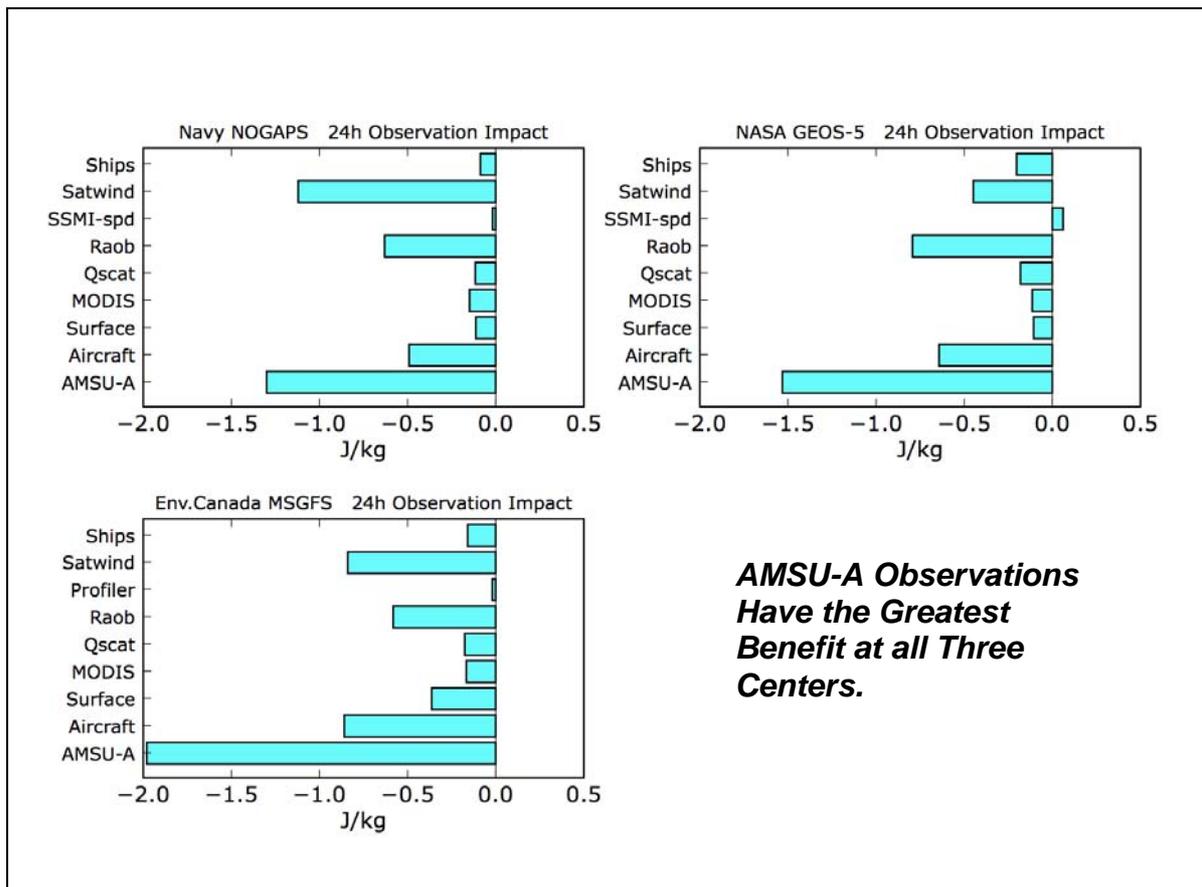


News in This Quarter Science Update

Impact of Different Observation Types on Forecasts at Three NWP Centers



**AMSU-A Observations
 Have the Greatest
 Benefit at all Three
 Centers.**

Daily average impacts of various observation types on the 24-hr forecasts from 00 UTC and 06 UTC combined during January 2007 in Navy NOGAPS (top left), NASA GEOS-5 (top right) and Environment. Canada MSGFS (bottom left). The units are J/kg. Negative values indicate forecast improvement.

An adjoint-based approach is used to compare the impact of different observations on 24-hr forecasts of three NWP systems: the Navy Operational Global Atmospheric Prediction System (NOGAPS) of the Naval Research Laboratory, the Goddard Earth Observing System (GEOS-5) of the NASA Global Modeling and Assimilation Office, and the Meso-Strato Global Forecast System (MSGFS) of Environment Canada. With this technique, first developed at NRL, the impacts of all observations are computed simultaneously from a single execution of the system, allowing results to be easily aggregated according to data type, location, satellite sounding channel, or other attribute.

The technique is highly economical as compared with running multiple data denial or observing system experiments (OSEs), but its accuracy is generally limited to forecast ranges of 1-3 days.

The figure shows impact results for a “baseline” set of observations assimilated by the participating centers during January 2007, in terms of a global error norm. The norm combines errors in wind, temperature and surface pressure into a single measure with units of energy per unit mass (J/kg). Negative values indicate that assimilation of a given observation type has improved the forecast. The NOGAPS



and GEOS-5 results were produced using 3D-Var data assimilation, while the MSGFS results were produced using 4D-Var. Despite these and other differences, the impacts of the major observation types are similar in each forecast system in a global sense. Large forecast error reductions are provided by AMSU-A radiances, satellite winds, radiosondes and commercial aircraft observations. Other observation types provide smaller impacts individually, but their combined impact is significant. The results are consistent with those obtained from (previous) OSEs, which typically focus on the medium-range. The small non-beneficial impact of SSM/I wind speeds in GEOS-5 has been traced to a deficiency in that system which has since been corrected. Also note that NOGAPS and GEOS-5 assimilate SSM/I wind speeds while MSGFS assimilates profiler winds, but both data types have little impact globally.

Regional aspects and other details of these results, such as the impact per-observation for a given data type, can vary significantly from one forecast system to another as a result of the number of observations assimilated and the quality control procedures used. It turns out, however, that in all forecast systems only a small majority (less than 54%) of the total number of observations assimilated actually

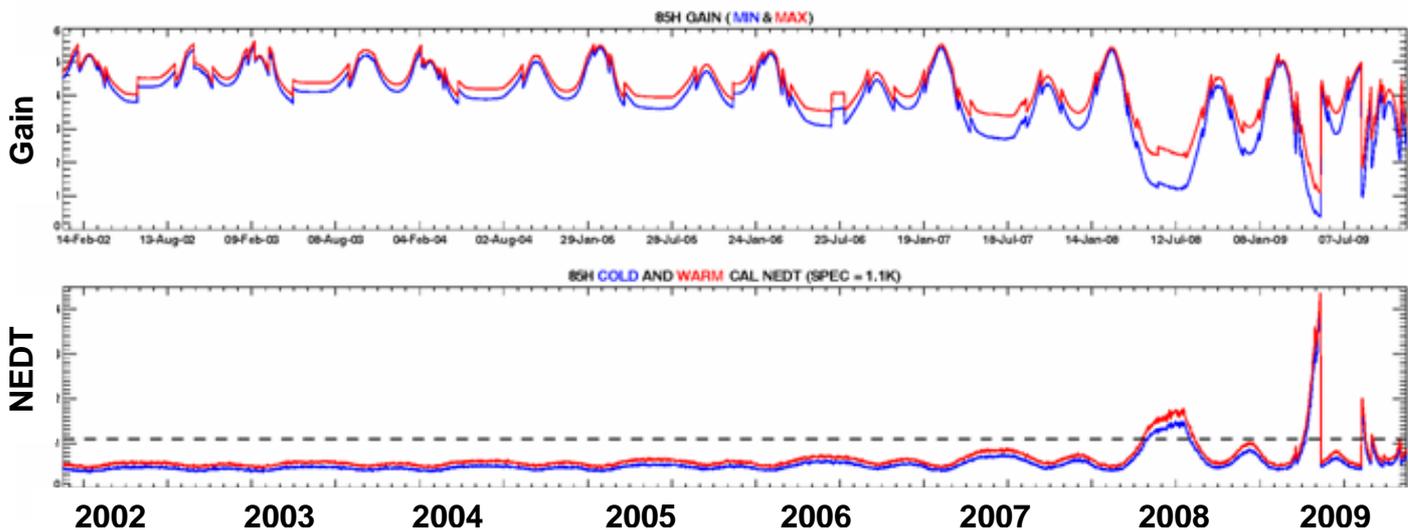
reduces the global 24-hr forecast error, and most of the reduction comes from a large number of observations that have relatively small individual impacts. Both findings point to the advantage of increasing the number of observations assimilated and to the potential benefit of having some level of redundancy between observing systems. Accounting for this behavior may also be important when considering strategies for deploying adaptive components of the observing system.

This is the first stage of an experiment to directly compare the impacts of observations in different forecast systems as part of a THORPEX initiative to quantify the value of observations provided by the current global observing network in terms of numerical weather prediction. It is anticipated that future experiments in this inter-comparison project will include more recent observation types such as AIRS, GPS and IASI, forecast metrics that better represent the impact of moisture observations, and results from other forecast systems.

(Ron Gelaro, NASA Global Modeling and Assimilation Office; Rolf Langland, Naval Research Laboratory; Simon Pellerin, Environment Canada; and Ricardo Todling, NASA Global Modeling and Assimilation Office)

SSM/I Instrument Rescued

F-13 SSM/I Calibration Stats 1 Jan 2002 - 18 Nov 2009



Time series of gain (upper panel, blue: min, red: max,) and noise (NEDT, lower panel, blue: cold target, red: warm target) of the SSM/I. The specification for the noise is 1.0 K, indicated by the dashed line.

For almost 15 years, the F-13 Special Sensor Microwave/Imager (SSM/I), built by the United States Air Force Defense Meteorological Satellite Program (DMSP) System Program Office (SPO) has measured ocean surface wind speed, rainrate, total precipitable water, sea ice, and snow cover, and monitored tropical cyclones globally. In May 2009, Naval Research Laboratory scientists detected a precipitous drop – from 4-5 to about 0.5 counts/K - in the receiver gain of the 85H channel (see figure), pointing

toward imminent failure of the longest performing US operational satellite passive microwave imager. Over the course of the following week, the NRL team took a series of mitigating actions that saved the sensor, brought it back to normal operating levels, and maintained continuity in the critical environmental data records that it provides.

The F-13 SSM/I had continued to meet specification until recently, when over-heating and aging of the 85GHz vertical

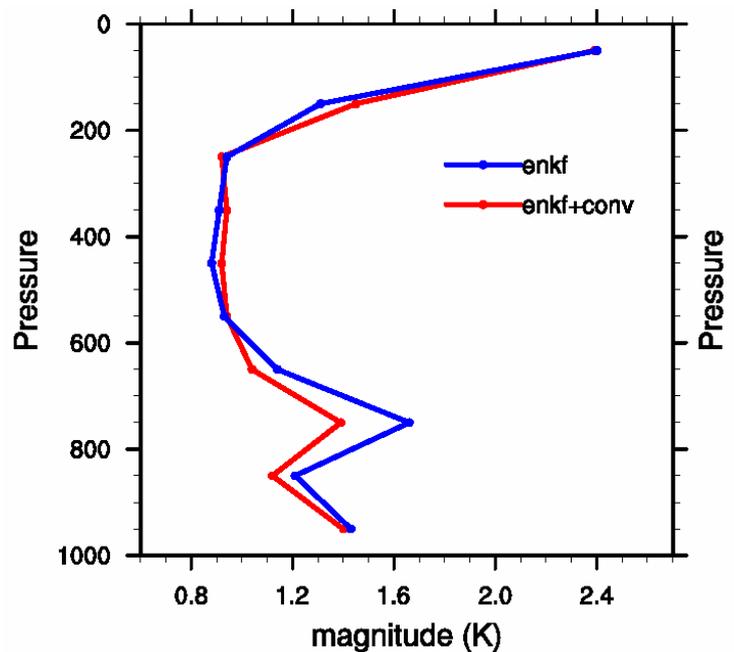


and horizontal polarization high frequency receiver channels caused degradation. For example, the time series of the min/max receiver gain of the 85H channel from 1 January 2002 to 20 June 2009 (see figure) shows the long-term increase in sensitivity to the annual seasonal orbital heating extremes, 283 to over 313 K and the precipitous decrease in gain and attendant increase in noise (NEDT0) in May 2009.

The DMSP SPO coordinated the response by a team consisting of NRL, the Air Force Weather Agency (AFWA), the Fleet Numerical Meteorological and Oceanography Center (FNMOC), NOAA's Spacecraft Operation Command Center (SOCC), Aerospace Corporation, and Lockheed Martin in a period of less than 1 week that resulted in saving the F-13 SSM/I instrument from continued overheating and imminent instrument failure. The F-13 spacecraft's solar array was repositioned to shadow the SSM/I instrument and reduce the amount of solar radiation and instrument temperature. The SSM/I sensor immediately returned to normal operating performance levels with all data products and imagery then back in sync. Due to F-13's orbital characteristics the solar array was adjusted again several months later to ensure sufficient battery power, once again resulting in enhanced SSM/I electronics solar heating, but at reduced levels than originally experienced. Finally, the solar array was stowed in the "nominal" position in September 2009 and SSM/I performance remained well within specification.

(Steve Swadley, Jeffrey Hawkins and Gene Poe, Naval Research Laboratory, Monterey CA; Dex Y. Landreth, Capt. USAF, Defense Meteorological Satellite Squadron, El Segundo CA; Eun-Sung Park and Donald J. Boucher, The Aerospace Corporation, El Segundo CA; Troy von Rentzell, Enzo Uliana and Beverly Gardiner, Interferometrics Inc., Herndon VA)

Over the past three years, a study sponsored by the NOAA THORPEX program has been carried out at NOAA/ESRL to investigate the potential of representing uncertainties of sub-grid convection through stochastically permuting various closure assumptions and perturbing associated parameters in a sub-grid convection parameterization scheme developed based on the Grell-Devenyi (2002) scheme. This scheme, similar to that used in the GFS model, is a deep convection parameterization scheme based on equilibrium statistics. It allows for a stochastic ensemble of convective plumes with inherently small sample size, leading to significant dispersion of some underlying probability distribution of sub-grid convection.



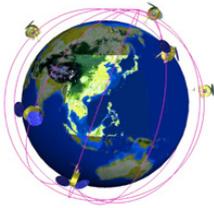
Root-mean-square error (RMSE) for the 6-h global tropical temperature forecasts as a function of altitude averaged between 20°S and 20°N for the period 14-21 Dec 2007. Blue lines are for the control forecast from the default NOAA/ESRL EnKF data assimilation system while red lines are for the forecast from the same data assimilation system with the stochastic representation of sub-grid convection.

Effect of a Stochastic Convection Scheme on Ensemble Forecasts

A major problem in ensemble prediction systems and ensemble Kalman filters (EnKFs) is insufficient spread between ensemble members; the ensemble's spread (its standard deviation about the mean) is smaller than the ensemble RMS error; the two should be consistent. The forecast uncertainty we seek to quantify with ensemble predictions has two general sources: (1) chaos, estimated by running ensembles from slightly different initial conditions, and (2) model uncertainty, manifested in the drift of the model climate from the atmosphere's climate. One remedy for model uncertainty is to build a better model, with more advanced physics, better numerics, and higher resolution. However, there is another source of model uncertainty, the use of deterministic parameterizations of sub-grid processes. A fundamentally appealing way to account for the model uncertainties due to the missing sub-grid processes is to develop a representation of stochastic uncertainties in sub-grid physics parameterization schemes.

In a preliminary evaluation example, the ensemble Kalman filter data assimilation system was run at the resolution of T126 for the period of one month (Dec 2007) with 6-h cycling, with and without stochastic convection. The figure shows the root-mean-square error (RMSE) for the 6-h global tropical temperature forecasts averaged between 20°S and 20°N from this experiment for the period 14-21 Dec 2007; the reference data are the in-situ temperature observations that were used in the update. The extra ensemble spread added by the stochastic representation of sub-grid convection led to an improvement in the 6-h temperature forecast of the lower troposphere.

(Tom Hamill, OAR; For more information on this project, contact Jian-Wen Bao, Jian-Wen.Bao@noaa.gov)



Cosmic Corner:

A record number of scientists from institutions around the world presented their latest results on research and operational uses of GPS-Radio Occultation (GPS-RO)

observations at the Fourth Formosat-3/COSMIC Data Users Workshop in Boulder, CO, 27-29 October 2009. Talks covered GPS-RO applications to the planetary boundary layer, climate, and atmospheric retrievals; impact studies with regional and global NWP models; and current and future RO missions. Following the Workshop, the status of the current COSMIC constellation and possibilities for a future RO capability were discussed at a COSMIC retreat, with participants from UCAR and NOAA.

At the JCSDA, positive impact test results have been obtained with MetOp/GRAS and GRACE-A RO satellite observations; a final real-time parallel run with these two RO sensors is scheduled for early 2010. In addition, the JCSDA has initiated evaluation of TSX and SAC-C RO measurements and the use of GPS-RO to evaluate and characterize possible biases associated with aircraft data. The aircraft results are similar to those obtained by ECMWF, thus reinforcing the need to bias-correct aircraft temperature measurements in the data assimilation systems.

Yen-Chih Shen, the first JCSDA visitor from the Central Weather Bureau (CWB), returned to Taiwan in late December. During his visit, he worked on the assimilation of GPS-RO observations in NCEP's regional data assimilation system. This work was conducted as part of a collaborative project between the CWB and NOAA on the use of GPS-RO observations. A second visitor, Yu-Chun Chen, arrived at the JCSDA in October (see People section, this issue). He will support work on the assimilation of GPS-RO data into NCEP's global and regional data assimilation systems.

(Lidia Cucurull, JCSDA)

People

Community Radiative Transfer Model Team Receives NOAA Award

Drs. Yong Han and Fuzhong Weng (NESDIS/STAR), and John Derber (NWS/NCEP) received the 2009 NOAA Administrator's Award for improving the accuracy of weather forecasts by developing new and powerful radiative transfer models and techniques to assimilate advanced satellite data. The award was presented by NOAA Administrator Jane Lubchenko at a ceremony on October 1 2009.



Left to right: Yong Han, NOAA Administrator Jane Lubchenko, Kathy Kelly, Director of Satellite Operations, NOAA/NESDIS, and Fuzhong Weng (Not present: John Derber)

The Community Radiative Transfer Model Team (CRTM) developed new and powerful radiative transfer models and techniques to assimilate advanced satellite data into the NWS/NCEP global forecast system to meet NOAA's mission goals for serving society's need for weather and water information. The team overcame the following challenges in new science and technology:

- Creating a computer code accurate enough and fast enough to assimilate the data from advanced hyperspectral infrared instruments, which have thousands of spectral channels of observations
- Separating the influence of land surface effects from atmospheric properties in the microwave (AMSU) and IR (AIRS and IASI) satellite observations to facilitate assimilation of increasing amounts of atmospheric data
- Developing methods to extend the capabilities of the radiative transfer model beyond the clear sky case - i.e., only the effects of atmospheric gases - to include clouds, precipitation and aerosols
- Integrating contributions from NOAA and external scientists into a community radiative transfer model (CRTM)
- Transferring the CRTM to other U.S. agencies - U.S. Navy, U.S. Air Force, and NASA - NOAA's partners in the Joint Center for Satellite Data Assimilation (JCSDA)

With strong collaboration between NESDIS and NWS, as well as support from JCSDA and external community scientists, the Team developed, tested and implemented the CRTM into the NWS/NCEP global forecast system (GFS) in the extraordinarily short period of 1-2 years. The new capabilities to assimilate the advanced hyperspectral IR observations and more atmospheric observations over land have resulted in large positive impacts on weather forecasts, increasing forecast accuracy and extending the useful range



of medium range predictions by almost half a day. Transfer of the CRTM technology to NOAA's JCSDA partners enabled the U.S. Navy, U.S. Air Force and NASA to improve their own data assimilation and forecast systems. And, the advanced CRTM, with modules for clouds and precipitation, paves the way for a next generation of assimilation models that will assimilate clouds and precipitation and improve storm prediction.

The Administrator's Award is a combination honorary and monetary award designed to recognize NOAA-specific contributions in areas ranging from scientific research to policy development.

Welcome Aboard, Yu-Chun



Yu-Chun Chen recently joined the JCSDA for a one-year visit as part of the NOAA and Taiwan Central Weather Bureau (CWB) collaboration on GPS-RO observations. He is the second Taiwanese visitor under this program and during his stay will support

work on data assimilation of GPS-RO observations.

Yu-Chun obtained his bachelor's and master's degrees in Atmospheric Science at the Chinese Culture University, Taipei, Taiwan. His master's thesis focused on numerical simulation of the interaction between the atmosphere and ocean. After receiving his master's degree, he joined the Central Weather Bureau, where he worked on data assimilation and global forecasting. In addition to his full-time research assistantship at the Central Weather Bureau, he is also a part-time Ph. D. student at the Graduate Institute of Atmospheric Physics at the National Central University.

Opportunities

JCSDA Short Term Visiting Scientist Program

The Joint Center for Satellite Data Assimilation announces a new short-term visiting scientist program for Fiscal Year 2010 (starting October 1st 2009). Scientists from institutions of higher education and other nonprofits; for profits; international organizations; foreign institutions, state, local and Indian tribal governments; and Federal agencies are invited to apply for an appointment of up to 3 months to work on qualifying projects with scientists at the JCSDA. Proposed work should be in the areas of data assimilation, radiative transfer, transition to operations of new science and new sensors or improvements to existing

sensors, or any other project jointly identified to be of value to the JCSDA by the host scientist and the visiting scientist. Interested scientists are encouraged to identify and coordinate with hosts scientists from JCSDA. This will help identify a commonly beneficial project to JCSDA and the visiting scientist. Positions are located in Camp Springs, MD. Complete information can be found at <http://www.jcsda.noaa.gov/visitingScientist2010.php>. There is no deadline for applying to this short-term visiting scientist program.

(Sid Boukabara, JCSDA)



A Note from the Director

A couple of interesting developments are in the works in the Joint Center and with a bit of luck 2010 could become a

transformational year for the organization. One of the new developments affects the external research program of the Center. Many of you know that the NOAA-administered JCSDA grants program is up and running again after a one-year hiatus. What perhaps is news to some of you is that in the future, the external research program will also include an option to issue contracts. This option is intended to be used for certain projects where the level of readiness for transition to operations is relatively high, and where specific deliverables are therefore both easier to define and desirable for both parties. You will hear more about this new element as we get closer to the actual announcement.

Another area of development is the JCSDA computing situation. It is widely recognized that the research community is able to generate ideas for many more good projects than we are able to fund. However, we in the Joint Center management often struggle with the lack of available computing resources even in those cases where we have been able to allocate funding. Almost one year ago, we convened the Second Meeting of the Joint Center Advisory Board, and the members of this board were very frank, to say the least, in their assessment of our computing situation. The report from this meeting has helped raise the visibility of this issue within the partner agencies of the Joint Center, and I am happy to report that we are now working aggressively with both NOAA and NASA to improve the access to high-end computing for both internal and external investigators funded by the Joint Center.

One of the roles of the Joint Center is to facilitate the flow of information between the operational data assimilation organizations and the external research



community, and arranging and/or participating in various meetings and workshops are important elements in fulfilling that role. It is my ambition that the Joint Center be in a position to host or co-host at least one flagship event every year, beyond our annual spring Science Workshop for the funded investigators. Last year we held our first Summer Colloquium, and this year we are looking forward to partnering with our colleagues at ECWMF in hosting the ECMWF-JCSDA Workshop on Clouds and Precipitation. For 2011 we are tentatively looking at a training event modeled on last year's Colloquium, and for 2012, I am working with WMO on having the Joint Center host the next WMO Workshop on the Impact on NWP of the Global Observing System. These Workshops take place every four years, and having attended the past three of the series I can say without a doubt that I consider them perhaps the most important meetings for many of our key areas of activities. All the previous Workshops were held in Europe, and I along with my colleagues in the JCSDA Executive and Management Oversight Board feel that the time has come for this country to host the next one.

Best wishes for a Happy New Year to all the readers of the JCSDA Newsletter!

Lars Peter Riishojgaard, Director, JCSDA

Outlook for Next Quarter

Upcoming Events

- 33rd meeting of the Working Group on Space-Based Lidar Winds, February 1-5, 2010, Destin, Florida. Contact Mike Hardesty <Mike.Hardesty@noaa.gov> or Lars Peter Riishojgaard <Lars.P.Riishojgaard@nasa.gov> if you are interested in participating or learning more about the meeting.

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. Off-site personnel may view and listen to the seminars via webcast and conference call. A complete listing of past and future seminars is at the above web-site.



Date	Speaker	Affiliation	Title
Jan. 6, 2010	Tomislava Vukicevic	NOAA/OAR/AO ML	Data Assimilation of Cloud-Affected Radiances
Jan. 13, 2010	Louis Garand	Meteorological Service of Canada	The Polar Communications and Weather Mission
Feb. 5, 2010	Erland Kaellen	Head of Research, ECMWF	TBD
Feb. 17, 2010	Jean-Luc Moncet	Atmospheric and Environmental Research	Radiative Transfer Modeling: Applications and Validation
March 24, 2010	Steve Goodman	NOAA GOES-R Program Senior Scientist	The GOES Lightning Mapper and Opportunities/Considerations for Assimilation of the Data into NWP Models

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.