



Robustness and Behavior of Adjoint Calculations of Observation Impacts in Numerical Weather Prediction

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Questions of Interest

- How do observation impacts on forecast skill evolve over the early forecast period (up to 48 hours)?
 1. How well does the adjoint capture the total observation impact?
 2. Do impacts evolve differently for various data types and regions?
- How does the use of self-analysis verification affect the estimation of
 1. Forecast error
 2. Forecast error growth
 3. Observation impacts



What is an OSSE?

An OSSE is a modeling experiment used to evaluate the impact of new observing systems on operational forecasts when actual observational data is not available.

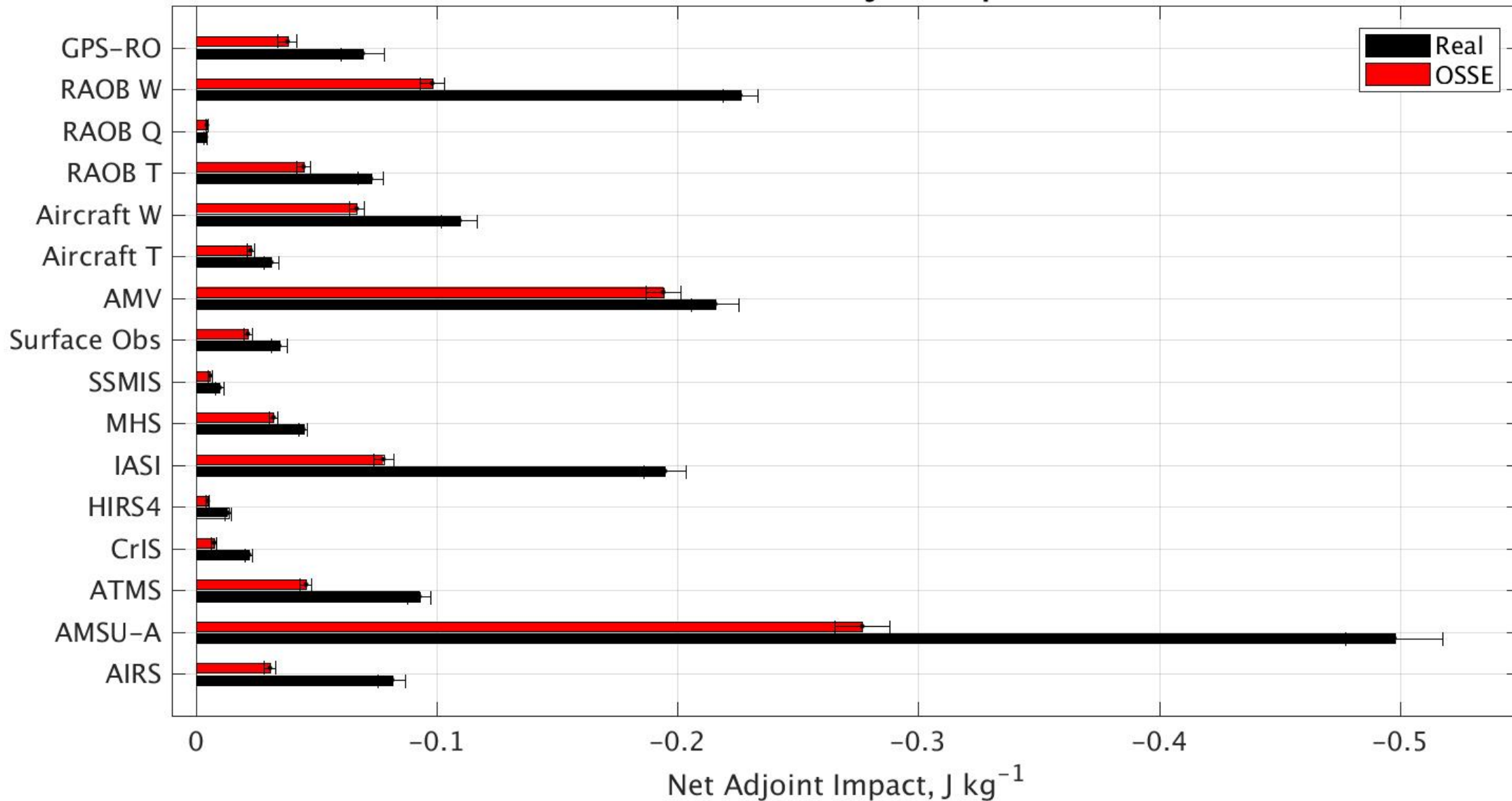
- A long free model run is used as the “truth” - the Nature Run
- The Nature Run fields are used to back out “synthetic observations” from all current and new observing systems.
- Suitable errors are added to the synthetic observations
- The synthetic observations are assimilated into a different operational model
- Forecasts are made with the second model and compared with the Nature Run to quantify improvements due to the new observing system



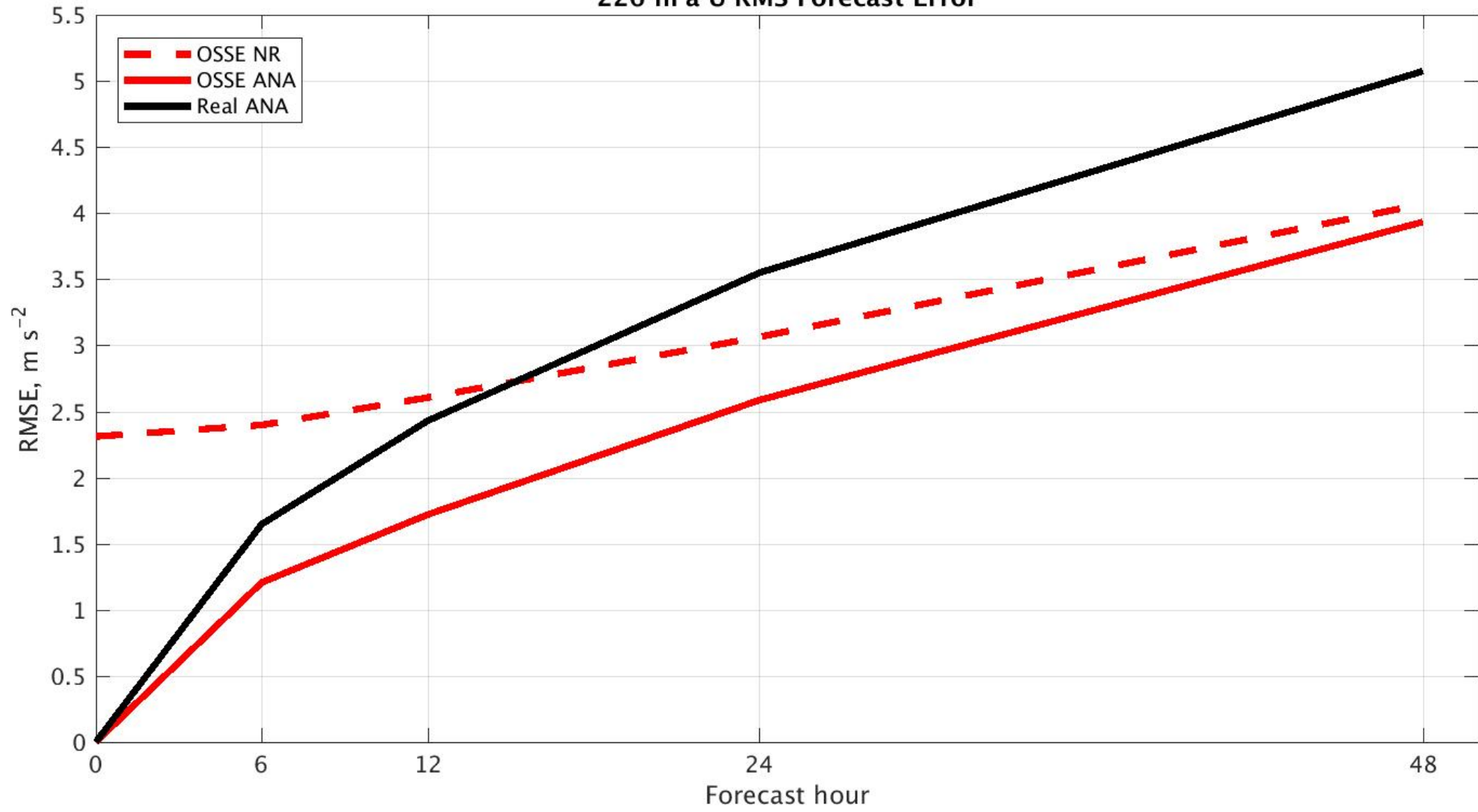
GMAO OSSE Framework

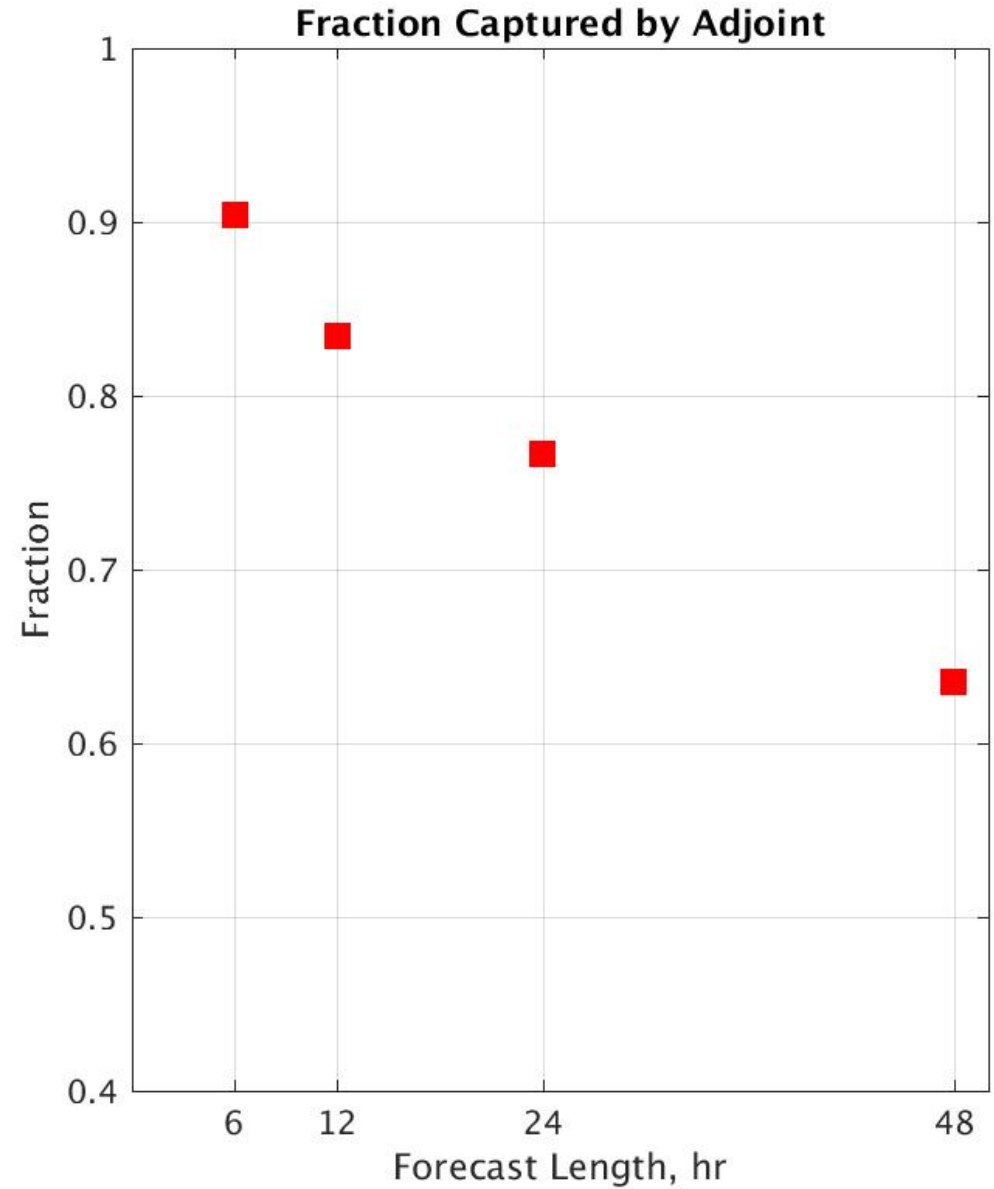
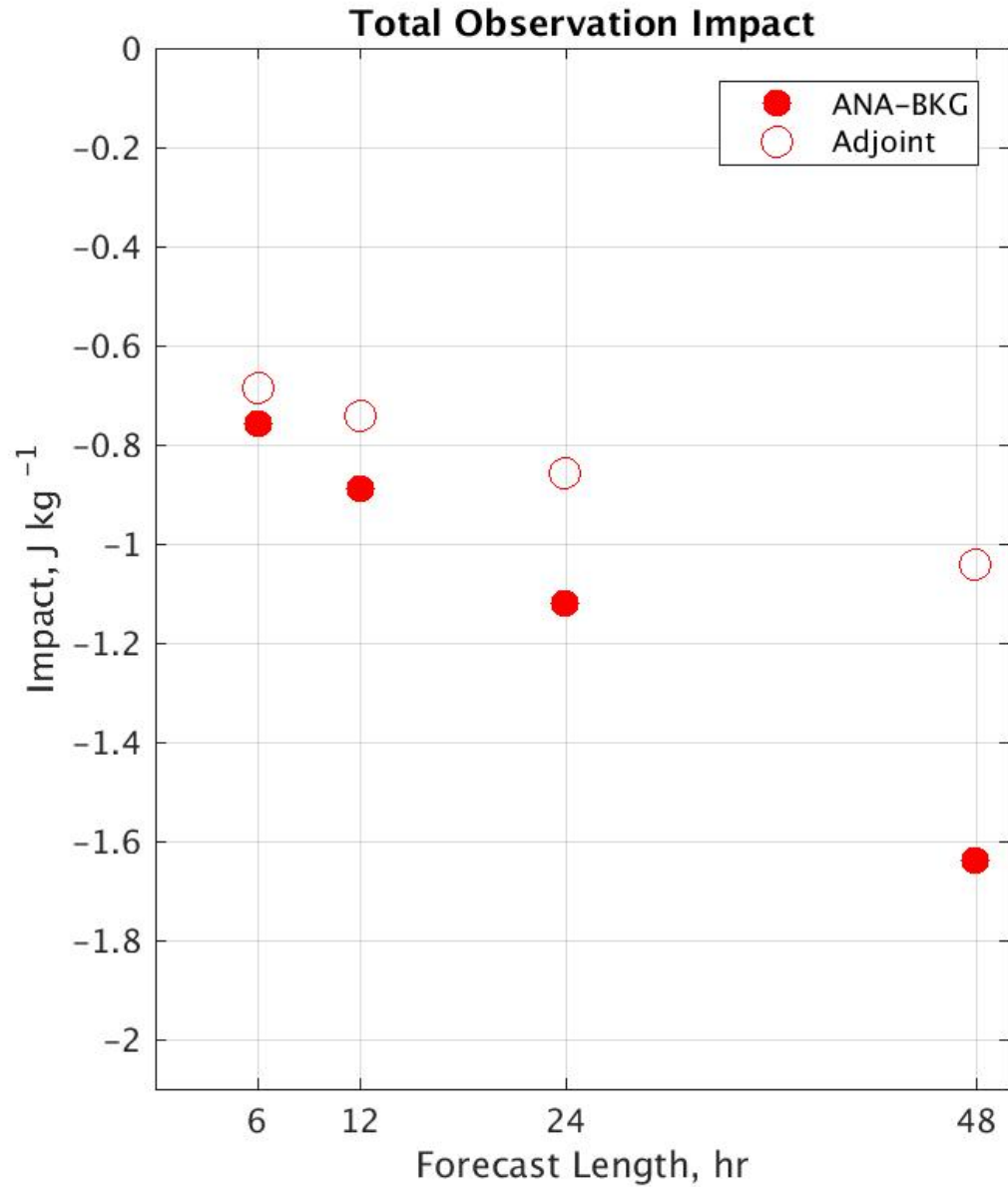
- **Nature Run**
 - ❖ 2 years free forecast of the GEOS-5 model (G5NR)
 - ❖ 7 km horizontal resolution, 72L
 - ❖ 30 min output, 13 aerosols
- **Synthetic observations**
 - ❖ Generated from G5NR output fields
 - ❖ Include G5NR cloud effects
 - ❖ Conventional, GPSRO, AIRS, IASI, CRIS, AMSUA, MHS, ATMS, SSMIS, HIRS4
- **Correlated and uncorrelated observation errors**
 - ❖ Calibrated and validated to match statistics of real data
- **Experimental model:**
 - ❖ GEOS-5 v. 5.17, 25 km horizontal resolution, 72L
 - ❖ 3DVar and 4DEnVar GSI available
- **FSOI:**
 - ❖ adjoint tool with moist physics option, total wet energy norm (TWE)

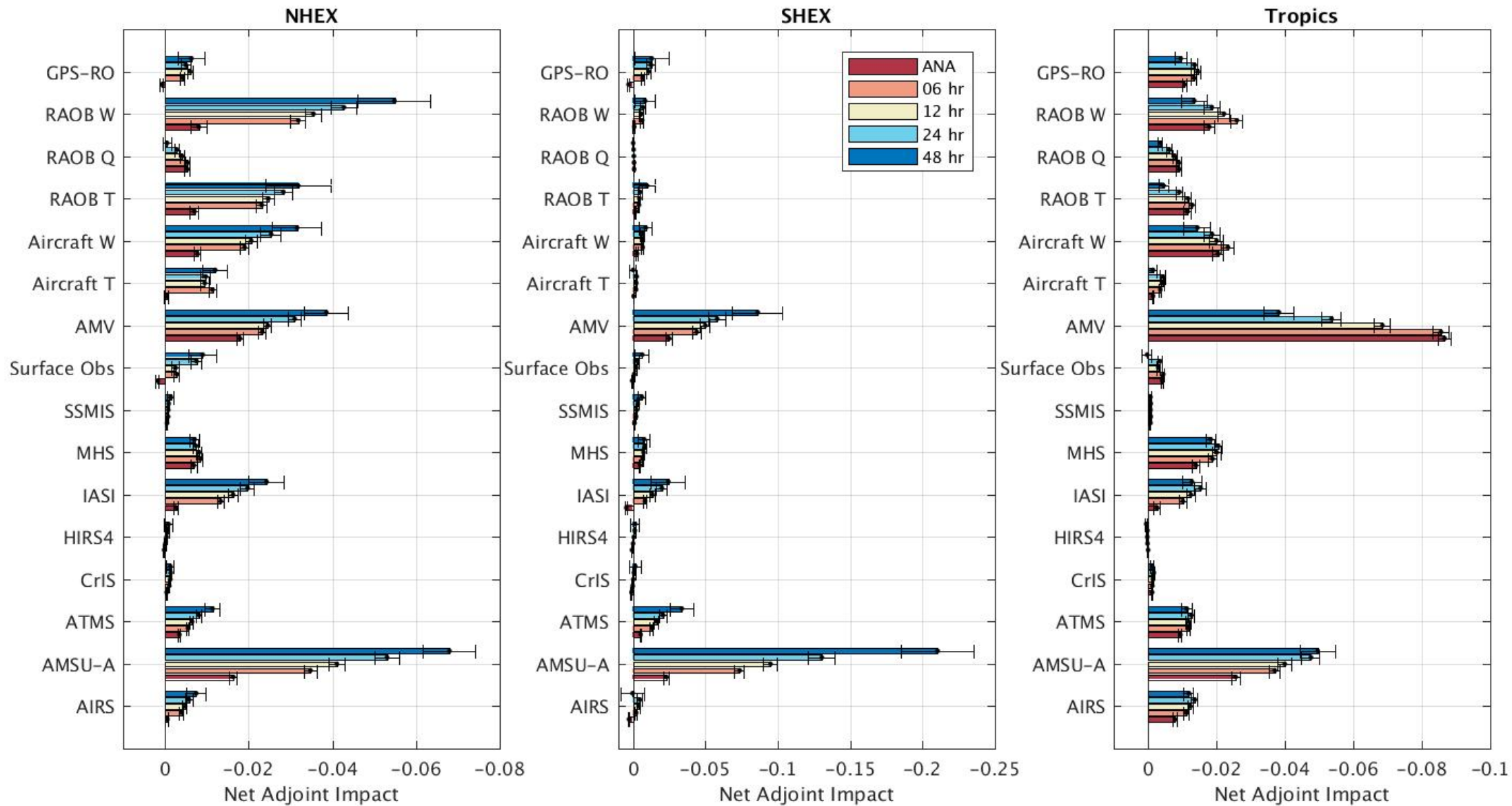
OSSE vs Real Adjoint Impacts

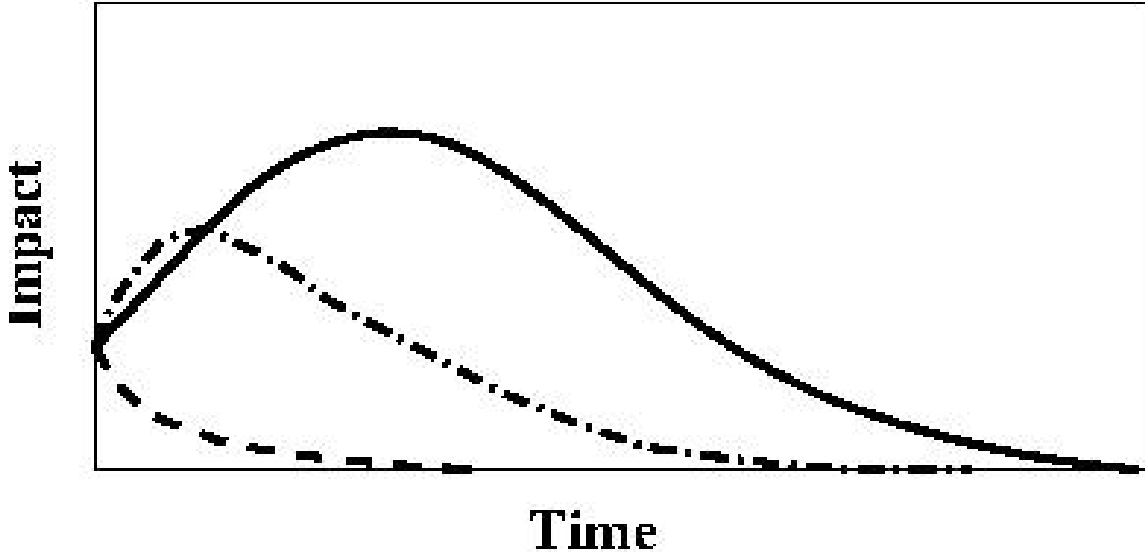
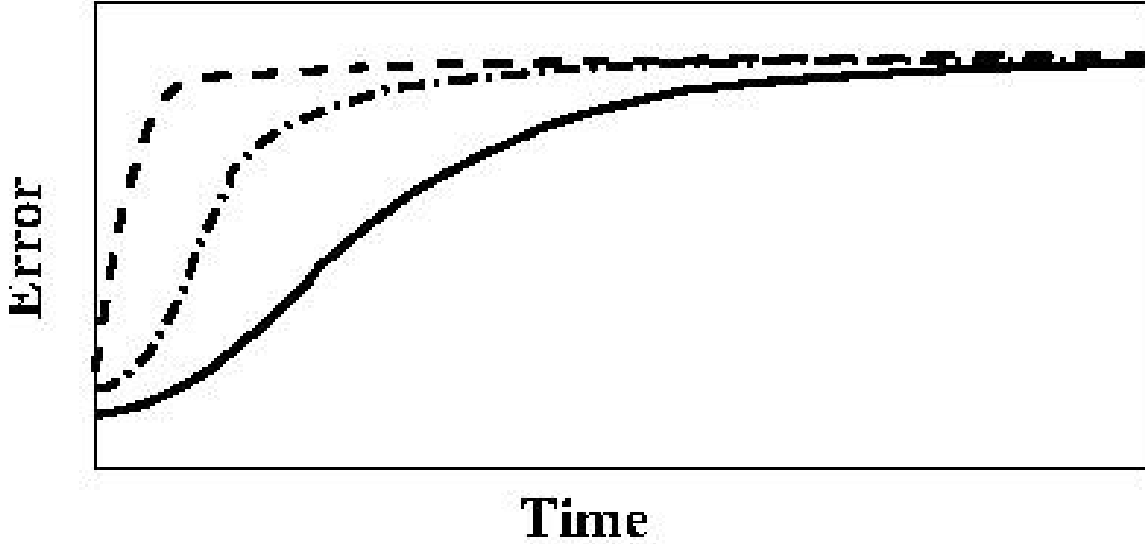


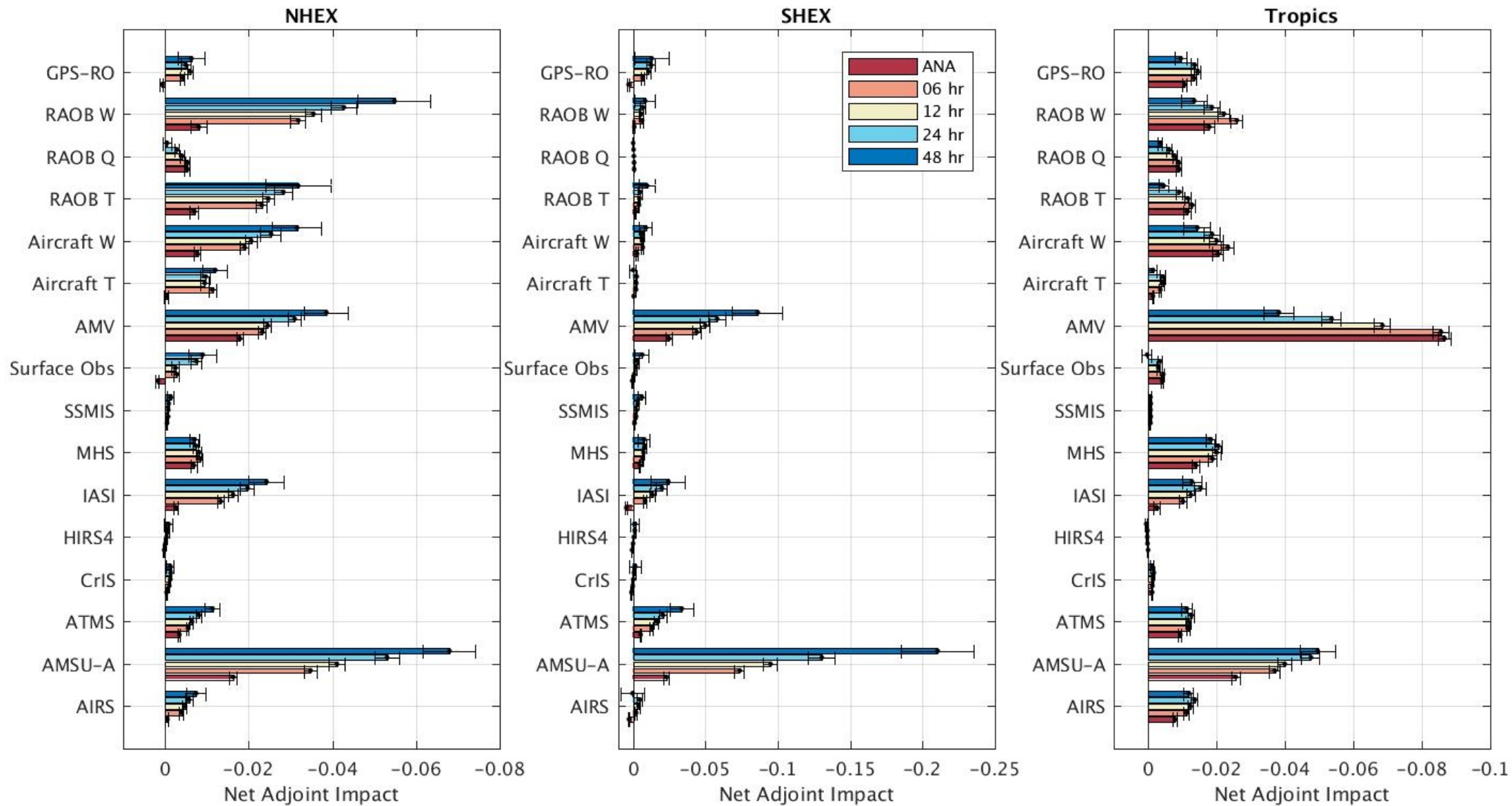
226 hPa U RMS Forecast Error

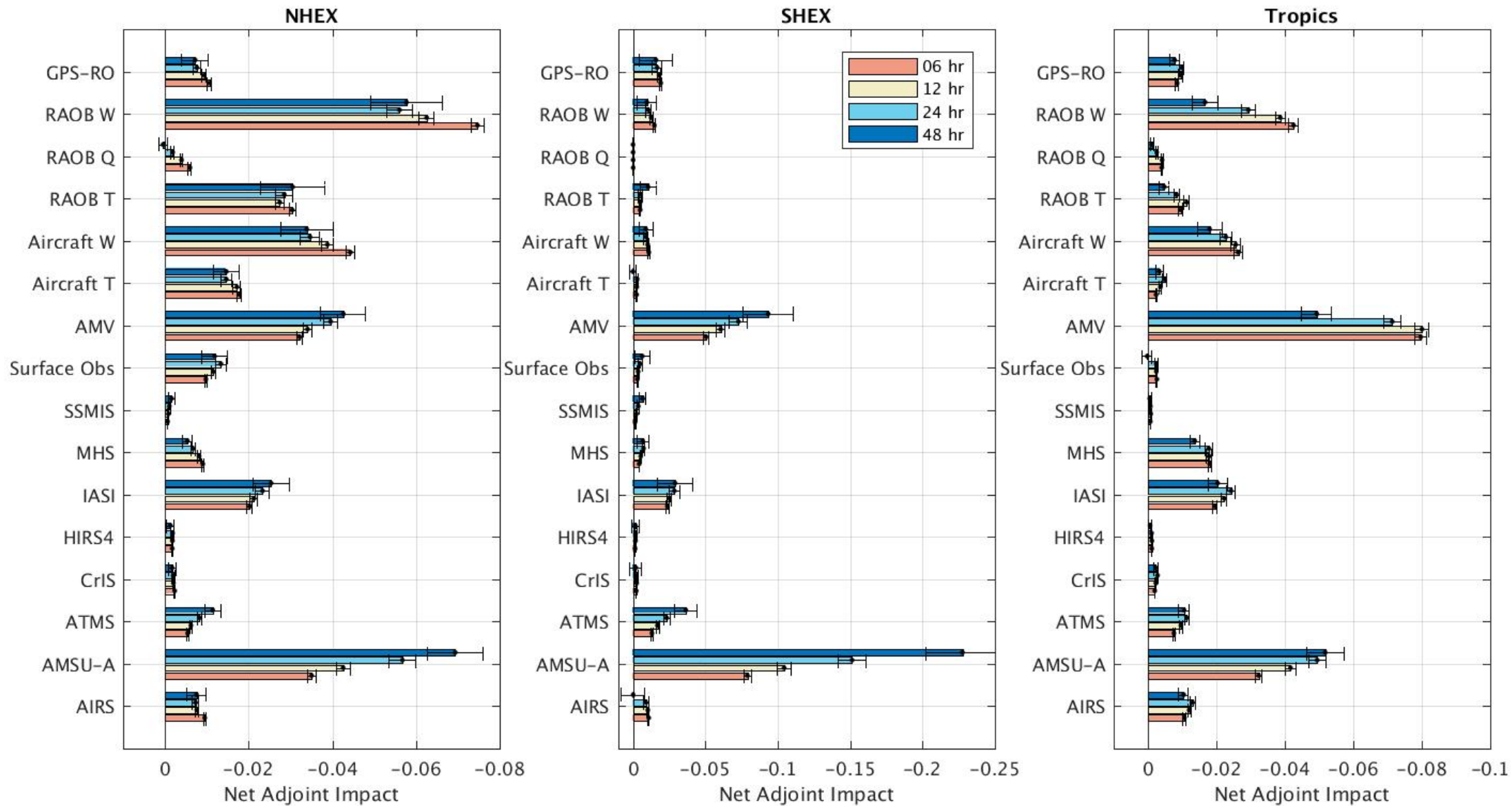




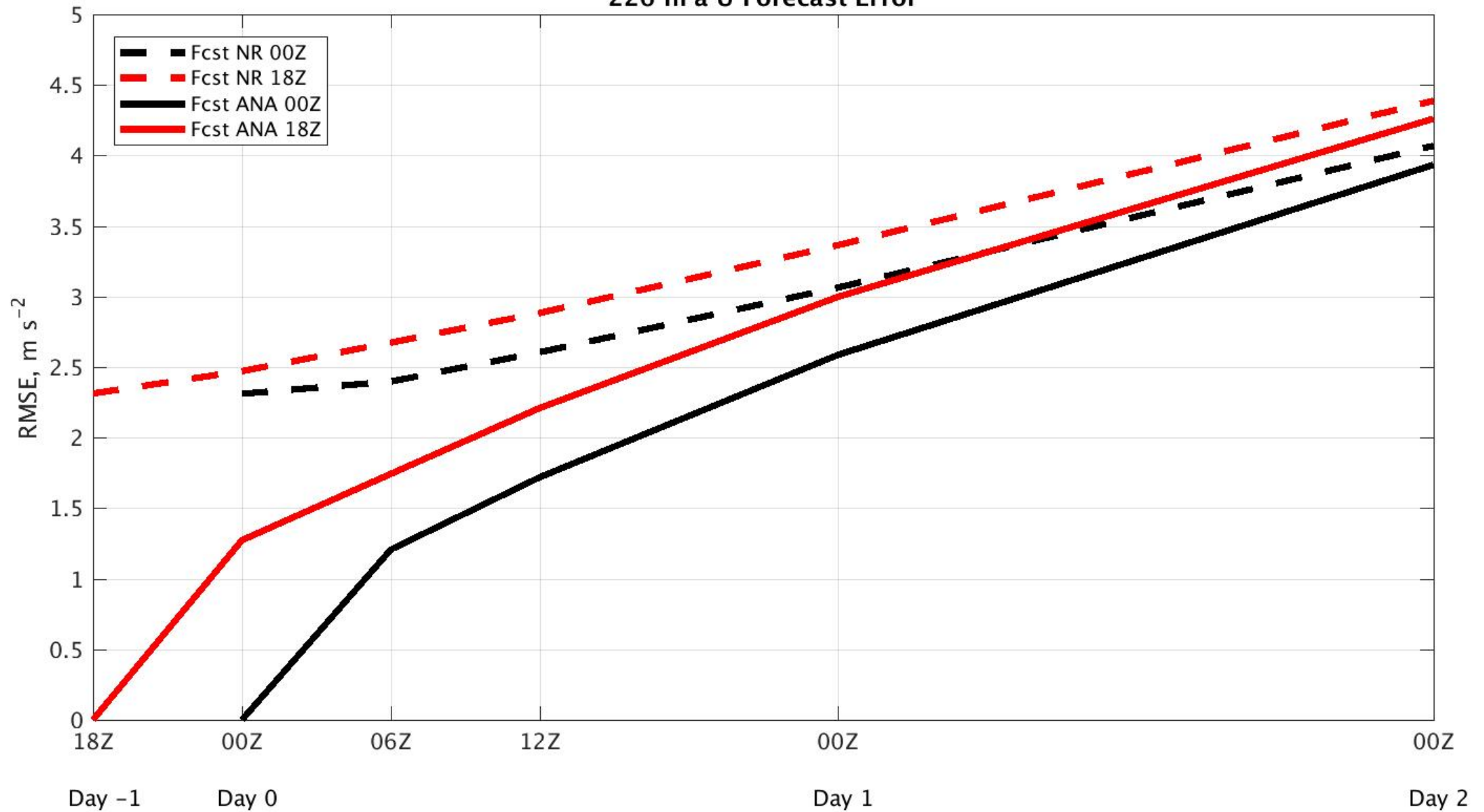


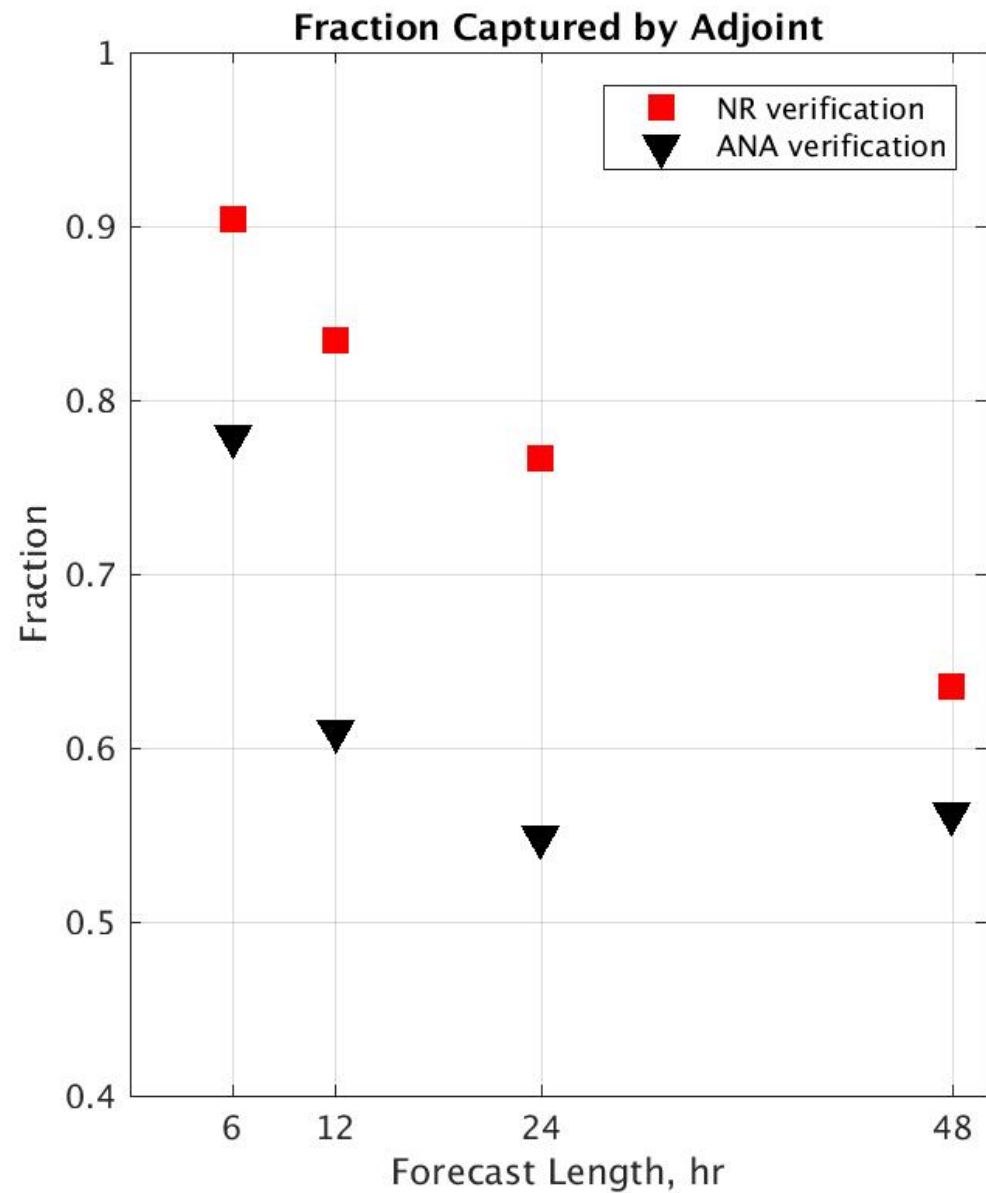
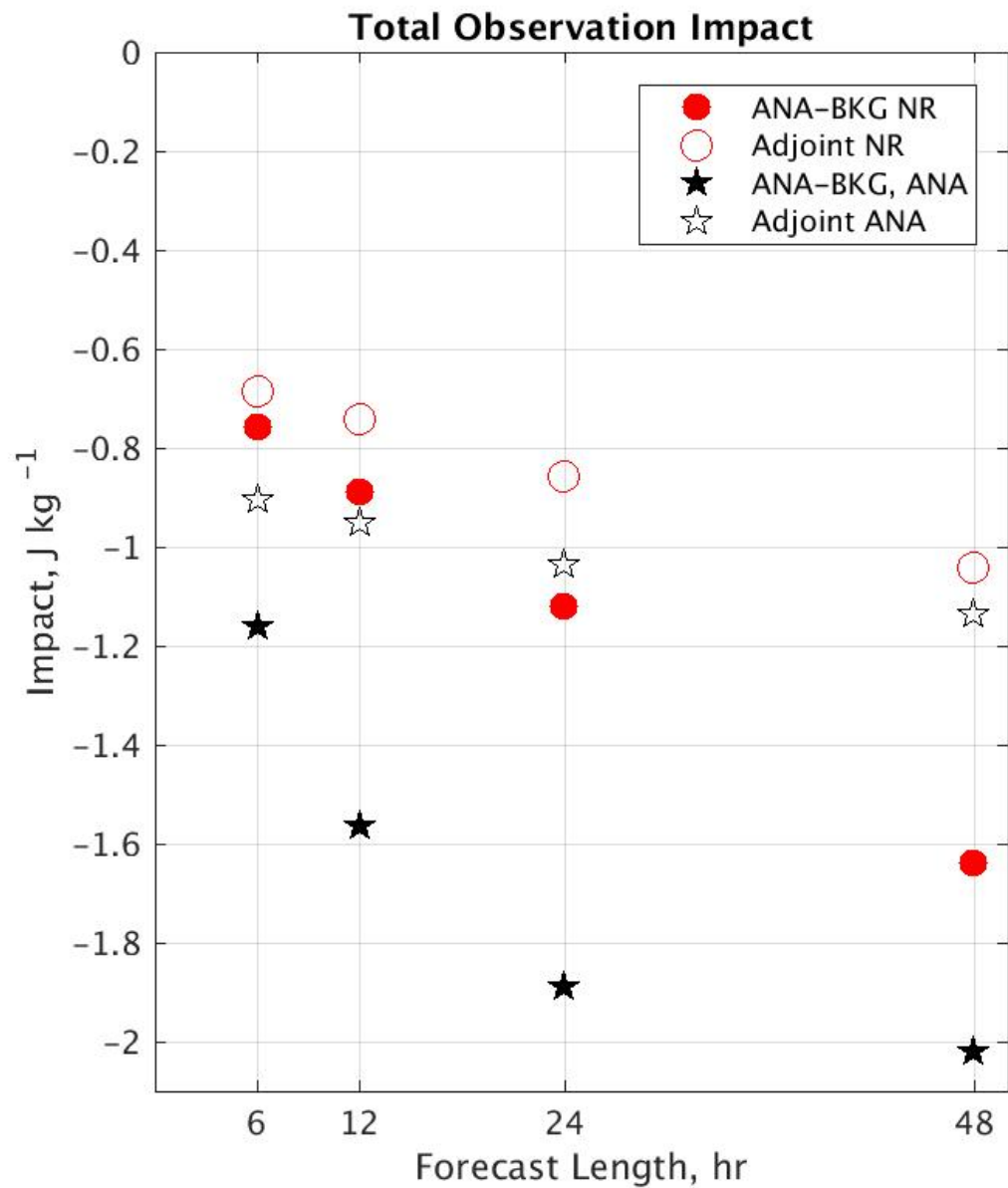






226 hPa U Forecast Error







Conclusions

- Observation impacts may grow or decay in time depending on the error growth behavior of the errors onto which the observation information projects
- Self-analysis verification grossly inflates error growth during the early forecast period while underestimating the actual forecast error
- Certain observing types are more strongly affected by self-analysis verification uncertainty, particularly RAOB and aircraft winds