

News in This Quarter Science Update

Improving Tropical Cyclone Forecasts with Water Vapor and Temperature Information from Satellites

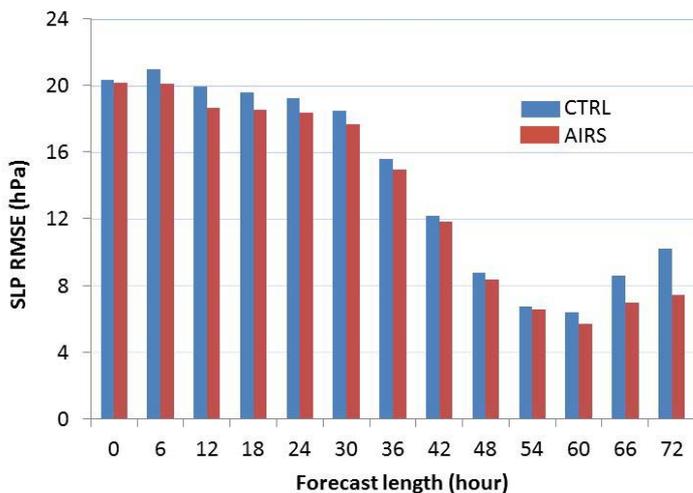


Fig 1. Hurricane Irene (2011) central sea level pressure (SLP) forecast RMSE for 0-h (analysis) and 6-h to 72-h forecasts. Every 6 hours between 06 UTC 23 and 00 UTC 25 August 2011 the data are assimilated with WRF/DART followed by a 72-hour forecast. The SLP RMSE is calculated from comparisons with the best track observations from the National Hurricane Center.

Under a grant from the JCSDA, scientists with the University of Wisconsin’s Cooperative Institute for Meteorological Satellite Studies (CIMSS) are examining the use of water vapor and temperature observations from satellites to improve path and intensity forecasts for tropical cyclones. Lack of good temperature and water vapor information appears to be a limiting factor for accurate predictions of these systems.

The high vertical resolution atmospheric temperature and moisture profiles from the Atmospheric InfraRed Sounder (AIRS) are used to initialize/analyze the development of a hurricane. The Weather Research and Forecast (WRF) model and Data Assimilation Research Testbed – DART (WRF/DART) developed by the National Center for Atmospheric Research (NCAR) are used to assimilate the

AIRS data and generate the forecasts. By assimilating these sounding measurements, the representation of environmental conditions around the hurricane is more realistic, and thus the path and intensity forecasts should be improved. The hurricane predictions are examined with and without the satellite atmospheric temperature and moisture information. We have conducted lifecycle forecast experiments for hurricane Irene (2011). The assimilation time window is 1 hour (minus/plus 30 minutes) for AIRS. Every 6 hours between 06 UTC 23 and 00 UTC 25 August 2011, the data are assimilated with WRF/DART using 32 ensemble members, and 72-hour forecasts are performed after each assimilation. Two types of forecast sequences are conducted: a control run, which assimilates data from radiosondes, satellite cloud winds, aircraft, ships, and land surface stations; and an experimental run, which assimilates the same data as the control run plus AIRS single field-of-view (SFOV) soundings in clear skies.

The root mean square errors (RMSE) of the hurricane track and intensity forecasts are calculated using verification data from the best track observations of the National Hurricane Center. The total forecast number for each lead time is 256. Hurricane Irene (2011) intensity (central sea level pressure) forecast RMSE for 0-h (analysis) and 6-h to 72-h forecasts are shown in figure 1. Since the background fields for the first analysis are from the Global Forecast System forecasts, both control and AIRS runs show relatively large errors in sea level pressure in the early stages; these errors are gradually reduced as the model progresses in time. However, the AIRS soundings consistently lead to improvement of intensity forecasts during the process. Results of additional experiments with WRF/3DVAR were consistent with those from WRF/DART.

The impact of assimilating Moderate Resolution Imaging Spectroradiometer (MODIS) and Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) total precipitable water (TPW) on tropical cyclone analyses is also investigated. MODIS has a high spatial resolution of 5 km but has limited spatial coverage in clear skies; AMSR-E has a coarse spatial resolution of 21 km but has the advantage of coverage in cloudy skies. The assimilation experiments were conducted with the WRF/DART for Typhoon Sinlaku from 8 to 13 September 2008. Results show that both IR (MODIS) and microwave (AMSR-E) TPW measurements improve the track and intensity analysis when compared with the control run which assimilates radiosondes, satellite atmospheric motion vectors, QuickSCAT winds, COSMIC GPS-RO, ship and land surface observations. Microwave TPW provides a better



analysis for intensity than IR alone, while combining IR and MW data generally provides a more positive impact on TC track and intensity analysis than that from either IR alone or MW alone (see results for intensity in fig. 2). The next generation of GOES is expected to improve tropical cyclone forecasting by providing critical high temporal and spatial TPW distributions, as well as improved satellite derived winds and cloud products.

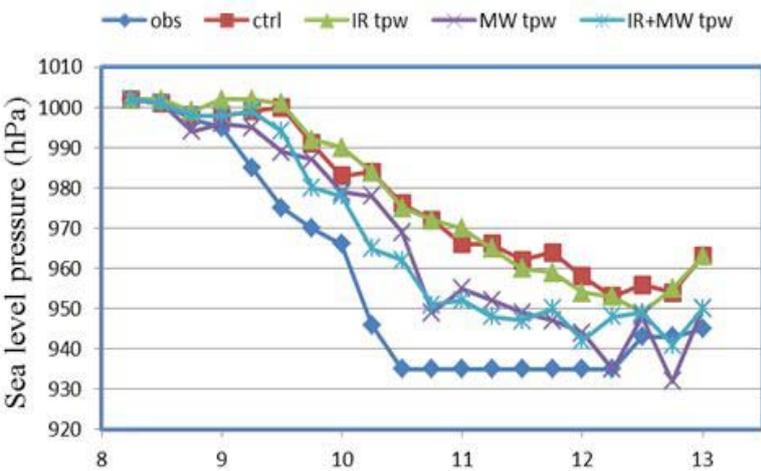


Fig 2 Typhoon Sinlaku sea level pressure analysis for September 8 - 13, 2008 from control and TPW assimilation along with the observations.

In summary, these preliminary results are encouraging and suggest a positive impact of available satellite temperature and water vapor information for forecasting hurricane tracks and intensity.

(Jun Li, Jinlong Li, and Jing Zheng, CIMSS, and Tim Schmit, STAR)

A Short Report from the 18th International TOVS Study Conference



The International TOVS Study Conference has been meeting every 18 to 24 months since 1983 to advance understanding and

effective use of passive infrared and microwave satellite sounding data, building on the heritage of the first operational satellite sounding system, TOVS. The latest and 18th meeting was held at Météo-France's excellent conference facility in Toulouse, March 21-27, 2012 and attracted nearly 170 participants from 25 countries. In addition to 50 oral presentations and 100 posters, the group also has six working groups covering NWP, radiative transfer, advanced sounders, climate, international aspects, and products/software packages. It also has technical sub-groups for the CRTM and RTTOV radiative transfer models, the Regional ATOVS Retransmission System (RARS), surface properties, and direct broadcast packages; users of these services can discuss them directly with developers.

The meeting presented an opportunity to show early results using new observations from the Suomi-NPP satellite and it is clear that both sounding instruments, ATMS and CrIS, are of excellent quality. The microwave sounder, ATMS, is already being tested in a pre-operational data assimilation environment, with both NCEP and ECMWF reporting some positive forecast impact. The CrIS instrument builds on the success of both AIRS and IASI, and the meeting presented new insights into improving use of high spectral resolution data, through both principal component analysis and more sophisticated treatment of clouds, aerosol and surface emissivity. High spectral resolution infrared observations from polar orbit now form a mature part of the global observing system and there is a strong requirement for both infrared and microwave sounders in three orbital planes. In addition to Low Earth Orbit imagery and sounding and other missions such as radio-occultation, the WMO 2025 vision for the global observing system includes geostationary high spectral resolution infrared sounding in a complete circle of the earth. Real progress is now being made towards this vision with the new baseline adopted by the WMO's Coordination Group for Meteorological Satellites (CGMS). Geostationary hyperspectral instruments are planned to be provided by Europe and China, and there is a US-led private initiative, GeoMetWatch, which could provide a service to other agencies wishing to contribute to the CGMS vision.



Conference participants (photo courtesy of Météo-France)

Another key topic at ITSC-18 was the Regional ATOVS Retransmission Service (RARS), which attracted considerable interest. RARS uses existing ground stations to receive direct broadcast ATOVS data from NOAA and Metop satellites and then process uniformly using the ATOVS and AVHRR Pre-processing Package (AAPP). The data are then redistributed via the WMO's Global Telecommunications System, giving 75% global coverage within 30 minutes. In this context it was also very welcome at ITSC-18 to hear about the *Community Satellite Processing Package* for direct broadcast Suomi-NPP data, and progress being made also for FY-3B data. Actions are being taken to include CrIS, ATMS, and IASI data into the RARS. It is known that data assimilation systems such as 4D-var are most sensitive to observations at the end of the data window, so acquiring these observations in a timely manner ensures good coverage of satellite sounding observations in the last hour of the data assimilation window.

Data assimilation methods are making increasing use of ensemble techniques to describe background error but the treatment of observation errors remains highly simplified. However, there were a number of presentations examining methods to characterize correlated error and its impact, as well as more basic retuning of the observation error variances. Forecast impact is being evaluated using observing system experiments, and increasingly also by forecast error contribution, using adjoint sensitivity techniques and/or ensemble spread to evaluate observations. Two centers outside the USA reported that they are now testing NCEP's GSI 3D-var for their data assimilation and by implication the CRTM model (the Brazilian Center for Weather Forecasting and Climate Studies and the Indian National Centre for Medium Range Weather Forecasting).

Finally it was a pleasure to award the prizes for the best oral presentations at ITSC-18 to Pauline Martinet (Météo-France) and Stuart Newman (Met Office), and the prizes for

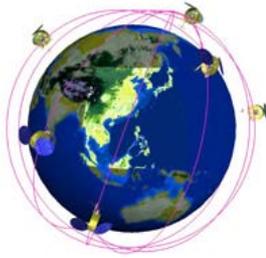
best posters to Graeme Martin (UW-SSEC), Anna Booton (Met Office) and Dave Tobin (UW-SSEC).

Météo-France was an excellent host and the appreciation of the ITWG community goes especially to Vincent Guidard and Jean Maziejewski as well as to Maria Vasys, Bill Bellon and Leanne Avila at UW-SSEC for their continued support.

The conference is supported financially by many organizations: NOAA (STAR, GOES-R program, and JPSS), NASA, Orbital Systems, GeoMetWatch, ITT, VCS, WMO, Spacetec, ABB, EUMETSAT, Met Office, CNES, CRNS and Météo-France. The support of all sponsors is fully acknowledged by all participants.

For more information about ITWG please visit the website at <http://cimss.ssec.wisc.edu/itwg/index.html>

(Stephen English, ECMWF, and Allen Huang, UW-SSEC, ITWG co-chairs)



Cosmic Corner



International Radio Occultation Working Group Meeting participants

The second meeting of the International Radio Occultation Working Group (IROWG) took place on 28 March – 3 April at Estes Park, in Colorado, and was attended by some 100 scientists from around world. Radio Occultation experts gathered together to discuss the state-of-the-art on Radio Occultation data processing; numerical weather prediction, space-weather and climate requirements/applications; new missions and payload technology; and innovative radio occultation techniques.

The IROWG was established as the 4th Working Group of the Coordination Group for Meteorological Satellites (CGMS) at its 37th meeting on 26-30 October 2011 (Jeju Island, South Korea). The IROWG is co-sponsored by CGMS and the World Meteorological Organization (WMO). The IROWG serves as a forum for operational and research users of radio occultation data. The other CGMS Working Groups are the ATOVS Working Group (ITWG), the Precipitation Working Group (IPWG), and the Satellite Winds Working Group (IWWG).

With respect to a COSMIC follow-on mission, we are pleased to report that with support from the US Air Force and Taiwan, COSMIC-2 is now officially a program. Funding approval exists for the launch of the first six equatorial satellites, scheduled for late 2015. These will also

carry space weather payloads. Although funding remains to be confirmed, the second six sensors are planned for launch in early 2018 and will cover the high inclination orbit providing global sampling with over 8,000 soundings per day.

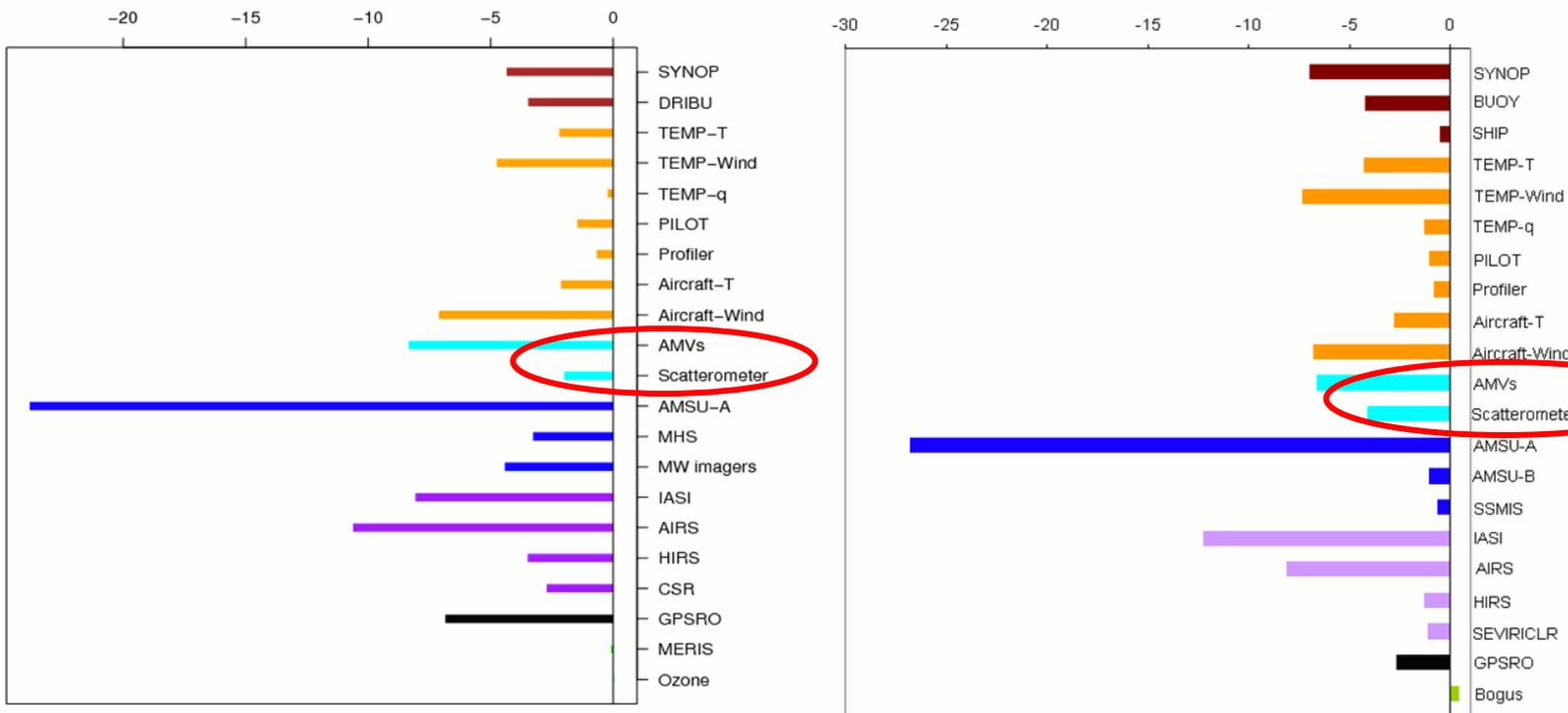
On a more technical side, at the next code upgrade, scheduled for May 2012, the NCEP's Global Data Assimilation System will switch operationally from the assimilation of Radio Occultation refractivities to bending angles. The new algorithms also extend the top of the radio occultation profiles to 50 km in the assimilation system. Details on the innovative characteristics of the NCEP's methodology to assimilate bending angles can be found in Cucurull et al. 2012, recently submitted to JGR. (Contact L. Cucurull (Lidia.Cucurull@noaa.gov) for a copy of the manuscript).

(L. Cucurull, NOAA/NCEP/EMC)



Eleventh International Winds Workshop

Forecast error reduction due to satellite winds (ovals) and other observations



Overall observation impacts on 24-hour forecast error reduction for ECMWF (left) and Met Office (right) global models using the adjoint-based Forecast Sensitivity to Observations (FSO) method for the study period 15 Aug – 30 Sep 2010. (Figure courtesy of Met Office and ECMWF)

The Eleventh International Winds Workshop was held February 20-24, 2012 in Auckland, New Zealand. The local host of the workshop was Roger Davies and the University of Auckland. Chaired by Jaime Daniels, NOAA/NESDIS, and Regis Borde, EUMETSAT, the workshop was attended by fifty-six scientists from twelve countries around the world.

The workshop consisted of seven plenary sessions with oral scientific presentations, three plenary general discussion sessions, and two parallel working groups. The seven plenary sessions covered a broad range of topics that included: the latest updates to and plans for Atmospheric Motion Vector (AMV) products generated at operational centers, the latest developments in AMV derivation, AMV error characterization, utilization and impact of satellite-derived winds in NWP, the status and future of polar AMVs, and status and plans for processing winds from NASA's Multi-angle Imaging Spectro-Radiometer (MISR) instrument and the European Space Agency's (ESA) Atmospheric Dynamics Mission (ADM)/Aeolus LIDAR instrument. Topics discussed in the three plenary general discussion sessions included: 1) Numerical Weather Prediction (NWP) Winds Impact Study and Mesoscale Winds; 2) AMV Inter-comparison Plan and Simulated Data Studies; and 3) AMV Open Source Software. The two

working groups focused their discussions on AMV Extraction/Quality Control Methods and Assimilation of satellite-derived winds in NWP.

Some key highlights from the workshop presentations and discussions were:

- This was the best ever attended winds workshop by the NWP community. The following organizations were represented at the workshop: NCEP, NASA, JCSDA, ECMWF, UK Met Office, Dwd, Météo-France, FNMOC, NRL, JMA, and KMA.
- An AMV NWP impact inter-comparison study involving nine NWP centers was coordinated by James Cotton (Met Office) and Christophe Payan (Météo France). NWP centers produced impact results from a coordinated set of Observing System Experiments (OSEs) for all geostationary AMVs over the same two 1-½ month periods, with MODIS AMV OSEs and scatterometer winds OSEs for one of the periods, respectively. Overall, the OSE results from the participating centers showed AMVs had a positive impact in most areas. Geostationary AMVs, for example, were shown by all NWP centers to have the largest and most robust impact at high levels in the



tropics, whereas, more mixed results were observed at low and mid-levels. Some of the more mixed results were attributed to verification problems or model deficiencies rather than

problems in the AMVs themselves. Forecast Sensitivity to Observation (FSO) metrics generated for AMVs by each NWP center indicated they were consistent and in the range 7-11% which places them among the top global observing system observations that contribute in a positive way to NWP forecast impact (see accompanying figure).

- New promising AMV derivation algorithms that have emerged include NESDIS' nested tracking algorithm developed for the future GOES-R ABI and EUMETSAT's Cross-Correlation Contribution (CCC) algorithm. NWP centers offered to work with these producers to evaluate the impact of AMVs generated by these new approaches in their data assimilation systems.
- Future satellite missions that will contribute to the generation of atmospheric wind observations include: EUMETSAT's Metop-B (2012), JMA's Himawari-8 (2014), ESA's Aeolus Wind LIDAR (2014), NOAA's GOES-R Advanced Baseline Imager (2015), and Environment Canada's Polar Communications and Weather (PCW) mission (2018).
- The launch of Metop-B will bring global full resolution AVHRR data from two spacecraft (Metop-A and Metop-B) in the same orbit plane for the first time ever. Overlap of half a swath or more in the AVHRR data from these two satellites will allow for the generation of AMVs over the entire globe.
- NASA/JPL described significant improvements to the quality and horizontal resolution of AMVs derived from the MISR instrument onboard NASA's Terra spacecraft. This, together with the potential for improving the latency of the MISR AMV products, bring the real possibility that the MISR AMV products could be used by operational NWP centers in their operational NWP forecast/data assimilation systems in the future.

More details about this workshop, including the presentations, can be found on the International Winds Working Group (IWWG) web page: <http://cimss.ssec.wisc.edu/iwwg/iwwg.html>

(Jaime Daniels, NOAA/NESDIS/STAR and co-chair, IWWG)



A Note from the Director

The utilization of JCSDA's jibb has been very high for each of the first three months of the year, so clearly we are filling a need for high-end computer

resources dedicated to satellite data assimilation. Part of that is due to the broad suite of data impact experiments we have been preparing for the "Fifth WMO Workshop on the Impact of Various Observing Systems on NWP" to be hosted by the Joint Center in Sedona May 22-25, and the remainder to other satellite data experiments

At this point, the program for the WMO Impact Workshop is complete, and it appears to be the largest and most comprehensive so far in this series of meetings, with around 40 presentations and somewhere between 60 and 70 participants in total. As mentioned previously, this will be the first time this Workshop is held in the US, and we look forward to welcoming our colleagues from around the world to this important meeting.

The applications are now in for the 2012 JCSDA Summer Colloquium to be held in Santa Fe, July 24 through August 3, and we were pleased to see a strong response once again with 26 mostly very well-qualified applicants. We continue to receive positive feedback from the participants in the 2009 event, and we look forward to hopefully building a lasting relationship also with this year's class.

Concerning the FY 2012 External Research announcement, the news is unfortunately not what we had hoped for. In spite of good intentions from all sides, we were not able to find an entity that was willing and able to administer this opportunity on behalf of the Joint Center, and it now looks as if we will have to defer issuing our next announcement until Fiscal Year 2013.

Finally, I would like to acknowledge all the hard work in preparing for assimilating the first data from NPP operationally at NCEP, hopefully as early as next month. The work has involved considerable commitment and flexibility, not only from the Joint Center but also from our partners at NCEP and NESDIS, and I hope to be able to report success on this front in the next issue of this newsletter.

Lars Peter Riishojgaard, Director, JCSDA



Outlook for Next Quarter

Upcoming Events

Annual Workshop on Satellite Data Assimilation



The new NOAA Center for Weather and Climate Prediction
(Image from University of Maryland website)

The Joint Center's Annual Workshop on Satellite Data Assimilation, which reviews ongoing and planned scientific developments sponsored by the Center, and plans and coordinate future efforts, usually takes place in the spring of each year. However, to avoid a conflict with the *Fifth WMO Workshop on the Impact of Various Observing System on NWP*, which will be held in the U.S. in May 2012 and which the Joint Center is hosting, the annual workshop will be shifted to the October-November 2012 time frame. Hopefully, the new NOAA Center for Weather and Climate Prediction (NCWCP) at the University of Maryland Campus in College Park will be completed by that time, and we will be able to host the workshop there. The NCWCP will be the new home for personnel from NOAA's Satellite and Information Service, Air Resources Laboratory, National Centers for Environmental Prediction and Joint Center for Satellite Data Assimilation. For workshop updates check the JCSDA website and the June 2012 Quarterly Newsletter.

(Sid Boukabara, JCSDA)

The 2012 Community GSI Tutorial

The Developmental Testbed Center (DTC) would like to announce the Community Gridpoint Statistical Interpolation (GSI) Data Assimilation System Tutorial on August 21-23, 2012 at the NCAR Foothills Laboratory, Boulder, Colorado.

The GSI system is a unified variational data assimilation system used by a number of operational centers, including the National Weather Service of the United States. The development of this system is a community effort of major government and academic operational and research facilities, including the National Oceanic and Atmospheric Administration's National Centers for Environmental Prediction (NCEP) and Global Systems Division (GSD), the National Aeronautics and Space Administration's Global Modeling and Assimilation Office (GMAO), the National Center for Atmospheric Research (NCAR), and other university affiliated institutes in the United States.

The tutorial will provide lectures and hands-on practical sessions based on the GSI community code release scheduled for July, 2012, which will contain state-of-art data assimilation techniques very similar to the latest operational capabilities. The topics covered will be the fundamentals of running GSI and some related specifics, e.g., background error generation, radiance data assimilation, etc. Speakers will come from primary development and community support teams including NOAA, NASA, NCAR, and DTC.

Registration is open starting on March 1, 2012 up to the first day of the tutorial (August 21, 2012). On-site registration is also an option if space is available. Registration options are as follows:

- * Tutorial: \$300 (includes lunch and refreshments). Due to the constraints of physical space and computers, registration for the tutorial with both lecture and practical sessions will be limited to 40.
- * Tutorial Lecture only (no practical session): \$150 (includes lunch and refreshments). No limit.

No refunds for cancellations made after July 16, 2012.

Further details and information are provided at <http://www.dtccenter.org/com-GSI/users/tutorials/2012.php>.

(Hui Shao, JCSDA/DTC)



The National Center for Atmospheric Research's Foothills Laboratory



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
April 18, 2012	Peter Bauer	ECMWF	Recent and Planned Development of Data Assimilation and Modeling Systems at ECMWF
May 16, 2012	Fatima Karbou	Météo-France	The Assimilation of Surface Sensitive Microwave Observations Over Land: Recent Results and Open Issues
June 20, 2012	Fuzhong Weng	NOAA/NESDIS/STAR	Assessments of the Advanced Technology Microwave Sounder (ATMS) and Special Sensor Microwave Imager/Sounder (SSMIS) for Data Assimilation

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.