data Record (CTDR) by applying the Naval Research Laboratory (NRL) and United Kingdom Met Office (UKMO) unified SSMIS preprocessor and the National Environmental Satellite, Data, and Information Service (NESDIS) SSMIS preprocessor.

7.9: Adaptive tuning of satellite radiances observation error in GRAPES

Presenter: Wei Han

Wei Han and Jishan Xue

This work proposed a new implementation of error tuning algorithm based on the posterior diagnosis of variational assimilation system by applying a iterative fixed-point procedure based on Desrosies et al(2005).The method is shown to be feasible in a practical tuning of background and observation error for operational variational assimilation. The iteration process converges very rapidly and the results are reasonable. The results are illustrated by utilizing the Chinese Meteorological Administration (CMA) new generation of NWP system GRAPES (Global/Regional Assimilation PrEdiction System) regional-meso version over the East Asia domain and the global version. The impacts of the tuning of background and satellite radiances observation error on analyses and forecasts are shown and discussed. The results are very promising.

7.10: Impact of AIRS and AMSU-A data in regional data assimilation over the Antarctic

Presenter: Thomas Auligne

Thomas Auligne, Hui Shao, Dale Barker, Zhiquan Liu and Hui-Chuan Lin

The Antarctic Mesoscale Prediction System (AMPS) is an experimental, real-time numerical weather prediction capability that provides a twice-daily forecast covering Antarctica. The current version uses the regional mesoscale model Weather Research and Forecasting (WRF). The model can be initialized through a variational assimilation system (WRF-Var), which involves specific background error statistics. The impact of observations from the Atmospheric Infrared Sounder (AIRS) and the Advanced Microwave Sounding Unit (AMSU) is studied for the Antarctic region. Temperature and

water vapor information are retrieved through the latest version of AIRS Standard Retrieval Products from NASA. The quality of the data is assessed for high latitudes and errors associated with these quantities are estimated. The performance of retrievals is then compared to the direct assimilation of radiances. Objective methods are used to estimate the radiance error statistics and to perform quality control. A cloud detection scheme is developed for AIRS and adapted to the polar regions where clouds are often more difficult to identify. The relevance of cloud-cleared radiances is also studied. Finally, a significant effort is focused on systematic errors in the innovations, which are a major problem for data assimilation in the polar regions. In particular, we will show results from the combination of a variational bias correction of observations with estimations of model bias.

SESSION 8

8.1: Neural Network Estimation of Atmospheric Profiles Using AIRS/IASI/AMSU Data in the Presence of Clouds

Presenter: William J. Blackwell

William J. Blackwell, Frederick W. Chen, and Michael Pieper

A novel statistical method for the retrieval of atmospheric temperature and moisture (relative humidity) profiles has been developed and evaluated with sounding data from the Atmospheric InfraRed Sounder (AIRS) and the Advanced Microwave Sounding Unit (AMSU) on the NASA Aqua satellite and the Infrared Atmospheric Sounding Interferometer (IASI) and AMSU on the EUMETAT MetOp-A satellite. The present work focuses on the cloud impact on the AIRS and IASI radiances and explores the use of stochastic cloud clearing mechanisms together with neural network estimation. A stand-alone statistical algorithm will be presented that operates directly on cloud-impacted AIRS/AMSU and IASI/AMSU data, with no need for a physical cloud clearing process. The algorithm is implemented in three stages. First, the infrared radiance perturbations due to clouds are estimated and corrected by combined processing of the infrared and microwave data using a Stochastic Cloud Clearing (SCC) approach. The cloud clearing of the infrared radiances was performed using principal components analysis of infrared brightness temperature contrasts in adjacent fields of view and microwave-derived estimates of the infrared clear-column radiances to estimate and correct the radiance contamination introduced by clouds. Second, a Projected Principal Components (PPC) transform is used to reduce the dimensionality of and optimally extract geophysical profile information from the cloud-cleared infrared radiance data. Third, an artificial feedforward neural network (NN) is used to estimate the desired geophysical parameters from the projected principal components. The performance of the method was evaluated using global (ascending and descending) EOS-Aqua orbits co-located with ECMWF forecasts (generated every three hours on a 0.5-degree lat/lon grid) and radiosonde observations (RAOBs) for a variety of days throughout 2003, 2004, and 2005. Over 1,000,000 fields of regard (3x3 arrays of footprints) over ocean and land were used in the study. The performance of the SCC/NN algorithm exceeded that of the AIRS Level 2 (Version~4) algorithm throughout most of the troposphere while achieving approximately four times the yield. Furthermore, the SCC/NN performance in the lowest 1 km of the atmosphere greatly exceeds that of the AIRS Level 2 algorithm as the level of cloudiness increases. The SCC/NN algorithm requires significantly less computation than traditional variational retrieval methods while achieving comparable performance, thus the algorithm is particularly suitable for quick-look retrieval generation for post-launch CrIMSS performance validation. Recent work has focused on retrieval performance in “problem areas” over land, near the poles, elevated terrain, etc. Retrieval performance has been improved by stratifying the neural network training data into distinct groups based on geographical (latitude, for example), geophysical (atmospheric pressure, for example), and sensor geometrical considerations (scan angle, for example.) Performance using IASI/AMSU has also been evaluated, with emphasis on the impact of vibration-induced noise on the cloud-clearing accuracy. In this talk, the algorithm methodology will be briefly reviewed, including a discussion of implementation differences for AIRS and IASI. Algorithm performance will then be discussed and compared with other methods. This work was sponsored by the National Oceanic and Atmospheric Administration under Air Force contract FA8721-05-C-0002. Opinions, interpretations, conclusions, and recommendations are those of the authors and not necessarily endorsed by the United States Government.

8.2: Using AVHRR radiances analysis for retrieving atmospheric profiles with IASI in cloudy conditions

Presenter: L. Lavanant

L. Lavanant

Developments are on-going at Météo-France/CMS for the processing of the IASI/AMSU/MHS sounders over Europe for helping French forecasters. A preliminary atmospheric retrieval scheme in clear and cloudy conditions is defined and its implementation in progress. This paper focuses on the processing of the IASI IR spectra in cloudy conditions. The processing of the AVHRR imager mapped inside the IASI fov allows to detect small amount of clouds and to determine the number of cloud layers and their cloud top temperature if they are black-body. Also possible is the hyper-fast treatment of the AVHRR clusters performed within the OPS IASI pre-processor and available at a global scale on the GTS and EUMETCast in the BUFR format. The CO2-slicing method based on a selection of IASI sounding channels is applied to homogeneous and semi-transparent cloudy situations to access cloud parameters when AVHRR methods fails. Systematic comparisons of observations to synthetic IASI spectra using retrieved cloud parameters allow to estimate the cloud information accuracy. The previous cloud information is used for the retrieval of the atmospheric profile in cloudy conditions from a selection of IASI channels. Two methods are compared. First, only the non-contaminated channels are selected above the cloud using the ECMWF method and the 1DVar retrieval process is done in clear conditions. Second, the cloud top pressure and effective cloud amount from the AVHRR/CO2-slicing method are used in the cost function of the 1DVar method. In that case more informative channels above/in the cloud are used. Status on these developments and preliminary accuracy assessment on meteorological situations of NWC interest will be presented.

8.3: CO2 Slicing Method for IASI

Presenter: Arlindo Arriaga

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

Slicing Method for IASI Arlindo Arriaga, Peter Schlüssel, Xavier Calbet, Thomas August, Olusoji Oduleye, Tim Hultberg EUMETSAT, Am Kavalleriesand 31, 64297 Darmstadt, Germany ABSTRACT The retrieval of the cloud top pressure and effective cloud amount within the fields of view of IASI is supported with the CO2 slicing method, based upon its classical version with a fixed number of pre-selected sampling frequencies. A few tests are implemented in the respective algorithm to characterize the feasibility of its application to a particular situation, as well as to refine further the selection of sampling frequencies, to account for temperature inversions in the lower troposphere, and for quality control purposes. The thermodynamic structure of the atmosphere and the surface skin temperature are available as forecasts from ECMWF, and the model outgoing cloud free radiance is computed with the RTIASI-4. The surface emissivity is modelled either for a rough sea surface or for a land surface with different fractional land type coverage corresponding to the scene within the IASI IFOV. The pre-selection of a set of fixed sampling frequencies is performed with a simple methodology, whose application has been supported by two large data sets with a large variety of surface-atmosphere-clouds scenarios, covering the whole globe and all seasons of the year. The criterion to select such a set of frequencies for retrievals is based on a trade off between the accepted lowest significance of a pre-defined critical retrieval error and the accepted percentage of scenarios left as non-retrievable. The results achieved with the present algorithm are based upon a pre-selected set of 41 CO2 sampling frequencies between 707.5 and 756.0 cm-1. The distribution of the retrieval error computed for realistic scenarios with multilevel ice or water clouds shows low bias (below 15 hPa) for cloud tops between 200 and 700 hPa, and respective cloud amounts not lower than 40%. The results achieved with a much larger data set of sampling frequencies have shown only marginal improvements. Broad results over different cloud fields have shown good spatial consistency with respect to co-located AVHRR images within the channels in the visible (0.6 μm) and infrared (10.8 μm) windows. The retrieval error is evaluated with cloud-radar measurements during an atmospheric sounding campaign at Lindenberg, Germany, from June to September 2007, in support of the validation of Metop products.

SESSION 9

9.1: Impact of rain-affected microwave data assimilation on the analyses and forecasts of tropical cyclones

Presenter: Remi Montroty

Montroty, R.; Rabier, F.; Westrelin, S.; Faure, G.

Tropical cyclones are tremendous natural hazards that threaten coastal populations worldwide. The purpose of this study is to perform data impact studies with the Aladin Reunion Limited Area Model, with a focus on the Indian Ocean area and a 3DVar data assimilation. Studies are performed for several storms of the 2006/2007 cyclonic season of the South West Indian Ocean basin. This last season proved to be very active with 10 named storms, 4 of which attained the major hurricane wind threshold of 50m/s. Satellite data has proven most invaluable when trying to initialize Numerical Weather Prediction (NWP) models since the oceanic zones over which the cyclones develop are, by nature, data sparse. Yet, the occurrence of clouds or rain proves to be a challenge when trying to assimilate satellite data: non linear processes dominate and the use of refined, costly numerical methods might be required. These computational costs are usually found to be prohibitive and cloudy/rainy data assimilation usually is a missing component in most operational centres. This proves to be of critical importance when dealing with tropical cyclones because their dynamics take place in the core, consistently missed by observations. Of the few centres that do not suffer from this crucial observational lack, the European Centre for Medium Range Weather Forecast- ing (ECMWF) has implemented a 1DVar inversion for cloudy/rainy areas which uses complex moist physical schemes to retrieve a Total Column Water Vapour (TCWV) equivalent from the rainy radiances, which is then used as pseudo-observation in the 4DVar assimilation. In order to alleviate the constraints posed by such a costly 1DVar inversion, we investigated an alternative to this approach. A statistical multi-linear regression that fits TCWV with the brightness temperatures of the SSM/I instrument in cloudy/rainy conditions is used, relying on the ECMWF analyses during a learning period. The convergence of the regression is investigated, and the tuning of the TCWV assimilation is performed. The resulting data are shown to be of good quality and to alter the hydrological cycle of the resulting analyses. The algorithm is then applied to combine clear-sky radiances with cloudy/rainy TCWV in the 3DVar data assimilation scheme. Impacts of further observations and pseudo-observations such as a 3D wind bogus and microwave SST are also conducted, both in terms of forecast impacts and of measures of data impact. High resolution forecasting nested from the 10km runs is also investigated in the AROME model.

9.2: Experiment of the Use of Satellite Microwave Data Affected by Cloud in Numerical Prediction

Presenter: Peiming Dong

Peiming Dong, Jianwen Liu, Qiang Ren, Xue Jishan

Currently, only cloud-cleared satellite data are used in most data assimilation systems. The observations in cloud area imply much information to weather system and numerical forecast. The use of satellite data affected by cloud will be one of the effective technological methods to improve the accuracy of numerical weather forecast continuously [1-2]. CRTM (Community Radiative Transfer Model), being developed currently in Joint Center for Satellite Data Assimilation (JCSDA) USA, is designed to make use of satellite data under all weather conditions. By including scattering and emission from the earth's atmosphere, along with its flexible interface, advances radiative transfer physical processes and efficiency of numerical computational schemes, it is expected to produce significant impacts on utilization of current and future satellite instruments [3]. The CRTM is implemented in our Grapes-3dvar [4], a three dimensional variational data assimilation system developed by Chinese Academy of Meteorological Sciences, to conduct research associated with the use of satellite data, especially the data affected by cloud and rain. Our studies include two parts. The use of ATOVS microwave satellite data affected by cloud is investigated firstly based on the present cloud examination scheme. Following the simulation of satellite observation in cloudy area is verified

by using CRTM. Taking the Typhoon 0604 “Bilis” as research case, a group of experiments associated with the cloud examination and channel selection are designed (see Table 1). The cloud examination methods include scattering index, precipitation probability and precipitation examination et al.. Different satellite data affected by cloud are used in data assimilation system by different cloud examination and channel selection scheme. The distribution of satellite data used with the weather system and bias between simulated bright temperature and observation and the analysis increment are examined, together with their influences on the numerical forecast of Typhoon Bilis’s three periods, corresponding to formation, maturation and landing, respectively. With the cloudy and rainy information as input to CRTM, the satellite brightness temperature is simulated including the radiant efficiency of cloud and precipitation particle. This information is provided by WRF model forecast output. The simulated bright temperature is compared with that of observation to show how the simulation of satellite observation in cloudy and rainy area is improved. Following, the error characteristics of simulated cloudy satellite data are investigated. It is expected that these investigation could provide the meaningful guide on the use of satellite data used by cloud and push the use of cloudy radiances directly in NWP model and enhance the impacts of satellite data that have been demonstrated through clear radiance assimilation. Key Words: ATOVS; Cloud; CRTM; Grapes-3dvar; Numerical Prediction; Typhoon

9.3: The inclusion of cloudy radiances in the NCEP GSI analysis system

Presenter: Min-Jeong Kim

Min-Jeong Kim, Fuzhong Weng, and John Derber

The impact of AMSU-A, AMSU-B and MHS radiance on numerical weather predictions has been found to be significant. The major limitation on the use of these data has been the presence of clouds. In the Joint Center for Satellite Data Assimilation (JCSDA) we have begun to develop the capability to use the information from cloudy microwave radiance in the NCEP Gridpoint Statistical Interpolation (GSI) analysis system. Radiance data assimilation in cloudy regions requires rapid and accurate radiative transfer and radiance gradient models. The Community Radiative Transfer Model (CRTM) was developed at the JCSDA for use in the radiance assimilation problem and has incorporated appropriate physics for a vertically stratified scattering and emitting atmosphere. This CRTM is employed in this study to calculate radiances and Jacobians at various microwave wavelengths for radiance assimilation under all weather conditions. In the first part of this study, the sensitivity of CRTM calculated radiances to the cloud variables are presented and the accuracy of CRTM calculated Jacobians for cloud profiles are evaluated. In the second part, methodologies for the cloudy radiance related bias corrections in the GSI are addressed. Preliminary results showing the impacts of cloudy radiance assimilation on analysis fields and forecast results will be presented.

9.4: Using Clear and Cloudy AIRS Data in Numerical Weather Prediction

Presenter: J Le Marshall

J. Le Marshall, J. Jung, M. Goldberg, C. Barnet, W. Wolf, J. Derber and S. Lord

The Atmospheric Infrared Sounder (AIRS) (Aumann et al. 2003, Chahine et al., 2006) was launched in 2002 on AQUA, the second of the EOS polar-orbiting satellites. The AIRS was the first of a new generation of meteorological advanced sounders able to provide hyperspectral data for operational and research use. Here, we briefly review the first assimilation trials to use full spatial resolution and higher spectral resolution hyperspectral radiance data, available in real time from the AIRS. The result from these assimilation trials was significant improvement in forecast skill in the National Centers for Environmental Prediction (NCEP) Global Data Assimilation System (GDAS), compared to the global system without AIRS data over both the northern and southern hemispheres. A second trial was an experiment which showed the advantage of using all AIRS fields of view in analysis as opposed to the use of sampled fields of view (typically one-in-eighteen) often used by Numerical Weather Prediction (NWP) Centers. Another trial showed the benefit of using hyperspectral data with expanded spectral coverage. We then describe recent experiments where radiances, derived from cloudy AIRS fovs and which represent the radiance emanating from the clear part of the cloudy fov, have been assimilated

for global NWP. The beneficial impact of these data in the GDAS is recorded. The impact indicates the potential benefit of using cloudy hyperspectral radiances routinely in global NWP. In support of this hyperspectral data assimilation activity attention has also been paid to the detection of cloud effects, the use of stratospheric radiances and estimation of surface temperature and emissivity.

9.5: 1DVAR Pre-processing System for NWP Assimilation

Presenter: S.-A. Boukabara

S.-A. Boukabara and F. Weng

A 1DVAR system was developed to process space-borne microwave measurements. The particularity of the system is its potential applicability in cloudy and precipitating conditions. The Microwave Integrated Retrieval System (MIRS) solves for the inversion of the radiative transfer equation by finding radiometrically appropriate profiles of temperature and moisture and cloud parameters as well as surface emissivity spectrum and skin temperature. The inclusion of the emissivity spectrum in the solved-for state vector makes the system applicable globally with the only differences between land, ocean, sea-ice and snow backgrounds residing in the covariance matrix chosen to constrain spectrally the emissivity spectrum. The forward operator used in the MIRS is the Community Radiative Transfer Model (CRTM) which provides both radiances and derivatives with respect to all geophysical parameters to be inverted, including hydrometeors. The computation of the derivatives (k-matrix) is performed using tangent linear and adjoint approaches. When used in absorption-only mode, it is found that convergence of the system is reached globally, even in coastal areas, with pockets of non-convergence being highly correlated to cases of precipitation, suspicious measurements and generally with any situation that the forward operator can not handle properly. The system convergence is modulated by computed instrument errors and by estimated modeling errors. The fitting of the measurements could be made stricter by reducing the assumed modeling errors, making the convergence stricter. The system is applied routinely to NOAA-18 and Metop-A AMSU and MHS sensors and the assumed modeling errors are around one Kelvin in all situations, except for the temperature-sounding channels, where they are estimated to be lower (between 0.17 and 0.45 Kelvin depending on the channel). It is suggested in this paper that the system could be an excellent tool to pre-process and filter microwave data for Numerical Weather Prediction (NWP) assimilation applications, based on the convergence metric. An additional benefit would be obviously to get an estimate of the geophysical state before starting the assimilation. This might be very useful especially if there is an interest in assimilating measurements taken in cloudy, rainy conditions and/or if there is interest in extending the assimilation over non-standard surface backgrounds.

SESSION 10

10.1: Effect and Improvement of Aerosol on Temperature Profile from MODIS

Presenter: Zhang Jie

Zhang Jie, Li Jun, Zhang Qiang

Based on statistical synthetic regression algorithm from America, temperature and moisture profile of atmosphere is retrieved from the Moderate Resolution Imaging Spectroradiometer (MODIS) longwave infrared radiances, on the basis of profile result, spectrum transmittance is estimated by using Pressure-Layer Fast Algorithm for Atmospheric Transmittances(PFAAST), then, temperature profile is retrieved by using Nonlinear physical retrieval algorithm. The results show that atmosphere temperature above the top of boundary layer is well retrieved, the error is within 2K, in boundary layer, retrieval error is large, the error is positive correlated with aerosol optical depth and estimated error of skin temperature, but it is not correlated with atmosphere water vapor mixing ratio. According to theory of radiative transfer equation, the research analyze effect of aerosol optical depth on retrieval error, moreover, the sensitivity of which with weighting functions are analyzed. Finally, aerosol optical depth is used for improving on atmospheric transmittance and physical algorithm, the results show that temperature profile can reflect real value of atmospheric temperature within boundary layer after improving on aerosol effect.

10.2: A Neural Network approach for temperature retrieval from AMSU-A measurements onboard NOAA-15 and NOAA-16 satellites and their applications for the analysis of super cyclone 'Gonu'

Presenter: A.K. Mitra

A.K. Mitra, A. K. Sharma, R.C Bhatia and Sankar Nath

A neural network (NN) technique is used to obtain vertical profiles of temperature from NOAA-15 and 16 Advanced Microwave Sounding Unit-A (AMSU-A) measurements over the Indian region. The corresponding global analysis data generated by National Center for Environmental Prediction (NCEP) are used to build the neural network training data-sets. NOAA-15 and 16 satellite data over the Indian region obtained in the form of level 1b (instrument counts, navigation and calibration information appended) format and pre-processed by AAPP. The root mean square (RMS) error of temperature profile retrieved with the NN is compared with the errors from the International Advanced TOVS (ATOVS) Processing Package (IAPP). The results based on the analysis of the data-set for the month of January, 2007 and June, 2007 show that the quality of retrievals with NN yield excellent for all atmospheric levels. The RMS errors of NN are found to be less than 3.5 °C at the surface, 2.3° to 2.5° between 700-300 hPa and less than 2.4°C between 300-200 hPa. It has also been observed that the neural network technique can yield remarkably better results than IAPP at the low levels and at about 200-hPa level. Finally, the network based AMSU-A 54.94-GHz (Channel-7) brightness temperature (Maximum Tb) and its anomaly near the center of the cyclone has been used for the analysis of 'gonu' cyclone formed over Arabian Sea during 31st May to 7th June 2007. Further, the anomalies are related to the intensification of the cyclone. It has been found that the single channel AMSU-A temperature anomaly at 200 hPa can be a good indicator of the intensity of tropical cyclone. Therefore it may be stated that optimized neural network can be easily applied to AMSU-A retrieval operationally and it can also offer substantial opportunities for improvement in tropical cyclone studies.

10.3: Demonstration of DMSP Special Sensor Microwave Imager and Sounder (SSMIS) Products

Presenter: Fuzhong Weng

Fuzhong Weng, Ninghai Sun, Sid Boukabara, Ralph Ferraro, Limin Zhao

US DMSP program has recently successfully launched the F-16 and F-17 satellites where the Special Sensor Microwave Imager/Sounder (SSMIS) is on board. This instrument is providing atmospheric sounding up to 100 km from a conical scanning mode at the first in addition to various environmental products such as cloud and precipitation. Thus, DMSP F-16 and -20 satellites will become a vital component in the polar-orbiting satellite constellation in the coming decade after a restructure to National Polar-orbiting Environmental Satellite System (NPOESS). Especially, F-17 and -19 satellites will uniquely provide sounding from their early morning orbits (5:30am, descending) where NOAA (future NPOESS) and MetOp will cover the afternoon and mid-morning orbits. In the past 20 years, NOAA has accumulated great experiences from operational uses of satellite microwave measurements. Since 1990s, we provided continual supports to the DMSP program through participating in SSM/I calibration and validation (Cal/Val) and delivered several versions of SSM/I algorithms to the Fleet Numerical Meteorology and Oceanography Center (FNMOC) for operational implementation. At National Environmental Satellites, Data, and Information Service (NESDIS), we are routinely producing monthly SSM/I products from 1987 to today and have being archived the data at National Climate Data Center (NCDC). These activities will be continued and expanded to include more end-to-end responsibility from radiance calibration, product developments and data assimilation into weather and climate models. NESDIS is responsible for developing enhanced products from operational satellites to meet the requirements of NOAA users as well as international community. This overview will summarize the recent SSMIS research and development activities at NOAA/NESDIS. Currently, SSMIS products are being experimentally generated through its microwave integrated retrieval system (MIRS). SSM/I-like products include cloud liquid water, total

precipitable water, precipitation, sea ice cover, snow concentration, and surface wind speed, surface emissivity at window frequencies (from 19 to 91 GHz). SSMIS sounding products include temperature, water vapor, and hydrometeor profiles. Several experiments are also conducted at the Joint Center for Satellite Data Assimilation (JCSDA) to prove the impacts of direct assimilation of SSMIS radiances on global and hurricane field analysis. It is shown that the hurricane warm core at the upper troposphere and improved temperature and wind fields at surface are dramatically improved after SSMIS radiances are assimilated.

10.4: Potential of CO2 Retrieval from IASI

Presenter: L. Chaumat

L. Chaumat, O. Lezeaux, P. Prunet, B. Tournier, F.-R. Cayla, C. Camy-Peyret and T. Phulpin

A specific processing of the high resolution infrared spectra, based on Discrete Fourier Transform (DFT) filtering to efficiently exploit the CO2 information of the IASI spectrum, is used to retrieve CO2 from IASI. Inversion experiments on a representative set of real data are performed to quantify the precision and quality of retrieved CO2 concentration. This analysis shows that one can retrieve the mean atmospheric CO2 concentration from a single IASI spectrum with a precision better than 2 ppmv, i.e., better than 1 %. These results are compared and consolidated with information content analysis and inversion based on simulations, in order to fully specify and characterize the IASI CO2 product, in terms of error figure, weighting function, profile information. In particular, the possibility to derive CO2 profile information from IASI (about 3 pieces of information) is demonstrated.

10.5: Analysis of Arctic clouds by means of hyper-spectral satellite

Presenter: F. Romano

F. Romano, E. Di Tomaso, E. Ricciardelli and V. Cuomo

Polar regions are usually characterized by cold and high reflective surfaces (ice and/or snow), very low humidity, and presence of ground and elevated temperature inversions, hence the detection of polar clouds with passive satellite observations presents several difficulties. First, there is little visible and thermal contrast between clouds and the background surface. Moreover, due to the presence of temperature inversion, clouds are not always identified as colder than the background. In addition, low humidity causes polar clouds to be optically thin; also polar clouds are usually composed of a mixture of ice and water, which leads to an unclear spectral signature. Single and bi-spectral threshold methods are sometimes inappropriate due to large variability of surface emissivity and cloud conditions. Uncertainties related to surface emissivity may play an important role, since spectral emissivity for ice/snow surfaces may differ significantly depending upon microphysical properties. More recently, the availability of hyper-spectral observations (e.g. AIRS and IASI) have increased the potential of polar cloud detection, but there are still fairly large uncertainties, especially in the case of thin clouds and weak inversions. In this paper, we present some new tests to detect clear and cloudy case studies collected in the Arctic. Ground-based active and passive measurements, CPR (Cloud Profiling Radar) and CALIOP (Cloud Aerosol Lidar with Ortogonal Polarization) are used to investigate the advantages and limitations of different IASI cloud detection tests.

10.6: NOAA Products Integrated Validation Dataset / Database

Presenter: Tony Reale

Tony Reale, Bomin Sun, Frank Tilley and Michael Pettey

Strategies to process, screen, collocate and analyze multiple data platforms of ground truth (radiosondes, GPS and NWP) and weather satellite (ATOVS, MetOp, GOES, Aqua-AIRS and COSMIC) observations and preliminary results are presented. Plans to migrate from the existing sounding profile oriented dataset (Phase-1) to more generalized sensor oriented radiometric database

(Phase-2)are outlined. The status of historical collocation database generation at NOAA-STAR (beginning with TOVS in 1979) is also presented in context of the longer term goal of producing consistent historical observations for tracking the performance of past, present and next generation sensor and product capabilities consistent with GEOSS (and climate).

10.7: Midtropospheric CO2 Concentration derived from infrared and microwave sounders. Application to the TOVS, AIRS/AMSU, and IASI/AMSU instruments

Presenter: Cyril Crevoisier

C. Crevoisier, A. Chédin, N. A. Scott, G. Dufour, R. Armante, and V. Capelle

Combined use of infrared measurements, sensitive to both temperature and carbon dioxide (CO2) variations, and of microwave measurements, only sensitive to temperature, allows deriving information on CO2 concentration in the mid-to-upper troposphere. Using a non linear inference scheme based on neural networks, four years (1987-1991) of TOVS observations, as well as five years (2003-2007) from the AIRS/AMSU instruments have been interpreted in terms of midtropospheric CO2 integrated content. Following the launch of the hyper-spectral infrared sounder IASI, together with AMSU, on board ESA/MetOp on October 2006, a set of IASI channels presenting optimum characteristics for CO2 estimation has been selected, based on a systematic sensitivity study of the observations to CO2, temperature, and other absorbers. Due to a better spectral coverage and a lower instrumental noise, the CO2 fields retrieved from IASI show a lower variability than those from AIRS. The first ten months of CO2 retrieved from IASI will be presented and compared with corresponding retrievals from AIRS, as well as with simulations from atmospheric transport and in situ data.

10.8: NNORSY-GOME Ozone Profile Retrieval Products and Climatology

Presenter: Anton Kaifel

Anton Kaifel, Jasmine Kaptur

The Neural Network Ozone Retrieval System (NNORSY) developed by ZSW was successfully applied to long term TOVS data for total ozone column retrieval and to GOME Level 1 spectra for total column and ozone profile retrieval. This presentation will focus on NNORSY-GOME ozone profiles retrieval and resulting products of the latest reprocessing of global GOME data in the time range 1995 to 2003. Beside ozone profile retrieval itself in a second step an new approach based on neural network technique for a dynamic ozone profile climatology was undertaken yielding to an easy to use software package for the dynamic NNORSY ozone profile climatology. NNORSY for GOME is a very fast ozone profile retrieval scheme based on neural networks. For training, ozone measurement data from ground based (e.g. ozone sondes and lidar) and satellite (e.g. SAGE, HALOE, POAM) based ozone profile measurements are used. In the first step we developed a special training procedure based on RPROP which is able to deal with incomplete target data without loss of generalization ability during application and in the second we established a two stage quality control (QC) procedure for ozone profile measurement data where the second stage is based on partial neural network training to find outlier and additional measurement errors that passed the first QC stage. After training application to GOME data is very fast. A whole GOME orbit with full spatial resolution can be processed in less than 1 minute and therefore NNORSY-GOME ozone profile retrieval can easily be applied in real-time with minimal costs on a simple workstation computer. NNORSY-GOME was already implemented in near-real-time at DLR-DFD but the service was stopped in June 2003 when the data recorder on ERS2 failed. Within the ESA project CHEOPS-GOME ZSW reprocessed of all available GOME Level 1 data at full spatial and temporal resolution up to June 2003 yielding to NNORSY-GOME Version 3 global 8 year ozone profile data. Beside the ozone profile information from ground up to 61 km height with a sampling rate of 1 km the data comprises for each profile level an ozone profile error estimation and contains temperature profile data derived from GEOS 4 model data. This data set was used to training different neural works without satellite instrument data yielding to the new dynamic NNORSY ozone profile climatology. Depending on which user input information is available, the NNORSY-CLIMATOLOGY does not only consider standard input information such as date, time and

geographical position but also optional dynamic input parameters like total ozone column and/or temperature profile into account which represents the current state of the atmosphere. Due to this option of respecting dynamic parameters this new approach exploits the supplied dynamic information leading to a significant gain of accuracy in climatological ozone profile retrieval. Each climatology product is delivered with ozone profile information as well as according standard deviations. If no input temperature profile is provided the NNORSY-CLIMATOLOGY delivers a climatological temperature profile as well. The presentation will show comparison of derived ozone profile data with independent data sources for single measurements as well as for long term time series of different regions and ozone profile regimes. It can be shown that the neural networks are able to compensate for GOME instrument degradation and calibration uncertainties if parameters about the GOME instrument (e.g. time in orbit) are supplied as input to the neural network trained with real ozone profile measurement data. The climatology ozone profile data are compared with measured time series as well as with classical lookup-up-table climatology products. Current developments for NNORSY are underway for ozone profile retrieval and near-real-time application from SCIAMACHY data and we are looking forward to implement NNORSY for the new atmospheric sounding instruments IASI and GOME-2 MetOp satellite in an new synergistic approach using UV and IR sounding data.

10.9: Pronounced Changes in Water Vapor, Ozone and Metrological Parameters Associated with Dust Storms Using MULTI SENSOR Data

Presenter: Ramesh P Singh

Ramesh P. Singh, Anup K. Prasad, Ritesh Gautam and Menas Kafatos

During the pre-monsoon season, the Indo-Gangetic plains is affected by the dust storms that affect the daily life of million people living in the Indo-Gangetic plains. These dust storms significantly affect the air quality, hydrological cycle and climatic conditions. The dust storms are originated from the Arabia peninsula and neighboring countries in the western parts of India. The multi sensor (MODIS, AIRS, MISR, AMSR, SSM/I, CALIPSO, TOMOS, OMI AURA) data for the period 2000 – 2006 show pronounced changes in the surface, aerosol, ozone, cloud, snow cover and meteorological parameters. The detailed analysis of these parameters have revealed that soon after the dust storm water vapor and ozone column enhanced and meteorological parameters (air temperature, relative humidity) change significantly at the pressure level 500 – 700 HPa. The changes in the surface, atmosphere and meteorological parameters will be discussed in the melting of snow cover and its consequence in hydrological cycle and climatic conditions. The radiative forcing calculations have shown changes in the surface and top of atmosphere forcing associated with the dust storms.

10.10: Advanced Infrared Sounding System for Future Geostationary Satellites

Presenter: Jun Li

Timothy J. Schmit, Jun Li, James J. Gurka, Jaime Daniels, Mitch Goldberg

The United States Geostationary Operational Environmental Satellite (GOES) Sounders (GOES-8/9/10/11/12) have provided hourly infrared (IR) radiances and derived products over the continental U.S. (CONUS) and adjacent oceans for over 14 years. The GOES-10 sounder now also provides hourly coverage over South America. The products derived include: clear-sky radiances; temperature and moisture profiles; Total Precipitable Water vapor (TPW) and layer PW; atmospheric stability indices such as Convective Available Potential Energy (CAPE), Lifted Index (LI) and K-Index; cloud-top properties; water vapor motion winds through radiance tracking; and total column ozone. These products are used in numerical weather prediction (NWP), short range forecasts and nowcasts, including severe weather forecasts. While broadband geo-sounding has proven useful, hyperspectral IR sounding will provide measurements that serve user requirements much better. Developing a GOES IR sounding capability with high temporal, spatial, and spectral resolutions is very important for supporting regional and convective-scale NWP over CONUS, as it will provide unprecedented detail on 3D fields of wind, temperature, and humidity. Nowcasting and very-short range forecasting (VSRF) will also benefit from these 3D fields from the monitoring of moisture convergence and convective instability and improving warnings of location and intensity of convective storms. The combination of

high spectral and temporal resolution will allow resolving the critical low-level moisture. Studies with available aircraft and satellite data have demonstrated the importance of geostationary hyperspectral IR radiances and products on severe storm forecasts. The benefits of a spaceflight demonstration in parallel with any operational program would be enormous.

10.11: Dust aerosol layer altitude from AIRS (01/2003 to 11/2007) and from Calipso (06/2006 to 11/2007): a comparison.

Presenter: Raymond Armante

S. Peyridieu, A. Chédin, C. Pierangelo, R. Armante and N. Lamquin

Mean infrared (10 µm) dust aerosol layer optical depth and altitude are retrieved over the tropics (30°S–30°N) for five years of Atmospheric Infrared Sounder (AIRS) observations covering the period January 2003 to December 2007. Retrieved optical depths show a very good correlation with the Moderate resolution Imaging Spectroradiometer (MODIS-Aqua) retrieved visible optical depths during the dust season. AIRS simultaneously retrieved mean dust layer altitude are then compared to Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP/CALIPSO) aerosol layer retrieved altitude for the period June 2006 to November 2007. Results for a region of the north tropical Atlantic downwind of the Sahara show a remarkably good agreement between the two products and demonstrate the capability of passive infrared sounders to accurately retrieve the mean dust layer altitude. An interesting conclusion is the fact that if the AOD clearly decreases from Africa to Caribbean as a result of transport and dilution, altitude does not exhibit a significant regular decrease. This is in agreement with in situ measurements made during the Puerto Rico Dust Experiment (PRIDE) campaign.

SESSION 11

11.1: Evolution of the Global Observing System

Presenter: John Eyre

John Eyre and Jerome Lafeuille

In 2002, the Commission for Basic Systems (CBS) of WMO adopted a “Vision for the Global Observing System (GOS) to 2015”. This vision covers both space-based and ground-based observing systems. Since 2002, there has been considerable development in thinking about the future of the GOS: the potential of several new observing systems to make substantial contributions to the GOS has emerged, and the GOS has been asked to respond to user requirements for an increased range of applications, in particular those of climate monitoring. These developments have prompted an activity within WMO to refresh the Vision for the GOS. By the end of 2008, CBS is expected to endorse a new “Vision for the GOS in 2025”, following discussion with a wide range of stakeholders. A draft of the new Vision for the GOS will be presented, with particular emphasis on the space-based component and on those systems in which ITWG members have considerable expertise. ITWG will be invited to comment on this draft, as part of the current discussion process.

11.2: Status report on the Global RARS initiative

Presenter: David Griersmith

Regional ATOVS Retransmission Services (RARS) are operational arrangements for rapid delivery of satellite data to the global community (especially NWP Centres). In particular the services involve acquisition of polar-orbiting satellite data over a wide region containing a network of NOAA/METOP ground reception stations with subsequent fast delivery to users. The Global RARS system comprises several regional RARS (e.g., Europe including North America, Asia-Pacific, and South America) each of which involves acquisition of satellite data from HRPT stations in that Region. The data are then locally processed and passed to a regional Processing Centre that is responsible for overall coordination, for near-real time concentration of local data from the direct readout stations and

for rapid delivery of consistent sets of data covering the region, for use throughout the region and worldwide. The impact of the global RARS system has been significant through improvements in NWP modelling since much larger quantities of sounder data have become available for assimilation. This paper will present a status report on the global RARS including recent developments in the Asia-Pacific Region and RARS planned evolution.

11.3: EUMETSAT Plans

Presenter: Dieter Klaes

Dieter Klaes

This paper gives an overview on EUMETSAT programmes, both mandatory and optional. EUMETSAT is currently operating the Meteosat-6/7 and the two satellites of the second generation Meteosat Second Generation (MSG-1, and 2) which have been renamed as Meteosat-8 and Meteosat-9 respectively. The MSG-3/4 satellites are under storage or production respectively. The MSG Programme has been developed in co-operation between EUMETSAT and ESA. EUMETSAT developed jointly with ESA the EUMETSAT Polar System (EPS). After the launch of Metop-A, the first of a series of three satellites in October 2006, the system is operational and provides all planned products to the Users. The EUMETSAT Advanced Retransmission Service (EARS) continued its operational services and provides observations from partner HRPT (High Resolution Picture Transmission) stations. Jason-2 is EUMETSAT's first optional programme, which will provide operational Ocean Surface Topography information services, the launch is planned for summer 2008. Preparations for Meteosat Third Generation (MTG) and Post EPS are under way.

11.8: Agency status reports: JMA and JAXA

Presenter: Kozo Okamoto

Kozo Okamoto

Current status of the Multi-functional Transport Satellite–1R (MTSAT-1R) and MTSAT-2 and future plans of MTSAT follow-on satellite of Japan Meteorological Agency (JMA) are presented. Plans of earth observing satellites of the Japan Aerospace Exploration Agency (JAXA) are also presented. They include the Greenhouse gas Observing Satellite (GOSAT) launched in Japanese fiscal year (JFY) 2008, the Global Change Observation Mission–Water (GCOM-W) carrying the Advanced Microwave Scanning Radiometer-2 (AMSR-2) in JFY2011 and a Japanese and European joint satellite of the Earth Clouds, Aerosol and Radiation Explorer (EarthCARE) carrying the Cloud Profiling Radar (CPR) in JFY2013, and the Global Precipitation Measurement (GPM) proposed jointly with the U.S. They are all going to be substantially beneficial to assimilation, climate monitoring and model validation.

SESSION 12

12.1: The National Polar-orbiting Operational Environmental Satellite System (NPOESS) and the NPOESS Preparatory Project (NPP) – Program Status and International Initiatives Status

Presenter: Peter A. Wilczynski

Peter A. Wilczynski

A Presidential Decision Directive (PDD), signed in May of 1994, directed the convergence of the polar orbiting weather satellites systems into a single national system. The Integrated Program Office (IPO) within NOAA was established in October 1994 as a result of the signing of a tri-agency Memorandum of Agreement (MOA) in May 1994. The new converged system was identified as the National Polar-orbiting Operational Environmental Satellite System (NPOESS). The IPO is staffed with representatives of NOAA, Department of Defense and NASA. This unique tri-agency office has the

mission to provide a converged polar-orbiting operational, environmental satellite system that meets user community requirements. The NPP is a joint-agency mission intending to serve the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO) and the National Aeronautics and Space Administration (NASA) and their user communities. The NPP provides the Earth science community with data continuity and also provides the IPO and its users a risk reduction demonstration of capabilities for critical NPOESS instruments. NPOESS was formally restructured in 2007. This restructure has changed the NPOESS and NPP payload compliments and has changed the anticipated launch dates. All these changes impact NPOESS-NPP data users as they prepare to receive data from this next generation polar-orbiting system. As a result of the restructure, the NPOESS Program Executive Office (PEO) initiated installing additional ground resources in Antarctica to capture Europe's current MetOp satellites, thus potentially reducing data latency by almost half of the current timeliness. This capability could be operational by 2012. Additionally, the PEO office is actively engaged internationally to seek other sources of satellite data to compliment NPOESS. For example, the PEO office and NOAA are actively discussing how to have JAXA's GCOM series of satellites compliment the NPOESS constellation. This paper shall briefly discuss NPOESS-NPP program status as well as a comprehensive update on international activities that will positively affect our world-wide data users.

12.2: The Joint Capabilities and Opportunities of Advanced Sounders on MetOp and NPOESS for NWP and Climate Monitoring In a GEOSS Era

Presenter: Stephen A. Mango

Stephen A. Mango

NPOESS, the National Polar-orbiting Operational Environmental Satellite System, managed by the Integrated Program Office [IPO], is structured as an operational, long-term, environmental, satellite monitoring system for weather, climate, and several other application/discipline areas for the "Next Generation" (~2009-2029). The IPO is developing for a 1st generation NPOESS a suite of advanced, atmospheric sounding/probing instruments as a major part of the next generation meteorological, environmental and climate operational satellite system in polar, low earth orbit [LEO]. The CrIS, Cross-track Infrared Sounder, an Advanced Technology Microwave Sounder [ATMS], an Ozone Mapping & Profiler Suite [OMPS], a MIS [Microwave Imager and Sounder] and a VIIRS – Visible and Infrared Imager and Radiometer. In addition, the 2nd generation NPOESS – post 2025, is already in its very early conceptual phase.

The European community, EUMETSAT, European Organization for the Exploitation of Meteorological Satellite Systems, has already launched (October 2006) the first of three next generation, operational polar-orbiting LEO system, MetOp, as part of its European Polar System [EPS]. MetOp has a highly capable FTS sounder, IASI [Infrared Atmospheric Sounder Interferometer], an Advanced Microwave Sounding Unit [AMSU], a Global Ozone Monitoring Experiment [GOME], a GNSS Receiver for Atmospheric Sounding [GRAS] and an Advanced Very High Resolution Radiometer [AVHRR]. EUTMETSAT is already in the Mission Formulation stage for their 2nd generation EPS – post 2020.

The combined MetOp and NPOESS sounders, which will be in complementary polar orbits, will represent a very significant combined capability and set of opportunities to establish a formative GEOSS grand sounding "system".

This paper will focus on:

1. the projected joint capabilities, synergies and opportunities of advanced sounders on MetOp and NPOESS during the emerging GEOSS era for primarily NWP and climate monitoring, namely – the IASI, AMSU, GOME and GRAS on MetOp and the CrIS, ATMS, OMPS and MIS on NPOESS.

2. the different requirements for the MetOP and NPOESS sounding sensors which will actually facilitate the the cross-calibration of the sounders of a formative GEOSS system .

3. the different requirements for the MetOp and NPOESS sounding products which will actually

facilitate an initial formulation of common requirements for the sounding products for GEOSS sounders and provide an opportunity for the mutual validation of the sounding products.

ITSC-16 POSTER PRESENTATIONS

SESSION A

A01: Radiative Transfer in Vertically Layered Soil

Presenter: Fuzhong Weng

Fuzhong Weng

At thermal wavelengths, the upwelling radiation at surface is often expressed as a product of emissivity and surface temperature. For a vertical stratified medium (e.g. permittivity varies with soil depth), the emissivity at the surface is normally calculated from Fresnell formula. For an electromagnetic (EM) wave that does not penetrate through soil (e.g. zero transmissivity), the emissivity and reflectivity equals unit. However, when the EM wave penetrates through the medium, the emitted radiation must be considered from the energy contributed from the deeper layers and can be calculated from variable radiative transfer schemes. This study will investigate on uses of auxiliary soil information to quantify the optical parameters used in surface radiative transfer schemes. The impacts of this newly developed approach on simulations of the radiances at the top of the atmosphere will be also discussed.

A02: A clear sky radiative transfer model for MTG-IRS

Presenter: Stephen Tjemkes

Stephen Tjemkes, Jochen Grandell and Rolf Stuhlmann

In support of the development of an end-to-end processing chain for METEOSAT Third Generation Infrared Sounder (MTG-IRS) candidate mission EUMETSAT has procured the radiative transfer model based on the Optimal Spectral Sampling (OSS) method from Atmospheric and Environmental Research, Inc. To build confidence in this radiative transfer code, a comparison has been performed involving results generated by OSS and results generated by LBLRTM for real IASI observations, and for MTG-IRS simulations for a number of atmospheric clear sky conditions. In addition to results for the upwelling radiance at top of the atmosphere, also jacobians for a number of state variables are included in the comparison.

A03: Scenes Analysis for the Meteosat Third Generation Infrared Sounder Observations

Presenter: Stephen Tjemkes

Stephen Tjemkes, Jochen Grandell, Phil Watts and Rolf Stuhlmann

EUMETSAT prepares for the next generation of geostationary satellites. Among the three candidate missions is an infrared sounder. The preparatory activities for especially this candidate mission will greatly benefit from exploring the hyperspectral IASI observations. The MTG-IRS candidate mission observations would be used to monitor vertical distributions of temperature and moisture. Although there are a number of promising activities, regarding the retrieval of thermodynamical properties from all sky observations, initially these temperature and moisture profiles will be derived from cloud free spatial samples. Thus an accurate scenes analysis is required to classify each observation according to its cloud amount. McNally and Watts (2003) described a cloud detection algorithm for high spectral resolution infrared sounders. To understand the performance of this algorithm in relation to a possible application to MTG-IRS observations, a number of tasks have been performed. First, in order to increase the confidence in the performance of this cloud detection algorithm, it was applied to IASI observations and compared to results of other scenes analysis methods like the CO2 slicing method and the operational cloud mask derived from collocated AVHRR observations. Results of this comparison will be presented during the presentation, as well as results of the method when applied to IASI as a proxy for MTG-IRS. This means that the spectral coverage of the original IASI data is reduced to match the MTG-IRS coverage, and also the spectral sampling is modified according to the

MTG-IRS specifications. The effect of these modifications on the performance of the cloud detection is presented.

A04: Comparison of IASI radiances with models from seven operational centres

Presenter: Fiona Hilton

Fiona Hilton (Met Office), Andrew Collard (ECMWF), Lars Fiedler (EUMETSAT), Vincent Guidard (Meteo-France/GMAP), Sylvain Heilliette (Environment Canada), Lydie Lavanant (Meteo-France/CMS), Benjamin Ruston (NRL)

Bias and noise in IASI spectra may be identified by comparing the data with radiances calculated from forecasts and analyses from Numerical Weather Prediction (NWP) models. The bias and standard deviation of fit against model fields are compared for seven operational centres: the Met Office, ECMWF, EUMETSAT, Meteo-France/GMAP, Meteo-France/CMS. Good agreement is found between IASI and NWP fields, showing that IASI is performing within its specification. Areas of the spectrum where the comparisons differ or agree can be used to investigate whether errors arise from the NWP model, the spectroscopy or the instrument.

A05: IASI Validation Studies using Airborne Field Campaign Data

Presenter: Allen Larar

Allen M. Larar, Daniel K. Zhou, Xu Liu, William L. Smith, Henry E. Revercomb, Jonathan P. Taylor, Stuart Newman, Peter Schlüssel, and Stephen A. Mango

Measurement system validation is critical for advanced satellite sensors to improve observations of the Earth's atmosphere, clouds, and surface for enabling enhancements in weather prediction, climate monitoring capability, and environmental change detection. Field campaigns including satellite under-flights with well-calibrated FTS sensors aboard high-altitude aircraft are an essential part of the validation task. This presentation focuses on IASI validation studies performed using data from the recently-completed Joint Airborne IASI Validation Experiment (JAIVEx) field campaign. Methodology developed and employed herein for IASI radiance validation will be discussed along with recent results.

A06: Identification of biases in the modelling of high peaking water vapour channels from IASI

Presenter: Stuart Newman, Fiona Hilton

Stuart Newman, Fiona Hilton, Andrew Collard

A major challenge in NWP is the assimilation of IASI water vapour channels. Results from the Joint Airborne IASI Validation Experiment (JAIVEx), utilising NWP model field data from the Met Office and ECMWF, show that upper atmospheric humidity is often not well represented in NWP models, with consequences for radiative transfer modelling in this spectral region. Observed minus background biases from NWP assimilation schemes are compared with biases derived from JAIVEx case studies. It will be shown that the findings from JAIVEx, though geographically and seasonally isolated, provide a useful insight into the source of spectral biases in the water vapour spectral region on a global scale.

A07: The water vapor continuum effect on the surface transmitted irradiance at 8 – 12 mu m atmospheric window

Presenter: Simone M.S. Costa

Simone M.S. Costa, Keith P. Shine, Juan C. Ceballos and Rodrigo A. F Souza

The continuum of the atmospheric water vapor plays important role in the 8-12 mu-m infrared window by absorbing the warmer radiation from the surface and re-emitting it at cooler temperature. This study aims to present an estimate of the continuum effect on the surface transmitted irradiance (STI, in Wm-2). Irradiances were calculated based on the state-of-the-art line-by-line radiation model; 12-year climatological dataset from ECMWF reanalyzes and clouds from the International Satellite Cloud Climatology Project (ISCCP). Results show that the global annual mean surface transmitted irradiance at the top of the atmosphere is around 65 Wm-2 for clear sky, and decreases to 22 Wm-2 due to clouds. The water vapor continuum absorbs more than 60% of the clear sky surface transmitted irradiance at the tropics, around 20 % at mid-latitudes and around 7 % at the poles. The stronger effect on the lower latitudes is because self-broadened continuum absorption is proportional to the square of the partial pressure of the water vapor. Future work will extend the analyses of the effect of water vapor continuum absorption on the satellite signal (i.e. brightness temperature/ radiance).

A08: The effect of Doppler shift due to Earth's spin on SSMIS UAS channels

Presenter: Yong Han

Yong Han

The effect of Doppler shift due to Earth's spin on SSMIS UAS channels Yong Han NOAA/NESDIS/Center for Satellite Applications and Research Camp Springs, MD, USA In the previous ITSC, we presented a report on a fast radiative transfer model for the SSMIS upper-atmosphere sounding (UAS) channels that are affected by Zeeman-splitting. In the model the Doppler shift of the radiance spectrum due to Earth's spin is neglected. Since then, further studies have been carried out to address several important issues, including the impacts of neglecting the Doppler shift on radiance simulations. We will show that the Doppler shift can have an impact of ~2 K in brightness temperature near the edges of the scan lines and in low latitude regions, and present the requirements and solution to take the frequency-shift into account. This study also provides evidence from the UAS channel measurements that indicate the correct polarization of the receivers, as different documents have disagreed whether the receivers is left- or right-circularly polarized.

A09: A fast radiative transfer model for AMSU-A channel 14 with the inclusion of the Zeeman-splitting effect

Presenter: Yong Han

Yong Han

A fast radiative transfer model for AMSU-A channel 14 with the inclusion of the Zeeman-splitting effect Yong Han NOAA/NESDIS/Center for Satellite Applications and Research Camp Springs, MD, USA In the previous ITSC, we presented a report on a fast radiative transfer model for the SSMIS upper-atmosphere sounding channels that are affected by Zeeman-splitting. Recently, we have extended the work to AMSU-A channel 14, which has a weak but measurable dependence on the Earth magnetic field and its orientation relative to the sensor's observation direction. To take the Zeeman-splitting effect into account, Liebe added in his 1993 model a correction term in the line width formula to roughly estimate the line behavior. However, application of this model to AMSU-A channel 14 may produce significant errors in radiance simulations, larger than the model when the correction term is removed. In this presentation, we will present a radiative transfer model for rapid radiance calculations that correctly describes the Zeeman-splitting effect. We will also describe the behavior of the radiance in the presence of Earth's magnetic field and quantify the difference between the model with and without the inclusion of the Zeeman-splitting effect.

A10: A graphical user interface for RTTOV

Presenter: Pascal Brunel

Philippe Marguinaud, Pascal Brunel

RTTOV is the radiative transfer model developed by the NWP SAF. The project has decided to create a graphical user interface to run the RTTOV model. We have chosen to develop an interface based on the Linux Desktop (Gnome/KDE). This interface will allow users to edit RTTOV initial conditions (atmospheric profiles, ground parameters, etc...) run the RTTOV model efficiently (keeping coefficients in memory, possibly using multithreading) and view the results (radiances, transmittances). Our poster will present the principles of this interface, and we intend to have a laptop running a demo as well.

A11: 4A/OP: An operational fast and accurate radiative transfer model for the infrared

Presenter: L. Chaumat

L. Chaumat, C. Standfuss, B. Tournier, R. Armante and N.A. Scott

4A/OP is a user-friendly software for various scientific applications, co-developed by LMD (Laboratoire de Meteorologie Dynamique) and NOVELTIS with the support of CNES (the French Space Agency). NOVELTIS is in charge of the industrialization and the distribution of the LMD 4A radiative transfer model. 4A (4A stands for Automatized Atmospheric Absorption Atlas) is a fast and accurate line-by-line radiative transfer model particularly efficient in the thermal infrared region of the spectrum. NOVELTIS has created an "operational" version of this code called 4A/OP. The 4A/OP software is a version of the 4A code for distribution to registered users. This version is regularly updated and improved and contains a graphical user interface and a reference documentation. The associated Website http://www.noveltis.fr/4AOP/ includes an on-line registration form. 4A/OP has the official support of CNES for radiative transfer applications in the infrared. This software is used by several research groups and can be integrated in operational processing chains. In particular, 4A/OP is the reference radiative transfer model for IASI level 1 Cal/Val and level 1 operational processing. Thanks to the computation of Jacobians, the model can also be coupled with an inversion algorithm for the atmospheric constituent retrieval from infrared radiance measurements.

A12: Forward Simulation for FY-3 MWHS using RTTOV-7

Presenter: Xiaoqing Li

Xiaoqing Li, Gang Ma, Fengying Zhang, Xuebao Wu

MWHS (MicroWave Humidity Sounder), together with MWTS (MicroWave Temperature Sounder) and IRAS (Infrared Atmospheric Sounder), constitutes vertical atmospheric sounding system (VASS) in FY3, the next generation polar orbit meteorological satellite of China. MWHS can provide three-dimensional distribution of global atmospheric humidity for all weather. Before research has been performed on forward simulation for MWHS by using RTTOV-7, Liebe-MPM89 and Liebe-MPM92 are used to compute line-by-line transmittances. Based on these transmittances, spectral parameters for MWHS and predictors defined in RTTOV-7, coefficients are calculated by a multiple linear regression model. In order to compare with AMSU-B, standard atmospheric profile of the United States is used to generate the weighting function of MWHS. After profiles in TIGR43 dataset are selected to yield the fast transmittances coefficients for MWHS, validation is performed by comparing the brightness temperature and the transmittances calculated by RTTOV7 and generated by the Line-by-line model.

A13: Convective-scale data assimilation of satellite infrared radiances over the Mediterranean: adaptation of the observation operator to the high-resolution.

Presenter: Fanny Duffourg

Fanny Duffourg, Véronique Ducrocq, Nadia Fourrié, Geneviève Jaubert and Vincent Guidard

Fine scale phenomena are still badly grasped whereas they are an important challenge to take up. For that reason, some meteorological centers have recently developed numerical weather prediction models with a kilometric mesh that explicitly resolve moist convective processes. With this higher resolution, new problems, particularly in assimilation, have appeared. For example, the model mesh is now smaller than any satellite observation spot. As a consequence, we need to gather model information from different grid points to simulate correctly the brightness temperature measured. This issue is examined more specifically for the newly developed convective scale 3D-Var data assimilation system of Météo-France: AROME. In AROME, satellite observations are simulated thanks to the RTTOV radiative transfer model. The brightness temperature is estimated at the center of the satellite observation spot using the four closest model columns surrounding this point. This interpolation procedure comes from previous assimilation systems for which the model mesh was larger than the observation spot. But with fine scale data assimilation systems such as AROME (2.5 km), such a procedure is no longer valid as a single AIRS or IASI observation spot covers more than 12 model grid-points at nadir. That is why, in this study, we explore different ways of aggregating the model information within a satellite spot in order to better represent the whole atmosphere sounded at once by these instruments. We then compare the different brightness temperatures obtained by using RTTOV with these different aggregating methods. The first results show almost no differences for temperature channels (the differences in brightness temperature are smaller than 0.1 K) but bigger ones (from 0.5 K to 1 K) for water vapour channels in some places where important gradients in the humidity field are present.

A14: Potential enhancement of AMSU-A/MHS/ATMS baseline microwave humidity and temperature sounders

Presenter: Stephen English

Abstract not available.

A15: A new method for estimating 1D-var B-matrix from 4D-var

Presenter: Stephen English

Stephen English and Marek Wlasak

Abstract not available.

A16: The radiometric requirements for a post-EPS Microwave Sounder

Presenter: Bill Bell

Abstract not available.

A17: SSMIS Upper Atmosphere Radiance Assimilation: Preprocessing Requirements and Preliminary Results

Presenter: Bill Bell/Nancy Baker

S. Swadley, N. Baker, G. Poe, K. Hoppel, Y. Han, S. Mahmood and W. Bell

The SSMIS Upper Atmosphere Sounding (UAS) channel set provides the first operational measurements of microwave radiation emitted by the earth's atmosphere at mesospheric altitudes. The SSMIS receives polarized radiation in the 60 GHz oxygen complex, specifically the 7+, 9+, 15+ and 17+ O2 lines. Significant hardware and scientific technical challenges arise from microwave temperature sounding of the mesosphere. These include 1) addressing the impact of large Noise Equivalent Temperature Difference (NEDT) associated with narrow channel bandwidths; 2) achieving high channel center frequency stability; 3) compensation of large spacecraft-induced Doppler shift; 4) better characterization the Zeeman splitting of the oxygen absorption lines; 5) development of a fast

polarimetric radiative transfer model (RTM). Preliminary global simulation results comparing the fully polarized NRL Line-by-Line (LBL) RTM with the fast RTM including Zeeman effects (CRTM-Z) showed the two models agreed to under a 1.0 K RMS, but the bias patterns indicated both residual geomagnetic and earth rotation Doppler signatures. Earth rotation Doppler signatures were shown to be significant when circular polarized radiation is being measured. The preliminary global simulations were performed using ECMWF analyses merged with COSPAR climatology above ~80 km level, and showed OB-BK biases in the 10-15 K for the highest peaking UAS channels. Results using the fast RTM with Zeeman effects to map the model backgrounds into SSMIS brightness temperatures for both NRL's high-altitude global NWP model (NOGAPS-ALPHA) and the new L70 Met Office global forecast model (model lid at ~80km) will be presented. Details of the SSMIS UAS preprocessing steps required prior to assimilation will also be presented.

A18: Joint poster with NRL on upper atmospheric sounder data

Presenter: Bill Bell

Abstract not available.

A19: Evaluating the Impact of the Geopotential Height Profile Data Assimilation Deriving from the AIRS/AQUA Sensor by the CPTEC's RPSAS Assimilation Model

Presenter: Carlos Frederico Bastarz

Carlos Frederico Bastarz, Dirceu Luis Herdies, Jairo Geraldo Gomes Junior, Luiz Fernando Sapucci, Rita Valéria Andreolli, Rita Micheline Dantas Ricarte

Due to improve the weather forecast through the geopotential height profiles data assimilation, this paper aims to present a case study occurred in the south of Brazil considering a period of the winter season (in the Southern Hemisphere), when strong raining events were occurred. This season were characterized by the incursion of several frontal systems which caused low temperatures, several strong raining and storms. The assimilation system used to data assimilation were the CPTEC's Data Assimilation System, the RPSAS – Regional Physical-Statistical Assimilation System, based on the DAO's Assimilation System (PSAS). In this process, the geopotencial height profile were assimilated during the period and some of the results show that the 1-3 days forecast are improved for some variables like temperature and precipitable water for the analysis.

A20: Impact of ATOVS geopotential heights retrievals over analyses generated by RPSAS.

Presenter: Jairo Geraldo Gomes Junior

Jairo Geraldo Gomes Junior, Weber A. Gonçalves, Rita V. Andreoli, Dirceu L. Herdies, Carlos F. Bastarz, Henrique M. J. Barbosa, Luiz F. Sapucci and Aimone S. Tomita L.

South America and adjoining oceans are known by having a very irregular and sparse meteorological data acquiring net and this fact implies a worse performance for Numerical Weather Prediction models operated by most of Weather Prediction Centres than it should be in terms of computacional capability. However, this lack of in situ observations has been treated by the usage of satellite-processed radiance. In this work, conventional data (e.g. from surface and oceanic stations, airplane and radiosondes) and ATOVS retrievals, in form of geopotential heights, were assimilated by RPSAS (Regional Physical-Space Statistical Analyses System) at CPTEC (Center of Weather Prediction and Climate Studies – Centro de Previsão do Tempo e Estudos Climáticos) and some verifications were done with RPSAS' outputs to quantify the impact of the assimilated data over its analyses. And also a case study was carried out about a frontal system that intruded Brazil in 09JUL2007. Some compares to a control experiment without ATOVS profiles, as Mean Absolute Error, took place to observe the impact of these retrievals in the analyses generated by the RPSAS. Furthermore, an Analyses Impact (AI) were calculated by taking the NCEP analyses as a "perfect" representation of the atmosphere state at some synoptic times during the period of 01st to 20th of July/2007. The results showed that

the incremental outputs of RPSAS were coherent with the spatial distribution of retrievals assimilated, but the AI showed that the data assimilated do not improved all the analyses fields, even when they were related to a very sparse-data in situ areas, like over Atlantic Ocean.

A21: Investigating the assimilation of IASI data in a limited area model

Presenter: Roger Randriamampianina

Roger Randriamampianina

The assimilation of IASI data in the ALADIN/Norway data assimilation system at the Norwegian Meteorological Institute is being carried out in the frame of the THORPEX-IPY Norway project. This project aims to improve the accuracy of high-impact weather forecasts in the Arctic region. The use of limited number of channels is being tested at the first stage using all the available IASI field of view. The next step concerns evaluation of the use of IASI data applying different bias correction techniques.

A22: Use of Regional Retransmission Networks in Global Data Assimilation

Presenter: Brett Candy

Brett Candy, Steve English and Nigel Atkinson

Along with other global NWP centres the Met Office routinely assimilates data from Regional ATOVS Retransmission (RARS) networks, such as the EARS service provided by EUMETSAT. Recently additional data has been made available for the Asia-Pacific region and Brazil. In this study we investigate the forecast impact of using this data in addition to the standard global ATOVS datasets. We also examine the forecast benefit if all ATOVS data arrived in time to make the main forecasts. This latter study gives insight into other geographical areas in which a RARS network would be useful.

A23: Satellite Data Assimilation over Antarctica: The Concordiasi Field Experiment

Presenter: Aurélie Bouchard

Aurélie Bouchard, Florence Rabier, Vincent Guidard, Fatima Karbou, Nadia Fourrié, Thomas Pangaud

In the framework of the International Polar year, a field experiment will take place in Antarctica, during the Austral Spring 2008: Concordiasi (http://www.cnrm.meteo.fr/concordiasi). There will be an increase in the number of observations over Antarctica such as driftsondes or radiosoundings at Concordia and Dumont D'Urville during the campaign. Thanks to these additional in-situ observations, studies will be performed in order to improve the assimilation of infrared and microwave observations over the high latitude. One of the major aims of this campaign is the validation of the assimilation of IASI (Infrared Atmospheric Sounding Interferometer) radiances. The most important problem for the infrared satellite observations is the cloud detection and especially stratospheric polar cloud (PSC) for these cold areas. Different methods such as Cloud Detect (McNally and Watts, 2003) or Co2 slicing (Chahine, 1974; Lavanant 2002) can be applied. Based on the conclusions of this preliminary work, a cloud detection method, for the high latitudes, will be tried in a future work. Moreover, new methods have been developed within the constraints of 4D-Var to help the assimilation of the microwave observations (Karbou et al. 2006). These methods have been successfully tested at a global scale and have shown to be beneficial to our 4D-Var system. However, due to the complexity of snow covered areas, further developments are still needed in order to better describe the surface over Antarctica. Focusing on this specific area, we will explore how a better modelling of the emissivity and/or the skin temperature could help the assimilation of microwave surface and sounding channels. The impact on our 4D-Var system will be also examined.

A24: Inclusion of time-distributed wind observations in 4D-Var for Tropical Cyclone bogussing.

Presenter: Yann Michel

Michel, Y. and Renshaw, R.

Tropical cyclones (TC) happen in tropical regions over warm seas where the density of conventional observations is significantly lower than more observed regions as the Northern hemisphere extratropical region. Over land, traditional observations or ground-based Doppler data are of great help to estimate the wind structure of TC. It is well recognized that the assimilation of satellite data has improved the TC forecast skill over the last few years. Among these data, advanced sounders help to diagnose convection and therefore estimate TC intensity. However, satellite data are mass field observations, and TC are highly non-linear physical phenomenons with a large range of scales still difficult to forecast accurately. As a result, different techniques have emerged as a practical way to cope with the initialization problem of TC, including the use of pseudo-observations of wind field variables. TC warning centers use high resolution satellite images to estimate the TC parameters, which are then issued within TC advisories and used in global data assimilation. The bogussing scheme of the MetOffice is described by Heming (1994) and relies on the specification of wind observations at successive radiis from the TC centre. The technique makes use of scatterometer winds and advisories estimating location and intensity of TC. Positive impact has been reported especially in short-range tracking skill. We study, within the MetOffice global 4D-Var framework, the inclusion of twice bogus observations - as TC advisories are available in a three-hourly frequency within the six hours time window of the data assimilation. We show that 4D-Var is partly able to make profit from the estimated changes in the intensity and positions of the TC that are deduced from satellite data and that it leads to small improvements in the track forecast of TC.

A25: Case studies of 4D-Var assimilation of potential vorticity observations derived from image processing.

Presenter: Yann Michel

Michel,Y. and Bouttier,F.

Short-range forecasts errors occurring in numerical weather prediction are often diagnosed by forecasters as being displacement errors: forecast locations of meteorological structures are displaced from their observations, and this displacement can be evaluated through inspection of satellite images. However, current representation of background error are based on Gaussian assumptions, and linear or weakly non-linear data assimilation schemes are used to correct errors. This hypothesis is more and more critical as resolution increases and as the meteorological situation evolves more and more non-linearly. Therefore, high resolution forecasts models of strongly non-linear processes, such as thunderstorms or tropical cyclones, need a different, more realistic initialization. Some methods have been developed to identify and correct the position and amplitude of storm-scale thunderstorms and of tropical cyclones, including bogussing practices and variational assimilation of simulated observations. Despite the growing number of radiance data being assimilated, global models sometimes fail to predict mid-latitude cyclogenesis, even if the upper or lower level precursors are visible in the images from advanced sounders or geostationary satellites. Different operational procedures, often based on potential vorticity inversion, have been developed to exploit the link between water vapour images and the initial state of the upper level of the troposphere. Our goal is to build observations of potential vorticity that correct the displacement and amplitude error of the dry intrusions using a image satellite processing technique. An algorithm developed for the identification and tracking of dry intrusions in water vapour imageries is used to define potential vorticity pseudo-observations in the upper troposphere. A simple object-based methodology produces observations that are built to locally correct the amplitude and displacement errors as diagnosed from the comparison of the trajectories in the image processing tool. An approximate form of Ertel potential vorticity operator is used to incorporate the pseudo-observations inside a 4D-var assimilation scheme. It is applied to real cases of cyclogenesis forecasts and within an operational data assimilation scheme, the high resolution (20 km over Europe) global model ARPEGE. Experiments on several cases studies highlight the ability of the algorithm to correct locally

the tropopause and to partially improve the forecasts of the cyclogenesis. Advantages and drawbacks of this procedure are finally discussed.

A26: Impact of variable O3 and CO2 on assimilation of high spectral resolution sounder data

Presenter: J. Cameron

J. Cameron, S. English, F. Hilton, E. Pavelin

The bias of AIRS observations relative to observations simulated from the Met Office global model show both seasonal variations and an on-going trend. Some of these changes are clearly caused by upgrades to the model but others are due to variable gases and in particular O3 and CO2. The variations that have been observed are displayed and possible approaches to reduce the effect of variable O3 and CO2 are presented.

A27: Impact Analysis of Assimilation of Integrated Water Vapor Estimates from AIRS/AMSU over Amazonian Region

Presenter: Luiz Fernando Sapucci

Luiz Fernando Sapucci; Dirceu Luis Herdies, Rita Valéria Andreoli; Renata Weissmann, B. Mendonça, Rodrigo Augusto F. de Souza; Sérgio Henrique S. Ferreira, José Antônio Aravéquia.

The Amazonian region is one of the most humid of the planet [Integrated Water Vapor (IWV) median values are in the order of 50 kg m-2] and it is also characterized by large space-time variability in the humidity fields. The cause of this large variability is the intense convective activity associated with the great humidity potential generated by high temperatures. Consequently, in the Numerical Weather Prediction the usage of initial conditions with errors in characterizing humidity over Amazonian region can generate erroneous precipitation forecast in the some areas over South American continent. In this aspect, there are two important points. The first point is the most realistic atmospheric state depends significantly on available data, and the second one is the low density of conventional information in the Amazonian region. Data from Atmospheric InfraRed Sounder/Advanced Microwave Sounding Unit (AIRS/AMSU) incorporate the most recent inversion procedure, which are able to produce IWV values of good quality over continental areas. Nowadays, this sensor is one of the most important sources of humidity over Amazonian region. Within this context, the present study investigates the impact on humidity forecast over Amazonian region with the inclusion of IWV estimate from AIRS/AMSU in the CPTEC data assimilation system: Physical-space Statistical Analysis System (PSAS). Two different cyclic processes using Atmospheric Global Circulation Model CPTEC/COLA were carried. In the first cyclic process all available data were assimilated, such as geopotential height from temperature profiles measured by NOAA/ATOVS [Advanced TIROS Vertical Operational Sounder]; derived surface winds from Quik Scatterometer; Cloud Track Wind from geostationary satellites; conventional data (SYNOP, BUOY SHIP, radiosonde, aircraft, pilot balloons); and IWV values over ocean region from the SSMI/DMSP (Defense Meteorological Satellite Program). In the other cyclic process the same data set was assimilated with the IWV values from AIRS/AMSU. The results obtained applying factor separation show that the inclusion of IWV-AIRS values present a significant impact in the IWV values from initial conditions over Amazonian region, the which is also observed in the short-range predictions of humidity. Some studies are being carried out using rainfall data from TRMM Passive Microwave Sensor to evaluate this impact on precipitation forecast.

A28: Towards better usage of AMSU observations over land at ECMWF

Presenter: Blazej Krzeminski

Blazej Krzeminski, Niels Bormann, Fatima Karbou, Jean-Noel Thepaut, Atony McNally and Peter Bauer

Assimilation of AMSU observations over land at the ECMWF has been limited in case of channels receiving strong contribution from the surface. This is due to the difficulties in accurately estimating surface emissivity in the microwave frequencies. Currently used ECMWF land surface emissivity models and their limitations will be discussed. There is an ongoing effort to improve the emissivity estimations. Retrieving emissivities from the observations in the microwave window region showed to be a promising approach. Issues covered in the presentation also include correction of biases and the quality control of the observations over land in the context of Numerical Weather Prediction.

A29: The Relative Contributions of the Various Observing Systems in the CPTEC Global Data Assimilation/Forecast System

Presenter: Rita Valéria Andreoli

Rita Valéria Andreoli, Sérgio Henrique S. Ferreira, Luiz Fernando Sapucci, Dirceu Luis Herdies, Rodrigo Augusto Ferreira de Souza, Renata Weissmann Borges Mendonça, José Antônio Aravéquia

A series of data withholding experiments was conducted with the Global Physical-space Statistical Analysis System (GPSAS) - a combination of the Spectral Atmospheric Global Circulation Model (CPTEC/COLA) with the Physical-space Statistical Analysis System (PSAS) -, with the purpose of assessing the relative contributions of the several types of observation within the context of the CPTEC data assimilation system. In these experiments one or more type of observation is removed from the assimilation cycle and the impact on the forecast skill indicates the effectiveness of that source of observation in the system. The major observing system included the conventional data (SYNOP, BUOY, SHIP, radiosonde, aircraft, pilot balloons), and satellite data (ATOVS and AIRS/AMSU retrievals, QuikScat wind, Cloud Track Wind and Total Precipitation Water from SSM-I sensor). The experiment including all these data is called control experiment and it is used as reference. The experiments involving “data denied” indicated that conventional data including all surface observations (SYNOP, SHIP, BUOY), rawinsonde and aircraft data, are the primary source of information utilized by GPSAS in the Northern Hemisphere. The largest impact in the Southern Hemisphere (SH) was obtained when all satellite-derived retrieval data were removed. Additional experiments were performed to assess the impact of removing ATOVS and AIRS/AMSU retrievals data individually. The results showed that withholding the AIRS/AMSU retrievals has a greater impact than withholding the ATOVS retrievals data. This disparity may be associated to fact that the AIRS/AMSU retrievals are reported in assimilation cycle as it independent observation of the model, while ATOVS retrievals were anchored in the first guess field generated by model. Over the South America, AIRS/AMSU retrievals and conventional data present similar contribution and have a positive impact on all range forecast (1-5 days). Besides it is found that all the types of observations generally contribute in a positive way to the overall improvement of the CPTEC forecast system. However, is important to note that the impact of several observations varies depending on the chosen verifying variable, vertical level or forecast period.

A30: Assimilation of cloudy AIRS observations in the French global atmospheric model ARPEGE

Presenter: T Pangaud

T. Pangaud, N. Fourrié, V. Guidard, F. Rabier

Infrared and microwave clear-sky observations from polar orbiting satellites are assimilated in the French numerical weather prediction (NWP) model ARPEGE through a 4 dimensional variational (4D-Var) assimilation scheme. They represent an important source of information. Since the end of 2006, a few stratospheric channels of the Atmospheric InfraRed Sounder (AIRS) are assimilated in ARPEGE. Moreover, a large majority of measurements from such advanced infrared sounders are affected by clouds, and cloud contaminated observations are currently rejected by the data assimilation system. As it is now well known that the sensitive regions, where cyclogeneses occur, are often cloudy, this motivates our research efforts to assimilate AIRS cloudy radiances inside the 4D-Var assimilation scheme. The observation operator which simulates the radiances from model fields include a radiative transfer model, RTTOV in the case of ARPEGE. Since clouds can affect the

infrared observations, a cloud detection is necessary before data are assimilated. Several cloud detection schemes have been used over sea: a cloud detection scheme based on channel ranking, called Cloud-Detect, from the ECMWF; a CO2-slicing method and a cloud detection based on the simulation of the sea surface temperature. Previous studies have shown that the two first cloud detection schemes are the most accurate ones. This paper focuses on the validation of both schemes applied to AIRS, by using independent data coming from the MODIS imager and from the POLDER radiometer. The validation of the cloud top pressure will also be discussed. Two approaches may be tested for the assimilation of cloudy AIRS radiances : the first one uses the cloud top pressure and the cloud cover derived from the CO2-slicing technique (CO2-slicing outputs are directly used by RTTOV to simulate the cloud-affected spectrum). In the second one, CO2-slicing outputs are adjusted by a prior 1D-VAR before being used by RTTOV. Preliminary experiments have been done which consisted in assimilating AIRS radiances, including those contaminated by clouds between 600 and 950 hPa, only over sea for 54 stratospheric and tropospheric peaking channels. A slightly positive impact in temperature and in geopotential is found for the first method. The impact of the cloudy assimilation on cloud fields in ARPEGE will also be studied in this paper.

A31: Data assimilation and use of EOS data in land surface model

Presenter: Lu Qifeng

Lu Qifeng, Yang Zhongdong, Tang Shihao, Zhang Peng, Lu Naimeng

For the land products retrieved from the remotely sensed datasets better using in the land surface model and weather/climate model, Land Data Assimilation Systems (LDAS) based on EnKF Technology and Community Land Model, has been developed at NSMC/CMA. In the context of numerical weather prediction applications, LDAS can provide optimal estimates of land surface state initial conditions by integrating with an ensemble of land surface models, the available atmospheric forcing data, remotely sensed observations of precipitation, radiation and some land surface parameters such as land cover and leaf area index. The validation from Yucheng comprehensive experiment site indicates that the preliminary results obtained are still inspiring. There are still many detailed work to do for the routine operation of LDAS, such as how to get dynamic P in 3dvar, how to select the spacing interpolation algorithm, etc.

A32: The GMAO 4d-Var System

Presenter: Ricardo Todling

Ricardo Todling and Yannick Tremolet

The fifth generation of the Goddard Earth Observing System (GEOS-5) Data Assimilation System (DAS) is a 3d-var system that uses the Grid-point Statistical Interpolation (GSI) system developed in collaboration with NCEP, and a general circulation model developed at Goddard, that includes the finite-volume hydrodynamics of GEOS-4 wrapped in the Earth System Modeling Framework and physical packages tuned to provide a reliable hydrological cycle for the integration of the Modern Era Retrospective-analysis for Research and Applications (MERRA). This MERRA system is essentially complete and the next generation GEOS is under intense development. A prototype next generation system is now complete and has been producing preliminary results. This prototype system replaces the GSI-based Incremental Analysis Update procedure with a GSI-based 4d-var which uses the adjoint of the finite-volume hydrodynamics of GEOS-4 together with a vertical diffusing scheme for simplified physics. As part of this development we have kept the GEOS-5 IAU procedure as an option and have added the capability to experiment with a First Guess at the Appropriate Time (FGAT) procedure, thus allowing for at least three modes of running the data assimilation experiments. The prototype system is a large extension of GEOS-5 as it also includes various adjoint-based tools, namely, a forecast sensitivity tool, a singular vector tool, and an observation impact tool, that combines the model sensitivity tool with a GSI-based adjoint tool. These features bring the global data assimilation effort at Goddard up to date with technologies used in data assimilation systems at major meteorological centers elsewhere. Various aspects of the next generation GEOS will be discussed during the presentation at the Workshop, and preliminary results will illustrate the discussion.

A33: Implementing Radiance Assimilation in NAVDAS-AR: Lessons Learned

Presenter: Nancy Baker

Nancy Baker, Ben Ruston and Tim Hogan and Tom Rosmond

NAVDAS – the NRL Atmospheric Variational Data Assimilation System – is an observation space 3dvar system and provides the initial conditions for the U.S. Navy's global NWP model (NOGAPS) and mesoscale model (COAMPS®). NAVDAS was designed to be the precursor for the 4dvar assimilation system NAVDAS-AR (Accelerated Representer). Because NAVDAS was designed to accommodate variable grid dimensions and map projections, the observation pre-processing is separate from the 3D-Var solution, which in turn is separate from the final mapping of correction vector into model space. The observations types are pre-processed independently, then combined into single file containing the observation and ancillary information needed for the 3D-Var solution. For satellite radiances, the pre-processor routine includes the quality control, observation selection and thinning, bias correction, radiance monitoring and Jacobian calculation using a fast radiative transfer model. One advantage to this approach is that it easily allows radiance observations to be passively monitored, rather than assimilated, by the operational assimilation/forecast model without appreciably affecting the total run time of the system. For example, with NOAA-18 AMSUA-A, we were able to move from passive monitoring to active assimilation within three weeks of the data becoming operationally available (and without operational code changes). While this approach provides flexibility for the development of new observation pre-processors, it has contributed to unexpected difficulties during the implementation of radiance assimilation with NAVDAS-AR. The initial NAVDAS-AR implementation followed the operational NAVDAS configuration. The NOGAPS fields are output on 30 fixed pressure levels at 0.5o resolution, and the 3-, 6-, 9-hour forecast fields from the previous update cycle are interpolated in space and time to the observation location. Within NAVDAS-AR, the observations are binned within 30 minute windows, and the background values are interpolated from the model Gaussian grid/sigma level fields. Differences between background fields used in the observation pre-processors and the NOGAPS trajectory lead to systematic differences in the computed brightness temperatures, inconsistencies with bias corrections and degraded forecast skill. We will present our diagnostic results and solutions, which have involved a re-examination of the role of observation pre-processors for data monitoring and selection, quality control, and bias correction. We have also encountered various difficulties upgrading our radiative transfer model from RTTOV-6, and results from assimilation tests using the JCSDA Community Radiative Transfer Model and RTTOV-8.7 will be presented. Finally, the differences in observation impact (computed using adjoint methods) between NAVDAS and NAVDAS-AR will be presented and discussed.

A34: Environmental Forecasting at NIWA: A Progress Report

Presenter: Michael Uddstrom

Michael Uddstrom, Hilary Oliver, Stuart Moore, Stuart Webster, Phil Andrews, Vanessa Sherlock, Trevor Carey Smith, Richard Turner, Mike Revell, Ed Yang and Martyn Clark

The New Zealand Limited Area Model (NZLAM) is an operational implementation of the Met Office Unified ModelTM (i.e. OPS, VAR (FGAT7), UM, SCS) on a 12 km resolution domain using a 6 hour assimilation cycle. NZLAM predictions are also being used to forecast weather impacts, including river flood. In the context of New Zealand's complex and steep topography and short rise time catchments, flood forecast accuracy is very sensitive to timing and magnitude errors in quantitative precipitation forecasts (QPF), which in turn are sensitive to the accuracy of the analysis and (NWP) model resolution. The poster outlines the operational NWP system, information delivery system and indicative verification statistics, and reports on data assimilation and model resolution experiments carried out to better understand forecast accuracy constraints.

SESSION B

B01: Fostering a new generation of Remote Sensing Scientists

Presenter: Paolo Antonelli

Paolo Antonelli, Steve Ackerman, Leanne Avila, Steve Dutcher, Liam Gumley, Allen Huang, Jean Phillips, Hank Revercomb, Tom Rink, Kathy Strabala, Bill Smith, and Paul Menzel

At the ITSC-XV we indicated that in addition to focusing on the design and development of future instruments and the associated data processing algorithms, SSEC also pursues educational goals by spreading environmental awareness and emphasizing the relevance of satellite remote sensing of the Earth in a wide variety of activities. Following the example of the distribution of the TOVS processing package and the personal efforts of SSEC and CIMSS leading scientists in the eighties, some of SSEC's recent training efforts have reached out to an international audience interested in theoretical and operational aspects of remote sensing. In the last two years SSEC and CIMSS have continued teaching weeklong remote sensing seminars that provide a broad fundamental perspective to young researchers as well as to graduate students around the World. Lectures are supplemented with laboratory exercises that emphasize investigation of high spatial resolution (MODIS) and high spectral resolution (AIRS, IASI) data; more recently high temporal resolution data (SEVIRI, GOES) have also been added. During 2006 and 2007, SSEC and CIMSS scientists, in collaboration with EUMETSAT and NOAA, have attempted to bring greater understanding of remote sensing technology to the international community, and to African and South American scientists in particular with the unchanged goal of helping in fostering a new generation of environmental scientists.

B02: Processing Package and Remote Sensing Training Workshops for International Direct Broadcast Users

Presenter: Allen Huang

Allen Huang, Liam Gumley, Kathy Strabala, and Tom Rink

Since 2004 SSEC/CIMSS has conducted international direct broadcast (DB) training workshops centered around the DB receiving countries/sites. So far six (6) DB workshops have been conducted at Perth/Australia, Nanjing/China, Beijing/China, Chung-Li/Taiwan, Andoya/Norway and Pretoria/South Africa. One additional workshop under the GEOSS initiative was conducted at Cachoeira Paulista/Brazil. These workshops focus on the complete end-to-end processing of the data into geophysical products. Basic remote sensing principals, algorithm theory, and limitations and applications of the products are taught in lectures followed by hands-on computer laboratory exercises. The user friendly visualization software tool HYDRA is freely distributed for students in the class room and allows examination of data and products at the pixel level for the purpose of manipulating and interrogating DB measurements, imagery, and products. SSEC/CIMSS is devoted to continue this kind of training workshop tailored for the international DB community as part of an ongoing effort to maintain and expand the use of the International MODIS/AIRS Processing Package (IMAPP), and in preparation for the development of the future International Polar Orbit Processing Package (IPOPP) for the National Polar-orbiting Operational Environmental Satellite System (NPOESS).

B03: Report on the first International IASI Conference

Presenter: Thierry Phulpin

Thierry Phulpin (CNES), Dieter Klaes (EUMETSAT) and Peter Schlüssel (EUMETSAT)

The First international IASI conference, organized by CNES and Eumetsat, took place in Anglet (France) from 13 to 16 November 2007, only one year after the successful launch of the IASI instrument on the MetOp-A platform. It is a credit to CNES and Eumetsat and to the manufacturers of IASI that so soon after launch users are already making significant use of IASI data and were able to

present exciting first results. The main topics of the conference were: the performance of IASI, the impact of IASI on NWP, the clouds and surface parameters, climate and atmospheric chemistry. The performance of IASI was assessed by the IASI Technical Center in CNES and validated against NWP model output and airborne and balloon coincidence flights. The results showed that the radiometric performance of IASI is better than 0.5K, likely between (0 and 0.2 K). ECMWF was the first to assimilate IASI data and showed already a significant impact of IASI on NWP – the largest single impact of any instrument despite coming on top of existing systems. The high spectral resolution of IASI is already showing benefits with several users describing techniques to use this information to retrieve surface and cloud properties – paving the way for even greater use of IASI data in NWP. Other sessions during the conference concentrated on retrieval of cloud and aerosol properties and on the growing number of trace gases that can be detected in IASI data. This highlights another critical role of IASI in the monitoring of the Earth's climate over a long time period. The IASI Sounding Science Working Group is called to maintain a coordination on the development of IASI products and will assist CNES and Eumetsat to organize the 2nd conference in 2009.

B04: Synergy between IASI sounding and AVHRR imagery for the processing of IASI data in non-uniform scenes

Presenter: T. Phulpin

P. Prunet, S. Bijac, J. Donnadille , D. Coppens , B. Tournier, O. Lezeaux , P. Prunet, S. Bijac, J. Donnadille , D. Coppens , B. Tournier, O. Lezeaux

A processing chain for the infrared sounding measurements above heterogeneous scenes was developed for IASI. It makes use of the information provided by a co-registered imager for characterizing the sounder sub-pixel information in terms of homogeneous radiative surfaces, and for extracting the sounder spectrum component associated with each homogeneous surface. Such a processing is required for any exploitation of non-homogeneous pixel measurements. This processing is applied for validation on a representative set of measured IASI spectra. The first results on partially cloudy scenes indicate that the global percentage of IASI measurements exploitable for atmospheric parameter retrieval and NWP assimilation should be increased by a factor of 3. This preliminary validation also suggests that improved geophysical products (e.g., low troposphere constituent concentration, surface properties classification) could be derived from this processing.

B05: Validation of IASI spectral radiances using aircraft underflight data collected during JAIVEx

Presenter: David Tobin

David Tobin, Hank Revercomb, Fred Best, Joe Taylor, Steve Dutcher, Bob Knuteson, William Smith

Direct airborne validation of radiances from the new IASI interferometer sounder on Metop was successfully performed during the Joint Airborne IASI Validation Experiment (JAIVEx) conducted 14 April - 4 May 2007. The experiment included the NASA WB57 aircraft carrying the UW Scanning HIS, the LaRC NAST-I, and the MIT/LL NAST-Microwave, flown in coordination with the Facility for Airborne Atmospheric Measurements BAe146-301 carrying the ARIES interferometer plus a wide range of in situ instrumentation and dropsondes. This presentation focuses on validation of IASI spectral radiances using the high altitude aircraft observations and a double observed minus calculated analysis technique. Results for various JAIVEx flights will be presented.

B06: Principle component analysis of IASI spectra with a focus on non-uniform scene effects on the ILS

Presenter: David Tobin

David Tobin, Hank Revercomb, Paolo Antonelli

Exploiting the inherent redundancy in hyperspectral observations, Principle Component Analysis (PCA) is a simple yet very powerful tool not only for noise filtering and lossy compression, but also for the characterization of sensor noise and other variable artifacts using Earth scene data. This presentation will include a description of our approach for dependent set PCA of IASI radiance spectra, characterization of the IASI sensor noise using PCA, and the characterization and removal of spectral artifacts due to scene inhomogeneity.

B07: Evaluation of IASI and AIRS spectral radiances using Simultaneous Nadir Overpasses

Presenter: David Tobin

David Tobin, Hank Revercomb, Fred Nagle, Robert Holz

We present direct comparisons of high spectral resolution radiance observations from today's two advanced infrared sounders. Observations collected by the Atmospheric Infrared Sounder on the NASA Aqua platform and by the Infrared Atmospheric Sounding Interferometer on the METOP-A platform for Simultaneous Nadir Overpasses (SNOs) are intercompared and, with knowledge of the different characteristics of each sensor, are evaluated to assess the spectral and radiometric accuracy of each set of observations. Preliminary results show no significant trend in the results versus time and mean channel by channel differences typically less than 0.2K.

B08: The use of principal component analysis in monitoring IASI radiances and diagnosing climate anomaly

Presenter: Zhaohui Cheng

Zhaohui Cheng, Lihang Zhou, Thomas King, Walter Wolf, Mitch Goldberg, Chris Barnet and Haibing Sun

Principal component analysis (PCA) is a useful technique in analyzing high spectral infrared radiance data (such as AIRS, IASI) due to the high correlation among the different spectral channels. IASI 8461 channels can be well represented by relatively few empirical orthogonal functions (EOFs), also called principle components. Each IASI spectrum can be expressed as a linear function of these EOFs by a unique set of coefficients. These coefficients are also called principal component scores (PCS). Reconstructed radiances and PCS can be used to estimate instrument noise and detect anomalies by comparing reconstructed with the original spectra. NOAA/NESDIS has made the IASI level 1C data products operationally available since October, 2007. NOAA/NESDIS/STAR has used PCA to process the real IASI data for the data monitoring and quality control for a couple of months. PCS and the corresponding reconstruction scores are computed in near real time. A web site was built to monitor the global IASI observations, IASI reconstructed radiances and reconstruction score on daily basis. Large reconstruction bias can be used to identify the suspicious channels/bands and climate anomalies. Monthly monitoring of statistics of IASI radiances had also been implemented in this visualization system. Static PCS are very stable over time. However, when some special event occurs, the anomaly signature of PCS will appear in the reconstruction scores. The STAR IASI monitoring system indicated that there was a big bias of reconstruction scores over the Ionian Sea between south Italy and Greece (around 19E, 39N) on Nov. 24th, 2007. More investigations showed that there was a high SO2 area due to the eruption of a volcano. The PCS level 1C product is a critical factor in regression retrieval. The accuracy of PCS will affect the quality of the level 2 products. The case study to be presented will show the effect of a climate anomaly event like above mentioned volcano case on the reconstruction scores. We will also show that by added this event to the training dataset, that we can dramatically decrease the reconstruction errors.

B09: Operational Processing of ATOVS data at the Satellite Application Facility on Climate monitoring

Presenter: Nathalie Selbach

Nathalie Selbach and Petra Fuchs, DWD

The Satellite Application Facility on Climate Monitoring (CM-SAF) generates, archives and distributes widely recognized high-quality satellite-derived products and services relevant for climate monitoring in an operational mode. Products covering cloud, radiation and humidity parameters are derived from different operational satellite and sensor types. The International ATOVS Processing package (IAPP) is applied for the retrieval of humidity and temperature parameters. Currently, data from ATOVS onboard NOAA 15,16 and 18 are used for the generation of global environmental data records in near real time at the CM-SAF. It is intended to include data from ATOVS onboard the Metop in the operational processing. Daily and monthly products including mean value and error information are provided to the user in a 90 km x 90 km sinusoidal projection. The current status and future plans concerning the ATOVS processing routines at CM-SAF will be presented from the operational point of view.

B10: Validation of level1b/1c LEO instruments in synergy with LEO/GEO companion instruments or in stand alone mode: Application to AIRS/Aqua, IIR/Calipso, IASI/Metop.

Presenter: R. Armante

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

High spectral resolution instruments as AIRS/Aqua or IASI and companion instruments on board Metop or other instruments of the A-Train (IIR/Calipso) etc. support the scientific community data requirements for weather forecasting and climate research. Such researches require quality data, well controlled (identification of systematic biases or spurious trends or variability). As an heritage of similar process for long term satellite data analysis (TOVS data of the NOAA/NASA Pathfinder programme, a five year-period of AIRS/Aqua data or, more recently IIR /Calipso) LMD is developing control of IASI channels primarily relevant to its own retrievals of level2 products: GHG (CO2, CO, CH4, …), clouds, aerosols and surface characteristics. This is obtained through the coupling of a validated and stable forward model (the LMD 4A model) with collocated ancillary or auxiliary data or instruments (LEO or GEO, radiosondes, analyses). The detection of bias, trends etc. from cloud free day/night land/sea spectra is performed globally or over selected areas. Validation approach – including the validation of the forward model itself - and results will be discussed. Relevance of such an approach to the GSICS (Global Space-Based Inter-Calibration System) mission and goals will also be discussed.

B11: Cloud properties from AIRS and evaluation with Calipso

Presenter: R. Armante

C. J. Stubenrauch, S. Cros, N. Lamquin, R. Armante, A. Chédin C. Crevoisier, and N. A. Scott

Since May 2002 the Atmospheric Infrared Sounder (AIRS), in combination with the Advanced Microwave Sounder Unit (AMSU), onboard the NASA Aqua satellite provides measurements at very high spectral resolution of radiation emitted and scattered from the atmosphere and surface. The instrument was developed to provide atmospheric temperature and water vapour profiles at a vertical resolution of about 1 km and 2 km, respectively, but the high spectral resolution of this instrument also allows the retrieval of cloud properties (especially cirrus), aerosol and surface properties as well as the quantity of trace gases. We present a cloud property retrieval scheme, which is based on a weighted 2 method using channels around the 15 micron CO2 absorption band, to determine effective cloud emissivity and cloud pressure. The influence of channel choice, cloud detection, spatial resolution and of assumed atmospheric profiles on the retrieval are discussed. The retrieval scheme is applied to all spots, without distinction between cloudy or clear sky spots. Cloud detection plays an important role in the cloud property retrieval: the tighter the cloud detection the larger the average cloud pressure and low cloud amount, because partly cloudy spots are identified as low clouds. To be independent on cloud detection thresholds which vary regionally and seasonally, a posteriori cloud detection is developed by comparing cloud pressure differences between AIRS and collocated L2 data from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) onboard

CALIPSO, both instruments part of the A-Train, for January and July 2007. This cloud detection is based on the coherence of cloud emissivity at different wavelengths and on brightness temperature heterogeneity. At the same time, CALIOP is used to evaluate the AIRS cloud altitude. Results are also compared to cloud properties from AIRS L2 products (version 5) and from the Moderate Resolution Imaging Spectroradiometer (MODIS) of the same time period, as well as to the cloud climatologies of the International Satellite Cloud Climatology Project (ISCCP) and TOVS (TIROS-N Operational Vertical Sounder) Path-B. The seasonal cycles of high, midlevel and low cloud amount in the tropical and subtropical regions are compared to the one of CALIPSO, using one year of data (August 2006 to July 2007) to results of cloud climatologies.

B12: A quantitative link between CO2 emissions from tropical vegetation fires and the daily tropospheric excess (DTE) of CO2 seen by NOAA-10 (1987-1991)

Presenter: Cyril Crevoisier

A. Chédin, N. A. Scott, R. Armante, C. Pierangelo, C. Crevoisier and P. Ciais

Four years of monthly mean mid-tropospheric CO2 columns over the tropics have been retrieved from evening and morning observations of NOAA-10 (1987-1991). The difference between these two columns shows a “Daily Tropospheric Excess” (DTE) up to 3 ppm over regions affected by fires. At regional scale over Africa, America, and Australia, the variations of the DTE are in good agreement with those of independently derived biomass burning CO2 emissions. In particular, a strong correlation (R2~ 0.8) is found between regional mean DTE and fire CO2 emissions values from the Global Fire Emissions Data base (GFEDv2) even though the two products span over periods ten years apart from each other. The DTE distribution over Africa is in good agreement with interannual variation of climate as indicated by temperature, precipitation and ENSO index. For instance, the southern hemisphere experiences 20% more fire activity during El Niño conditions than during La Niña conditions and the reverse for the northern hemisphere, even if the estimated one sigma uncertainty on the DTE remains close to the DTE ENSO variability. The physical mechanism linking DTE with emissions is not fully elucidated. Hot convective fire plumes injecting CO2 into the troposphere during the afternoon peak of fire activity, seen by the satellite at 1930 LT, and then being diluted by large scale atmospheric transport, before the next satellite pass at 0730 LT, could explain the tight observed relationship between DTE and fire CO2 emissions. Through the reprocessing of the 25-year archive of TOVS observations, the DTE data may prove very useful to quantitatively reconstruct fire emission patterns before the ATSR and MODIS era when better quality fire count and burned area data became available.

B13: SIFTI : a Static Infrared Fourier Transform Interferometer dedicated to ozone and CO pollution monitoring

Presenter: C. Pierangelo

C. Pierangelo, P. Hébert, C. Camy-Peyret, C. Clerbaux, P. Coheur,T. Phulpin, L. Lavanant, T. Tremas, P. Henry, A. Rosak

Measuring pollutants concentrations in the boundary layer of the atmosphere is a major challenge for air quality. Infrared sounding, providing vertically resolved profiles for several trace gases in the troposphere, is a must for pollution observation. In this framework, CNES is currently leading a phase-A study for SIFTI, a Static Infrared Fourier Transform Interferometer devoted principally to ozone and CO measurements in the thermal (TIR) and short-wave infrared (SWIR). We will first describe the high-level mission requirements, including orbital considerations like the revisit frequency or the need for cloud-free observations. Instrument specifications, like spectral band position, spectral resolution, radiometric noise, are then derived from the precision needed in CO and ozone profile retrievals. The sensitivity of the profile retrievals, given in terms of vertical sensitivity and errors, to instrument performances are studied using the optimal estimation theory. The instrument concept proposed by CNES, an interferometer with no moving part, based on scaled mirrors, is a simple and efficient solution to meet these requirements and obtain very high resolution spectra (below 0.1 cm-1) with a high signal-to-noise ratio. Spectra are measured within two thermal infrared bands (for CO and O3)

and one optional shortwave infrared band (for CO and CH4) for synergetic more accurate SWIR/TIR inversion of CO profile. Thanks to an intelligent pointing mechanism based on real-time analysis of observations from an imbedded infrared imager, the probability of clear sky is dramatically increased. An optimization of the instrument, based on an irregular but well-chosen sampling of the interferogram, opens the way to still higher quality profiles.

B14: Derivation of tropospheric carbon dioxide and methane concentrations in the boreal zone from satellite-based hyper-spectral infrared sounders data

Presenter: Alexander Uspensky

Alexander Uspensky, Alexey Rublev, Alexander Kukharsky, Sergey Romanov

The development of space-borne hyper-spectral IR sounders (AIRS/EOS-Aqua, IASI/MetOp) opens new opportunities for detecting the variations of atmospheric carbon dioxide (CO2) and methane (CH4) concentrations. The capabilities to retrieve atmospheric column-average CO2 mixing ratio QCO2 and similar average mixing ratio QCH4 for CH4 from satellite measurements is of significant importance in the context of global carbon cycle research, climate change studies and due to sparse network of ground-based CO2&CH4 observations This poster presents an updated status of QCO2 and QCH4 retrieval schemes based on the clear-sky AIRS and IASI data inversion algorithms. The presentation first describes the approach developed for clear-sky or cloud-cleared AIRS data inversion and retrieval of the QCO2. The sensitivity studies (using FRTM SARTA simulations) enabled to select a set of CO2-dedicated channels in both SW an LW regions with strong signal responses to CO2 concentration changes and weak signal responses to variations of interfering factors, i.e. surface temperature Ts, water vapor(QH2O(p)) and ozone (QO3(p)) profiles. To retrieve the QCO2, the original method has been proposed based on the iterative least squares physical inversion algorithm. Its important features are as follows: clear-sky or cloud-cleared AIRS spectra and AIRS-based Level 2 retrievals (Ts, QH2O(p), QO3(p)) together with AMSU-based and “AIRS-independent“ temperature (T(p)) profile retrievals are utilized as input data; a radiative tuning is applied to the AIRS data in CO2-dedicated channels to account for biases between actual and synthetic spectra; initialization of the iterative inversion algorithm is carried out through a correct choice of the QCO2 first guess; the inter-consistency check between AIRS LW-and SW-based QCO2 retrievals as well as the spatial and temporal filtering of the results are performed for the cluster of AIRS sounding points. The validation effort carried out with real AIRS data for two areas in the boreal zone of Western Siberia (Novosibirsk and Surgut regions) and for 10 months of year 2003 demonstrates that the retrieved monthly-averaged QCO2 values reproduce seasonal variations of CO2 column amounts (in a layer between ~3,5 km and about 7-8 km) with a precision about 3.0 ppmv comparing to in-situ airborne observations. We discuss also how the above methodology can be applied to IASI data inversion and provide some examples of QCO2 retrievals. The sensitivity studies (using FRTM simulations) enabled to specify the preliminary list of LW CO2dedicated channels (some channels have central wave numbers close to those for AIRS CO2channels). The adjustment of AIRS data inversion technique to IASI data requires accurate knowledge of Ts, T(p), QH2O(p), QO3(p) in sounding points. One possible option is to utilize the IASI-based Level 2 retrievals (Ts, QH2O(p), QO3(p)) together with collocated ATOVS-based T(p) retrievals; another one is to use NWP output products as ancillary information. Now both options are under consideration. Along with this we study the way how to suppress the effect of T(p) uncertainties on the signal variations in the CO2-dedicated channels (time and space averaging, building of super- channel). With respect to the QCH4 retrieval from AIRS and IASI data the approach is being developed based upon the application of iterative physical inversion algorithm to clear-sky AIRS or IASI data in 3 CH4 – dedicated super- channels. The measurements in super-channels, that are generated as linear combinations of data in T- and CH4-dedicated channels with wave numbers 706.5&1332.5, 715.25&1341.75, and 714.0&1346.75 cm-1 respectively, have reduced sensitivity to T(p) uncertainties. It should reduce the effect of inaccurate profile T(p) knowledge in sounding points on accuracy of QCH4 retrievals. The performance of the retrieval algorithm is evaluated in the case study experiment on the base of dataset of quasi-synchronous and collocated IASI and AIRS data complemented with AIRS-based L2 retrievals . The first experimental retrievals of QCH4 from AIRS and IASI data are consistent to each other, that seems promising.

B15: Total ozone depletion due to tropical cyclones over Indian Ocean

Presenter: Devendra Singh

Devendra Singh and Sanjiv Nair

We have analyzed the perturbations in the total ozone due to four severe Tropical Cyclones formed over Arabian Sea and Bay of Bengal. Total Ozone data derived from Total Ozone Mapping Spectrometer instrument aboard Earth Probe satellite was used for this study. The daily total ozone anomalies have been calculated for the life span of each tropical cyclone. Theses anomalies were observed local in character and moved with the tropical cyclone. Further, these anomalies have been found related to the intensification of the cyclonic system. In general, negative anomalies were observed to be more than 20 Dobson units at the time of maximum intensity of cyclones. The variations in daily total ozone anomalies, from development to intensification stage and then to decaying stage of each cyclone have brought out clearly the impact of tropical cyclone on the total ozone, which got depleted, considerably over the affected region.

B16: From TOVS to ATOVS based ozone monitoring – implication for the quality and homogeneity

Presenter: B.Lapeta

B.Lapeta, Z.Ustrnul

The satellite monitoring of the total ozone content over Poland has been performed with the use of NOAA/TOVS data since 1993. The total ozone time series has been evaluated and homogenised using ground measurements. Meanwhile, the new generation of NOAA satellite with ATOVS instrument were launched implying the changes both, in type of data and software applied for ozone retrievals. Therefore, the quality of the total ozone amount derived from TOVS and ATOVS data for the period with simultaneous measurements, July 2005 – May 2007, was studied and the results will be presented in the paper. The analysis was performed for monthly mean values using the ground total ozone measurements from Belsk (21E; 51N). Furthermore, effect of the transition from TOVS to ATOVS data on the total ozone series homogeneity will be discussed.

B17: Preliminary Comparisons Between the CO Retrievals from AIRS and the CO CATT-BRAMS Model Estimations over the Amazon Region During the 2002 Dry-to-wet Season

Presenter: Rodrigo Augusto Ferreira de Souza

Rodrigo Augusto Ferreira de Souza, Jurandir Ventura Rodrigues, Karla M. Longo, Saulo R. Freitas, Plínio C. Alvalá, Rudinei M. de Oliveira

The high concentration of aerosol particles and trace gases observed in the Amazon and Central Brazilian atmosphere during the dry season is associated with intense anthropogenic biomass burning activity. The biomass burning emissions have a strong impact on the tropospheric and stratospheric chemical composition and are an important agent of weather and climate change. Therefore, the estimation of the amounts inject into the atmosphere at regional as well as global scales is needed. During the past decade, trace gas abundance in the troposphere were obtained from sparsely distributed measurement sites, and observations were mostly confined to the surface. The advent of downward looking instruments to probe the troposphere from polar-orbiting satellites has increased our ability to access the impact of human activities on the chemical composition of the atmosphere and on the climate changes. In this work the CO retrievals from AIRS/AQUA are compared with estimations of CO using the Coupled Aerosol and Tracer Transport model to the Brazilian developments on the Regional Atmospheric Modeling System (CATT-BRAMS) for the dry-to-wet transition season of 2002 over the Amazon region. In general, the results showed a relatively good agreement between both estimates, particularly in the mid-troposphere.

B18: Multi-satellite observation on upwelling after the passage of typhoon Hai-Tang in the southern East China Sea

Presenter: Kung Hwa Wang

Yi Chang, Ming-An Lee, Kung Hwa Wang

The serial remote sensing based imageries clearly revealed large scale of upwelling within large regional enhancement of chlorophyll-a (Chl-a) concentration in the southern East China Sea (ECS) after the passage of super typhoon Hai-Tang in July 2005. After the typhoon on July 22, the upwelling area (< 26°C) expanded rapidly to 9146 km2 on the shelf-break. The large increased upwelling persisted for more than a week. Ocean color images also reveled that high Chl-a concentration of >3.0 mg/m3 appeared in the shelf region, where the high Chl-a pattern matched the upwelling in terms of location and time. On the other hand, a large offshore SST cooling was also observed mainly to the right of typhoon track on July 20, it lasted in a period of 2-3 days. Utilization of AVHRR, MODIS, AMSRE and SeaWIFs, this paper provides clear and high-resolution evidence that typhoon significant increased upwelling and Chl-a concentration in the southern ECS. Key word: Remote sensing, upwelling, chlorophyll-a, southern East China Sea, typhoon Hai-Tang.

B19: Retrieval of atmospheric water vapour profile using the Megha-Tropiques

Presenter: Filipe Aires

Filipe Aires, Frédéric Bernardo, Hélène Brogniez, and Catherine Prigent

Megha-Tropiques (MT) is a French/Indian mission designed to study the energy and water cycle in the Tropics. Its launch date is expected to be March 2009. This CNES/ISRO platform possesses two microwave instruments: - a cross-track sounder, SAPHIR, for the retrieval of atmospheric water vapour (6 channels in the 183 GHz band); - and a conical scanning imager, MADRAS, designed mainly to study precipitation and cloud properties, with 9 channels (18.7, 23.8, 36.5, 89 and 157 GHz with vertical and horizontal polarizations, except for the 23.8). In this study, we combine Saphir and Madras observations for the retrieval of atmospheric water vapour over ocean and land and for clear sky. The statistical inversion scheme is developed using a synthetic data simulated with the RTTOV radiative transfer model. The atmospheric temperature profiles from the ECMWF forecast are used as auxiliary information. Furthermore, a microwave surface emissivity atlas is utilized over land to better constrain the surface contribution in surface sensitive channels. These auxiliary information are added to Madras and Saphir observations to feed a neural network retrieval scheme that estimates the atmospheric water vapour profile. The synergy of the two microwave instruments comes from the sounding abilities of Saphir added to the vertically integrated water vapour information derived from Madras. Together with the development of the retrieval scheme, an information content analysis is conducted. In particular, the vertical resolution is optimized with respect to the retrieval capability of Saphir. In parallel, we perform a sensitivity analysis with respect to the various sources of uncertainty, i.e. satellite observations or auxiliary information. The evaluation of the retrieval algorithm is performed using AMSR-E and HSB observations that have roughly the same viewing geometry than Saphir and Madras (cross-track for HSB; conical for AMSR-E) and provide similar observations of the atmosphere. Radiosonde measurements are also utilized.

B20: The Use of HSB to Derive the Integrated Water Vapor Content: An Example Using the RACCI/LBA Experiment

Presenter: Luiz Augusto Toledo Machado

Wagner Flauber Araújo Lima and Luiz Augusto Toledo Machado

This work presents the capability of the HSB (Humidity Sensor Brazil) channel in retrieving Integrated Water Vapor Content. The data analyses of this study have been carried out in two stages: firstly using simulations of the HSB channel brightness temperatures from RTTOV radiative model, and secondly, using data from the “RACCI/LBA” (Radiation, Cloud, and Climate Interactions/Large Scale

Biosphere Atmospheric Experiment in Amazônia) experiment in Rondônia, during the period of September and October 2002. The results show the potential of the 183 ± 1, 3 e 7 GHz channels in retrieving middle and upper tropospheric water vapor for clear sky situations. The estimation of integrated water vapor contents in the atmosphere using HSB channels was not possible due to the absence of troposphere low level information, where most of the water vapor is concentrated. The 150 GHz channel, which has the maximum peak of its weight function next to the surface, is strongly influenced by the surface emissivity.

B21: High-Resolution Passive Millimeter-wave Measurements from Aircraft: Validation of Satellite Observations and Radiative Transfer Modeling

Presenter: William J. Blackwell

R. Vincent Leslie, Laura J. Bickmeier, William J. Blackwell, and Laura G. Jairam

The NPOESS Aircraft Sounder Testbed-Microwave (NAST-M) passive microwave spectrometer suite was used to help validate the radiometers (AMSU and MHS) on the MetOp-2/A satellite. Underflights of MetOp-2/A were made by the WB-57 high-altitude research aircraft during the Joint Airborne IASI Validation Experiment (JAIVEx – Apr. 2007). Microwave data from other satellites (Aqua, NOAA-16, and NOAA-17) will also be presented. Also, NAST-M data is used to validate the parameter tuning in a scattering Radiative Transfer Algorithm (RTA) coupled with a cloud circulation model. The NAST-M instrument suite includes a total of four spectrometers, with three operating near the oxygen lines at 50–57, 118.75, and 424.76 GHz, and a fourth spectrometer centered on the water vapor absorption line at 183.31 GHz. The NAST-M 54-GHz spectrometer has five channels corresponding to the AMSU-A instrument, and the 183-GHz spectrometer has three channels corresponding to the MHS instrument (or AMSU-B). This enables radiance-to-radiance comparisons, which can circumvent potential pitfalls and modeling errors that can be introduced when simulating spaceborne radiances. All four of NAST-M's feedhorns are co-located, and have 3-dB (full-width at half-maximum) beamwidths of 7.5°, which translates to ~2.5-km nominal pixel diameter at nadir incidence. The four feedhorns are directed at a single mirror that scans cross-track beneath the aircraft, spanning ± 65 degrees. The NAST-M sensor is mounted on an aircraft platform with a typical cruising altitude of 17-20 km, which results in a nominal swath width of 100 km. The high-altitude platform enables high spatial and temporal coincidence with satellite measurements, and NAST-M's 100-km swath width provides complete coverage of both AMSU and MHS nadir footprints. The paper will detail the essential techniques used to correct for the difference in altitude and view angle between the satellite and aircraft sensors along with procedure for co-locating NAST-M measurements with satellite measurements. The radiance-to-radiance comparisons will be evaluated against a purely simulated validation technique. The RTA parameter tuning utilizes the MM5 regional-scale circulation model to generate atmospheric thermodynamic quantities (for example, humidity and hydrometeor profiles). These data are then input into the Rosenkranz multiple-stream initial-value RTA [Rosenkranz, 2005] to simulate at-sensor millimeter-wave radiances at a variety of viewing geometries. The simulated radiances are filtered and resampled to match the sensor resolution and orientation. While the parameters chosen in the circulation model are important, the focus of the current work is the parameter selection in the RTA, and we aim to extend the work of Surussavadee and Staelin to higher spatial resolutions (from 15 km to 2 km) and frequencies (from 183 GHz to 425 GHz). The RTA parameters are optimized by co-locating the model data with observations from the NAST-M instrument and choosing the parameters for which the RMS deviation between the simulated and actual brightness temperatures is minimized. The optimization is performed numerically with parameter sweeps using the MIT Lincoln Laboratory LLGrid High Performance Computing Facility, which consists of approximately 1000 Xeon processors. Over a dozen storms consisting of over 5,000 precipitation-impacted pixels have been studied. Comparisons of the observed versus calculated brightness temperatures will be presented. This work was sponsored by the National Oceanic and Atmospheric Administration under Air Force contract FA8721-05-C-0002. Opinions, interpretations, conclusions, and recommendations are those of the authors and not necessarily endorsed by the United States Government.

B22: Synergetic Operational Earth observations with Metop-A instruments

Presenter: Dieter Klaes

Dieter Klaes

Metop satellites are the European contribution to the space-based global observing system and to the joint European/US operational polar satellite system. Metop covers the mid-morning (9:30) orbit, whereas the US continues to cover the afternoon orbit with the NOAA satellites. .Metop-A provides advanced observations of temperature and humidity profiles, wind, ozone and other trace gases. The instrumentation of Metop is a judicious balance between continuity of known instruments and novel observations, notably the hyperspectral thermal infrared observations with IASI and radio occultation measurements. The Metop instruments have a great potential to provide synergetic measurements. Some of the instruments are synchronized (IASI, AMSU, MHS) or co-registered (AVHRR via the Integrated IASI Imager). IASI is expected to provide trace gas information, as is also the GOME-2 instrument. By flying different instruments on the same platform a large potential exits to combine measurements from different instruments and improve products. An example could be Ozone vertical information with GOME/IASI, the combination of IASI/GRAS (high vertical sampling at high accuracy) and others. The poster will provide an overview on the EPS/Metop system and the payload, and illustrate the synergetic potential of the instruments.

B23: Australian Bureau of Meteorology Satellite Data Exchange and Use

Presenter: Gary Weymouth

Gary Weymouth, Anthony Rea, David Griersmith, Ian Grant, Chris Tingwell, AP-RARS participants, other Bureau staff

The Australian Bureau of Meteorology has recently improved its use of locally-received ATOVS data in NWP, with significant positive impact. Additionally, the Bureau both supplies and receives Asia Pacific Regional ATOVS Retransmission Service (AP-RARS) data. This data also has shown positive impact on local and international NWP, and is produced using AAPP. The AP-RARS network has expanded, with stations added from New Zealand, Singapore, Japan (Siyowa in Antarctica), Korea and Hong Kong, in addition to stations in Australia, Japan and China. During 2008, additional AP-RARS stations are expected to include Townsville (Australia), Casey and Davis (Antarctica). Provision of AP-RARS data from Noumea and Tahiti has been announced for some future date, and data from Fiji, Honolulu, and either Guam or the Marshall Islands is under investigation. The WMO goal for ATOVS availability on the various RARS networks is 90% global coverage with less than 30 minutes latency. The Bureau is also implementing X-band reception sites in Melbourne (Crib Point, March 2008), Darwin (June 2008) and Casey (summer 2008/9). Satellite data should be received from terra, aqua, NPP, NPOESS, FY3 and possibly other satellites. One of the drivers of this program is to improve the timely availability of hyperspectral satellite data for NWP. The data is also expected to be used for oceanography and other purposes. GPS precipitable water estimates are in test production, while production and NWP use of GPS RO soundings are under investigation.

B24: Operational dissemination of IASI data using principle component compression.

Presenter: Simon Elliott

Simon Elliott, Tim Hultberg and Peter Schluessel

In response to the request of its users to revisit the dissemination strategy for IASI data, EUMETSAT plans to begin the dissemination of level 1 data (spectra) using principal component compression. The principal component scores will be calculated using a robust training set, and disseminated in near real time both globally via the GTS and via EUMETSAT's DVBS multicast system, EUMETCast. The data will be encoded in BUFR and will comprise around 180 principal component scores per spectrum. Several technical issues are currently being addressed, such as the possible prior separation of the spectra into distinct bands, the distribution of the residuals and the exact number of scores to be used.

B25: NOAA/NESDIS Updates on Operational Sounding Data Products and Services

Presenter: A.K. Sharma

A.K. Sharma

The National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Services (NOAA/NESDIS) has been a pioneer in producing and distributing atmospheric sounding data products as a part of its operation for operating a fleet of civilian, Polar Orbiting Environmental Satellites (POES) and providing users and researchers a suite of operational atmospheric and environmental data products. Sounding Data Products are being generated from the advance TIROS Operational Vertical Sounder (ATOVS), onboard NOAA polar orbiting satellites (NOAA-15, NOAA-16, NOAA-17, and NOAA-18), and Infrared Atmospheric Sounding Interferometer (IASI) onboard Meteorological Operational Satellite (MetOp-1). ATOVS consists of three instruments, Advanced Microwave Sounding Units (AMSU), AMSU-A and AMSU-B, and a High-resolution Infrared Radiation Sounders (HIRS) instrument. NOAA-18 launched in May 2005 contains the Advanced Very High Resolution Radiometer (AVHRR/3), HIRS/4, AMSU-A, and the Microwave Humidity Sounder (MHS) instruments. AMSU-B has been replaced by MHS for deriving the sounding data products on NOAA-18. HIRS/4 on NOAA-18 has not been stable and has encountered numerous problems to prevent using its data in ATOVS processing. A new data distribution technique, Data Distribution Server (DDS), has been employed at the NOAA/NESDIS Environmental Satellites Processing Center (ESPC) for distributing the soundings data. This presentation will include the discussion on the ESPC system architecture involving sounding data processing and distribution for Infrared Atmospheric Sounding Interferometer (IASI), improvements made for data quality measurements, pipeline processing and distribution via DDS, and user timeliness requirements envisioned from the next generation of satellites. There have been significant changes in the operational system due to system upgrades, algorithm updates, and value added data products and services. User requirements for data products and services for sounders like ATOVS and IASI would help us determine the products and services required from the next generation of sounders such as Cross-Track Infrared Sounder/ Advanced Technology Microwave Sounder (Cris/ATMS) as planned for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) program and the future missions of the European Organization for the Exploitation of Meteorological (EUMSAT) satellites. The operational IASI systems producing level 2 data will also be discussed.

B26: Operational Implementation of Integrated Microwave Retrieval System

Presenter: Limin Zhao

Limin Zhao, Aiwu Li and Jiang Zhao

The MIRS is a state-of-the-art retrieval system developed to support POES, MetOp, DMSP, NPP/NPOESS programs at NESDIS in generating operational temperature, water vapor, and hydrological parameters from microwave sensors. It is based on an assimilation-type scheme and capable of optimally retrieving atmospheric and surface state parameters simultaneously. It provides enhancements to the NESDIS current operational surface and precipitation products from Microwave Surface and Precipitation Products System (MSPPS), and also generates temperature and moisture profiles in all weather and over all-surface conditions. The MIRS aims to produce the operational microwave sounding, surface and precipitation products from different sensors cross several satellites, so its products are being developed and implemented into operation through a multi-years stratified phase approach. Recently, the MIRS was successfully transitioned into operation at NESDIS. Its Phase-I and –II products from POES and MetOp were declared operational, and have been made available to both real-time users and climate users through NESDIS Environment Satellite Processing Center (ESPC) Data Distribution Sever (DDS) and Comprehensive Large Array-data Stewardship System (CLASS). In this presentation, we will discuss the transition of MIRS from research to operation, its operational implementation procedures, products validation, monitoring and dissemination. Detailed information on the operational MIRS, its products and their application in supporting NESDIS precipitation operation will also be presented.

B27: Enhancements of the AIRS Eigenvector Regression Algorithm

Presenter: Lihang Zhou

Lihang Zhou, Zhaohui Cheng, Thomas King, Walter Wolf, Mitch Goldberg, Xingpin Liu Fengying Sun, Chris Barnet and Haibing Sun

The differences between observed and simulated AIRS spectra, acquired from validation campaigns, are very small (usually decimals of degree in brightness temperature); this encourages the development of a physically-based regression. The physical regression coefficients are derived by first acquiring an ensemble of truth data, simulating ensemble spectra with the latest AIRS science team rapid radiative transfer algorithm, and then generating the regression coefficients. The truth data is consist of a set of radiosonde/rocketsonde temperature and moisture profiles, collocated with forecast model fields as well as other routine observations. The training set is augmented with representative profiles of CO2 and other greenhouse gases. The physically-based algorithm is tested and validated on our global multi-years re-processing dataset. Results and comparisons with the current regression algorithm will be presented.

B28: Global Coverage of Total Precipitable Water using the Microwave Integrated Retrieval System (MIRS)

Presenter: S.-A. Boukabara

S.-A. Boukabara, K. Garrett, C. Kongoli, B. Yan, P. Pellegrino, F. Weng and R. Ferraro

This study focuses on the performances of the total precipitable water (TPW) operational product, generated using the Microwave Integrated Retrieval System (MIRS) at NOAA/NESDIS. These retrievals are made operationally available over ocean and also, experimentally, over land, coast, sea ice and snow surfaces. MIRS is a 1DVAR inversion scheme that employs the Community Radiative Transfer Model (CRTM) as the forward operator. It solves simultaneously for the surface and the atmospheric parameters in a consistent fashion. The surface is represented by its temperature and emissivity spectrum. The main difference between retrieval over land and that over ocean is confined to the shape of the spectral constraint imposed on the emissivities being retrieved. This renders the retrieval of atmospheric profiles over different surfaces, trivial. The main challenge becomes simply the determination of the appropriate constraint for each type of surface background. Although MIRS retrieves the entire temperature and moisture profiles, we will focus in this study on the assessment of the TPW retrieval over all-surfaces, namely ocean, sea-ice, land, coast and snow. Note that the TPW is not retrieved independently in MIRS, but is rather a vertical integration of the retrieved moisture profile. The assessment of the performances is done using NOAA-18 and METOP-A AMSU/MHS data. The retrievals are compared to the NCEP Global Data Assimilation System (GDAS) outputs and to a network of radiosondes, encompassing a wide variety of meteorological situations. Specific comparisons over a one-year period, to data from three Atmospheric Radiation Measurement (ARM) sites (Southern Great Plains, Northern Alaska and Tropical Western pacific) are also presented. It is found that TPW accuracy over snow and sea-ice backgrounds is higher than that over non-frozen land surfaces, consistent with expectations determined in simulation. Over ocean, the MIRS retrievals are also compared to operational products, namely the Microwave Surface and Precipitation Products System (MSPPS). Visual inspections of TPW fields seem to indicate that MIRS is consistent with meteorology, with no apparent discontinuity of moist/dry fronts at the boundaries of surface backgrounds. This adds confidence that MIRS is functioning as expected and suggests that coastal retrievals might also be accurate. In this case, the retrieved surface emissivity spectrum handles the mixed terrain within the pixels, avoiding therefore a contamination of the TPW. The statistical performances are broken down by surface type.

B29: CrIS Radiance Simulations in Preparation for Near Real-Time Data Distribution

Presenter: Haibing Sun

Haibing Sun, Kexin zhang Lihang Zhou W. Wolf T. King C. Barnet, and M. Goldberg

A simulation system is under development to support pre-launch preparations for the Cross-Track Infrared Sounder (CrIS) NOAA Unique near real-time processing and distribution system. CrIS, a Michelson interferometer infrared sounder with over 1305 channels per spectrum, will fly on the NPOESS satellite series that is dedicated to the operational meteorology and climate monitoring. It will replace the AIRS and HIRS as the next generation operational infrared remote sensor to provide improved measurements of the temperature and moisture profiles in the atmosphere. The CrIS simulation system will emulate the instrumental and orbital characteristics of the CrIS instrument on NPOESS. The utilities of this system are: (1) to provide simulated observation radiances that support NOAA Unique product (cloud clearing and trace gases) development and testing, (2) to provide a robust data distribution environment for development and testing of the CrIS data sub-setting system, and (3), most importantly, to allow for a smooth transition of the CrIS NOAA Unique Product processing system from the development environment to the operational environment. Details of the simulation system shall be presented.

B30: Serendipitous Characterization of the Microwave Sounding Unit during an Accidental Spacecraft Tumble

Presenter: Thomas J. Kleespies

Thomas J. Kleespies

In September 2006 the NOAA-14 spacecraft suffered a hydrazine thruster failure. A locked valve apparently failed, releasing to space hydrazine which had remained in the line from early orbit operations, sending the spacecraft in a tumble. Most of the instruments were in their normal scanning mode at the time. Through the extraordinary efforts of the Satellite Operations Control Center engineering staff, the spacecraft recovered from the tumble and resumed nominal station keeping. Data were collected and downloaded to the Command and Data Acquisition stations until the instruments were turned off to conserve power. The Microwave Sounding Unit is very important for climate studies in that it has collected a twenty-eight year atmospheric temperature time series. This accident presented a wonderful opportunity to collect data of the MSU viewing deep space and permitted characterization of side-lobes and asymmetries. This paper presents an analysis of such data collected from the MSU during the tumble, and compares it with that taken from a planned maneuver in August 2006.

B31: A Geostationary Microwave Sounder for NASA and NOAA

Presenter: Hartmut H. Aumann

Bjorn Lambrigtsen

At the 2007 AMS Annual Meeting the National Research Council, an arm of the National Academy of Sciences, released its just completed report on a “decadal survey” of NASA and NOAA Earth space missions that had been under way for two years. Among the 15 missions that the NRC recommended that NASA undertake was one called the “Precipitation and All-weather Temperature and Humidity” mission (PATH). A “MW array spectrometer” was identified as the presumed instrument payload for PATH. Such an instrument, called the Geostationary Synthetic Thinned Aperture Radiometer (GeoSTAR), has been developed at NASA’s Jet Propulsion Laboratory, and it is likely that it will be implemented for a space mission in the near future. First conceived in 1998 for a NASA New Millennium Program mission and subsequently developed in 2003-2006 as a proof-of-concept prototype under the NASA Instrument Incubator Program, it will fill a serious gap in our Earth remote sensing capabilities – namely the lack of a microwave atmospheric sounder in geostationary orbit. GeoSTAR is a microwave sounder with the same capabilities as have been available on low earth orbiting (LEO) satellites for nearly 10 years with the Advanced Microwave Sounding Unit (AMSU) system and soon to be succeeded by the Advanced Technology Microwave Sounder (ATMS). Providing such a capability in geostationary orbit (GEO) has long been a goal for NOAA and NASA, since the GEO vantage point offers key advantages over LEO – such as a continuous view of the

entire life cycle of storms and hurricanes. Due to the very large antenna aperture needed for a microwave sounder to provide the required spatial resolution, it has not been possible to develop such instruments for GEO. Only infrared sounders have been feasible, but they are severely hampered by clouds – which is not a problem for microwave sounders. GeoSTAR overcomes those difficulties by using a new approach to synthesize a large aperture, and the development of the GeoSTAR concept therefore makes a GEO microwave sounder possible. This was clearly viewed by the NRC as a very important breakthrough, and plans for a PATH mission are now under development. GeoSTAR will meet all key requirements of such a mission, and because of the substantial investment NASA has already made in GeoSTAR technology development, this concept is now at the necessary maturity for implementation in the next decade. NOAA is keenly interested in GeoSTAR as a potential payload on a future series of geostationary weather satellites and has closely monitored the technology development since 2003 and is considering flying a demonstration mission. An intriguing possibility is to fly GeoSTAR as a Mission Of Opportunity on one of the first two satellites in the new geostationary satellite series now being developed by NOAA, the GOES-R series. The first two satellites will have unallocated payload space available due to the cancellation of the Hyperspectral Environmental Suite (HES), and this space could be used for a GeoSTAR demonstration mission. In such a scenario NASA would build the GeoSTAR instrument and NOAA would provide platform and launch services. GeoSTAR will provide a number of measurements that are crucial for the monitoring and prediction of hurricanes and severe storms – including hemispheric 3-dimensional temperature, humidity and cloud liquid water fields, rain rates and rain totals, tropospheric wind vectors, sea surface temperature, and parameters associated with deep convection and atmospheric instability – everywhere and all the time, even in the presence of clouds. GeoSTAR, with its ability to map out the three-dimensional structure of temperature, water vapor, clouds, precipitation and convective parameters on a continual basis, will significantly enhance our ability to observe hurricanes and other severe storms and would greatly improve the GOES-R capabilities in these areas. We discuss the GeoSTAR concept and basic design, the performance of the prototype, and the most important science applications that will be possible with GeoSTAR. The work reported on here was performed at the Jet Propulsion Laboratory, California Institute of Technology under a contract with the National Aeronautics and Space Administration.

B33: A Canadian satellite mission for continuous imaging of the northern latitudes

Presenter: Louis Garand

Louis Garand, Guennadi Kroupnik, Ron Buckingham, Alexander P. Thrischenko

The Polar Communications and Weather (PCW) mission of the Canadian Space Agency has the dual goal of providing communications and weather information pertaining to latitudes 50-90 N in continuous fashion from two satellites in a highly elliptical orbit. The presentation will focus on the meteorological aspect of the mission, its uniqueness and motivation. The main payload will be an advanced radiometer providing imagery with a refresh time of the order of 15 minutes. An industrial consortium is currently evaluating the various aspects of the mission based on user requirements defined by Environment Canada and other federal departments. PCW could be realized as early as 2013, either as a standalone Canadian mission or with international partners.

B33: Examining the mid winter severe weather outbreak of 7 January 2008 using satellite data with McIDAS-V

Presenter: Thomas Achtor

Thomas Achtor, Kathleen Strabala, Jason Brunner

On 7 January 2008 a strong mid latitude cyclone swept across the midwest United States producing an outbreak of severe weather that resulted in 48 tornadoes spanning an area from southeast Wisconsin through Eastern Oklahoma. There were two tornadoes in southeast Wisconsin, an EF1 and an EF3 which damaged or destroyed 105 homes and injured 15 people. There had previously been only 1 tornado reported in Wisconsin's history in the month of January (150+ years). This poster will review this very unusual severe weather event, and apply various satellite imager and sounder

products, some which are available to forecasters in real time, to help identify key features of the event.

B34: The ITWG Web Site

Presenter: Bill Bellon

Leanne Avila, Bill Bellon, Stephen English, Allen Huang, Tom Achtor, Roger Saunders

For the past six years, the CIMSS webmaster has maintained and updated the ITWG Web site. Following an initial major redesign, the site has grown considerably. In particular, the pages devoted to the conferences have grown to accommodate more information to keep the community informed of updates, as well as to serve as a central location to host conference presentations, posters, Working Group reports, Proceedings, and even photos from participants. In addition, several more Working Groups have created pages and/or redesigned their sites, and continue to add more details about their activities and research. Working with the co-chairs, the webmaster has sought to create a more useful forum for the ITWG community via the Web site, updating the site more frequently to encourage users to continue to visit. We have continued to find ways to enhance the usefulness of the site with input from the community.

B35: Sub-mm Wave Micromachined Free-Standing Frequency Selective Surfaces

Presenter: Norman Grant

The spectral transmittance of a frequency selective surface (FSS),which consists of two free-standing arrays of short-circuited nested annular slots, is presented.
The FSS was designed to provide a minimum of 20 dB isolation between the frequency bands 316.5–325.5and 349.5–358.5 GHz when the filter operates in the TE and TM plane sat 45_ incidence.

Experimental results, which are in close agreement with the computed transmission coefficients, show that the maximumin sertion loss is 0.9 dB, and the minimum cross-polar discrimination is at least21 dB in the passbands.

The FSS yields virtually identical spectral responses in the two polarisation planes over the frequency range 315–359 GHz.