Introduction

The Ensemble Forecast Sensitivity to Observation (EFSO) formulation (Kalnay et al. 2012) has been implemented at NCEP. For 4DEnVar, this approach requires Ensemble Kalmann Filter (EnKF) products as input, and has been implemented within the current source code that provides EnKF assimilation at NCEP (Holtslag et al. 2013; Groff et al. 2016). An all-ens forecast Sensitivity to Observation (FSO) approach (Friedlingstein and Baker 2004, Zhu and Galindo 2008) has been effectively utilized to enable a simultaneous forecast impact estimate for any and all observations assimilated in an NWP system. The FSO formulation incorporates the relationship between forecast error and analysis update to provide a measure of 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 FSO update can be used in the representation of the analysis error covariance, and accordingly the system gain. This study pertains to 24-hour moist total EFSO calculations that are based on the development of output from the 4DEnVar GFS for December 2014.

Objective

Most previous FSO/FSO studies have emphasized observing system summary statistics. These studies have been helpful in addressing some of the overarching questions that relate to application of EnKF output from the 4DEnVar GFS for December 2014. The current investigation assesses the impact of cloud liquid water (CLW) on EFSO impacts. The intent of this synthetic EnKF information is to provide direct insights for further enhancement of variational radiance bias correction approaches, improved quality control procedures and guidance for prioritizing forward operator development.

Methodology

The Ensemble Assimilation Forecast System (EnFSO) for the 4DEnVar GFS for 24-hour moist total EFSO calculations that are based on the analysis update from the 4DEnVar GFS for December 2014. The current investigation assesses the impact of cloud liquid water (CLW) on EFSO impacts. As shown in Figure 2, the spatial distribution of observational error covariance is based on individual observation impacts and is dependent on the model-based bias correction. The results suggest that the addition of cloud water from assimilating these channels is coincident with EFSO detriment. This result suggests that the addition of cloud water from assimilating these channels is coincident with EFSO detriment.

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

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EFSO Asymmetries w.r.t. Innovation Sign for Cross-track Infrared Sounder (CRIS) Radiances

In the operational 4DEnVar GFS, CRIS channels within both the long-wave (8 CO) band and short-wave window portion of the IR spectrum are assimilated. These assimilated channels primarily provide temperature sounding information by taking advantage of the well mixed nature of CO in the atmosphere.

Partitioning of EFSO quantities for a subset of CRIS temperature sounding channels into bias corrected innovation bins with corresponding non-bias corrected innovations that had corresponding positive non-bias corrected innovations. The overall per observation impact is made up of the sum of the positive and negative impacts. This information can further enhance variational radiance bias correction.

Composite Mean EFSO Impact Maps for Advanced Microwave Sounding Unit-A (AMSU-A) Surface Channels

Composite mean EFSO maps can be helpful in highlighting coherency between EFSO suggested impact and climatological features. Among the AMSU-A channels, channel 2 is the most sensitive to variability in surface conditions. 7.3 to 7.5 composite mean EFSO maps for AMSU-A channel 2 suggest that assimilation of these channels is relatively problematic in areas of warm surface temperatures.

Summary

EFSO quantities for CRIS and AMSU-A radiances were partitioned by innovation sign, bias corrected and non-bias corrected EFSO impacts. For CRIS temperature sounding channels, total EFSO versus CRIS channel bias corrected innovation revealed large asymmetries. For AMSU-A surface sounding channels, partitioning of EFSO impacts by CLW amount was almost relevant to partition EFSO impact by CLW. Overall per observation impacts were dominated by EFSO associated with negative innovations. Future efforts are planned to test the utility of this information in further improving variational radiance bias correction.

Note that negative EFSO quantities indicate forecast benefit, whereas positive EFSO quantities indicate forecast detriment.

References


