Progress of the NASA/GMAO Observing System Simulation Experiments using the GEOS-5 Nature Run

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The GMAO OSSE Framework

The Global Modeling and Assimilation Office (GMAO) has been developing an Observing System Simulation Experiment (OSSE) framework (Figure 1). For the past decade, the GMAO OSSE has used a Nature Run developed by the European Centre for Medium-Range Forecasting (ECMWF) that consists of a 13 month forecast of their operational model at T511/91L. Recently, the GMAO has generated a new Nature Run using the GEOS-5 forecast model in a 2-year simulation at 7 km/72L.

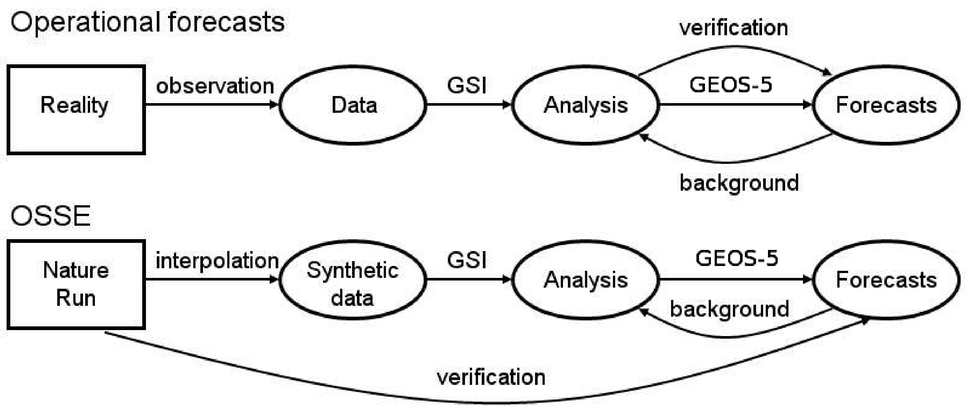

Figure 1. Schematic diagram illustrating the differences between the GMAO OSSE and operational numerical weather prediction.

This new Nature Run (G5NR) is currenly being tested for use in the GMAO OSSE framework. Synthetic observations have been generated based on the G5NR fields, including conventional observations, GPS, and satellite radiances, using methods described in Errico et al. (2013). These synthetic observations are ingested using the Gridpoint Statistical Interpolation data assimilation system, with forecasts performed by the GEOS-5 model at 55 km/72L.

Synthetic errors have been added to the synthetic observations generated from the G5NR. The synthetic errors include both a random component, and a correlated component for certain observation types (vertically correlated errors for rawinsondes, horizontally correlated errors for AMSU-A, HIRS4, and MHS; and channel correlated errors for AIRS and IASI). These errors are calibrated so that the statistics of observation innovations and analysis increments found in the OSSE match those from real data experiments.

Some recent improvements to the GMAO OSSE framework include the easier user-control of options via resource files, removal of some bugs, optional output of additional diagnostics, and simplification of scripts. The new codes avoid re-reading of the G5NR data sets when generating synthetic observations and use ESMF Shared Memory to accomodate large datasets. The selection of observation error correlation functions has also been generalized.

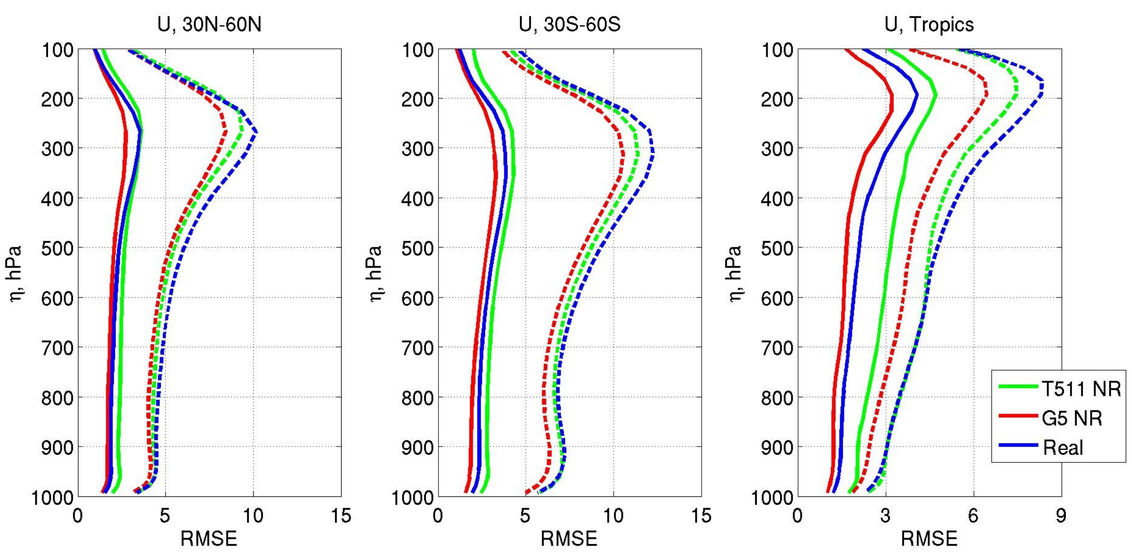

Figure 2. Root mean square error of zonal wind at the 24 hour forecast (solid lines) and at 120 hour (dashed lines) for daily forecasts initiated at 0000 UTC during the month of July. Real data from 2013, blue lines. OSSE using ECMWF T511 Nature Run, green lines. OSSE using GMAO G5NR, red lines.

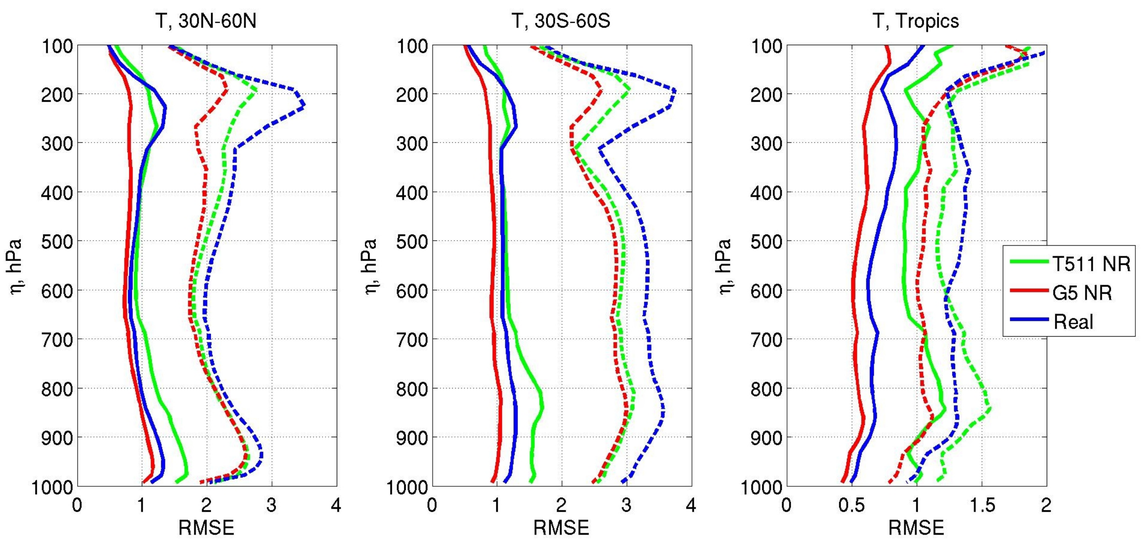

Figure 3. Root mean square error of temperature at the 24 hour forecast (solid lines) and at 120 hour (dashed lines) for daily forecasts initiated at 0000 UTC during the month of July. Real data from 2013, blue lines. OSSE using ECMWF T511 Nature Run, green lines. OSSE using GMAO G5NR, red lines.

OSSE Validation

The GSI/GEOS-5 system is spun up over a period of three weeks, and then cycled for the month of July 2006, with 10-day forecasts launched at 0000 UTC each day. For calibration and validation, the same model version is run using real observations from the month of July 2013. The performance of the G5NR data can be compared also with the ECMWF T511 Nature Run derived synthetic observations from July 2005 (Privé et al, 2013a), using a previous version of GEOS-5.

Figures 2 and 3 show the root mean square error of the 24-hr and 120-hr forecast fields of zonal wind and temperature over different regions from the real data, G5NR, and T511 NR cases. Verification of errors is calculated using self-analyses. The G5NR case has lower RMSE than the real data case and the T511 case for all regions. The greatest difference between the G5NR and T511 cases occurs in the tropics, where the T511 case has larger forecast RMSE than the real data case. The discrepancy between the G5NR and real data RMSE persists through the extended forecast period, and is believed to be due to insufficient model error in the GMAO OSSE. The anomaly correlations for the real data case and the G5NR case are shown in Figure 4. The G5NR case has greater forecast skill than the real data case in both hemispheres.

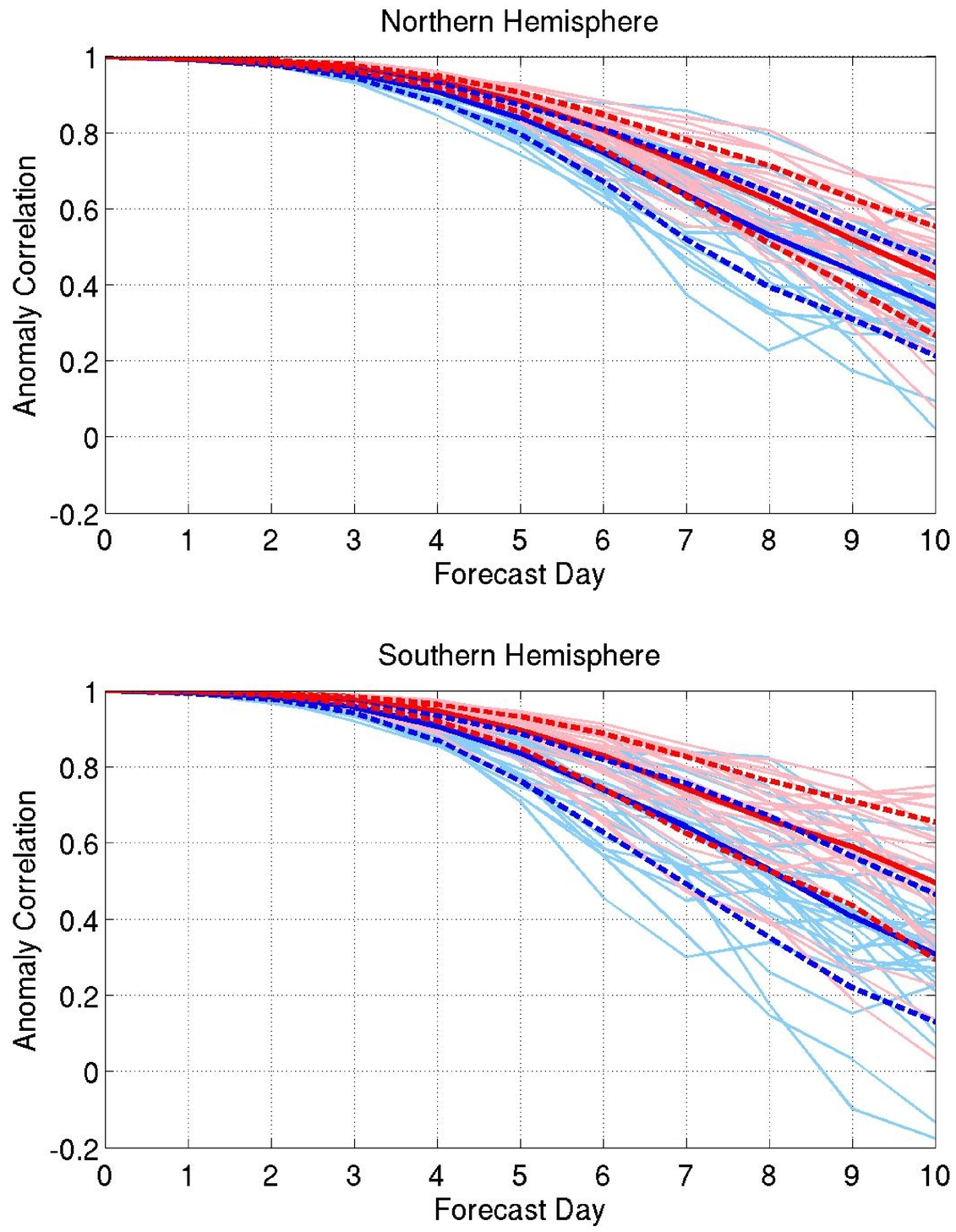

Figure 4. Anomaly correlation of 500 hPa geopotential height in the extratropics. Blue thin lines, forecasts using real data from 2013; pink thin lines, forecasts using synthetic observations from the G5NR for July 2006. Heavy solid lines indicate monthly mean anomaly correlations for the real data (blue) and G5NR (red); heavy dashed lines indicate one standard deviation above and below the mean anomaly correlations.

Future Work

Plans for upcoming OSSE projects include applications of newly proposed wind and radiance observing systems as well as applications to understand and improve the GSI data assimilation system techniques.

References

Errico, R. M., R. Yang, N. Privé, K.-S. Tai, R. Todling, M. Sienkiewicz, and J. Guo, 2013. Development and validation of observing-system simulation experiments at NASA's Global Modeling and Assimilation Office. *Q. J. Roy. Meteor. Soc*, **139**, 1162-1178. doi: 10.1002/qj2027.

Privé, N., R. M. Errico, and K.-S. Tai, 2013a. Validation of forecast skill of the Global Modeling and Assimilation Office observing system simulation experiment. *Q. J. Roy. Meteor. Soc.*, **139**, 1354-1363. doi: 10.1002/qj.2029.