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on the Impact of Various Observing Systems on Numerical Weather Prediction and Earth System Prediction

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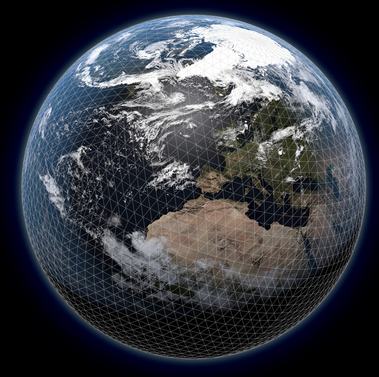

Assessing observation impact in the GEOS Data Assimilation System

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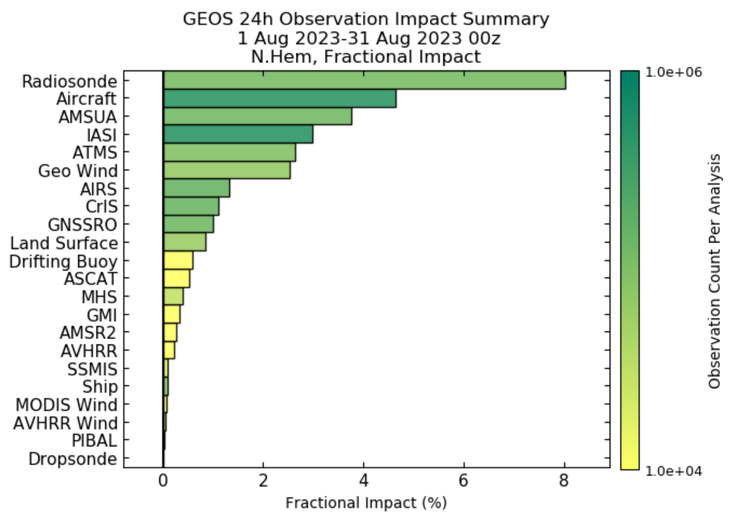
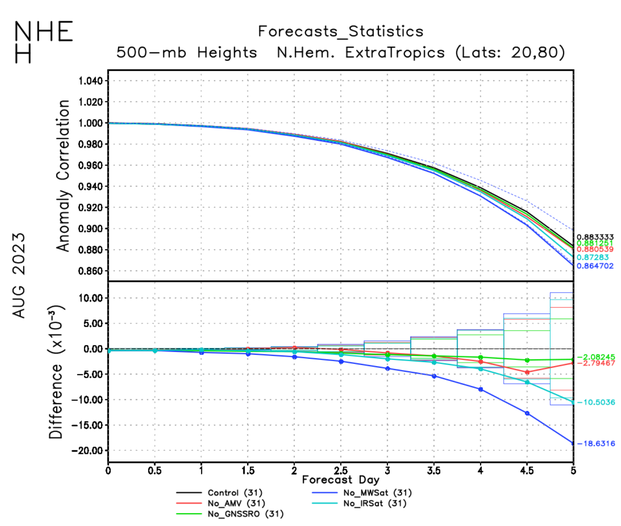
The Global Modeling and Assimilation Office (GMAO) runs a number of assimilation systems including GEOS-FP, a real-time atmospheric hybrid four-dimensional ensemble–variational (4D-EnVar) system with associated aerosol assimilation that is used to support NASA satellite missions and field campaigns (Todling and El Akkraoui 2018). To assess the impact of various observing systems we routinely use the adjoint of the GEOS data assimilation system to compute forecast sensitivity-based observation impact (FSOI) statistics (Gelaro et. al, 2010, Trémolet, 2018). From time to time the GMAO also conducts data denial experiments in order to get a different look at the interactions of the various observing systems and their relative importance to the assimilation. Most recently, we have conducted tests in which atmospheric motion vectors, GNSS-RO, microwave radiances and IR radiances have been removed from the assimilation, using an assimilation system being evaluated as a candidate for our next operational implementation of GEOS-FP. The plots below show FSOI statistics from the control run along with forecast anomaly correlation statistics verified against the control run.

Northern Hemisphere

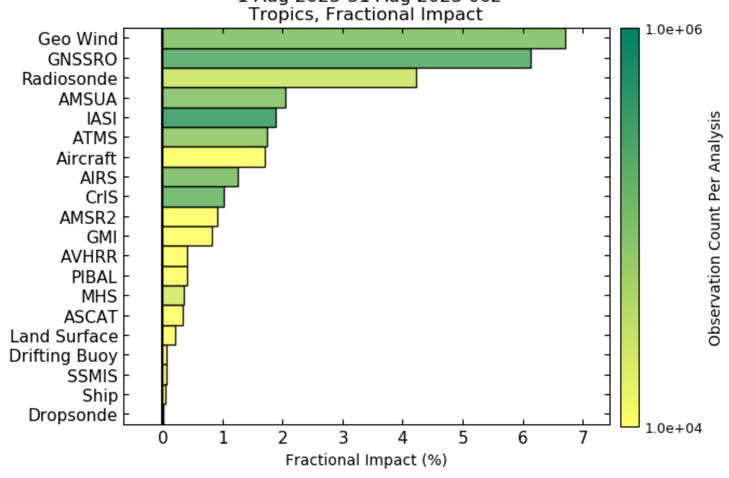
In the Northern Hemisphere the FSOI statistics show microwave radiances have the highest impact of satellite observation types. The results from data-denial assimilations were consistent with this, with the removal of microwave radiance data (No_MWSat) showing the most degradation in forecast skill. The geostationary AMVs and GNSSRO data had less impact and assimilations without those data showed less forecast degradation.

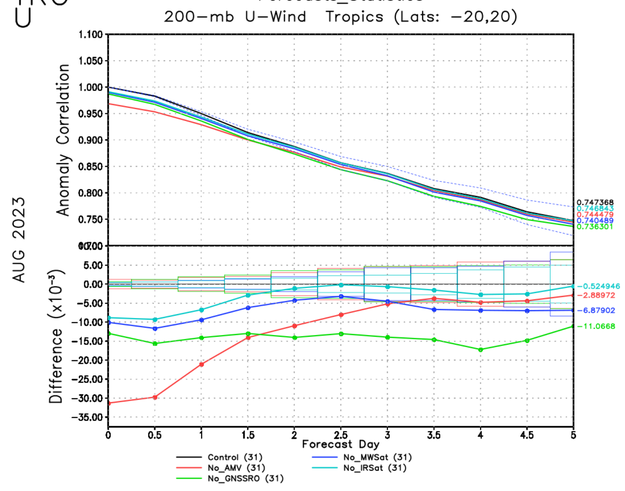




Tropics

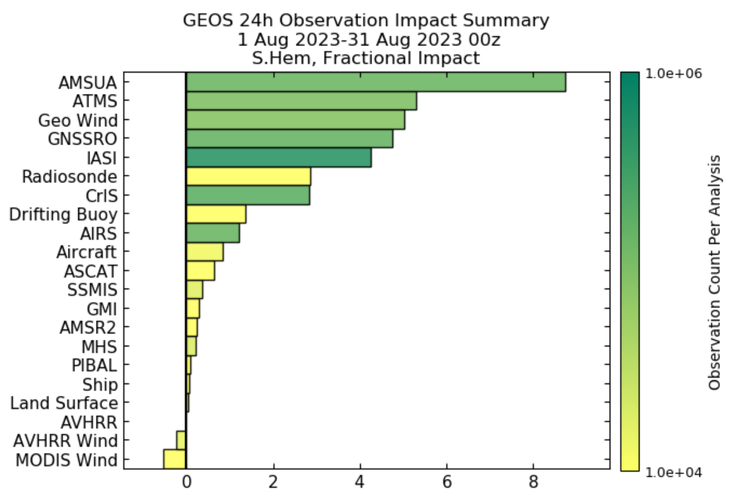
In the Tropics the FSOI statistics show the highest impact from geostationary AMVs and GNSSRO. Removal of satellite data impacted the assimilations as shown by the reduced anomaly correlation at day 0 particularly for AMVs. The largest degradation in skill at day 5 occurred with removal of GNSSRO data.

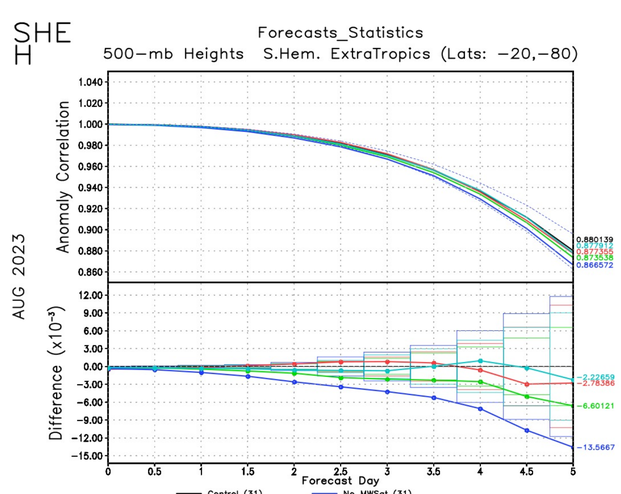




Southern Hemisphere

The FSOI statistics for the Southern Hemisphere show that microwave radiances, geostationary AMVs and GNSSRO have the most impact. The conventional observations are much less than in the Northern Hemisphere so they have less influence. The data denial experiments were again consistent, with removal of microwave radiances and GNSSRO observations showing the most degradation in forecast skill.





Globally the radiosonde data have the greatest impact although they are most influential in the Northern Hemisphere where they are most plentiful. The microwave radiance data (AMSUA, ATMS, GMI, AMSR2, MHS) are next in importance and the denial experiments showed that withholding the data has a significant detrimental impact. Withholding GNSSRO data has a significant impact on forecast skill in the Tropics where the data has the most influence. Observation impacts also show geostationary winds are important globally though their removal had less of an impact on forecast skill. The IR radiances overall did not have as much impact as other satellite observations and their removal was less detrimental to the forecast skill as removal of microwave radiance. This analysis however only shows a broad overview of the influence of each of the satellite types to help assess the state of our current assimilation system.

Contact

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References

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2. Trémolet, Y., 2008: Computation of observation sensitivity and observation impact in incremental variational data assimilation. Tellus, 60A, 964-978.
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