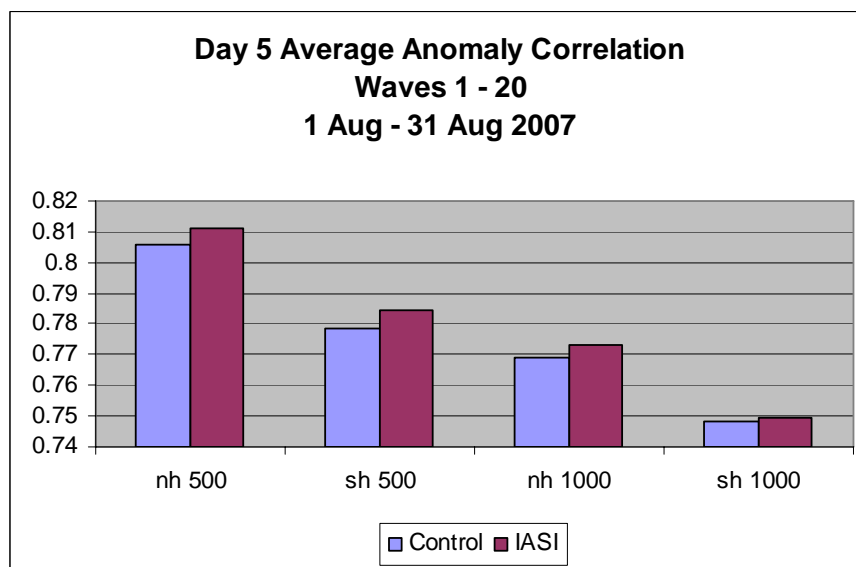


## News in This Quarter

### Science Update

## Upgrade to NCEP Global Data Assimilation System Includes IASI Data

### JCSDA Tests of IASI Impact



Anomaly Correlation Scores for forecasts at day 5 without IASI (control) and with IASI (IASI) data for 500 hPa and 1000 hPa heights for the Northern and Southern Hemispheres

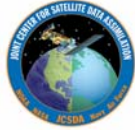
After more than one year of testing and validation, a major upgrade to the NCEP Global Data Assimilation System (GDAS) – including assimilation of IASI data – was implemented on 24 February, 2009. Among the tests were JCSDA evaluations of the impact of IASI data, results of which are shown in the figure. Assimilation of IASI observations improved anomaly correlation scores for both the Northern and Southern Hemispheres, at both 500 hPa and 1000 hPa. These results were obtained using the standard IASI EUMETSAT longwave IR channel selection (165 channels).

The upgrade included the following changes:

- Inclusion of IASI long-wave channels
- Introduction of variational Quality Control
- Flow dependent re-weighting of background error variances
- Change in land/snow/ice skin temperature variance
- Reduced number of AIRS water vapor channels
- New version of CRTM (and new coefficients)
- Modification of height assignment for wind observations
- New background error file

Results of tests that included all the changes over the period 1 July 2008 to 23 February 2009 showed reduced root-mean-square errors and increased 500 hPa anomaly correlations (indicative of improved synoptic scale forecast performance) in both Northern and Southern Hemispheres.

NCEP is now assimilating observations from two hyperspectral IR sounders - NASA's AIRS instrument and EUMETSAT's IASI. IASI is the first operational hyperspectral IR sounder and was launched on Metop-A in October 2006. (Steve Lord, NCEP)



*International Items*



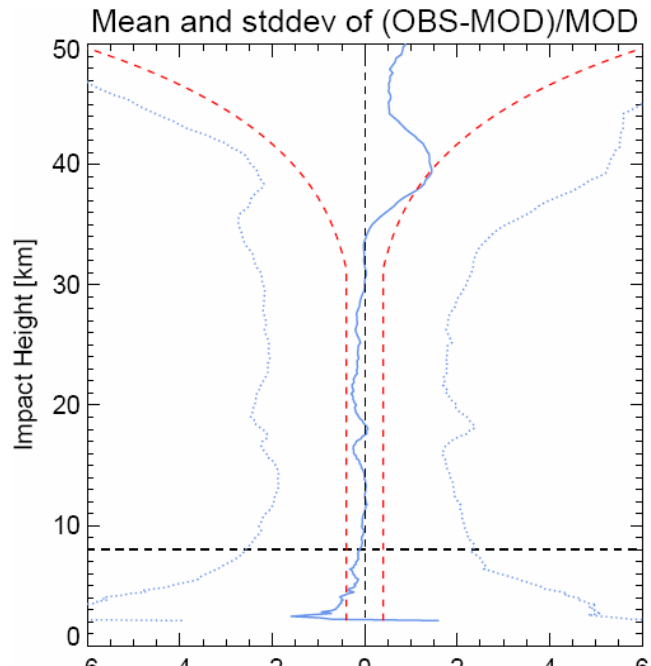
**Metop-A GRAS Radio Occultation Data**

Metop-A, EUMETSAT's first polar orbiting satellite, launched on 19 October 2006, carries, among other sensors, the GRAS [GNSS (Global Navigation Satellite System) Receiver for Atmospheric Sounding] radio occultation instrument. With the current GPS constellation, about 650 occultations are observed on average per day, which are processed by EUMETSAT to bending angle profiles and provided operationally in Near-Real-Time to users. The timeliness, expressed as the delay from the time of sensing on Metop-A to when the data is received at NWP centers, is excellent. Close to 100% of GRAS data is provided within 2 hours, thus well within the requirements of 2h 15min.

Validation of GRAS bending angles against co-located COSMIC profiles has shown a small bending angle bias for altitudes above about 18 km. Further investigations by the EUMETSAT and the COSMIC teams have shown this to be introduced by a smoothing implementation on COSMIC data, which is currently being revised. Nevertheless, it also confirms the climate capabilities of radio occultation data, with agreement between the two different instruments well in the sub-Kelvin range. GRAS provides on average as much data as two COSMIC satellites. Validation of GRAS against ECMWF 6-hr forecast data (see Figure) shows that it is well within requirements, except for a bias of up to 1.5% around 40 km impact height, possibly caused by uncorrected satellite radiance assimilation at ECMWF. The current processing is based on a geometrical optics retrieval that is unable to fully invert signals that have traversed atmospheric regions with strongly varying density gradients, thus degrading the results below about 8 km in the tropics. Work is ongoing to expand the processing with a wave optics retrieval that correctly handles these atmospheric conditions.

The further processing of bending angles to refractivities is done by the GRAS SAF (Satellite Application Facility), led by the DMI (Danish Meteorological Institute) and with consortium members ECMWF, IECC (Institute d'Estudis Espacials de Catalunya, Barcelona, Spain), and the Met Office. In addition to radio occultation profiles of atmospheric parameters, the GRAS SAF is also developing climate products based on monthly mean zonal grids. A third product is the ROPP (radio occultation processing package), which will aid users wishing to process, quality-control and assimilate radio occultation data into NWP and other models.

Validated refractivity data have recently been declared pre-operational and are made available to NWP users via the GTS system and the archive at the GRAS SAF website: <http://garf.grassaf.org>. The agreement with ECMWF forecast data is well within the threshold requirement and generally within the target requirement. The refractivity timeliness is also excellent: on average it is 1h 41min, and 98.75% of the products are disseminated within 2 hours from the time of



**Comparison of GRAS Observations with ECMWF Forecasts**  
 Bias (solid line) and standard deviation (outer dotted lines) of GRAS bending angles compared to co-located ECMWF profiles. Bending angle requirements are shown in red, they are expressed in absolute accuracy: 1μrad or 0.4% (whichever is larger). The dotted horizontal line indicates current processing limitation due to multi-path.

sensing which is well below the Near-Real-Time timeliness requirement of 3 hours.

GRAS bending angle data are operationally assimilated at ECMWF, and refractivity at the Met Office, where improvements in, e.g., forecasts of stratospheric temperatures are observed. Other centers, including NCEP, are currently in the process of conducting trial experiments with the aim of assimilating GRAS data.

(Axel von Engel, EUMETSAT, Kent Bækgaard Lauritsen, Danish Meteorological Institute, and the GRAS teams at EUMETSAT and GRAS SAF at DMI)

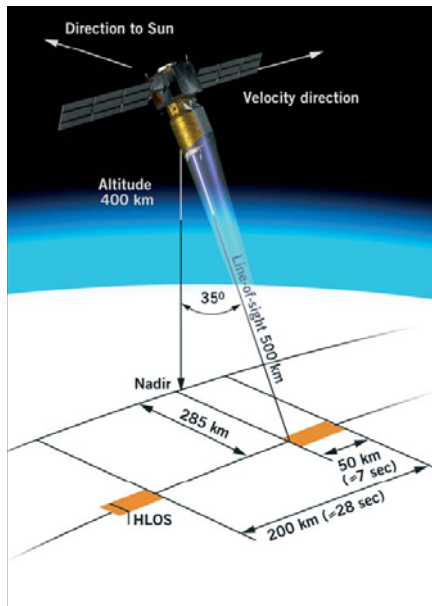


## Lidar Working Group Meeting

Approximately 25 U. S. and European scientists and lidar specialists attended the 31st meeting of the Working Group on Space-Based Lidar Winds (Lidar Working Group), held in Destin, Florida, January 27 - 30, 2009. The meeting highlights included: an update on ESA's Atmospheric Dynamics Mission (ADM) by Gert-Jan Marseille from KNMI; results from the Fall 2008 wind lidar airborne campaign in the Western Pacific as part of the THORPEX Pacific Asian Regional Campaign (T-PARC) by Dave Emmitt; an update on the status of TWiLiTE, the NASA/GSFC direct detection component of the hybrid Doppler Wind Lidar (DWL) by Bruce Gentry (presented by Mike Hardesty); and an update on the status of DAWN, the NASA/LARC coherent detection component of the hybrid DWL by Michael Kavaya. TWiLiTE and DAWN are scheduled to fly together in the first airborne test of the hybrid DWL in the next 1 to 2 years. The hybrid wind lidar should be ready for the first U.S. space demonstration in 2016 - 2017, pending the necessary funding. The next Lidar Working Group meeting is scheduled for June 16 - 19, 2009, in Wintergreen, Virginia.

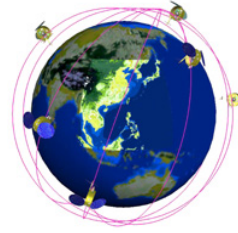
ESA's Atmospheric Dynamics Mission (ADM), the first space-based wind lidar, is scheduled for launch in April 2011. The geometry of its measurements is illustrated in the figure.

(Wayman Baker, JCSDA)



### ESA's Atmospheric Dynamics Mission

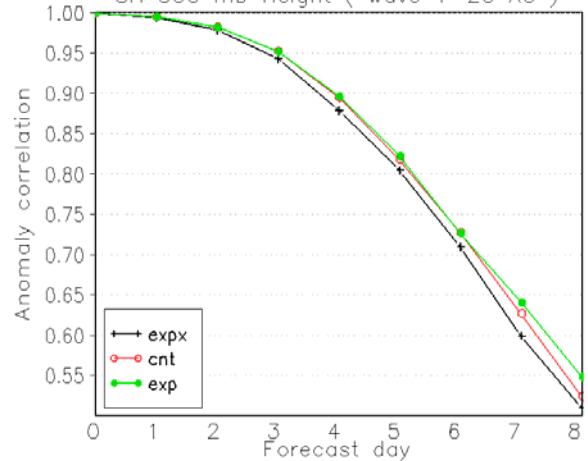
The wind is observed orthogonal to the satellite ground-track, pointing 35° off-nadir, away from the Sun. Observations are averaged over 50 km along the flight direction, and are spaced 200 km apart. (H)LOS means (horizontal) line of sight.



## Cosmic Corner

### Assimilation Algorithm Upgraded

AVERAGE FOR 00Z25MAR2008 - 00Z30APR2008  
SH 500 mb Height ( wave 1-20 AC )



Anomaly Correlation coefficients for: EXPX (without COSMIC), CNT (operations with COSMIC), and EXP (updated assimilation algorithm with COSMIC) forecasts of 500 mb height in the Southern Hemisphere extratropics.

The JCSDA has recently upgraded several components of the GPS RO assimilation algorithm in NCEP's Global Data Assimilation system, resulting in improved model skill in the Southern Hemisphere and Tropical latitudes.

Anomaly Correlation scores for the 500 mb geopotential heights as a function of the forecast day are shown in the figure for three different experiments EXPX (without COSMIC), CNT (operations - with COSMIC), and EXP (updated assimilation algorithm - with COSMIC) for the Southern Hemisphere extratropics. The benefits of using COSMIC in EXP are already obvious at the short-range forecasts. The steady decrease in model skill when COSMIC is removed from the observing system (EXPX) extends to the longer-range forecasts. There is ~8 hr decrease in forecast skill at day 4 that grows to ~15 hr at day 7 when COSMIC data are removed. Results are statistically significant at the 95% confidence level. Overall, EXP, with its updated assimilation algorithm, performs better than CNT, and adds ~4.5 hr in forecast skill at day 7. Differences between EXP and CNT are statistically significant at the 95% confident level starting at day 5. For the period evaluated in this study, the impact of COSMIC was found to be neutral in the Northern Hemisphere extratropics, probably due to the larger number of observations already being assimilated. To provide a rough estimate of the percentage of COSMIC observations being



assimilated in the operational suite (CNT), of the total of 6,321,520 satellite observations that were globally assimilated in April 2008, COSMIC only accounted for 3.6%. The upgraded assimilation system also results in reduced errors in high-level and low-level tropical winds.

The changes implemented in the RO assimilation algorithm in EXP are:

- Improved Quality Control system
- More accurate representation of observational error
- More accurate forward model

### Upcoming Meeting

"GNSS Radio Occultation Workshop in Pasadena, CA, April 7-9, 2009" sponsored by JPL, NOAA and UCAR. The purpose of the meeting is to develop documents to help guide future operational and research radio occultation missions. Additional details are at <http://gnssro.geolinks.org/>. JCSDA's Lidia Cucurull has been invited to give a talk on the NOAA/NCEP perspective for GPS/RO data.

### Visiting Scientist



Yen-Chih Shen of the Taiwanese Central Weather Bureau (CWB) recently joined the JCSDA for a 10-month visit as part of the U.S.-Taiwan collaboration on the COSMIC mission. Yen-Chih will work on a project established by JCSDA, the CWB, and UCAR on the assimilation of GPS radio occultation data using the NCEP/JCSDA GSI assimilation algorithm. The main

objective is to accelerate and enhance the assimilation of GPS RO data in the regional and global numerical weather prediction systems at CWB and to accelerate the operational use of COSMIC data in NCEP's regional forecast system.

Yen-Chih received Bachelor's and Master's degrees in the Atmospheric Sciences from the National Taiwan University (NTU) in 2005 and 2007, respectively. His research work focused on the use of a shallow water model to understand the vortex interaction, structural change and spinup effect of typhoons. After graduating from NTU, he joined the CWB where he contributed to the maintenance and development of the global forecast and data assimilation systems (Lidia Cucurull, JCSDA)



### New Ensemble Kalman Filter Data Assimilation System

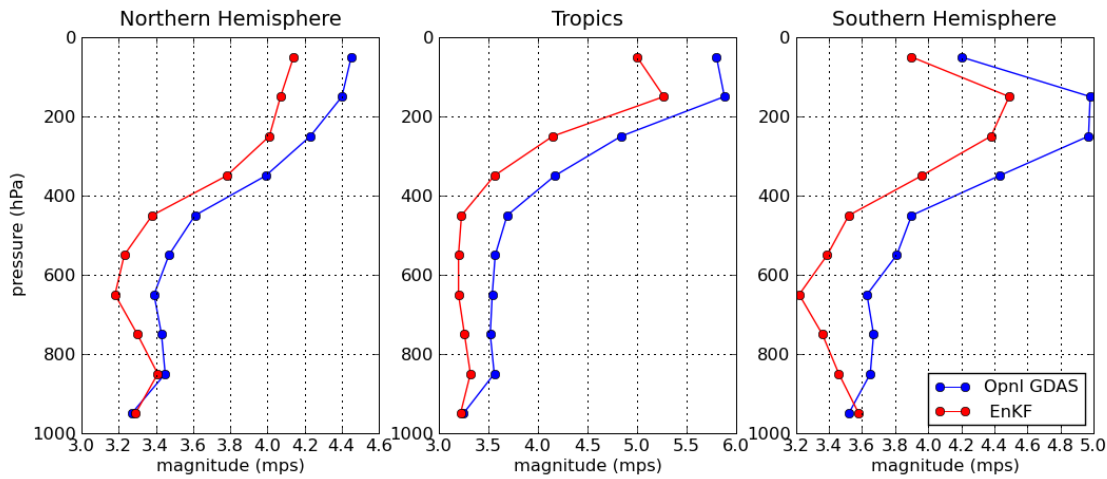
As part of a NOAA-THORPEX-funded collaborative project, an ensemble Kalman Filter (EnKF) data assimilation system has been developed for use with the NCEP Global Forecast System. The EnKF is a nonlinear, Monte-Carlo application of the Kalman Filter equations, and is a potential alternative to 4D-Var, which solves the same problem using variational minimization techniques. The EnKF utilizes short-range ensemble forecasts to produce flow-dependent background-error covariance estimates required for four-dimensional data assimilation. However, it does not require a linearized version of the forecast model or forward operator, or their adjoints. But, unlike variational methods, sampling error in the estimation of the background-error covariance must be accounted for. Accounting for these errors with ~50 ensemble members is one of the main challenges of EnKF research. Both the EnKF and 4D-Var are similar in computational expense.

NOAA's partners at the University of Maryland, Naval Research Lab/Monterey, Colorado State University, and NCAR have all contributed to the development of a software system for running the EnKF with the NCEP GFS model as part of the NOAA THORPEX initiative. This software, freely available for download by the research community ([tinyurl.com/cuoz9t](http://tinyurl.com/cuoz9t) ; [Jeffrey.s.whitaker@noaa.gov](mailto:Jeffrey.s.whitaker@noaa.gov) for more detail), serves as both a research platform and a candidate for future operational implementation at NCEP. One of the more recent additions to the software is an algorithm developed by Takemasa Miyoshi of the University of Maryland for online, adaptive bias correction of satellite radiances, similar to the "VarBC" algorithm now used at NCEP and ECMWF.

Below is a plot showing the fit of 6-hour forecasts to in-situ wind observations for the EnKF and the operational NCEP GDAS system for December 2007. All the satellite radiances assimilated in the operational GDAS system in December 2007 were assimilated into the EnKF system, which was run with 64 ensemble members at a spectral resolution of T190 (the operational GDAS system was run at T382).



**Wind Speed Differences: Observed Minus Forecast**



Vertical profiles of the RMS difference between six hour forecasts and in-situ observations for the period 2007120700 – 2008010718. Observations are aggregated in 100 hPa layers. The red curve is for the ensemble mean of the experimental 64-member T190 EnKF system, and the blue curve is for the T382 GSI-based GDAS system operational in December 2007.

The EnKF system is currently undergoing active development at the NOAA Earth System Research Lab in Boulder, and will be formally evaluated by a panel of scientists from NOAA, NASA, and several universities, alongside both the current operational NCEP GSI system and the new 4D-Var GSI system developed at NASA/GMAO. One of the goals of this evaluation will be to provide NCEP with guidance on how to proceed with the eventual operational implementation of a fully four-dimensional data assimilation system.

A primary objective of ongoing THORPEX research in the coming years will be how to combine 4D-Var and EnKF techniques in order to leverage the strengths of each method to provide a system that performs better than either one separately.

**Third International THORPEX Science Symposium**

The Third International THORPEX Science Symposium will be held from 4-8 May 2009 in Monterey, CA. Please see [tinyurl.com/cahbmz](http://tinyurl.com/cahbmz) for more details. (Tom Hamill, NOAA/OAR)

**JCSDA Science Workshop**

The 7th annual JCSDA Science Workshop will be held May 12-13, 2009, at the University of Maryland at Baltimore County (UMBC). The purpose of these Workshops is to review the ongoing and planned scientific development sponsored by the Center and to plan and coordinate future efforts. To provide adequate visibility to both management-level presentations from the JCSDA partners and to contributed material, the format of the Workshop has changed with respect to previous years. More time will be devoted to plenary and poster sessions, and the break-out sessions will be limited to relatively short group discussions of the plans and progress for the six science priority areas.

- Radiative transfer
- Clouds and precipitation
- Advanced instruments
- Land data assimilation
- Ocean data assimilation
- Air quality data assimilation



## A Note from the Director

One of the constant challenges for the Joint Center is to find ways of improving the collaboration among the scientists working for the six JCSDA partner organizations. As a relatively new initiative in this area, the Joint Center has created Working Groups consisting of scientists from each partner (members from non-JCSDA organizations can be added where appropriate). Each Working Group is responsible for the exchange of information and coordination among scientists working in a particular subject area, and judging from the initial meetings the format is off to a very successful start. Each Working Group has two co-chairs, typically representing different agencies. The co-chairs will be reporting to JCSDA management on the activities of their groups and they will be well positioned to help map out future directions for JCSDA activities within their areas. At this point, three Working Groups are active, responsible for the Community Radiative Transfer Model, Microwave Sensor Assimilation, and Hyperspectral Infrared Sounding. Additional Working Groups to be established in the near future include Ocean Data Assimilation, Atmospheric Constituents, and GPS Radio Occultation.

As many of you already know, the External Research Program under the Federally Funded Opportunity has been under tremendous budget pressure, and we were therefore unable to issue a call for new proposals for Fiscal Year 2009. I view this as a very unfortunate situation that severely limits the ways in which the Joint Center partners can engage with the external research community. I am doing everything I can to address the funding situation with our sponsoring agencies, and at this point I am optimistic that we will be able to resume issuing annual calls for new proposals from FY 2010 onwards.

The annual JCSDA Science Workshop will take place at UMBC on May 12-13 as mentioned elsewhere in this newsletter. In spite of the temporary hiatus of the FFO mentioned above, we still have a number of funded projects – both internal and external – for which progress needs to be reported and discussed. This is also the main scientific venue where directions for future funding opportunities will be discussed. I hope that many of you will take the opportunity to come to Baltimore to learn about both internal and external JCSDA work and provide your input to the discussions.

Training and entrainment of young scientists who can help the JCSDA partners move forward is an important part of our

overall activities, and I am very enthusiastic about the upcoming JCSDA Summer Colloquium on Data Assimilation to be held July 7-17 in Stevenson, WA. The Organizing Committee chaired by Dr. Wayman Baker has done a tremendous job in putting together a program that allows for a comprehensive overview of the field given by a world-class roster of lecturers. We deliberately chose a setting that while easily accessible by air travel is both attractive and remote enough to force the organizers and lecturers out of their daily routine for at least a couple of days. We hope that this will also help stimulate the informal interaction between participants and lecturers, and we look forward to what will hopefully be a fruitful and memorable event both for the participating graduate students and early career scientists and for us in the Joint Center.

Lars Peter Riihøjgaard, Director, JCSDA

## Visiting Scientist Opportunity

The JCSDA announces a new Visiting Scientist Program in satellite data assimilation. The program is sponsored by UCAR, in cooperation with the Air Force Weather Agency (AFWA), and the positions are tenable at the JCSDA in Camp Springs, Md. Applications are being sought for research scientists interested in advancing satellite data assimilation techniques in numerical weather prediction (NWP) and land surface modeling, and transitioning these improvements into the operational community-supported weather models run at the AFWA.

For further details and application information see:

[http://www.vsp.ucar.edu/opportunities/AFWA\\_JCSDA.html](http://www.vsp.ucar.edu/opportunities/AFWA_JCSDA.html)

## Outlook for Next Quarter

### Update on JCSDA Summer Colloquium on Data Assimilation

Plans are being finalized for the upcoming JCSDA Summer Colloquium on Data Assimilation, scheduled to be held July 7 - 17, 2009, in Stevenson, Washington. The objective of the Colloquium is to foster the education of the next generation of data assimilation scientists. As of April 3, 2009, there are 37 students/postdocs and 20 lecturers confirmed. The students/postdocs represent a cross-section of universities and research organizations in the United States, Australia, Austria, France, Germany, Taiwan, and The Netherlands. The lecturers are internationally recognized experts in data assimilation in the United States and Europe, with all of the JCSDA Partners participating. (Wayman Baker, Chair, Colloquium Organizing Committee)



## Upcoming Events

- GNSS Radio Occultation Workshop, April 7-9, 2009, Pasadena, CA.,
- Third International THORPEX Science Symposium, May 4 – 8, 2009, Monterey, CA
- JCSDA 7<sup>th</sup> Annual Science Workshop, May 12-13, 2009, University of Maryland at Baltimore County (UMBC)
- Lidar Working Group Meeting, June 16 – 19, 2009, Wintergreen, VA
- JCSDA Summer Colloquium on Data Assimilation, July 7 – 17, Stevenson, WA

## JCSDA 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 presentation and off-site personnel may listen in via conference call. A complete listing of past and future seminars is at the above web-site.

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](mailto:George.Ohring@noaa.gov).

<i>Date</i>	<i>Speaker</i>	<i>Affiliation</i>	<i>Title</i>
<i>April 21, 2009</i>	Steve Fletcher	Colorado State University	Non-Gaussian Data Assimilation Methodologies
<i>April 23, 2009</i>	Erland Källén	Stockholm University	The Vertical Structure of Arctic Warming
<i>May 20, 2009</i>	Jonathan Case	NASA MSFC SPoRT	A Sensitivity Study of the Operational NSSL WRF Using Unique NASA Assets
<i>June 17, 2009</i>	Gary Jedlovek	NASA MSFC SPoRT	High-Resolution MODIS / AMSR-E Composite SST for Diagnostic and Regional Weather Prediction Studies
<i>June 30, 2009</i>	Wayman Baker	JCSDA	Concept for a U.S. Space-Based Wind Lidar: Status and Current Activities