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NEWS IN THIS QUARTER

SCIENCE UPDATE

Assessment of Ensemble Forecast Sensitivity to Observation (EFSO) Quantities for Satellite Radiances Assimilated in the 4DEnVar GFS

The Ensemble Forecast Sensitivity for Observation (EFSO) formulation (Kalnay et al. 2012) has been implemented at the National Centers of Environmental Protection (NCEP). For the Global Forecast System (GFS), this approach requires Ensemble Kalman Filter (EnKF) products as input, and it has been implemented within the current source code that provides EnKF functionality at NCEP (Ota et al. 2013 and Groff et al. 2017). As with the adjoint Forecast Sensitivity to Observation Impact (FSOI) approach (Langland and Baker 2004, Zhu and Gelaro 2008), EFSO capabilities effectively enable a simultaneous forecast impact estimate for any and all observations assimilated in a numerical weather prediction (NWP) system.

The EFSO formulation incorporates the relationship between Kalman gain and analysis-error covariance to construct observational increments that can be projected forward in time with a forecast model, enabling an estimate of the forecast impact due to assimilating individual observations. The ensemble of analyses resulting from the applicable EnKF update (Whitaker and Hamill 2002) can be used in the representation of analysis-error covariance, and accordingly the Kalman gain.

Based on EnKF output from a control low-resolution configuration of the four-dimensional

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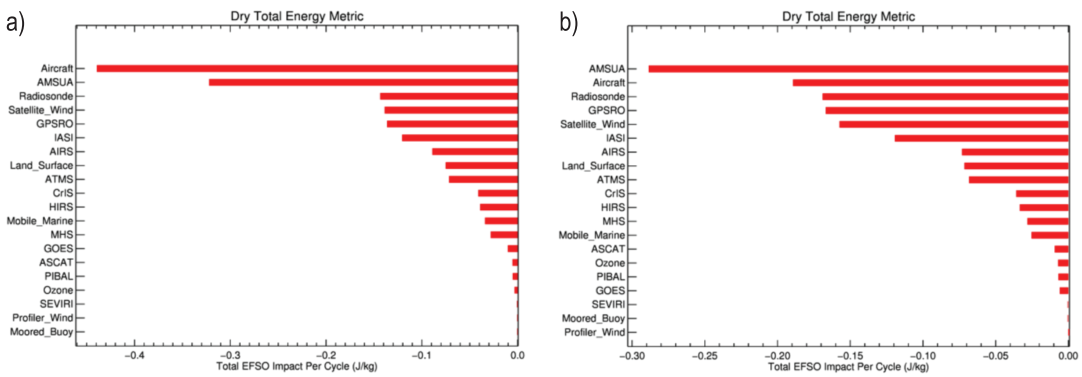

Figure 1. (a) EFSO dry total energy impact by observation type for the control 4DEnVar GFS; (b) same as (a) but for a configuration of the 4DEnVar GFS in which aircraft data are thinned.

ensemble-variational (4DEnVar) GFS, and an experimental low-resolution configuration of the 4DEnVar GFS in which aircraft data are thinned, two EFSO datasets are being generated for the retrospective time period December, January, and February 2014/2015. Thinning is done similar to radiances and other observation types for the EnKF. As with other standard forecast sensitivity-observation impact (FSOI) datasets, the EFSO quantities in these two datasets represent an estimate for the extent to which an assimilated observation has increased or decreased 24-hour forecast error. The forecast error metrics applied are dry total and moist total energy norms (Ehrendorfer et al. 1999). Self analyses are applied as verification for this EFSO dataset, but in general anything considered to be close to the truth relative to the relevant forecasts can be applied.

For the plots and maps in this article, note that negative EFSO quantities indicate that the assimilation of an observation (or subset of observations) decreased 24-hour forecast error; whereas positive EFSO quantities indicate that the assimilation of an observation (or subset of observations) increased 24-hour forecast error. On this basis, negative EFSO quantities will hereafter be referred to as beneficial and positive EFSO quantities will be referred to as detrimental.

Similar to the interpretation of adjoint Forecast Sensitivity to Observation (FSO) calculations (Zhu and Gelaro 2009), EFSO calculations represent an estimate of the forecast impact due to assimilating an observation in the context that all other observations have been assimilated. Therefore, the result of an observing system experiment (OSE) in which a subset of observations is removed has a different, but complementary, interpretation with respect to EFSO or adjoint FSOI approaches.

With this context in mind, EFSO total impact summary statistics are helpful in providing, among other insights, the extent to which an observing system is coincident with model forecast error sensitivity to initial conditions, approaches for specifying observation error, relative influence by observation type, and the spatial configuration of the full assimilated observing system. In a previous EFSO study for a pure EnKF configuration of the GFS (Ota et al. 2013), summary statistics were helpful in quantifying some of these overarching considerations for the GFS. Bar plots representing total EFSO suggested impact by observation type are indicative of the relative influences for an NWP system by observation type.

The extent to which EFSO/FSOI can be applied to identify observing system configurations that result in improved forecast skill

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5830 University Research Court
College Park, Maryland 20740

Website: www.jcsda.noaa.gov

is a matter of further investigation. It should be noted, however, that relative influence by observation type, and an observation type's value as it relates to forecast skill, are two distinct topics. Total impact bar plots by observation type for a one-week sample of the EFSO dataset corresponding to the control 4DEnVar GFS configuration, fig. 1, show a much larger relative influence from aircraft data with respect to satellite radiances than was reported in Ota et al. 2013. This change in the influence of aircraft data relative to satellite radiances is due to a large increase in the number of assimilated aircraft observations that occurred between 2013 and 2015. In particular, the availability of Aircraft Communications Addressing and Reporting System (ACARS) data for assimilation in the GFS increased substantially during this timeframe.

For the aforementioned experimental 4DEnVar GFS configuration that included thinning of aircraft data, the relative influence of aircraft data for the 4DEnVar GFS as suggested by EFSO calculations is more similar to that reported in Ota et al. 2013. Efforts intended to assess how the changes in the relative influence from aircraft data may impact forecast skill are underway. In conjunction with an FSOI interagency comparison study presented at the 97th AMS annual meeting (Auligne et al. 2017), further efforts to assess influence by observation type for the 4DEnVar GFS are planned.

It is relevant to note again that EFSO and FSO approaches effectively enable a simultaneous estimate of forecast impact for any and all observations assimilated. Taking advantage of the simultaneity aspect of EFSO, the suggested observation impacts can be sorted by conditional information. Based on a few-week sample of EFSO calculations

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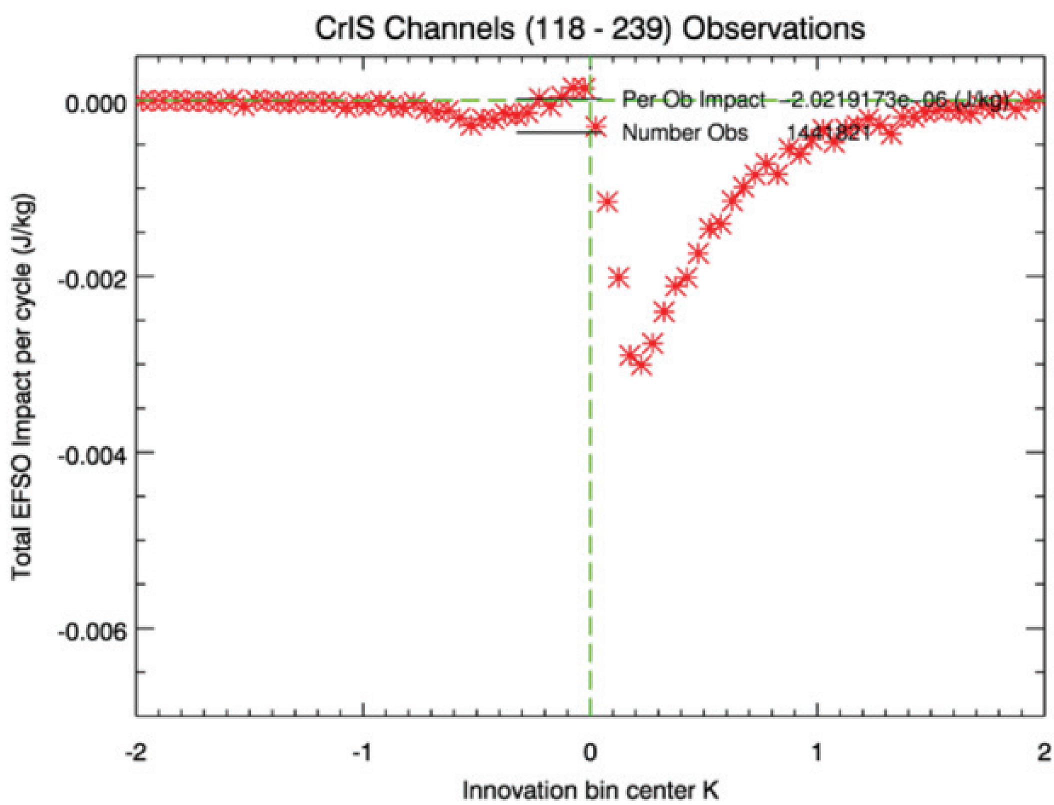


Figure 2. Total EFSO impact per cycle versus binned innovation for a subset of CrIS temperature sounding channels.

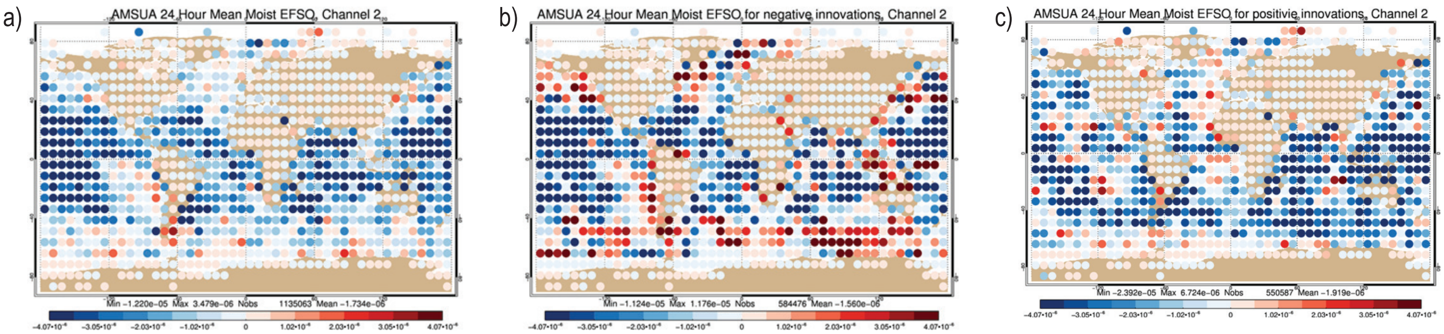
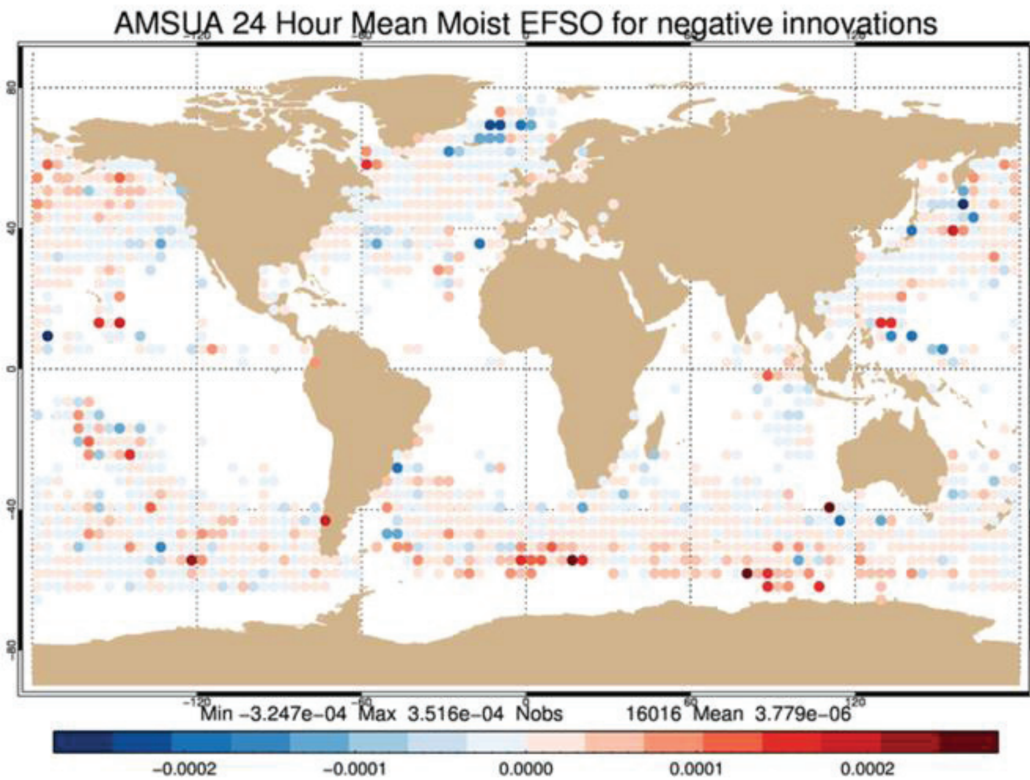


Figure 3. (a) 7.5 by 7.5 composite mean EFSO for all AMSUA channel 2 assimilated observations; (b) same as (a) but for negative innovations; (c) same as (a), but for positive innovations

Figure 4. 3.75 by 3.75 composite mean EFSO for assimilated AMSUA channels (6-8) coincident with background and retrieved Cloud Liquid Water (CLW) greater than .27 kg/m2. The map accounts only for negative innovations assimilated.



from the DJF 2014/2015 dataset, fig. 2 shows plots of binned bias corrected innovation versus total EFSO for a subset of CrIS temperature sounding channels. For the CrIS temperature sounding channels, there are notable asymmetries in EFSO-suggested impact with respect to innovation. In particular, positive innovations tend to be far more beneficial than negative innovations. The extent to which this result may reflect model bias, cloud contamination, forward operator errors, or situation-dependent limitations in the application of variational bias correction is a matter of further investigation.

For the same few-week sample, fig. 3 shows 7.5 by 7.5 composite maps of mean EFSO for AMSUA channel 2. In general, EFSO suggests that these observations are relatively problematic poleward of 40°N and 40°S (figure 3). Compos-

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ite mean EFSO maps by innovation sign, figs. 3b and 3c, indicate that the assimilation of negative innovations is particularly problematic over ocean surfaces poleward of 40°N and 40°S.

For the microwave radiances assimilated in the 4DEnVar GFS, it is also relevant to sort EFSO quantities based on cloud amount. Initial results indicate that the overall per-observation EFSO-suggested benefit for AMSUA temperature sounding channels is larger for cloud-affected radiances than for clear-sky AMSUA radiances. As indicated in fig. 4, however, assimilated negative innovations for AMSUA channels (6–8) tend to be detrimental when the coincident observed and background cloud liquid water (CLW) amounts are larger than .27 kg/m^2. Further investigation is necessary to determine how to utilize this conditional EFSO information in the 4DEnVar GFS.

Initial results indicate that EFSO detriment with respect to innovation sign has a strong dependence on conditional radiance bias-correction information. In the next quarter, 4DEnVar GFS experiments based on EFSO/FSOI guidance with respect to bias correction are planned, and the traditional Verification Statistics Data Base (VSDB) software package will be applied to assess forecast skill. In addition, efforts to better understand EFSO asymmetries with respect to innovation sign, and the relationship between EFSO quantities for microwave radiances and CLW, are ongoing.

David Groff (I.M. Systems Group, Inc., [IMSG] at NOAA/NCEP/EMC)

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Hybrid 4DVar Data Assimilation System

Scientists from the Marine Meteorology and Remote Sensing Divisions of the Naval Research Laboratory (NRL) developed and delivered a new hybrid ensemble-variational global data assimilation capability to the Fleet Numerical Meteorology and Oceanography Center (FNMOC) for operational use with the NAVy Global Environmental Model (NAVGEM; Hogan et al. 2014). The new Hybrid 4DVar system (NAVGEM v1.4) became operational at FNMOC on October 12, 2016.

The implementation of Hybrid 4DVar in NAVGEM (Kuhl et al. 2013) combines flow-dependent ensemble uncertainty with a static climatological background error covariance, allowing for more effective extraction of environmental information from the observations. This linear combination of static and flow-dependent error covariance models is expected to outperform either of the contributing covariance models alone (Bishop and Satterfield 2013), leading to more accurate environmental characterization and numerical weather forecasts.

The localized ensemble covariance matrix part of the Hybrid is derived from an 80-member NAVGEM ensemble of 3-hour forecasts using the approach outlined in McLay et al. (2010). The static, climatological part of the Hybrid covariance is based on the formulation described in Daley and Barker (2001).

To the extent that the Hybrid background error covariance model is closer to the true

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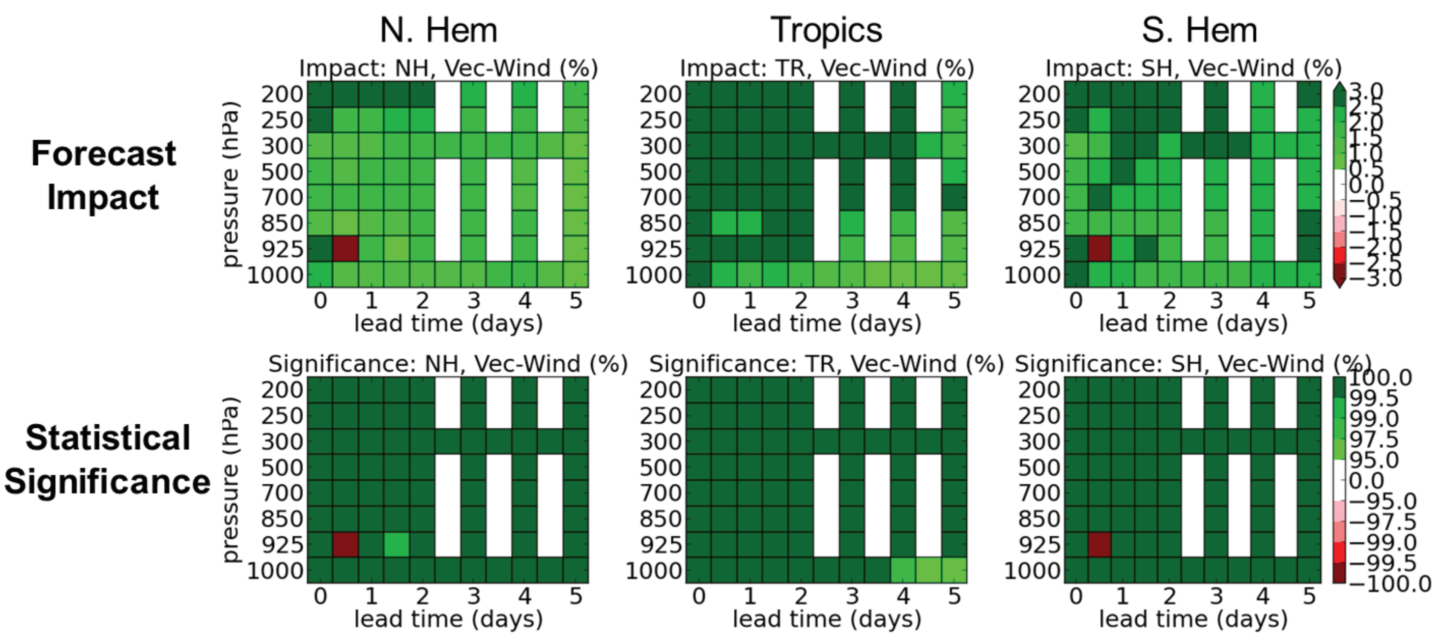

Figure 1. *Comparison of Hybrid 4DVar versus 4DVar for Vector Wind RMS verified against ECMWF analysis fields for an ensemble weight of α =0.25, for Oct. 10, 2014, through Jan. 7, 2015. Green shading indicates Hybrid 4DVar is better while red shading indicates 4DVar is better.*

flow-dependent error covariance matrix, it enables better weighting of the observations and the model short-term forecast in the data assimilation process. Without properly representing magnitude and spatial structure for both sources of error, we cannot effectively exploit many of the observations from current and future observing systems. This is especially important for remotely sensed observations that are nonlinearly and indirectly related to the model state variables—e.g., satellite radiances and global navigation satellite system (GNSS) radio-occultation measurements.

The Hybrid 4DVar capability was developed as a component or option within the NRL Atmospheric Variational Data Assimilation System Accelerated Representer (NAVDAS-AR) data assimilation system (Rosmond and Xu 2006, Xu et al. 2005) and the operational ensemble forecasting system (McLay et al. 2008 and 2010). The operational ensemble is based on a local formulation of the Bishop and Toth (1999) Ensemble Transform technique and features a short-term cycling ensemble of 80 members generated at the analysis resolution of T119 (approximately 100 km).

Most hybrid operational systems use the extended control variable form of hybrid ensemble assimilation (originally proposed by Lorenc 2003). Due to our observation-based DA system, we can use a different form proposed by Hamill and Snyder 2000. These two forms were proven to be mathematically equivalent in Wang et al. 2007. In our implementation, the background error covariance matrix $\mathbf{P}_0^b$ takes the form

$$\mathbf{P}_0^b = \left(\mathbf{I}-\alpha\right)^{1/2}\mathbf{P}_{static}^b\left(\mathbf{I}-\alpha\right)^{1/2} + \alpha^{1/2}\mathbf{P}_{flow}^b\,\alpha^{1/2} \quad (1)$$

where $\mathbf{I}$ is the identity matrix and α is a diagonal matrix whose elements are positive scalars between zero and 1. The Hybrid form given by (1) allows for the possibility of spatially varying weights for the static and flow dependent of the covariance model. If all of the elements of α equal zero, then $\mathbf{P}_0^b$ is identical to $\mathbf{P}_{static}^b$ (i.e., 4DVar); however, if all of the elements of α are equal to 0.5, then $\mathbf{P}_{static}^b$ and $\mathbf{P}_{flow}^b$ are weighted equally. Details on the horizontal and vertical ensemble covariance localization can be found in Kuhl et al. (2013).

The computational cost of applying $\mathbf{P}_{flow}^b$ to a vector was significantly reduced by applying the methods of Bishop et al. (2011). It was found that increasing the contribution of ensemble background error covariances in (1) increased the number of iterations required to meet the convergence criterion. For this reason, a conservative ensemble weight of 0.25 was selected for the initial operational implementation.

Hybrid 4DVar significantly improves the NAVGEM analysis and forecast quality and skill throughout the atmosphere and at all forecast lead times, as illustrated in Fig. 1. Both Hybrid 4DVar and 4DVar were cycled for 3 months and the resulting analyses and forecasts were verified against the TIGGE analyses from the European Centre for Medium-range Weather Forecasts (ECMWF), with TIGGE standing for The Observing system Research and Predictability Experiment (THORPEX) Interactive Grand Global Ensemble. The root mean squared (RMS) error comparisons for vector winds are summarized in Fig. 1, for forecasts out to 5 days (abscissa) versus pressure level (ordinate).

The top row of charts summarizes the per-

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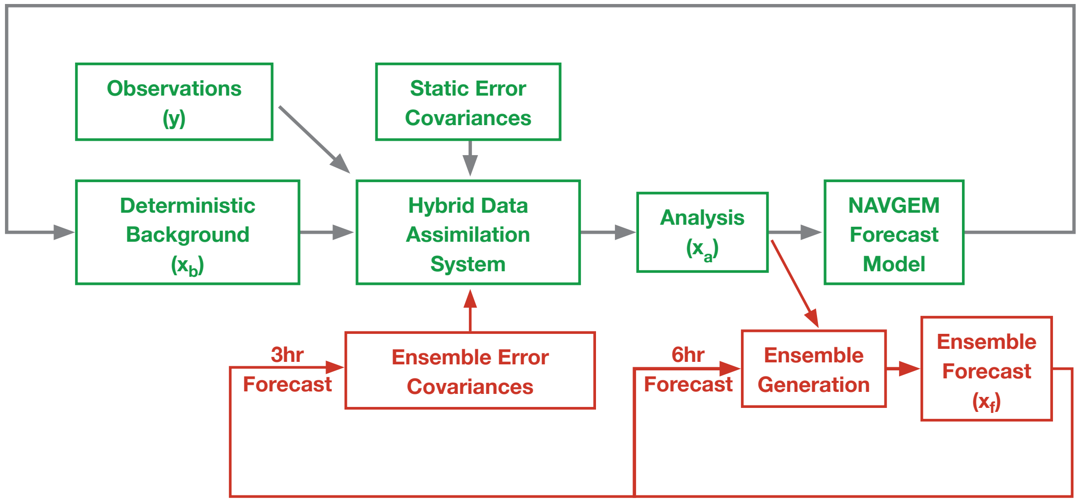

Figure 2. *Flowchart of Hybrid 4DVar system. The new components are shown in red.*

centage change in vector wind error, while the bottom row summarizes the statistical significance of the differences in percent. The three columns (left to right) are for the Northern Hemisphere (20°N to 80°N), Tropics (20°S to 20°N), and Southern Hemisphere (20°S to 80°S). Green shading indicates that Hybrid 4DVar has less error compared to ECMWF while red shading indicates that 4DVar has less error. Similar results were obtained for temperatures and verification against radiosonde. These results clearly demonstrated that Hybrid 4DVar outperforms 4DVar.

A flowchart of the Hybrid 4DVar system is presented in Fig. 2. All items in green are part of the original 4D-Var system; the items in red are the new Hybrid components. After the analysis state has been created, the ensemble is generated using the Ensemble Transform (ET) code, as shown by the red arrow from the analysis state pointing to the Ensemble Generation box in Fig. 2. The ET generates an ensemble of states at the analysis time centered on the analysis and with a combination of variances from the previous date-time group (DTG) 6-hour forecasted ensemble (as shown by the 6hr Forecast red arrow) and a prescribed analysis error variance (not shown on the flowchart). The covariance of the ensemble comes from the previous DTG 6-hour ensemble forecasts. The ensemble is then forecasted forward as shown in the box in the flowchart. The 3-hour ensemble forecasts are used to compute the initial ensemble error covariance for the Hybrid Data Assimilation System as shown by the red box below the Hybrid Data Assimilation System. This initial ensemble error covariance is combined with the initial static error covariance to form the hybrid error covariance.

Hybrid 4DVar is more computationally expensive than 4DVar, with most of the increased run time occurring during the four-dimensional minimization step. Typically, about 80 iterations are required for Hybrid 4DVar to meet the prespecified convergence criterion. This represents an increase of 10–15 iterations, or ~3 minutes wall time (using 96 processors on an IBM iDataPlex). An additional ~4 minutes are needed for ensemble I/O and computations, although these computations do not need to be run sequentially.

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Hybrid 4DVar uses the MPI2 standard to increase the efficiency of the model spectral history file input/output. This was essential for timely processing of the ensemble members. Recent tests performed by NRL scientists using a high-resolution version of NAVGEM showed that using MPI/IO decreases the percentage of time spent on file input/output to total runtime from 30 percent to 5 percent. To achieve this, however, it was necessary to "stripe" the I/O across the disks. This level of optimization is best performed for each computing platform.

Nancy Baker (NRL Marine Meteorology Division), David Kuhl (NRL Remote Sensing Division), Ben Ruston (NRL MMD), Randal Pauley (Fleet Numerical Meteorology and Oceanography Center), Tim Whitcomb (NRL MMD), Craig Bishop (NRL MMD), Dan Hodyss (NRL MMD), Elizabeth Satterfield (NRL MMD), and Tom Rosmond (retired NRL MMD)

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Assimilation of Megha-Tropiques SAPHIR Observations at NOAA

In October 2011, the Indian Space Research Organization (ISRO) and the Centre National d'Etudes Spatiales (CNES) launched the Megha-Tropiques satellite in a non-sun-synchronous orbit to observe the tropical latitudes from 22°S to 22°N. Megha-Tropiques houses the Sondeur Atmosphérique du Profil d'Humidité Intertropicale par Radiométrie (SAPHIR) instrument, a cross-track passive microwave water vapor radiometer.

SAPHIR scans with a 1661 km swath-width and a horizontal resolution of 10 km at nadir. With six channels in the 183 GHz band peaking at different levels of the atmosphere, SAPHIR is able to provide profiles of atmospheric water vapor in layers between the surface and up to 100 hPa (Eymard et al. 2001), and offers slightly more vertical coverage than other similar humidity sounders, like the Advanced Technology Microwave Sounder (ATMS) on the Suomi National Polar-orbiting Partnership (SNPP) satellite, since its channels peak higher and lower in the atmosphere than the highest and lowest peaking channels on ATMS, respectively.

Efforts to assimilate SAPHIR brightness temperatures in global and regional models have shown positive impacts on model forecasts (Chambon et al. 2015, Singh et al. 2013). These encouraging results have compelled the National Oceanic and Atmospheric Administration's Center for Satellite Applications and Research (NOAA STAR), in support of the JCSDA, to extend NOAA's Global Data Assimilation System (GDAS) to assimilate SAPHIR L1A2 brightness temperatures and assess what impacts assimilating these brightness temperatures in clear-sky, ocean-only conditions might have on GDAS analyses and Global Forecast System (GFS) forecasts.

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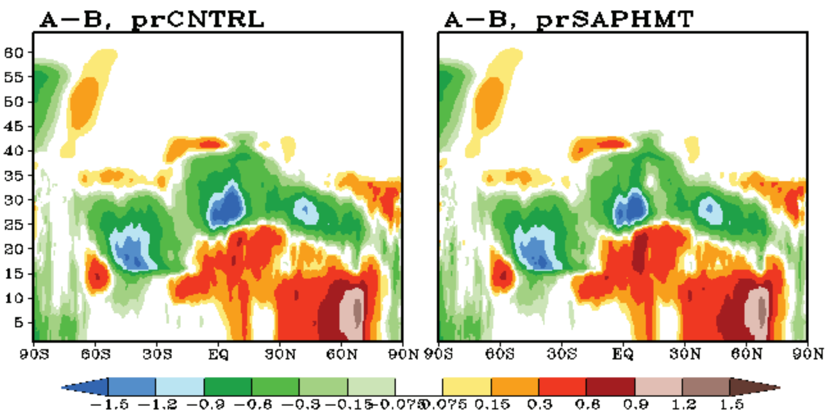

Figure 1. *Zonal mean RH analysis increments for CNTRL (left) and SAPHMT (right) experiments averaged over all cycles from 00Z 7 June 2015 to 00Z 18 July 2015.*

The main quality control (QC) component for the assimilation of clear-sky, ocean-only SAPHIR brightness temperatures in the GDAS is a graupel water path (GWP) retrieval and check. The retrieval is a multi-linear regression trained on brightness temperatures from all six SAPHIR channels that have been simulated by the Community Radiative Transfer Model (CRTM) from European Centre for Medium-Range Weather Forecasting (ECMWF) analysis fields. Comparisons of retrieved GWP from observed SAPHIR brightness temperatures and ECMWF analysis GWP yielded good results (not shown), and the filtering of SAPHIR brightness temperatures where retrieved GWP exceeded 0.05 kg/m2 was found to be sufficient for removing observations poorly simulated by CRTM outside of the assimilation system.

To assess the impacts of assimilating SAPHIR brightness temperatures in clear-sky conditions on GDAS analyses and GDAS forecasts, experiments were performed using a recent version of the GDAS run at T254/L64 resolution (about 50 km horizontal resolution with 64 vertical levels) cycled at four synoptic times (00Z, 06Z, 12Z, and 18Z), and the GFS run at a T670 resolution (about 25 km horizontal resolution) for the 00Z cycle only. Data assimilation was performed using the hybrid 3D variational ensemble Kalman filter (3DVar/EnKF) method, and the radiative transfer model used was the CRTM version 2.1.3. A control experiment (hereafter CNTRL) was performed assimilating the observation system current at the time of work, and an experiment (hereafter SAPHMT) was run, with the same setup as the CNTRL experiment but assimilating SAPHIR observations in clear-sky conditions over ocean, using a 45 km thinning grid. In addition to filtering observations where retrieved GWP was found to be over 0.05 kg/m2 (these were assumed to be observations affected by precipitation), a filter/gross check was applied to points where the bias corrected departure from the background exceeded 3 K. Experiments were initialized from 31 May 2015 18Z initial conditions and run out to 18 July 2015 00Z, with the first seven days taken as spin-up and removed from assessment.

Owing to the fact that SAPHIR is a water vapor sounder, the impacts of assimilating SAPHIR brightness temperatures on analysis and forecast moisture fields were the primary focus of assessment. Comparisons of relative humidity (RH) fields

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from CNTRL and SAPHMT experiments at varying levels indicate that, when verified against ECMWF analyses, the addition of SAPHIR observations has a neutral to positive impact on analysis RH; the impact being strongest at upper levels. Analysis increments averaged over the time period of the experiments (Fig. 1) show that, as expected, SAPHIR seems to be changing analysis RH most in the tropical latitudes.

When GFS forecasts from the CNTRL and SAPHMT experiments were verified against ECMWF analyses, the addition of SAPHIR observations was found to have a generally neutral impact for most forecast variables. Assimilating SAPHIR was shown to have a significant positive impact on upper level RH, with the impact greatest in the northern hemisphere and for short-term forecasts (Fig. 2). These findings appear consistent with those presented in Chambon et al. (2015), where the most significant positive impacts were found for RH above 400 hPa toward the beginning of the forecast period.

The results from assimilating clear-sky, ocean-only SAPHIR brightness temperatures are encouraging, and all capability has been prepared in the NOAA GDAS/GFS for transition to operations in the Spring 2017 upgrade.

Erin Jones, Kevin Garrett, Eric Maddy (RTi at NOAA/NESDIS/STAR)

Sid Boukabara (NOAA/NESDIS/STAR)

Acknowledgements

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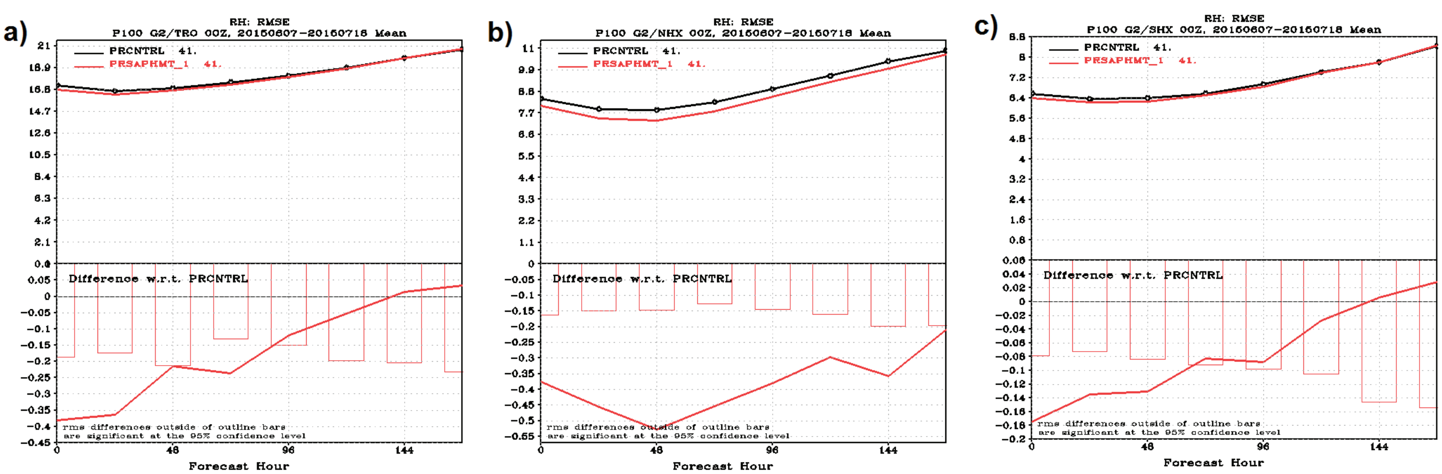

Figure 2. *Root mean square error (RMSE) dieoff curves for forecast 100 hPa RH from CNTRL (black line) and SAPHMT (red line) experiments for a) the tropics, b) the northern hemisphere, and c) the southern hemisphere, verified against ECMWF for 00Z 7 June 2015 to 00Z 18 July 2015. Boxes in the bottom panel of each plot indicate the 95 percent significant level; line segments outside of these boxes indicate that the SAPHMT experiment is significantly different from the CNTRL experiment.*

1769–1779, doi: 10.1002/qj.2478.

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JCSDA Observing System Assessment Standing Capability (JOSASC)

One of the latest efforts of JCSDA is the development of a new *JCSDA Observing System Assessment Standing Capability* (JOSASC). The main objective is to develop a set of capabilities to assess impacts of observing systems (from research and operational missions) on operational forecast systems (at both global and regional scale).

It is a collaborative project between the Cooperative Institute for Research in the Atmosphere (CIRA) at Colorado State University and NOAA's National Environmental Satellite Data and Information System (NESDIS), in College Park, Maryland. The research work is being done at the NOAA Center for Weather and Climate Prediction at the University Research Court in College Park.

By using the JOSASC, observing system experiments (OSEs) will be conducted to assess the impacts of existing satellite instruments on NOAA global and regional numerical weather prediction (NWP). A typical design of an OSE is to study the improvement of the forecast skill between a control (with the assimilation of all existing observation) and a sensitivity run (without the assimilation of the investigated instrument).

Many operational centers (e.g., ECMWF, NCEP, and Met Office) have performed OSEs to study the benefits from various observations. With the development of a new JCSDA observing system assessment infrastructure, the goal is to conduct data denial experiments for assessing existing satellite instruments and optimizing NOAA's observation systems. A few of the deliverables of JOSASC include:

- Development of a new infrastructure to perform comprehensive observing system assessment standing capability based on the NCEP Gridpoint Statistical Interpolation (GSI) and the Global Forecast System (GFS).
- Establishment of a routine data flow and system interface for the JOSASC.
- Continuous evaluation of all existing satellite sensors and their contributions to the various NOAA NWP systems.
- Application of the NOAA operational Hurricane Weather Research and Forecast-

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ing (HWRF) model and GSI to conduct regional OSEs to evaluate the benefit of existing satellite data on regional NWPs.

- Quick assessment of the impacts of existing instruments on the predictability of extreme weather events such as hurricanes and severe thunderstorms.

Suryakanti Dutta

DEVELOPMENT EFFORTS

CRTM Development Status and New Features in the Next Release

At JCSDA, we are working on the release of Community Radiative Transfer Model (CRTM) Rel-2.3.0. About 17 CRTM tickets are related to this new version, including scientific development, bug fixes, and new and updated sensor coefficients. Development of these tickets has been mostly completed, and we are testing and merging all the changes from CRTM repository branches into the trunk and then creating the new release.

A major scientific implementation for this new release is the capability for simulating all-sky radiance. To do so, the CRTM is initiated with the cloud fraction for each atmosphere profile to be simulated. In CRTM, there are four options (maximum overlap, random overlap, maximum-random overlap, and hydrometeor-weighted average overlap) to calculate the total cloud cover (TCC) from the input cloud fraction profiles. The all-sky radiance is the sum of the TCC-weighted 100 percent clear-sky radiance and 100 percent cloudy radiance:

$$Rv,allsky=(1-TCC)*Rv,clear+TCC*Rv,cloudy$$

The new CRTM release will also include CRTM coefficients for JPSS-1 VIIRS, INSAT3DR IMGR and SNDR sensors, and two OSSE sensors (CubeSat MicroMAS2 and CIRAS); the full spectral resolution (FSR) CrIS; the updated Himawari8 coefficient; and the updated AIRS coefficients with the nonlocal thermodynamic equilibrium (NLTE) correction. A bug related to simulation of those IR bands with solar contribution (e.g., GOES-R ABI 3.9 μm) is fixed by changing the “Visible_Flag” to “Solar_Flag” in CRTM ADA_Module.

Recently, we finished implementation of the Optimal Spectral Sampling (OSS) method into CRTM v2.2+. The OSS approach is a fast and accurate method for treating molecular absorption in radiative transfer calculation (Moncet et al. 2015). The OSS method provides a new way for modeling band transmittances and radiances with a weighted sum of monochromatic RT calculations. The OSS model was developed at Atmospheric and Environmental Research (AER), and then implemented in an offline version of CRTM v2.0.5. Because the flow structure of OSS is different from current CRTM ODPS/ODAS, a separate CRTM-OSS alpha version

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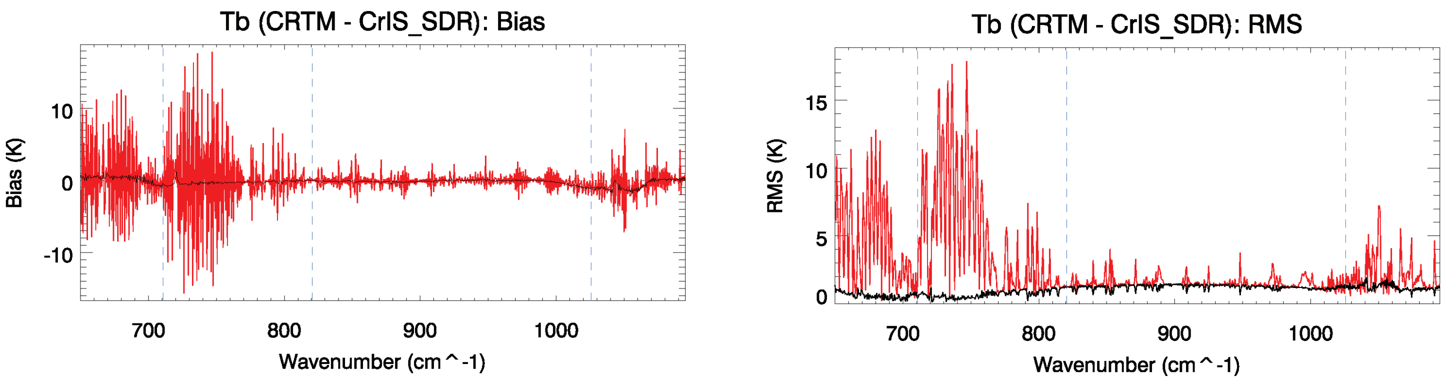

Figure 1. *The biases and RMSEs of CRTM-OSS (black curve) and CRTM-ODPS (red curve) simulated brightness temperatures against CrIS SRD band1 observations under clear-sky conditions over ocean.*

was recently created. AER is working on testing, enhancement, and impact study using this version.

The performance of CRTM-OSS forward and Jacobian calculations were benchmarked against the AER-delivered version. We also evaluated the CRTM-OSS simulations against those of CRTM-ODPS. The Jacobians simulated by the OSS method are similar to those of the ODPS method, but with some fine oscillations. Comparing them with the CRTM-ODPS simulations and CrIS real observations shows the capability of the CRTM-OSS method in simulating unapodized radiances (Fig. 1). Depending on the number of spectral nodes used in the OSS coefficients training, in general, the speed of OSS simulations of hyper-spectral IR sensors is about two times faster than the speed of the ODPS method.

Tong Zhu (CIRA/CSU@JCSDA)

References:

Moncet, J.-L., Uymin, G., Liang, P., and Lipton, A.E., 2015: Fast and Accurate Radiative Transfer in the Thermal Regime by Simultaneous Optimal Spectral Sampling over All Channels. *J. Atmos. Sci.*, **72**, 2622–2641.

Unsolicited articles for the JCSDA Quarterly Newsletter are encouraged as are suggestions for seminar speakers or topics. Please send them to Biljana Orescanin, biljana.orescanin@noaa.gov.

OTHER NEWS

ROSES Selections

From its inception, the JCSDA has sought to harness talent and innovative research from the broader research community in the academic and private sectors. To this end, an alternating cycle of competitively selected research projects has been established, using a NOAA Federally Funded Opportunity to select several two-year projects in one year, and the NASA Research Opportunities in Space and Earth Science (ROSES) vehicle to choose a project the following year.

In 2016, proposals were received and reviewed in response to a ROSES call. Four of these proposals have been accepted and new projects initiated. The project titles and principal investigators are listed in the table below. We look forward to fruitful collaboration between these investigators and the JCSDA.

Project #	Title	Institution	Principal Investigator
1	Linear filtering of sample covariance for ensemble data assimilation: application of optimality criteria for the estimation of four-dimensional localization function	University Corporation for Atmospheric Research (UCAR)	Francois Vandenberghe
2	Using multi-sensor aerosol optical depth retrievals to improve infrared radiance assimilation	University of Alabama, Huntsville	Aaron Naeger
3	Optimizing multiple scattering calculations in the CRTM	University of Wisconsin	Tom Greenwald
4	Assimilating GPM satellite radiances and CYGNSS ocean-surface winds into the NCEP new-generation non-hydrostatic global forecast model for improved prediction of tropical convection	University of Utah	Zhaoxia Pu

PEOPLE

Meet Dr. Suryakanti Dutta

Dr. Suryakanti Dutta has joined the JCSDA at NOAA/NESDIS/STAR Cooperative Institute for Research in the Atmosphere (CIRA), Colorado State University.

After completing his master's degree from the University of Calcutta, he received his Ph.D. from the Faculty of Science at Jadavpur University, India. He started his research career at the Department of Atmospheric and Space Sciences, University of Pune, India, where he also taught university students for a semester. Later he worked as a scientist at the National Centre for Medium Range Weather Forecasting (NCMRWF) in India. During his tenure at NCMRWF he was involved in research on numerical weather prediction and data assimilation, including various operational jobs.

Prior to joining JCSDA, he was a visiting fellow at the Meteorological Research Branch – Data Assimilation and Satellite at Environment Canada. There his primary focus was on assimilation of hyper-spectral infrared radiance observations with sensitivity to land surfaces in the Canadian Ensemble-Variational System.

His main responsibility at NOAA will be on JCSDA observing system assessment standing capability development. This will include on-demand, quick assessment of the impacts of existing satellite instruments on the predictability of extreme weather events.

In addition to computational work, he is interested in field work involving on-site activities in remote areas. His interests also include research involving severe weather events like tropical cyclones and thunderstorms. In his free time, Surya enjoys reading, listening to music, watching movies, and cooking as indoor activities. Outdoors, he loves traveling, meeting people, and exploring new places. Meeting penguins, sea lions, and polar bears in their natural habitats are among many goals on his bucket list.

Welcome Dr. Stéphanie Guedj

Dr. Stéphanie Guedj joined the JCSDA at NOAA/NESDIS/STAR as a research associate for the Cooperative Institute for Research in the Atmosphere (CIRA) at Colorado State University, in February 2016. Her focus is on supporting development of the JCSDA Observing System Assessment Standing Capability (JOSASC) project. The main objective of this project is to establish a new infrastructure to perform on-demand, comprehensive satellite observing system experiments with an emphasis on hurricanes or other high-impact weather events.

Focused on improving satellite observation usage, Stéphanie held several internships at EUMETSAT and the Centre de Recherche en Climatologie/Laboratoire de Météorologie Dynamique (CRC/LMD) during her master's degree work. She received her Ph.D. in meteorology and remote sensing from the Université de Toulouse III and Météo-France in 2011. Her thesis subject was on introducing a new method to assimilate surface-sensitive infrared observations over land surfaces.

As a EUMETSAT fellowship post-doc, she implemented an Observing System Simulation Experiment (OSSE) system in Météo-

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France to evaluate the potential improvements related to the assimilation of the future European geostationary sounder (MTG-IRS). She also spent some time in the Norwegian Meteorological Institute located in Oslo, Norway, to help install the OSSE system over the Arctic (ACCESS International Project). She has attended many international conferences and received the Best Oral Presentation Award at the XVII International TOVS Study Conference (ITSC) in Monterey, CA.

Apart from science, Stéphanie is a French backpacker. She has been traveling since she was young and completed a full world tour in 2015, crossing 17 countries in Asia, Africa, Oceania, and South America. She enjoys different indoor and outdoor sports such as volleyball, tennis, squash, trekking, and snowboarding.

CAREER OPPORTUNITIES

An opportunity with AER for a satellite data assimilation scientist to support the NOAA-NESDIS activities in cloud-, rain- and ice- impacted radiance data assimilation in operational Numerical Weather Prediction (NWP) models is available.
The job posting:
https://careers.verisk.com/viewjob.html;jsessionid=93C56AB94DB813DB736A161D22B7B08D?optlink-view=view-49836&ERFormID=newjoblist&ERFor

Opportunities in support of JCSDA may also be found at http://www.jcsda.noaa.gov/careers.php as they become available.

NOTE FROM THE DIRECTOR

My best wishes to all of you for this new year! Looking back at 2016, we have accomplished a lot together—yet we are not short of challenges for 2017. We need to prepare for the assimilation of new sensors. Our current work with the Japan Meteorological Agency's Advanced Himawari Imager (AHI) is intended to prepare for the GOES-16 Advanced Baseline Imager (ABI). Also, the Joint Polar Satellite System (JPSS) and COSMIC-2 are not very far down the road. In our constant striving for improved organizational management and interagency coordination, we are gradually integrating our activities in a project structure.

I am happy to announce that Benjamin (Ben) Johnson has been chosen to take the lead of the Community Radiative Transfer Model (CRTM) project. Paul van Delst has undoubtedly left gigantic shoes to fill, but Ben brings a unique set of experience, scientific and technical skills, and leadership. I am confident he will do a fantastic job.

The Joint Effort for Data Assimilation Integration (JEDI) project has found its "JEDI master" with Yannick Tremolet. He has crossed the Atlantic and is joining us from the European Centre for Medium-range Weather Forecasts (ECMWF), where he was a critical player in the implementation of weak-constraint 4DVar and the Object-Oriented Prediction System (OOPS), refactoring their data assimilation system. Yannick will be responsible for building the infrastructure of next-generation unified data assimilation to address the grand scientific challenges of tomorrow, such as coupled data assimilation or the ability to handle a wide range of spatio-temporal scales.

Please join me in wishing Yannick and Ben success in their new endeavors. We are plan-

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ning a lot more in our Annual Operating Plan, including but not limited to improved use of radiances over land, sea-ice data assimilation, and observation impact assessment.

As I write these lines, we are getting ready for the annual meeting of the American Meteorological Society, and I hope to see many of you there at the Fifth Symposium of the Joint Center for Satellite Data Assimilation.

Thomas Auligné
Director, JCSDA

SCIENCE CALENDAR

UPCOMING EVENTS

JCSDA Meetings and Events sponsored by JCSDA:

- May 16: CRTM Users/Developers Workshop. NCWCP, College Park, MD.
- May 17–May 19: JCSDA 15th Technical Review Meeting & Science Workshop on Satellite Data Assimilation—NOAA NCWCP, College Park
- Summer GSI/EnKF Community Tutorial—TBD 2017
- JCSDA Summer Colloquium on Satellite Data Assimilation—TBD 2018

JCSDA seminars are generally held on the third Wednesday of each month at the NOAA Center for Weather and Climate Prediction, 5830 University Research Court, College Park, MD. 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. If you would like to present a seminar, contact Ling Liu, ling.liu@noaa.gov, or Biljana Orescanin, biljana.orescanin@noaa.gov.

MEETINGS OF INTEREST

DATE	LOCATION	WEBSITE	TITLE
27 February–2 March, 2017	RIKEN, Kobe, Japan	http://www.data-assimilation.riken.jp/risda2017/	Third RIKEN International Symposium on Data Assimilation (RISDA 2017) / Seventh Annual Japanese Data Assimilation Workshop (DAWS)
13–17 March, 2017	Lorentz Center, Leiden, Netherlands	https://www.lorentzcenter.nl/lc/web/2017/856/info.php3?wsid=856&venue=Oort	Emerging Applications of Data Assimilation in the Geosciences
22–26 March, 2017	Institute for Pure and Applied Mathematics, UCLA, Los Angeles, USA	http://www.ipam.ucla.edu/programs/workshops/workshop-iii-data-assimilation-uncertainty-reduction-and-optimization-for-subsurface-flow/	Data Assimilation, Uncertainty Reduction, and Optimization for Subsurface Flow
23–24 March, 2017	University of Reading, Reading, UK	http://www.met.reading.ac.uk/~darc/training/ecmwf_collaborative_training/	2-day intensive course on advanced data-assimilation methods
27–31 March, 2017	University of Reading, Reading, UK	http://www.met.reading.ac.uk/~darc/training/ecmwf_collaborative_training	ECMWF Training Course on Data Assimilation
23–28 April, 2017	Vienna, Austria	http://www.egu2017.eu	European Geosciences Union (EGU) meeting
12–14 June 2017	Oslo, Norway	http://www.iris.no/enkf/enkf-homepage	12th EnKF workshop
31 July–2 August 2017	Vancouver, Canada	http://siags.siam.org/siagla//meetings/2017-07-31-precon17.html	Preconditioning 2017: International conference on preconditioning techniques for scientific and industrial applications
11–15 September 2017	Florianopolis, Brazil	http://www.cptec.inpe.br/das2017/	Seventh International WMO Symposium on Data Assimilation
29 November–5 December, 2017	Darmstadt, Germany	https://cimss.ssec.wisc.edu/itwg/itsc/itsc21/index.html	21st International TOVS Study Conference
11–15 December 2017	New Orleans, USA	http://fallmeeting.agu.org/2016/future-meetings/	American Geophysical Union Fall Meeting