JCSDA Quarterly

No. 37, December 2011

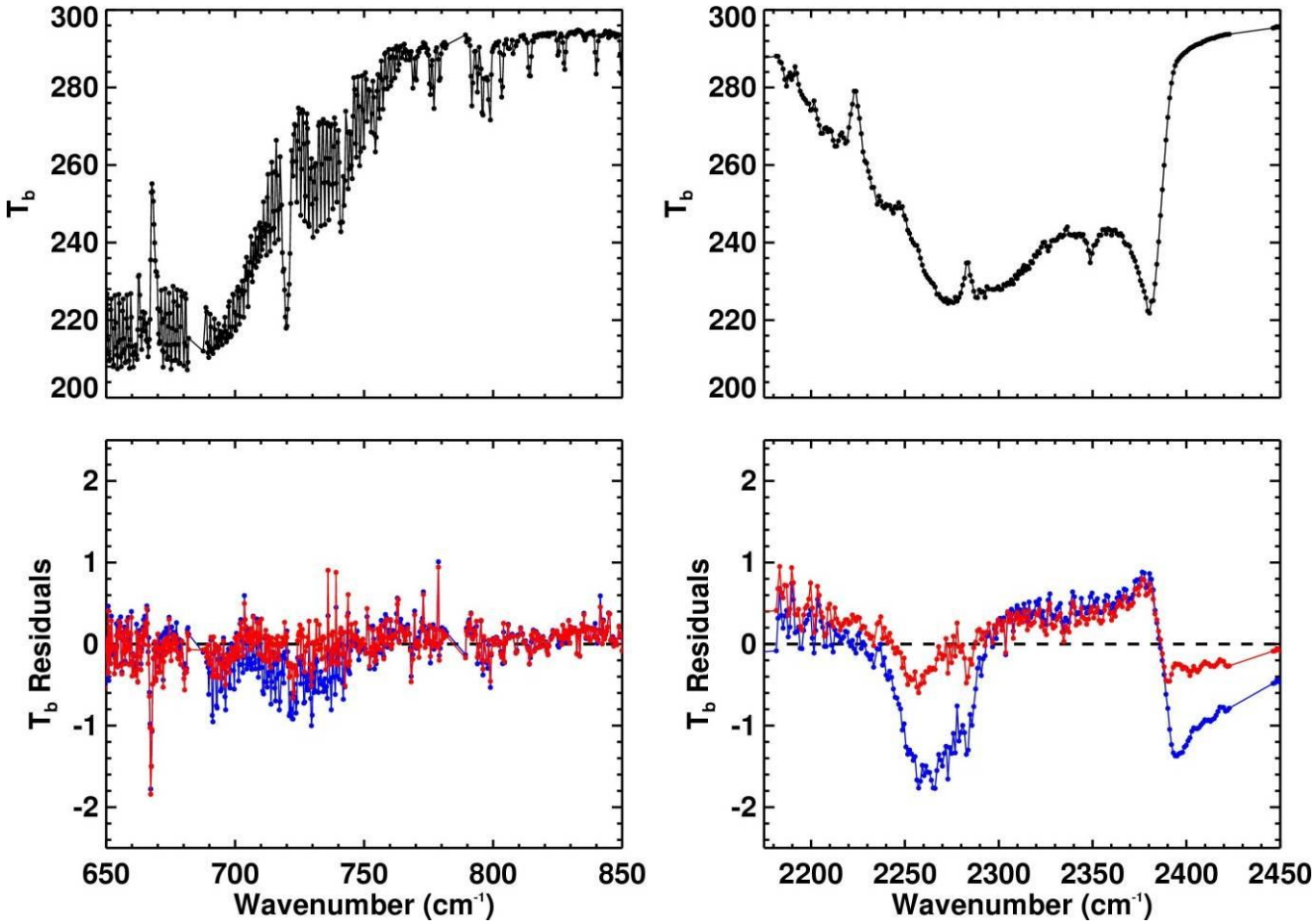
Joint Center for Satellite Data Assimilation • 5200 Auth Road • Camp Springs • MD • 20746 *Editor: George Ohring*

NOAA……NASA……US Navy……US Air Force *Web-site: www.jcsda.noaa.gov*

News in This Quarter

Science Update

Ongoing Improvements in Spectroscopy for Satellite Data Assimilation



Improvements in consistency between CO_2 spectral regions since 2006. The upper two panels show averaged AIRS measured brightness temperatures (K) in the 15 μm (650-850 cm^{-1}) and 4 μm (2200-2400 cm^{-1}) CO_2 regions for 36 cases for which temperature and humidity profiles are well known. The lower two panels show the spectral residuals (LBLRTM-AIRS) – the differences between the brightness temperatures calculated with the line-by-line model and those observed by AIRS – in 2006 (blue) and 2011 (red).

Among the factors affecting the positive impact of satellite data on numerical weather prediction is the accuracy of the fast radiative transfer (RT) models used in radiance assimilation systems. These fast models, such as the Community Radiative Transfer Model (CRTM), rely on accurate line-by-line calculations as a reference in their training. In turn, the accuracy of the reference microwave and infrared line-by-line models used by weather centers across the world is limited mainly by uncertainties in our knowledge of spectroscopic line parameters and continua. Improvements in the quality and consistency of the spectroscopic input to the models will ultimately enable more effective utilization of the wealth of potentially available information from satellite measurements. Refinements in spectroscopy for line-by-line models

therefore have important implications for the impact of satellite data on forecasts.

Since 2006, the Joint Center has been providing support for ongoing improvements to the spectroscopic input used by line-by-line models. The reference models used to train the CRTM are the Line-By-Line Radiative Transfer Model (LBLRTM) and the Monochromatic Radiative Transfer Model (MonoRTM), developed at Atmospheric and Environmental Research (AER). Significant improvements in the line-by-line models for the microwave and infrared regions have been implemented under JCSDA support (Cadeddu et al., 2007; Payne et al., 2008; Shephard et al., 2009; Payne et al., 2011; Mlawer et al., 2011). A key goal of this work is consistency of spectroscopic information across spectral regions. One example – the modeling of CO_2 absorption in the infrared – is illustrated in the accompanying figure.

The infrared CO_2 bands at 4.3 μm and 15 μm are sensitive to atmospheric temperature, and measurements from hyperspectral sounders such as AIRS, IASI and CrIS can provide detailed information on the vertical structure of the temperature field. However, uncertainties in the spectroscopic parameters have so far resulted in inconsistency between the modeling of CO_2 absorption in these two spectral regions, making it impractical to assimilate all possible temperature channels from the hyperspectral instruments.

The figure shows the improvement in consistency in the modeling of the CO_2 15 and 4.3 μm bands between 2006 and 2011. Comparisons were made between LBLRTM simulations and AIRS measurements for a number of cases for which the atmospheric and surface state were well characterized by independent measurements from radiosondes and surface instruments at a Department of Energy Atmospheric Radiation Measurement (ARM) site in the tropics. Spectroscopic improvements between 2006 and 2011 that impact these spectral regions include the implementation of improved CO_2 line coupling, updated CO_2 line positions and strengths, and improvements to the CO_2 and H_2O continua.

The latest versions of the AER line-by-line models, as well as references for the sources of spectroscopic improvements, are publicly available at http://rtweb.aer.com.
(Vivienne Payne, Matthew Alvarado, Eli Mlawer and Jean-Luc Moncet, AER)

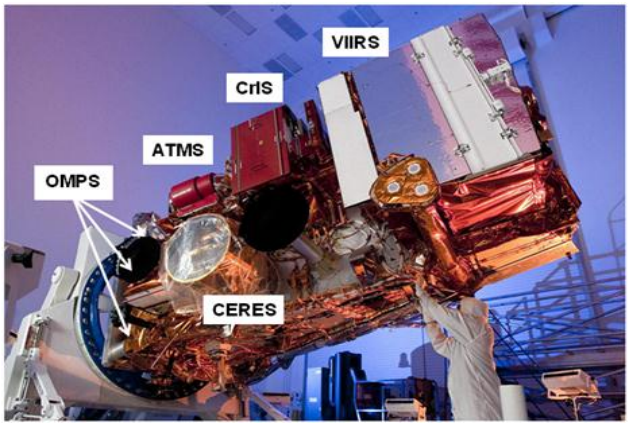
NPP Update

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) mission, the first in a series of next generation weather satellites, was successfully launched into orbit on October 28, 2011. The NASA-NOAA NPP satellite is the pathfinder for NOAA's operational Joint Polar Satellite System (JPSS), which will provide operational continuity of satellite-based

observations and products for NOAA's Polar-orbiting Operational Environmental Satellites (POES). NPP is flying in the 1330 polar orbit; EUMETSAT will provide data from the 0930 orbit (via METOP). NPP has 2 major mission objectives: 1) Provide continuation of the group of Earth system observations initiated by NASA's Earth Observing System Terra, Aqua, and Aura missions. 2) Provide the operational forecasting community with pre-operational risk reduction, demonstration, and validation for selected JPSS instruments and ground processing data systems.

NPP is now flying with the following major instruments:

- **Visible/Infrared Imager/Radiometer Suite (VIIRS)** has multi-band imaging capabilities to support the acquisition of high-resolution atmospheric imagery and generation of a variety of applied products including visible and infrared imaging of hurricanes and detection of fires, smoke, and atmospheric aerosols.
- **Cross-track Infrared Sounder (CrIS)** is the first in a series of advanced operational sounders that will provide more accurate, detailed atmospheric temperature and moisture observations for weather and climate applications. This information will help to improve climate prediction and both short-term weather "nowcasting" and longer-term forecasting.



- **Advanced Technology Microwave Sounder (ATMS)** operates in conjunction with the CrIS to profile atmospheric temperature and moisture. Higher (spatial, temporal and spectral) resolution and more accurate sounding data from CrIS and ATMS will support continuing advances in data assimilation systems and NWP models to improve short- to medium-range weather forecasts
- **Ozone Mapping and Profiler Suite (OMPS)** will measure the concentration of ozone in the atmosphere,

providing information on how ozone concentration varies with altitude. Data from OMPS will continue three decades of climate measurements of this important parameter used in global climate models. The OMPS measurements also fulfill the U.S. treaty obligation to monitor global ozone concentrations with no gaps in coverage.

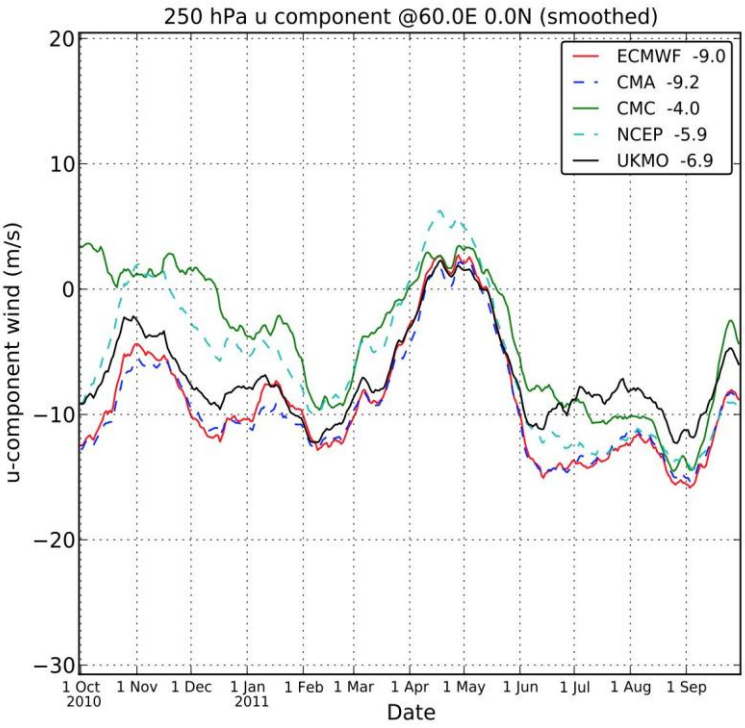
- **Cloud and Earth Radiant Energy System (CERES)** provides measurements of the space and time distribution of the Earth's Radiation Budget components. The observations from CERES are essential for monitoring and understanding climate change, in particular the role of clouds and the energy cycle in global warming, one of the largest sources of uncertainty in our modeling of the climate.

NPP instruments are now undergoing a period of intensive cal/val. The Joint Center and its partner agencies are preparing to assimilate the observations. NOAA/NCEP is working on bias characterization of the ATMS data. NOAA/STAR is monitoring several instruments. ATMS noise and bias are being assessed using Global Forecast System 6-hour guess and analysis fields. The VIIRS visible channels display some anomalies, and the solar diffuser, which is used for visible channel calibration, indicates a relatively rapid degradation of the I2 and M7 bands (0.84 to 0.88 microns). STAR is also developing a CrIS bias monitoring and noise trending online system for community access. The Center is preparing to conduct forecast impact experiments with CrIS data. The OMPS and CERES instruments await opening of their nadir doors.
(Fuzhong Weng, NOAA/STAR)

THORPEX
A World Weather Research Programme

Differences Between Global Analyses Using the Thorpex TIGGE Data Set

TIGGE, the THORPEX Interactive Grand Global Ensemble, is an archive of analyses and ensemble forecasts from the major operational centers (NCEP, ECMWF, UK Met Office (UKMO), Meteo France, Canadian Meteorological Centre (CMC), China Meteorological Agency (CMA), Korea Meteorological Agency, Japan Meteorological Agency, Bureau of Meteorology/Australia, and the Center for Weather Forecast and Climatic Studies (CPTEC) from Brazil). In a small pilot study, differences in the analyses between NCEP, the UK Met Office, ECMWF, CMA, and CMC were considered. A year of global analyses and forecasts were downloaded at 2.5 degree resolution and compared. A more complete analysis of results to date is available at
http://www.esrl.noaa.gov/psd/people/tom.hamill/analysis-errors-wgne-hamill.pdf.



Time series of the u component of the wind at 250 hPa at the location 60°E, 0°N from analyses of ECMWF, China Meteorological Administration (CMA), Canadian Meteorological Centre (CMC), NCEP, and UKMO.

The accompanying figure shows a time series of the analyses of the 250 hPa u component from the four centers, with a smoothing using +/- 15 days. This grid point is along the equator in the eastern Indian Ocean, and as shown, the various analyses disagree on the time-averaged analysis state. Early in the period, for example, CMC and NCEP have time-averaged analyses with more westerly winds than the others. The average u-component over the time period at this grid point ranges from -4.0 m/s for the CMC analysis to -9.2 m/s for the CMA analysis (see box in upper right of figure)

For many agencies, verification against analyses is a rather standard practice. The results shown here suggest that in many regions the analyses can be radically different from one another. This may render it difficult to evaluate one model forecast against another, for the analyses may differ widely from one another. The presentation linked to above provides several other illustrations of how TIGGE analyses and short-range forecasts may be used to illuminate characteristics of analyses, short-range forecasts, and ensemble initialization characteristics. These data sets may be useful to others in the data assimilation community, illustrating where the multi-agency analyses agree and where they disagree. This may be useful in determining which aspects of the assimilation/forecast system may be targeted for more intensive examination.

For more information, contact Tom Hamill (tom.hamill@noaa.gov).

(Tom Hamill, NOAA/OAR)

Some 70 scientists from major NWP and satellite centers around the world participated in the Third Workshop on Remote Sensing and Modeling of Surface Properties, in Beijing, China, October 18-20, 2011. JCSDA partner agency NOAA/Center for Satellite Applications and Research joined with Nanjing University of Information Science and Technology, the Chinese Meteorological Administration, and the French Observatory to sponsor the event.

The radiance data from NOAA operational satellite instruments are routinely ingested into NWP models. However, it remains very difficult to assimilate the lower tropospheric sounding data in regions where the surface properties are highly variable. In 2006 the International TOVS Study Conference (ITSC) formed a working group to develop theories, models and data bases of land surface properties for NWP applications. Scientists from the remote sensing and data assimilation communities participate in the group, which meets every two years. The first two workshops were held at the French Observatory and Meteo-France. After each meeting, a special issue of IEEE Transaction on Geoscience and Remote Sensing (TGRS) with papers from the workshops has been published. The new science and models that are developed are shared with the entire NWP user community.

JCSDA's community radiative transfer model (CRTM) has been widely distributed to the NWP community and is used in data assimilation systems, observing system simulation experiments (OSSE), satellite proxy data simulation, and remote sensing algorithms. The surface emissivity spectra at infrared and microwave wavelengths are simulated under a variety of surface conditions. The latest updates on CRTM microwave emissivity and infrared emissivity models over land and oceans were reported at the workshop by JCSDA scientists.
(Fuzhong Weng and Sid Boukabara, JCSDA)

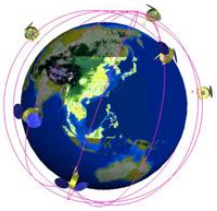
ECMWF-JCSDA Cloud/Precip Assimilation Workshop Papers Published

A number of papers from the ECMWF-JCSDA Workshop on Assimilating Satellite Observations of Clouds and Precipitation into NWP Models, held in Reading, England, June 2010, have been published as a Special Section of the October 2011 issue of the Quarterly Journal of the Royal Meteorological Society (QJRMS). The Special Section was co-edited by George Ohring, JCSDA, and Peter Bauer, ECMWF, under the overall guidance of John Thuburn, Editor, QJRMS. **To read the papers, go to Wiley Online Library.** If you don't have access, please contact your Librarian.

ISSN 0035–9009 Volume 137 Number 661 October 2011 Part B

QUARTERLY JOURNAL OF THE ROYAL METEOROLOGICAL SOCIETY

Special section: The use of cloud and precipitation observations in data assimilation (CPDA)
Guest editors: G. Ohring and P. Bauer



Cosmic Corner:

As some readers may already know, NOAA was unsuccessful in obtaining funding for COSMIC-2 – the follow-on to COSMIC – in its FY2012 budget. Additional options to finance the project are currently being explored, including support from other U.S. agencies. Updates on the status of this U.S.-Taiwan follow-up GPS RO constellation will be provided in the next JCSDA quarterly newsletter.

NOAA is examining possibilities to process GPS RO data from missions of opportunity – that is, satellite missions which are designed for other objectives but which carry GPS RO receivers – in real time for operational NWP applications. Aside from data processing systems, antenna support to down-link the data from the satellites is required. With the degradation of the COSMIC system, these missions of opportunity are critical to maintain GPS RO as part of the global observing system. But they will not provide the same quality and number of observations that a COSMIC-2 constellation would produce. Without replacement of the current COSMIC satellites, much of the positive impact of GPS RO on NWP could be lost.

On a more technical matter, with the operational implementation of the Hybrid variational-ensemble data assimilation system (Hybrid GSI) at NCEP scheduled for April 2012, the GPS RO system will assimilate bending angle profiles rather than refractivity profiles. This change in the treatment of the GPS RO observations includes major modifications to the forward operator, updated quality control, and optimized observation errors. It also extends the top of the profiles from 30 to 50 km. A technical report describing all the changes in the GPS RO algorithms is under preparation and will be available to the community in the near future. For more information, please contact Lidia Cucurull (Lidia.Cucurull@noaa.gov).
(Lidia Cucurull, JCSDA)

People

Meet Xiaoyan Zhang

Xiaoyan Zhang recently joined the JCSDA as a member of ERT, Inc. As a data assimilation scientist, she will work on preparing the NOAA NWP global data assimilation and forecast system (GDAS) for the assimilation of the NPP CrIS data into numerical weather prediction models, within the JCSDA and/or NESDIS/STAR infrastructure. Her effort will focus on testing the impact of assimilating the real data from NPP CrIS and performing data denial experiments.

Before joining JCSDA, Xiaoyan was an Associate Scientist at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, where she worked with the Data Assimilation team in the Mesoscale & Microscale Meteorology (MMM) division for seven years. Her research centered on 3D- & 4D-Variational Data Assimilation – including development and testing for the Weather Research and Forecasting (WRF) model data assimilation system – studies of satellite radiance and radar data assimilation, forecast sensitivity to the observations (FSO), and hurricane initialization.

Xiaoyan received her Bachelor of Atmospheric Science Degree from the Lanzhou University, Lanzhou, China, in July 1999. She was awarded a M.S. Degree in Meteorology in July 2002 from the Chinese Academy of Sciences, Beijing, China.

Welcome aboard, Xiaoyan.

Summer Colloquium Sponsored by the Joint Center for Satellite Data Assimilation

Santa Fe, New Mexico, USA, July 24-August 3, 2012

Program Announcement

The NASA/NOAA/Department of Defense Joint Center for Satellite Data Assimilation (JCSDA) is pleased to announce a Summer Colloquium on Data Assimilation in 2012. The Colloquium will engage graduate students and researchers with early postdoctoral appointments in the science of satellite data assimilation for the atmosphere, land, and oceans. The program will include lectures by internationally recognized experts in data assimilation and provide an extended opportunity for students to interact with the lecturers in an informal setting. The objective of the program is to foster the development of the next generation of data assimilation scientists to support environmental modeling.

Colloquium Topics

- Data assimilation fundamentals including variational and ensemble techniques
- Satellite data applications including infrared and microwave
- Overview of atmospheric, ocean, and land data assimilation
- Overview of the global observing system

- Career Opportunities – Research and Operational; Agency/Academic/Private

Eligibility

Graduate students who expect to be awarded their PhD in the physical, environmental, atmospheric, or related sciences prior to June 2013 are invited to apply, as well as individuals with no more than two years of postdoctoral experience at the time of the Colloquium. Applicants of all nationalities are eligible. However, in case the number of qualified applicants exceeds capacity, preference will be given to those who are either employed in the United States or who are actively pursuing a relevant graduate degree at a U.S. university.

Application Process

There is no application form. Qualified applicants are encouraged to apply by sending the following materials via email to the Chair of the Organizing Committee, Dr. James G. Yoe (james.g.yoe@noaa.gov) by February 29, 2012:

- Curriculum Vita
- Statement of interest (no more than one page) with a summary of the applicant's doctoral research
- Three supporting letters from faculty members

Candidates will be selected competitively based on the documentation they provide, and will be notified of the disposition of their applications by **April 18, 2012.**

Financial Support

Travel support to and from the Colloquium, lodging expenses, and per diem will be provided for the program to approximately 15 participants. Additional applicants may be invited to participate, but they will need to provide their own financial support. Priority for financial support will be given to U.S. citizens and permanent residents, and to those employed or actively pursuing a graduate degree in the United States.

Venue

The Colloquium will be held in Santa Fe, New Mexico, in the southwestern United States. Arrangements for the facility are being completed at the time of this announcement, and will be made available as soon as possible. Detailed logistical information for the Colloquium will be provided to the individuals invited to participate at the time they are notified of their selection.

A Note from the Director

Happy New Year to all our partners and collaborators!

We have now completed the initial porting efforts to jibb, the Joint Center computer at the Goddard Space Flight Center, and to its sister platform, the S4 machine operated by the University of Wisconsin for NESDIS/STAR. The ports include the CRTM, the JCSDA radiative transfer model, the GFS, the NCEP operational forecast system, as well as several WRF versions. The GFS validation experiments have been completed, and we are now in production mode on a number of JCSDA projects.

One of the major efforts on jibb right now is a comprehensive suite of data denial experiments with the NCEP GFS. These experiments will be featured at the "Fifth WMO Workshop on the Impact of Various Observing System on NWP" to be hosted by the Joint Center in Sedona, AZ, in May this year. This workshop series has become the premier venue for these types of comparative data impact studies, and we look forward to having it here in the U.S. for the first time. You can read more about the meeting on the JCSDA website.

As you will see elsewhere in this newsletter, we are also gearing up for the 2012 installation of the "JCSDA Summer Colloquium", our major training event. This year's colloquium will take place in Santa Fe, NM in late July and early August. The program builds on the experience from the very successful 2009 event in Stevenson, WA. We are once again assembling a roster of outstanding lecturers, and we look forward to providing the opportunity to learn from them and interact with them to a new generation of graduate students and post-docs with an interest in satellite data assimilation.

Unfortunately, we still have no definitive news on the FY 2012 External Research announcement. The good news is that it still looks like we will have funding available, but we are not yet done working through the challenges of executing the program.

Finally, we would like to congratulate NASA and the NPP team on a successful launch in October. We have taken a good look at the data from ATMS, and we have been pleased with what we have seen so far. We hope that any remaining issues with VIIRS will be resolved soon, so that we can resume data reception for this sensor and hopefully from CrIS soon thereafter. As many of you know, one of the goals when the Joint Center was formed was to have new satellite data

implemented in operations within a year from launch. We are now on a very aggressive schedule to try to meet this goal for NPP. This includes significant contributions from all partners as well as a major role for our new computer. Wish us luck!

Lars Peter Riishojgaard, Director, JCSDA

Outlook for Next Quarter

Upcoming Events

Seminars

JCSDA seminars are generally held on the third Wednesday of each month in Room 707 of the World Weather Building. Presentations are posted at http://www.jcsda.noaa.gov/JCSDASeminars.php prior to each seminar. Off-site personnel may view and listen to the seminars via webcast and conference call. Audio recordings of the seminars are posted at the website the day after the seminar.

Check http://www.jcsda.noaa.gov/JCSDASeminars.php for updates.

Upcoming Seminars

Date	Speaker	Affiliation	Title
Jan. 18, 2012	Kazumasa Aonashi	Japan Meteorological Agency	Ensemble-Based Variational Assimilation Method to Incorporate Microwave Imager Data into a Cloud-Resolving Model
March 21, 2012	John Derber	NOAA/NCEP	Progress and Plans for the Environmental Modeling Center's (EMC) Gridpoint Statistical Interpolation (GSI) Development
April 3, 2012	William Bell	ECMWF	The Assimilation of Microwave Imager Data at ECMWF
April 18, 2012	Peter Bauer	ECMWF	Recent and Planned Development of Data Assimilation and Modeling Systems at ECMWF

Editor's Note: Unsolicited articles for the JCSDA Quarterly Newsletter are encouraged as are suggestions for seminar speakers or topics. Please send them to George.Ohring@noaa.gov.