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# *News in This Quarter*

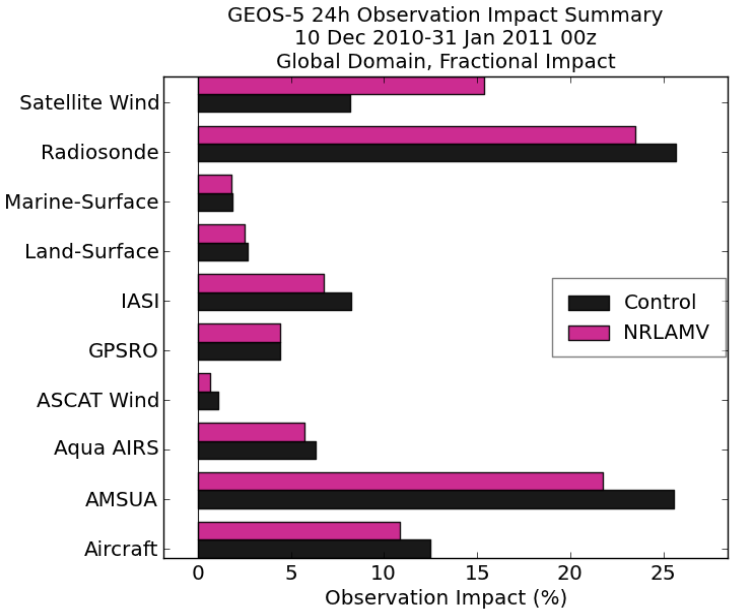
## *Science Update*

### The Impact of Satellite Atmospheric Motion Vectors in the Navy and NASA Global Data Assimilation Systems

An often-asked question is why the U.S. Navy global forecast model reaps a larger positive impact from satellite-derived Atmospheric Motion Vectors (AMVs) than models at other forecast centers. Possible reasons for this result include (1) the greater number of AMVs assimilated in the Navy system, (2) the Navy's data selection and quality control procedures, especially the use of carefully averaged "super-ob" wind vectors, and (3) the influence of other data types in the assimilation system, including the greater number of satellite radiances assimilated in some systems. A scientific team from the Naval Research Laboratory (NRL) and NASA's Global Modeling and Assimilation Office (GMAO) is examining the significance of these various factors.

The impact of observations in the Navy and GMAO NWP systems are summarized on these websites (http://www.nrlmry.navy.mil/metoc/ar_monitor/ and http://gmao.gsfc.nasa.gov/forecasts/systems/fp/obs_impact/) The top five observation categories for Navy are: AMV, radiosonde, aircraft (AMDAR and MDCRS), AMSU-A and IASI, in that order. The top five categories for GMAO, in order, are AMSU-A, radiosonde, aircraft, IASI and AMV. The overall Navy observation impact from microwave and infrared atmospheric sounders is less than for the GMAO system.

This study investigated the impact of AMVs on short-range weather forecasts produced by GMAO's GEOS-5 atmospheric data assimilation system. A cycling data assimilation experiment, including forecasts and adjoint-based observation impact calculations, was conducted for a two-month period during the 2010-2011 Northern Hemisphere winter season. Results from a control experiment that included all AMVs and other data types assimilated operationally in GEOS-5 were compared with those from an experiment in which the GEOS-5 AMVs (only) were replaced by ones produced by NRL for the Navy's operational forecast system. The NRL set includes geostationary AMVs from the University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies and the Air Force Weather Agency, in addition to AMVs produced by the operational data providers (NESDIS, EUMETSAT and JMA) as in the control set. All NRL AMVs (NRLAMV) are assimilated as super-obs.




*Average impacts of various observing systems on the GEOS-5 24-h forecasts from 00Z during the period 10 Dec 2010 – 31 Jan 2011 for the control and NRLAMV experiments. Results are expressed in terms of the fraction of the total error reduction due to assimilation of all observations based on a global error measure. The observation impacts are computed using the adjoint of the GEOS-5 atmospheric data assimilation system.*

The figure compares the relative impacts of selected observing systems assimilated in GEOS-5 for the control experiment and the experiment using NRLAMV in terms of their fractional contributions to the reduction of a global measure of 24-h forecast error. The measure combines errors in wind, temperature and surface pressure with respect to the verifying GEOS-5 analysis. In both experiments, radiosondes and AMSU-A radiances have the largest beneficial impact, with each providing 20-25% of the total error reduction due to the assimilation of all observations. Satellite winds rank fifth and provide roughly 8% of the total error reduction in the control experiment, but rank third with nearly double the fractional contribution to the total error reduction in the NRLAMV experiment. It is of interest that while the fractional contribution from satellite winds is nearly doubled in the NRLAMV experiment, the contributions from other leading observing systems such as aircraft, radiosondes, AMSU-A and IASI satellite radiances are reduced by 10-15%.

There are roughly twice as many satellite winds in the NRLAMV observation set as in the control set. Other

diagnostics not shown here indicate that the greater volume of the NRLAMV is primarily responsible for their larger impact, although there is evidence that the super-ob processing is beneficial.

The mix of observations plays an important role in modulating the impact of any one data type. For example, while the NRLAMV have a much larger impact in GEOS-5 than do the control AMVs, the NRLAMV impact is still smaller than in the Navy forecast system. This result is likely due to the larger number of satellite radiances assimilated in GEOS-5. Experiments are ongoing to examine this difference and other aspects of the results reported here.

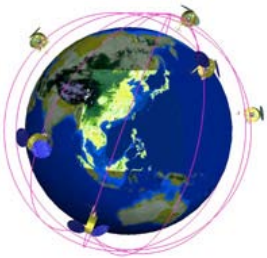
(Nancy L. Baker, NRL/Monterey, Dagmar Merkova, NASA/GMAO/SSAI, Rolf Langland, NRL/Monterey, Ron Gelaro, NASA/GMAO, Patricia M. Pauley, NRL/Monterey, Will McCarty, NASA/GMAO, Liang Xu, NRL/Monterey)

## NCEP Global Forecast System Upgrade

The operational NOAA/NCEP Global Forecast System underwent a major upgrade on May 22, 2012, in which the assimilation system, the forecast model, and the post-processing system were all modified. The most significant changes were the introduction of a hybrid variational/ensemble data assimilation system, the use of the ATMS data from the NPP satellite, the use of GPS RO bending angle rather than refractivity, the introduction of an operational satellite radiance monitoring system, and the production of additional post-processed fields requested by forecasters and the wind-energy industry. In addition, GOES-13, GOES-15, and Meteosat SEVIRI radiance data were introduced along with additional satellite wind estimates. Finally, compressibility factors were added to the analysis, SBUV observation errors were modified, the use of some radiance channels was changed based on quality flags, and an updated version of the forecast model was implemented.

Multiple parallel runs were made over many seasons to examine the impact on the analyses and forecasts. The impacts on the forecasts were in general very significant and were among the largest ever seen in an upgrade to the forecast system. The largest impacts were attributed to the introduction of the hybrid variational/ensemble assimilation system (a collaborative effort with NOAA/ESRL Physical Sciences Division, Jeff Whitaker). The most noteworthy impacts were the improved prediction of tropical winds, mid-latitude forecasts, and fits to observations. In the winter, improved precipitation forecasts were found. In summer months, a small degradation in the precipitation forecasts was noted. The summer degradation can be addressed by modifications to the forecast model's convective parameterization.

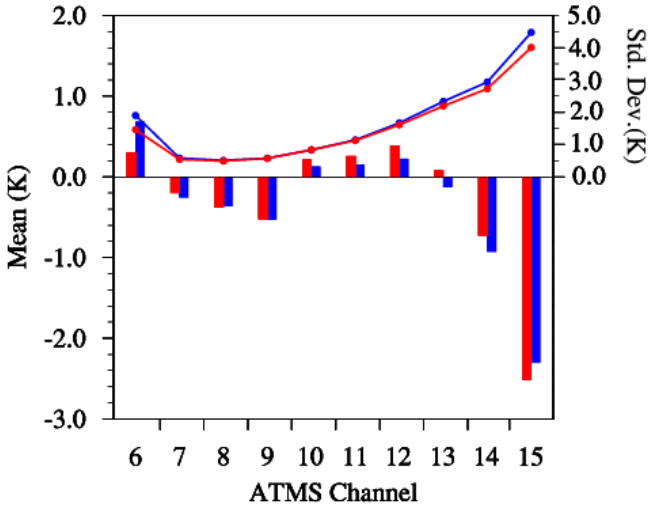
(John Derber, NOAA/NWS/NCEP)



## Cosmic Corner

With the operational implementation of the hybrid variational/ensemble assimilation system in the Global Forecast Model at NCEP on 22 May 2012, the assimilation of GPS RO bending angles replaced the assimilation of refractivities. The assimilation of soundings of bending angle includes the extension of the top of the profiles from 30 km to 50 km and the use of the compressibility factors in the calculation of the forward operator. Using the forward operator for bending angles provides slightly better results for all fields and pressure levels. Bending angles are closer to the raw observations of time delay, which is what GPS RO satellites measure, whereas refractivities involve an additional retrieval process. Thus, the use of bending angles avoids more complicated error structures and less need to retune the quality controls and observation errors when processing centers update their software. Furthermore, soundings of bending angle are not affected by a formal negative bias in the lower troposphere under super-refraction conditions, and there is no need for the auxiliary climatological/meteorological information needed to retrieve refractivity.

NOAA/NESDIS has recently started to explore two different applications of GPS RO data. First, to calibrate the brightness temperatures of the Suomi National Polar Partnership (NPP) Advanced Technology Microwave Sounder (ATMS) and second, to evaluate the impact of GPS RO observations on hurricane predictions using the Hurricane Weather Research and Forecasting (HWRF) model. Some results of the first application are summarized here.




*Biases (bars) and standard deviations (lines) of the differences between observed ATMS brightness temperatures and those simulated from GPS RO soundings for all collocated data over the globe (blue) and only under clear-sky conditions over ocean within 55S-55N (red) from December 10, 2011 to April 30, 2012.*

GPS RO observations are considered to be of very high accuracy. In this study they are used to check the accuracy of ATMS observations. Real-time COSMIC RO temperature and water vapor profiles processed by the University Corporation for Atmospheric Research (UCAR) are collocated with 16496 ATMS observations from December 10, 2011 to April 30, 2012. Collocation criteria are: spatial distance less than 30 km and time difference less than 30 minutes.

The differences between ATMS brightness temperatures and brightness temperatures simulated from COSMIC data using the Community Radiative Transfer Model (CRTM) are shown in the figure. For channels 7 to 13, the mean differences are within 0.5 K and the standard deviations of the differences are generally less than 2 K for both all data and data under clear-sky conditions over ocean. Both are well within the pre-launch specifications – especially considering that there are errors introduced by match-up differences - and indicate that the ATMS mid- and upper troposphere temperature sounding channels (7 to 13) have high accuracy. Channels 14 and 15 are sensitive to the stratosphere, and since the COSMIC profiles extend only to 39 km, the US Standard Atmosphere temperature profile is used above this level in the simulation of these ATMS channels. This results in an artificially induced increase in ATMS-Cosmic differences for these channels.

(Lidia Cucurull, NOAA/NCEP/EMC and Lin Lin, NESDIS/STAR)

## Summer Colloquium Update


*Meeting Room, Hilton Sante Fe Historic Plaza Hotel*

As the Newsletter "goes to press", the final preparations are being made for the Joint Center for Satellite Data Assimilation Summer Colloquium, which will be held at the Hilton Santa Fe Historic Plaza Hotel (see accompanying photo) in Santa Fe, New Mexico July 24 – August 2, 2012. The event will provide an opportunity for nineteen highly qualified participants – senior graduate students and early post-doctoral researchers - to learn more about data assimilation techniques and applications for using satellite data to improve environmental analyses and model forecasts. Following the format of the very successful Colloquium conducted in 2009, experts representing the JCSDA partner agencies and academia will deliver a series of lectures, and will be on hand for extended informal discussions with the students to consider specific questions and applications in greater detail. Look for a detailed summary of the Colloquium in the next Newsletter!

(Jim Yoe, JCSDA)

## 2012 Data Assimilation Tutorial: Remote Access Available

The Developmental Testbed Center (DTC), sponsored by NOAA, AFWA, and the NSF, will host the Third Community Gridpoint Statistical Interpolation (GSI) Data Assimilation System Tutorial on August 21-23, 2012 at the National Center for Atmospheric Research (NCAR) Foothills Laboratory, Boulder, Colorado. The tutorial will provide lectures and hands-on practical sessions based on the upcoming GSI community code release in July, which will contain state-of-art data assimilation techniques very similar to the latest operational capabilities.

*The National Center for Atmospheric Research's Foothills Laboratory*

Due to numerous community requests, the DTC decided to provide remote access to the tutorial. This new option will use commercial audio and web conferencing services. The cost is $150 for all three days. On-site options are still available for those who would like to be included in the full tutorial, including hands-on practical sessions.

A toll-free dial in number will be provided for those remote participants in the US. For those outside the US, please be aware that you may be charged an international rate for dialing into the US. If you are interested in participating and are outside the US, please contact Pam Johnson (johnsonp@ucar.edu ) to find out if there is a toll free international number for your country. We do not want an international participant to be surprised after the tutorial, if there are toll charges. The week prior to the event, a Meeting Invitation will be sent to participants with this option, which will have the dial-in and log-in information. The DTC reserves the right to cancel the webcast option if the webcast has non-solvable technical problems during the tutorial, and prorated reimbursement will be arranged.

Since multiple people may share the same remote access, we would like to get an accurate head-account of the remote participants so that we can prepare our presentation materials accordingly. Therefore, please register as well even if you are not the primary participant (who pays for the service), and indicate the name of the primary participant during the registration.

Further details and information about all registration options are provided at http://www.dtcenter.org/com-GSI/users/tutorials/2012.php.

(Hui Shao, JCSDA/DTC)

# WMO Impact Workshop Summary

*WMO Impact Workshop participants*

The *Fifth WMO Workshop on the Impact of Various Observing Systems on NWP* was hosted by the Joint Center 22-25 May 2012 at the Sedona Rouge in Sedona, AZ, under the joint sponsorship of WMO, the International THORPEX Program, NASA, and the NOAA/NESDIS GOES-R Program Office. Over the last 15 years the workshops in this series have evolved into the premier venues for presenting and discussing NWP data impact studies, and the guidance provided in the official Workshop Reports has been widely cited in the literature and in other contexts.

The Sedona Workshop was a milestone in several respects: It marked the first time this meeting was held in the United States, in fact it was the first meeting in the series held outside Europe. It also had the broadest representation of NWP centers that we had ever seen, both in terms of institutional and national affiliation. The meeting was attended by 56 individuals from 13 countries, including experts in data assimilation and observation impact, representatives from space agencies, and managers of other observing networks. The program included some 40 presentations covering a broad range of data impact studies done with a wide variety of global and regional data assimilation systems, and ample time was reserved for discussions meant to develop and express consensus where it was possible, and to capture any open questions where it was not.

Similar to what was shown both at the Third Workshop in Alpbach 2004 and the Fourth Workshop in Geneva 2008, the Sedona meeting showed that the satellite component of the Global Observing System continues to be extremely important for forecast skill. However, in contrast to the conclusions from 2004 and 2008, when the impact was dominated by AMSU-A and later on by AIRS in particular, it is now much more difficult to identify specific satellite systems responsible for maintaining forecast skill, especially when traditional Observing System Experiments (OSEs), or data denial, methodology is used.

The overall picture is still similar to what it has been for 10 years or more: When all satellite observations are withheld from the forecast systems, the forecast skill suffers: considerably in the Northern Hemisphere and dramatically in the Southern Hemisphere. However, most NWP systems now seem to be remarkably resilient when data from only a single sensor – or even a single class of sensors – is withheld. However, the workshop participants issued strong words of caution against over-interpreting these statements: Due to a largely fortuitous alignment of schedule slips for some systems and the unexpected longevity of others, the coverage provided by the satellite-based systems are at a historical high, and a substantial decrease in overall coverage is projected to occur over the next five to ten years.

The mostly adjoint-based Forecast Sensitivity to Observations (FSO) diagnostics continue to progress, and most NWP centers now either have or are planning to develop this capability. These diagnostics are typically less expensive to run and allow the experimenters to drill down into very detailed data impact – and indirectly network design – issues. Much more is now understood about the relationship between OSE and FSO-based impact studies, and the participants in the Workshop agreed that both methodologies will need to continue to be used.

Another difference with respect to previous workshops is that wind observations are now found by most experimenters to have a larger impact on skill than they have had previously. This was found to be true for wind observations of all types, whether from radiosondes, aircraft, or feature-tracking winds derived from satellite imagery. There was no unanimous opinion regarding the cause of this. It was speculated to be due to improved data quality, improvements in the use of wind data in the data assimilation systems, or the fact that the horizontal resolution of many model systems is approaching scales where wind observations are expected to be important based on atmospheric dynamics.

The decrease in relative importance of radiosonde observations for forecast skill appears to have halted for most NWP systems, and workshop participants expressed strong support especially for radiosonde stations in the tropics, isolated islands, and high-latitude locations far from other sources of vertically resolved wind observations.

Much more information about the discussions and the guidance provided by the meeting can be found in the Preliminary Report. This document was drafted by the Scientific Organizing Committee in the weeks immediately following the meeting, with the aim of presenting it at the *Fifteenth Session of the WMO Commission for Basic Systems* in Jakarta in September this year. In preparation for the CBS session, the Preliminary Workshop Report was presented and discussed at the Implementation/Coordination Team on The Integrated Observing System (ICT/IOS)-7 session in Geneva in June. A link to the ICT-IOS document that includes the report can be found by going to http://www.wmo.int/pages/prog/www/OSY/Meetings/ICT-IOS7/DocPlan.html and clicking on document 6.8(2).

A Final Report will be published once the input from all Workshop participants has been incorporated, tentatively in the September time frame. Contrary to the practice from previous meetings, the report from this meeting will not be published in paper form but rather electronically, and it will be hosted permanently on a WMO website. This format allows the organizers to include the presentations themselves as part the Final Report and thus of the permanent record of the meeting. A link to the WMO Report will be provided on the Joint Center webpage when it is made available.

(Lars Peter Riishojgaard, JCSDA)

## Heads Up: Tentative Dates Set for Annual Science Workshop

The Joint Center's Annual Workshop on Satellite Data Assimilation, which reviews ongoing and planned scientific developments sponsored by the Center, will be held on November 13 – 15, 2012, at the new NOAA Center for Weather and Climate Prediction at the University of

*The annual workshop will be held at the new NOAA Center for Weather and Climate Prediction (NCWCP).*

Maryland's Research Park adjacent to its College Park campus. These dates are not completely finalized. As more detailed information becomes available, it will be posted to the JCSDA website and will appear in the September Newsletter.

(Sid Boukabara, JCSDA)

## Call for Papers for the Special Symposium on the Joint Center for Satellite Data Assimilation


The Special Symposium on the Joint Center for Satellite Data Assimilation, sponsored by the American Meteorological Society, and organized by the AMS Satellite Meteorology, Oceanography, and Climatology Committee, will be held on 8 January 2013. The Symposium is embedded within the Third Conference on Transition of Research to Operations: Successes, Plans, and Challenges, and is part of the 93rd AMS Annual Meeting in Austin, Texas. Preliminary program, registration, hotel, and general information will be posted on the AMS Web site (http://www.ametsoc.org/meet/annual/) in late-September 2012.

The theme for the 2013 AMS Annual Meeting is "**Taking Predictions to the Next Level: Expanding Beyond Today's Weather and Climate Forecasts and Projections**". Over the past 60 years the meteorological community has made tremendous strides in making prediction a fundamental part of its scientific and

operational/service heritage through the development and application of complex numerical models involving the atmosphere, ocean, land and cryosphere components of the Earth System.

Much of this progress has been made possible by the development of better data assimilation systems that in turn have made it possible for the operational prediction centers to increase and improve their use of a wider range of observing systems. For certain application areas – especially numerical weather prediction - the increased use of satellite data has been a critical element of this overall thrust since comprehensive spatial and temporal coverage of weather data for the full global domain can only be obtained from space.

The Joint Center for Satellite Data Assimilation is an interagency collaboration sponsored by NASA, NOAA, the US Air Force and the US Navy that is tasked with improving and accelerating the use of satellite data and related research in operational environmental prediction systems. As one of its primary responsibilities, the JCSDA strives to help the operational agencies implement data from new satellites as quickly as possible after launch. Thus, the JCSDA helps the nation maximize the benefits from its investment in these systems. The Symposium will include both invited and contributed presentations and we solicit presentations highlighting the role of satellite data in numerical weather prediction, as well as on the current and potential future use of satellite data in air quality, ocean, land surface, and climate prediction systems. Contributions may focus on the data themselves or on algorithmic developments that are/will be necessary to optimize the use of the data.

The $95 abstract fee includes the submission of your abstract, the posting of your extended abstract, and the uploading and recording of your presentation, which will be archived on the AMS Web site.

Please submit your abstract electronically via the Web by **1 August 2012** (refer to the AMS Web page at http://www.ametsoc.org/meet/online_submit.html). An abstract fee of $95 (payable by credit card or purchase order) is charged at the time of submission (refundable only if abstract is not accepted).

Authors of accepted presentations will be notified via e-mail by late-September 2012. All extended abstracts are to be submitted electronically and will be available on-line via the Web. Instructions for formatting extended abstracts will be posted on the AMS Web site. Manuscripts (up to 3MB) must be submitted electronically by **6 February 2013**. All abstracts, extended abstracts and presentations will be available on the AMS Web site at no cost.

For additional information please contact the program chairperson, Lars Peter Riishojgaard (email: Lars.P.Riishojgaard@nasa.gov).

# A Note from the Director

*The dates for the 2012 JCSDA Summer Colloquium in Santa Fe are getting closer (July 24 – August 3). In turbulent budget times, with frequent updates and re-interpretation of guidance regarding government spending on travel and all types of workshops, conferences and other events, it has been a bit of a nail-biter for the organizing committee, chaired by Jim Yoe, to get ready for it. The last tweaks to the program have been made, the participants have been selected and notified, and everything now seems ready to go. We look forward to another successful event, and we hope that JCSDA, our partners, and the participants will continue to work together in various ways for many years to come.*

*Congratulations to NCEP for their implementation of the new hybrid data assimilation system on May 22. This is a major milestone for US numerical weather prediction, and from a JCSDA perspective, it was particularly gratifying to see that data from the ATMS instrument flying on Suomi NPP was bundled in with this implementation. Thanks to a strong collaboration between JCSDA, NCEP, NESDIS and NASA, these data were implemented operationally within seven months after launch of a brand new satellite system and one month before the satellite itself was declared to be operational.*

*The Joint Center continues to be very active in using Observing System Simulation Experiments (OSSEs) to help the space agencies assess the potential impact of future systems on forecast skill. We are now embarking on a series of experiments aimed at assessing the impact of various alternatives for the early morning orbit previously envisaged to be covered by one the NPOESS platforms (and later the cancelled Defense Weather Satellite System (DWSS)) and we are preparing to study also the impact of hyperspectral infrared sounders from geostationary orbit.*

*Finally, a couple of words about the recent Fifth WMO Workshop on the Impact of Various Observing Systems on NWP, hosted by the Joint Center in Sedona AZ May 22-25. You can read more about it elsewhere in this Newsletter, and on the JCSDA and WMO webpages. I hope that those of you who were there will agree with me that it was a very successful meeting, and I was particularly pleased to note a very strong representation from all JCSDA partners. Thank you both to those who presented or participated in other ways, and to your home institution who contributed your time and in several cases your travel support to this effort. I also want to say a big thank you to my fellow Local Organizing Committee members, Sid Boukabara, Ken Carey, Ron Gelaro, and Jim Yoe, and to our local sponsors, the International THORPEX Program, NASA, and the NOAA/NESDIS GOES-R Program Office*

*Have a great summer!*

*Lars Peter Riishojgaard, Director, JCSDA*

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.

## Seminars

JCSDA seminars are generally held on the third Wednesday of each month in Room 707 of the World Weather Building. Starting in September 2012, the seminars will be held at JCSDA's new home at the NOAA Center for Weather and Climate Prediction. 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 |
|---|---|---|---|
| Sept. 13, 2012 | Louis Uccellini | Director, NOAA National Centers for Environmental Prediction | Satellite Data in NWP: Past, Present and Future |
| Nov. 7, 2012 | Al Gasiewski | University of Colorado | Developments in Radiative Transfer Modeling, Microwave Observing Systems, and Radiance Assimilation over Clouds |