Performance and Evaluation of the Global Modeling and Assimilation Office Observing System Simulation Experiment

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GMAO
Global Modeling & Assimilation Office

National Aeronautics and Space Administration

GMAO OSSE

The Global Modeling and Assimilation Office at NASA Goddard Space Flight Center (NASA/GMAO) has developed an Observing System Simulation Experiment (OSSE) framework for evaulation of proposed new observing systems and for investigating the behavior of data assimilation systems. The main components of the GMAO OSSE are:

Nature Run: GEOS-5 model forecast from May 2005 to June 2007. 7 km horizontal resolution, 72 vertical levels, 16 aerosols, 30 minute output (Gelaro et al., 2015).

Experimental Data Assimilation and Forward Model: 3D-Var Gridpoint Statistical Interpolation (GSI) with the GEOS-5 version 5.17 at C360 (25 km) horizontal resolution, 72 vertical levels.

Synthetic Observations: conventional types (AMVs, rawinsondes, aircraft, pibal, surface, etc), GPS-RO, AIRS, HIRS-4, GMS, IASI, CrIS, MHS, ATMS, SSMIS, AMSU-A

Observation Errors: uncorrelated errors for most types; horizontally correlated errors for microwave radiances and AMVs; vertically correlated errors for rawinsondes, AMVs, GPS-RO; channel correlated errors for AIRS, IASI, CrIS.

Calibration: Counts of observations ingested by the GSI are matched to a corresponding experiment using real data from June 2015. Variance of observation innovation (O-F) is also matched as closely as possible for all types by adjusting the added observation errors.

Details of the methods used to generate the synthetic observations and observation errors, as well as the calibration procedure, are described in the new technical memorandum, Errico et al (2017).

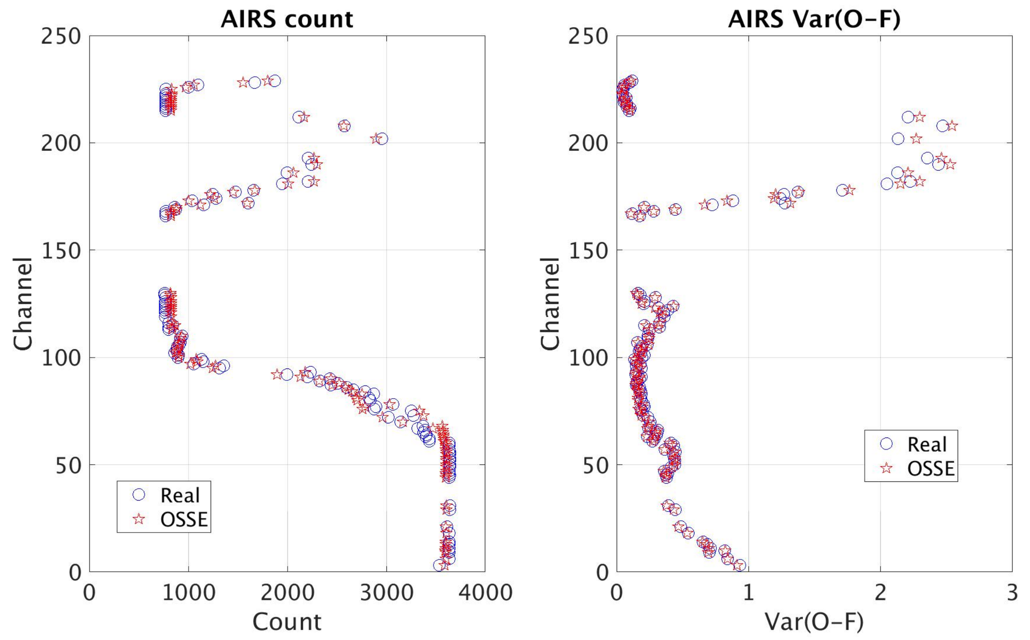


Figure 1. Left: Counts of AIRS observations that are ingested by the GSI for an average data assimilation cycle. Blue circles for real data case, red stars for OSSE experiment, month of July. The observation count is the first field that is calibrated to match that of real observations.

Right: Variance of observation innovation for AIRS data during the month of July. After matching the observation counts, this is the second field used to calibrate the synthetic observations in the OSSE.

New OSSE Features

These new features have been added to the most recent update of the GMAO OSSE:

Synthetic Observations:
- automated error tuning, including covariances
- more realistic atmospheric wind vectors
- GPSRO translating impact parameters
- text file option for radiance observation input

Forward Model:
- C360 horizontal resolution (25 km)
- two-moment microphysics for convective processes
- changes to boundary layer parameterization to reduce incestuousness
- GEOS-5 version 5.17 (current operational version)

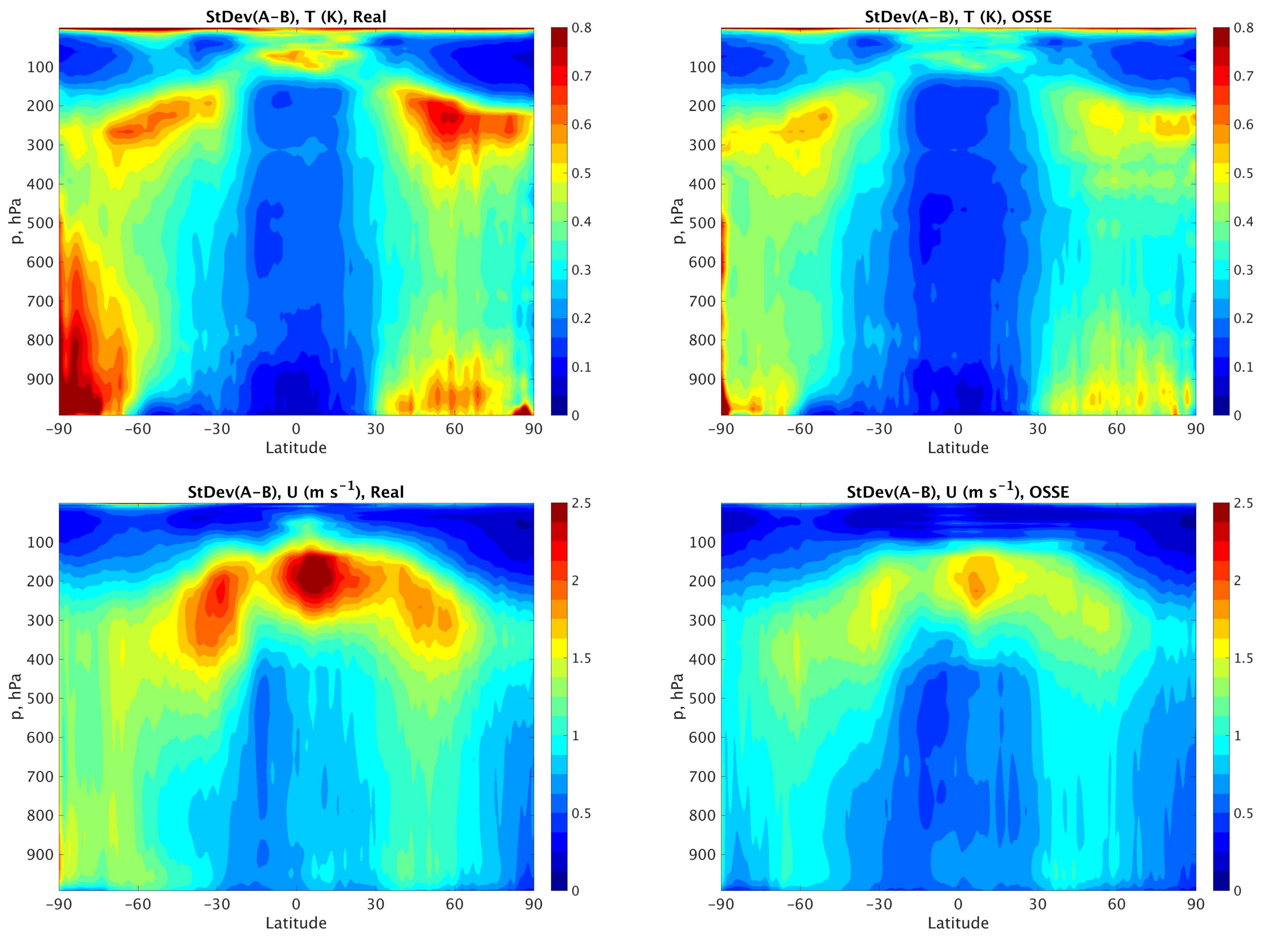
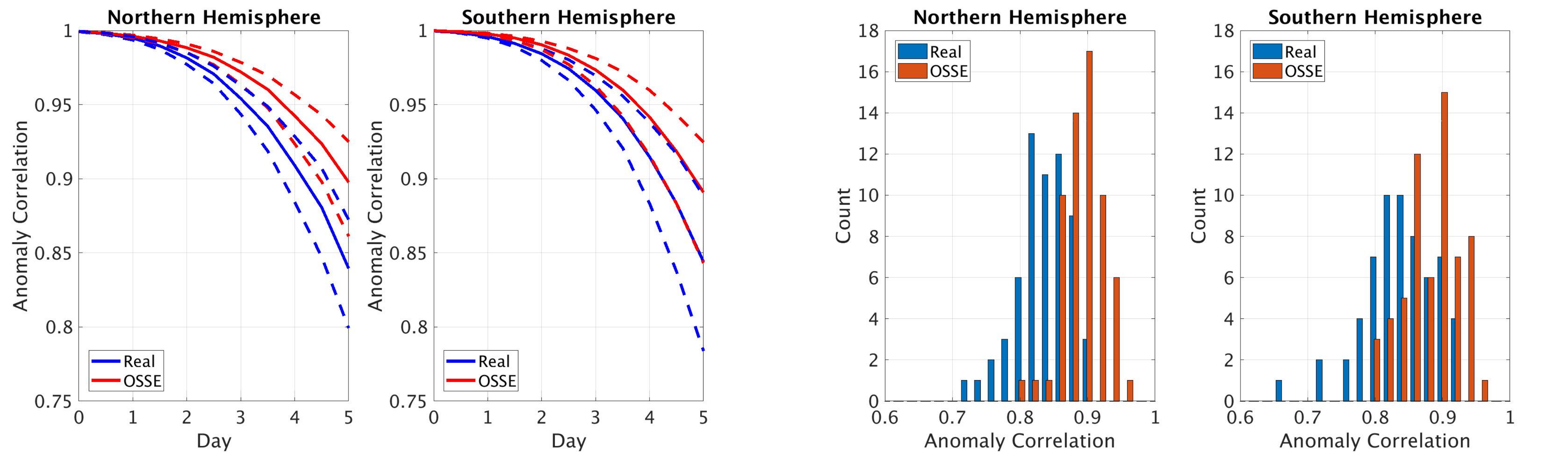


Figure 2. Zonal mean monthly standard deviation of analysis increment (A-B) for temperature (top panels, K) and zonal wind (bottom panels, m s^{-1}) for the real data (left panels) and OSSE (right panels). Analysis increments are not calibrated in the OSSE, weaker increments are due to insufficient model error in the OSSE compared to the real world.

Figure 3. Anomaly correlations of 500 hPa geopotential height for five day forecasts in July and August. Left panels show monthly mean hemispheric anomaly correlations (solid lines) with spread of one standard deviation (dashed lines); right panels show distribution of skill at the day 5 forecast over two months of forecasts.



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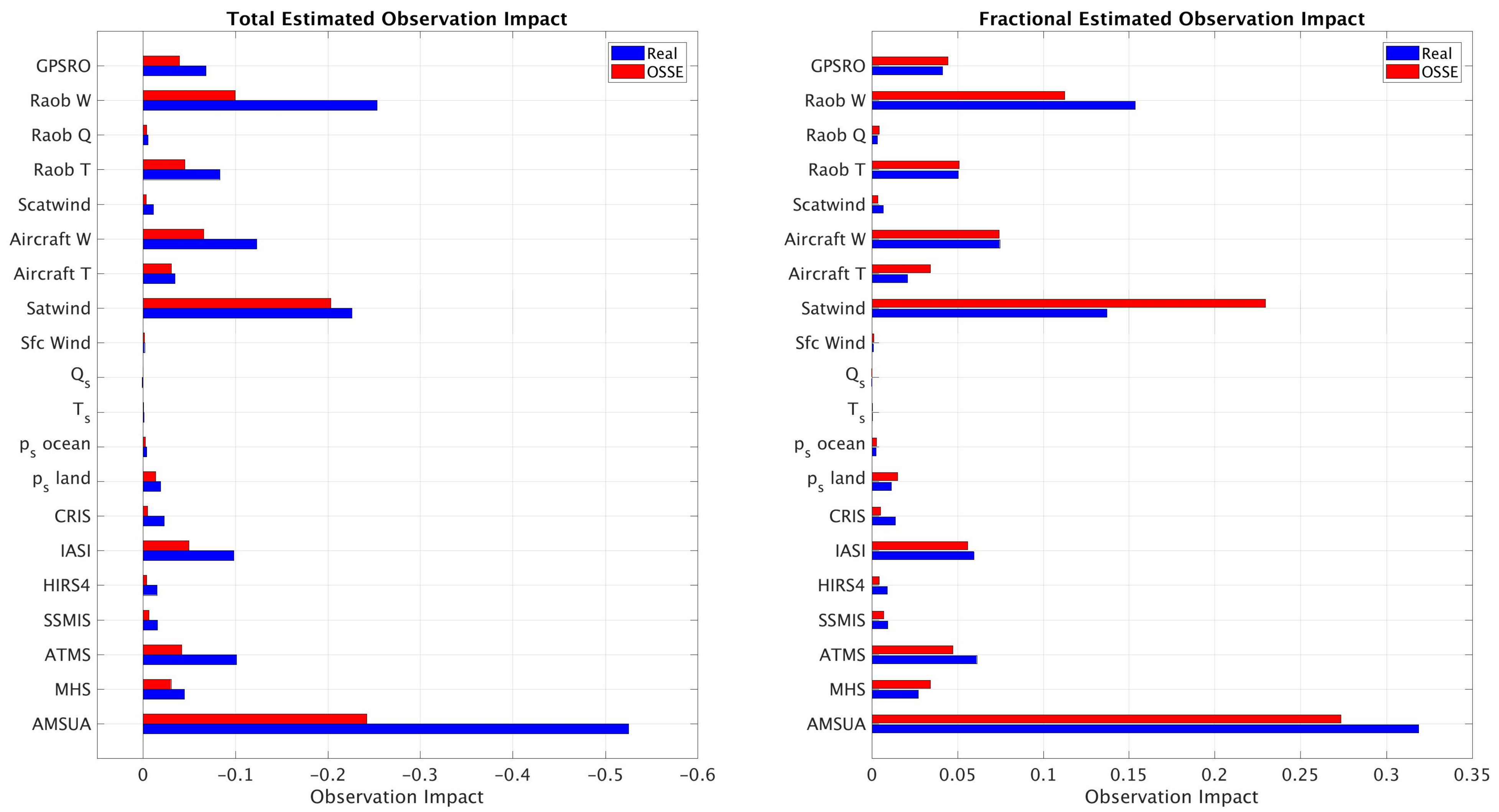
Observation Impacts

The GMAO OSSE includes an adjoint tool that can be used to estimate the impact of all ingested observing types on the 24-hour forecast skill simultaneously. The adjoint observation impact in the OSSE is compared to the real data observation impact in Figure 4. While the total observation impact in the OSSE is smaller than for real data (left panel), the relative fraction of impact for each data type is generally well represented in the OSSE (right panel). This allows qualitative statements to be made about the potential impact of new observing systems in the OSSE by comparing the impacts of different data types.

Figure 4. Adjoint estimates of observation impact on the 24-hour forecast of total wet energy. The adjoint calculations include moist physics processes. Left panel, total impact (negative values indicate an improved forecast with reduced error). Right panel, fraction of total impact for each observation type.



References

Errico, Ronald M., et al, 2017. **Description of the GMAO OSSE for Weather Analysis Software Package: Version 3**. *NASA Technical Report Series on Global Modeling and Data Assimilation, NASA/TM-2016-104606*, Vol. **48**, 156 pp.

Gelaro, R., et al, 2015. **Evaluation of the 7-km GEOS-5 Nature Run**. *NASA Technical Report Series on Global Modeling and Data Assimilation, NASA/TM–2014-104606*, Vol. **36**.