

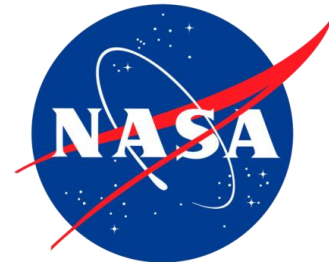


Adjoint estimation of observation impact explored with an Observing System Simulation Experiment

5 July 2018

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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

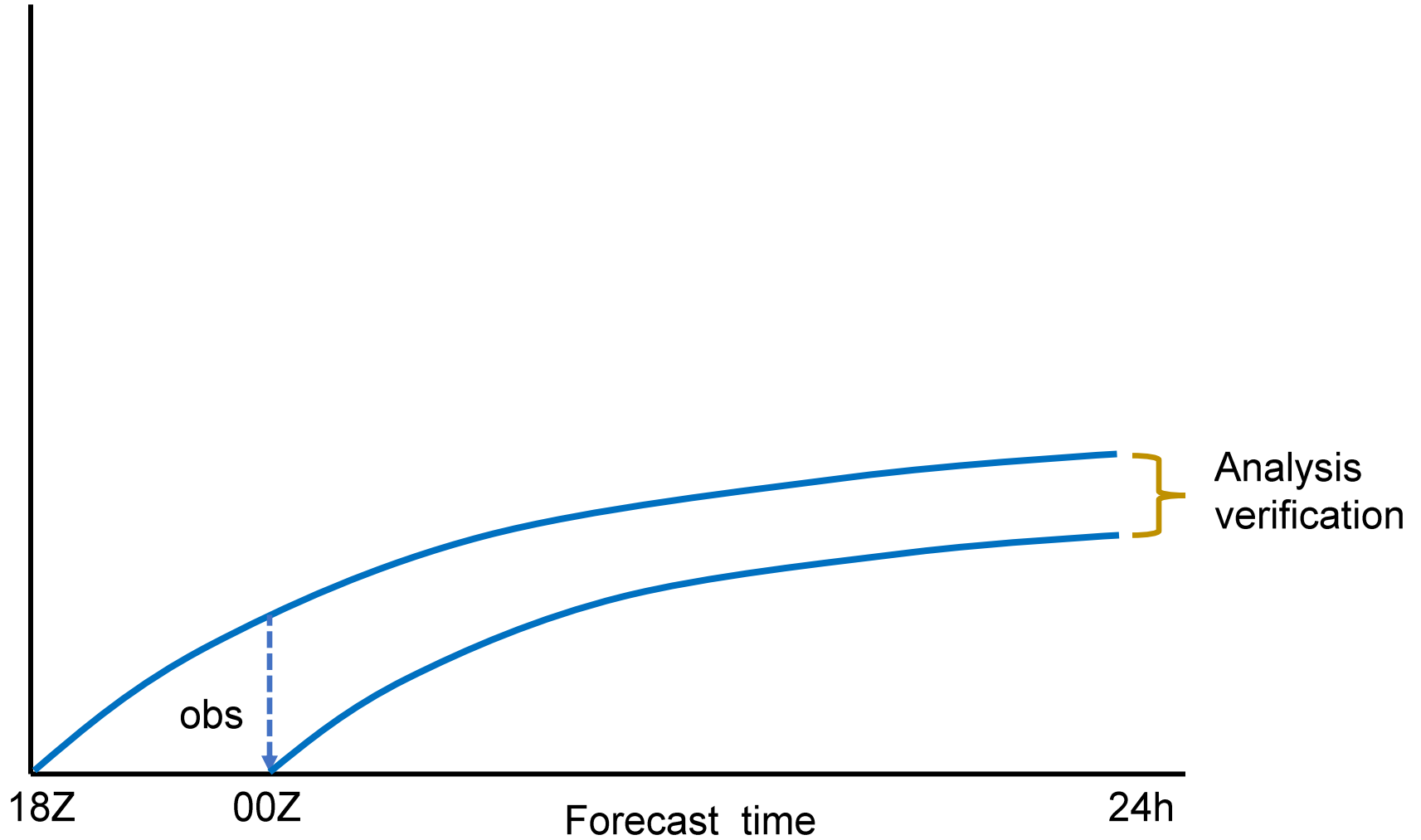


GMAO OSSE

- **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, 3DVar GSI
 - 25 km horizontal resolution, 72L
- **Adjoint:** moist physics available, total wet energy norm (TWE)

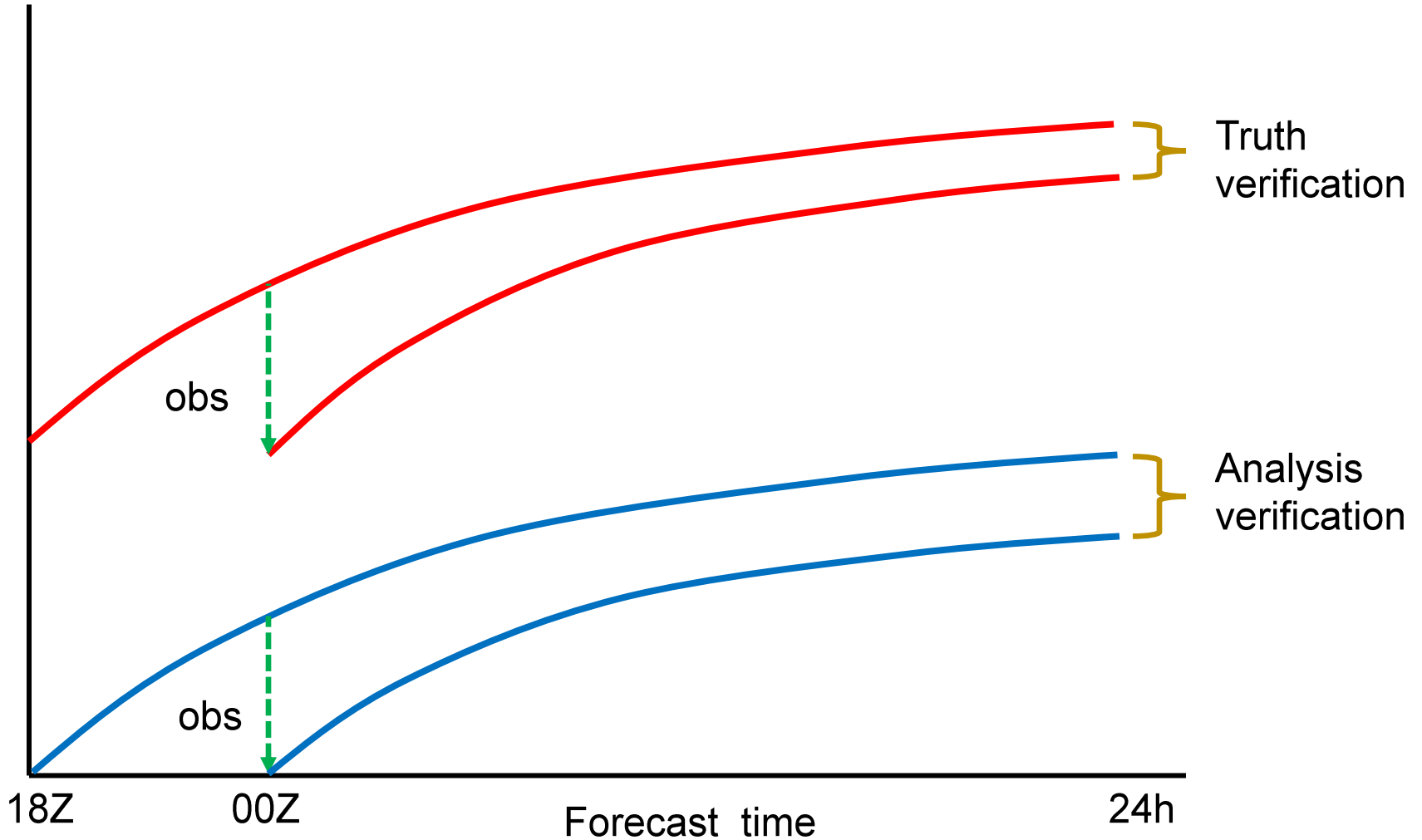


Adjoint estimation of observation impact



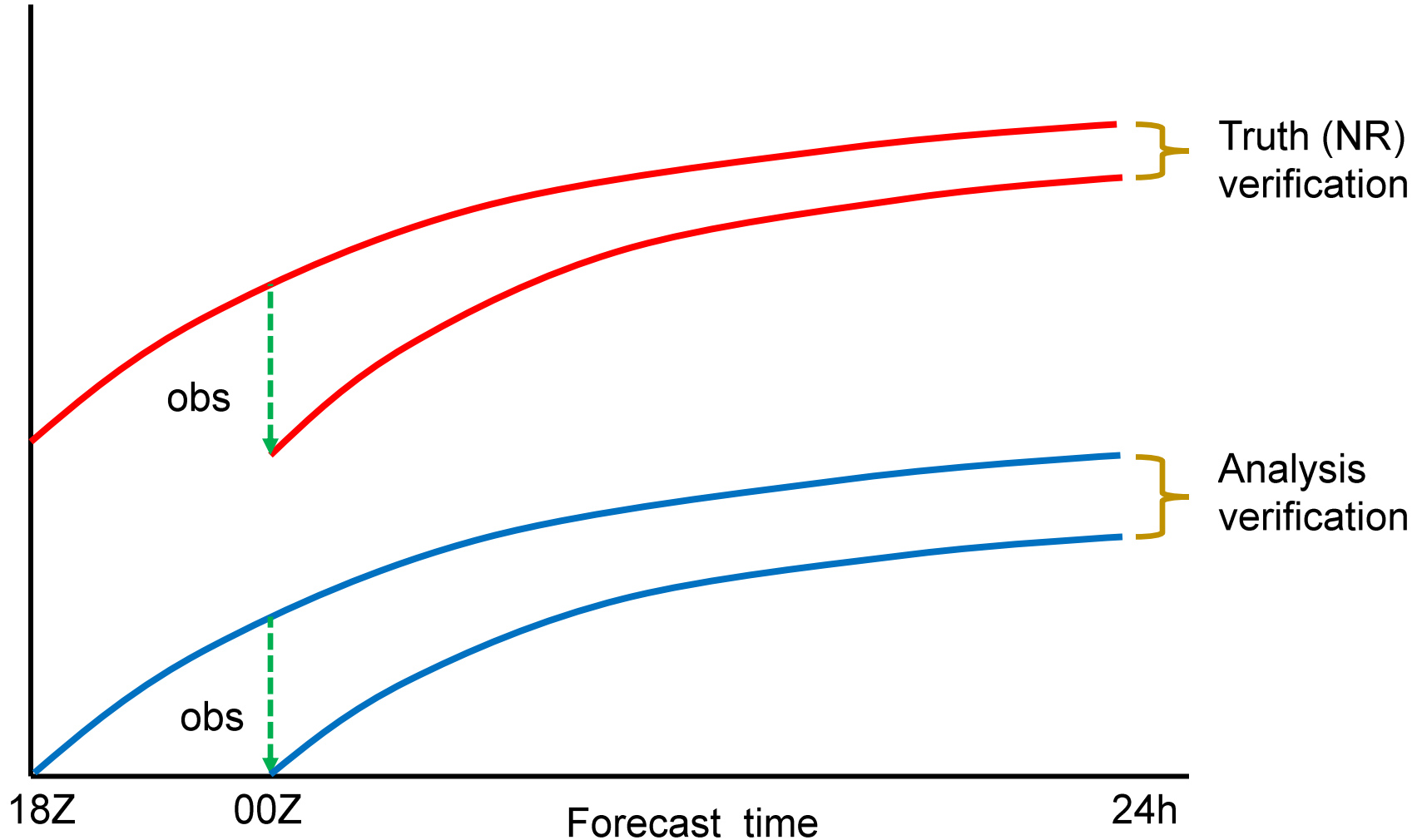


Adjoint estimation of observation impact



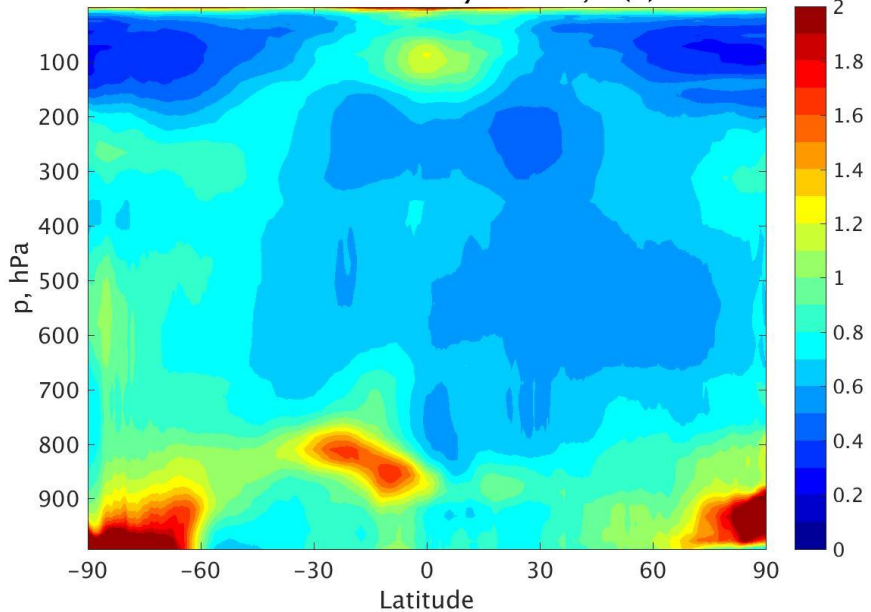
How does the incestuous nature of self-analysis verification affect the adjoint estimate of observation impact?

Use the availability of the Truth (NR) in the OSSE to investigate.

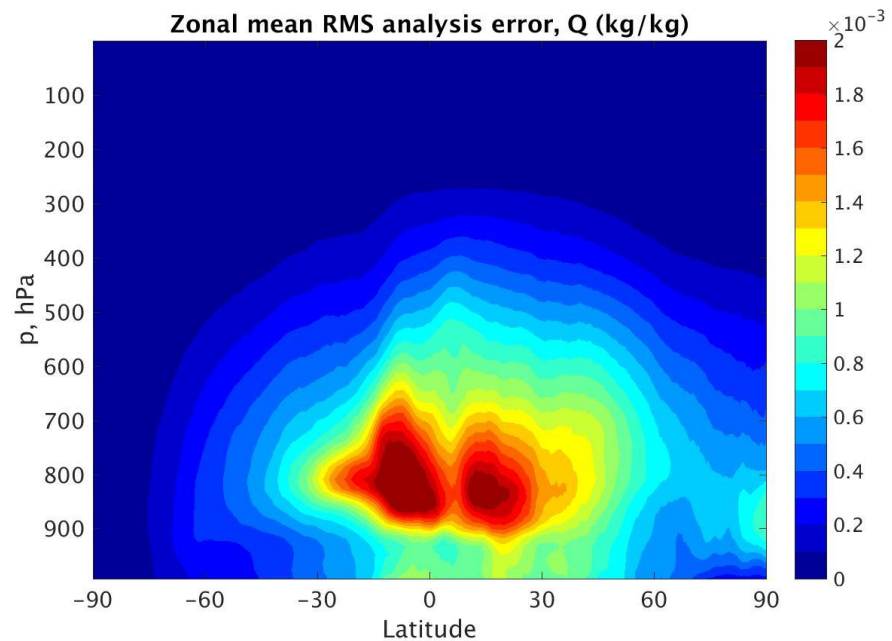


Analysis Error

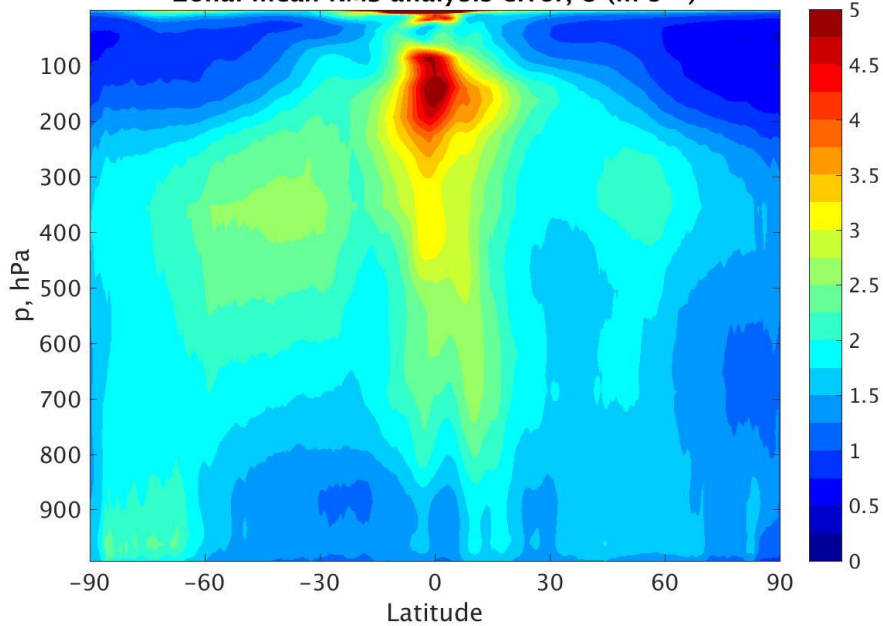
Zonal mean RMS analysis error, T (K)



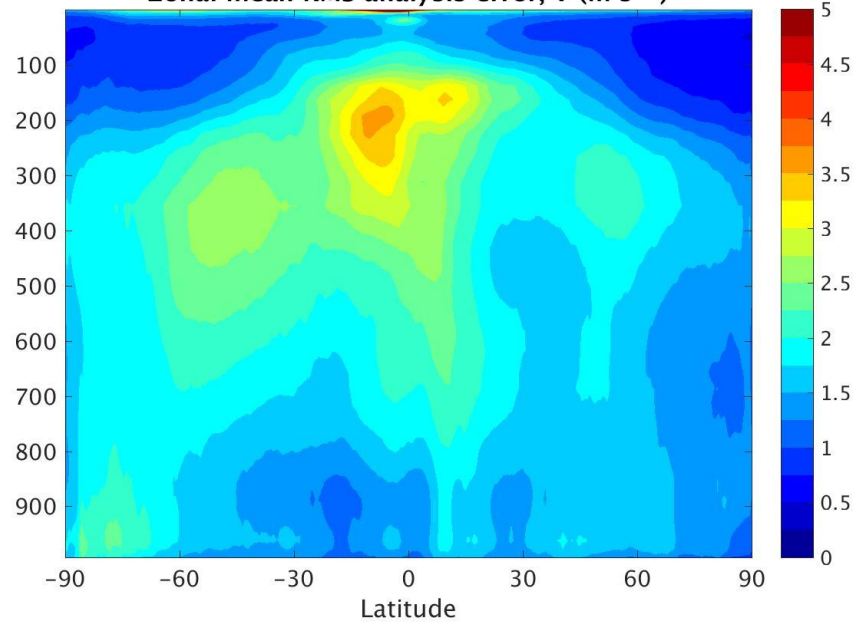
Zonal mean RMS analysis error, Q (kg/kg)



Zonal mean RMS analysis error, U (m s^{-1})

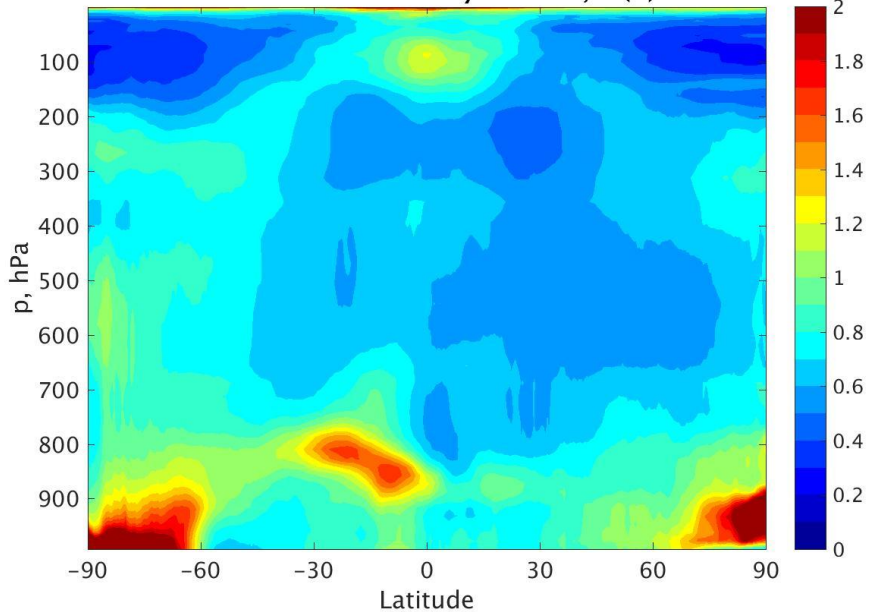


Zonal mean RMS analysis error, V (m s^{-1})

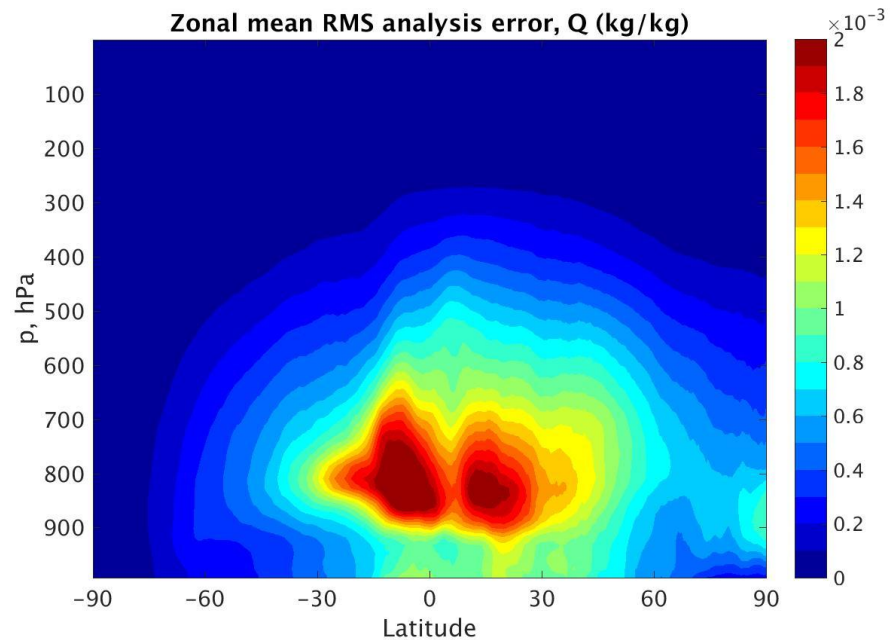


Analysis Error

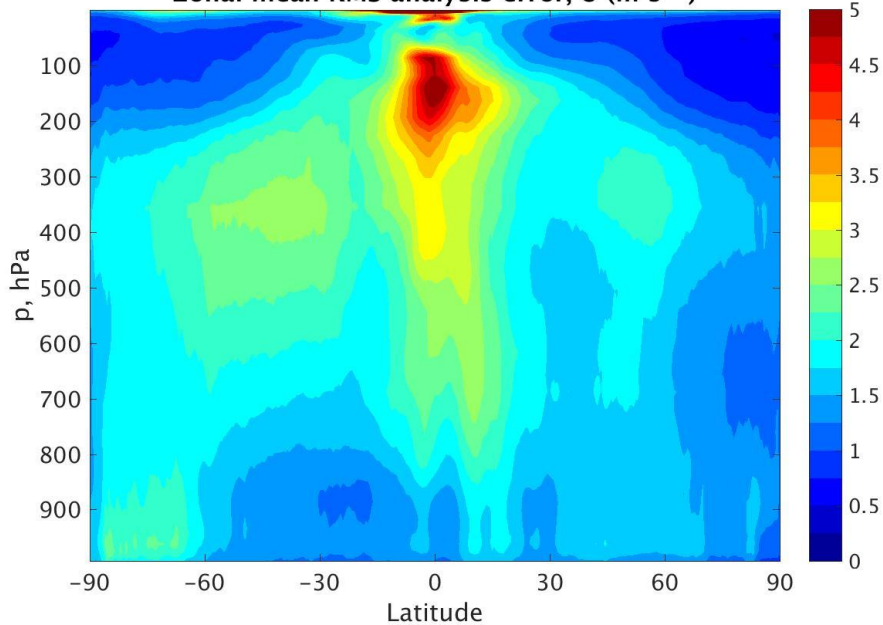
Zonal mean RMS analysis error, T (K)



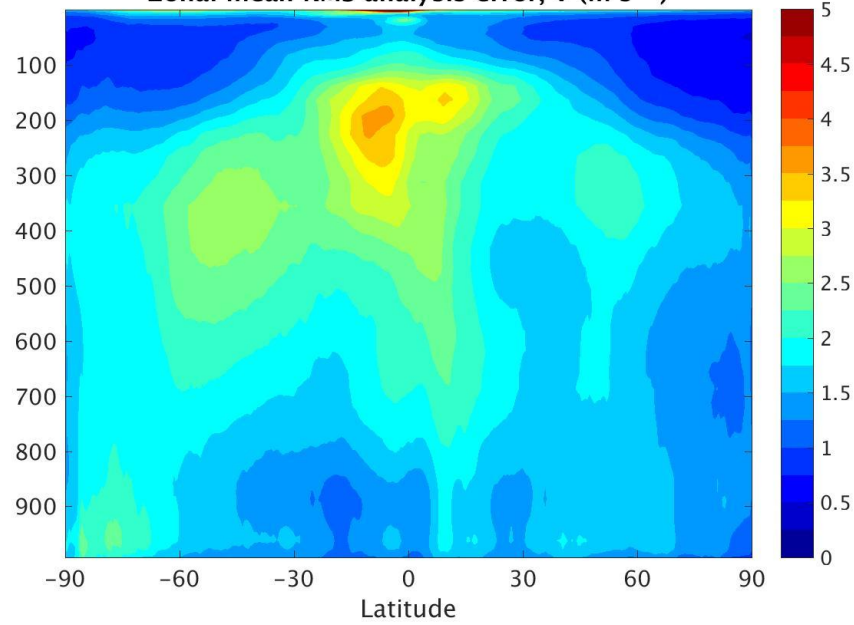
Zonal mean RMS analysis error, Q (kg/kg)



Zonal mean RMS analysis error, U (m s^{-1})

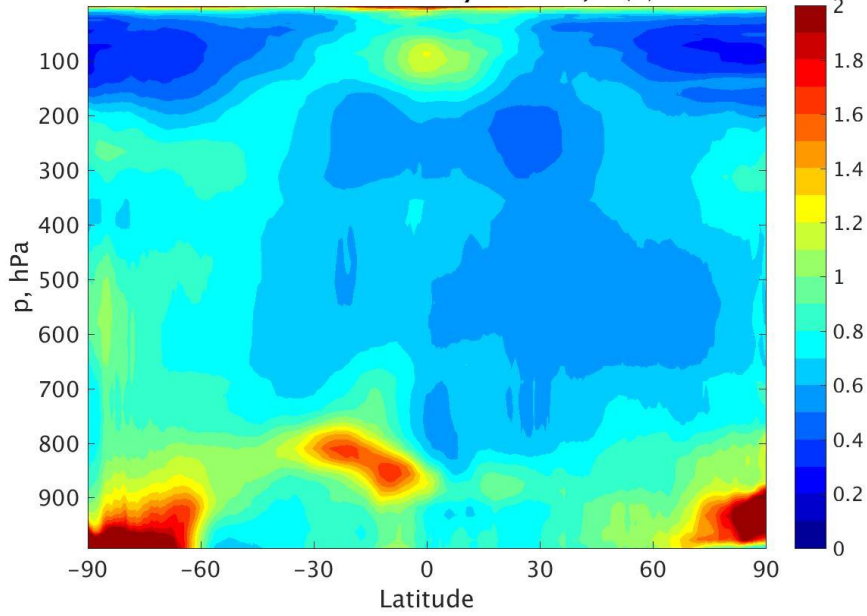


Zonal mean RMS analysis error, V (m s^{-1})

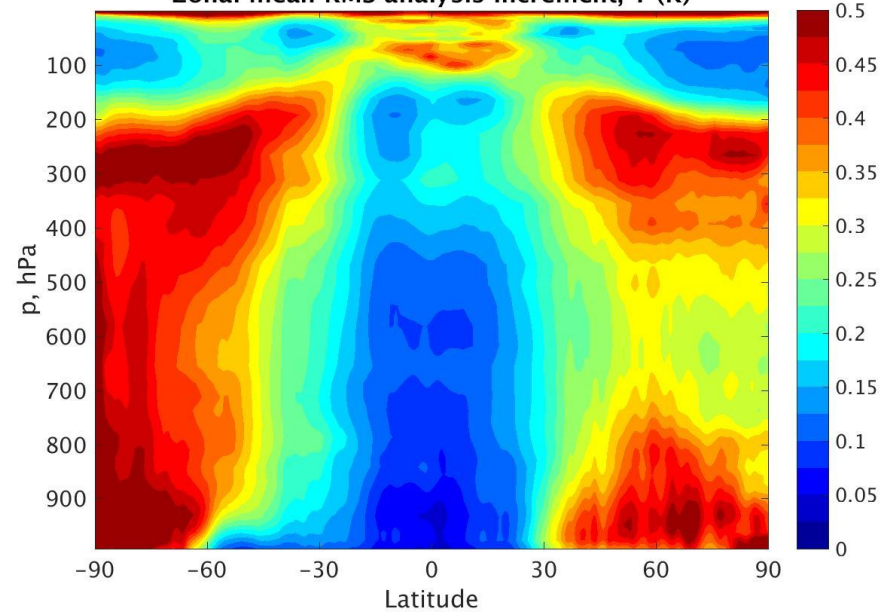


Analysis Error and Increment

Zonal mean RMS analysis error, T (K)

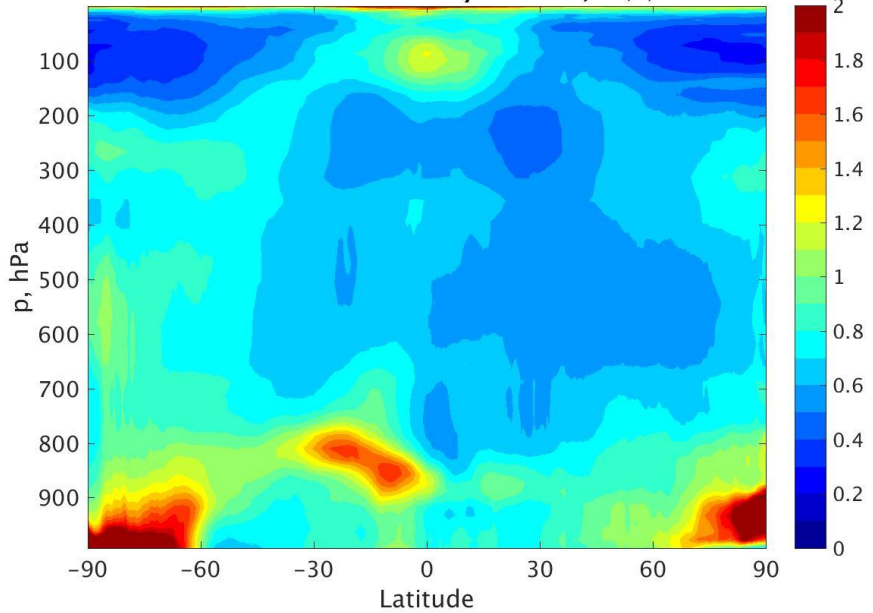


Zonal mean RMS analysis increment, T (K)

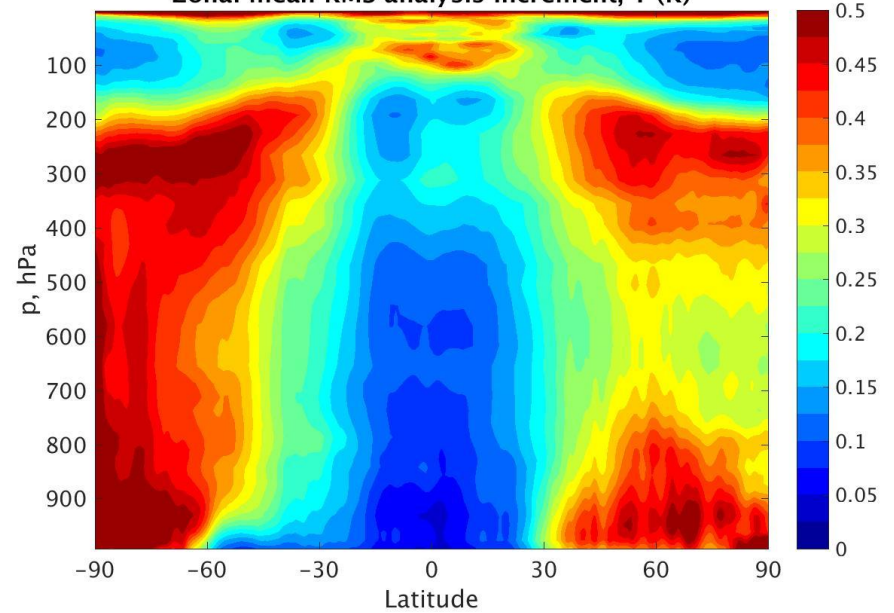


Sensitivity (Total Wet Energy norm)

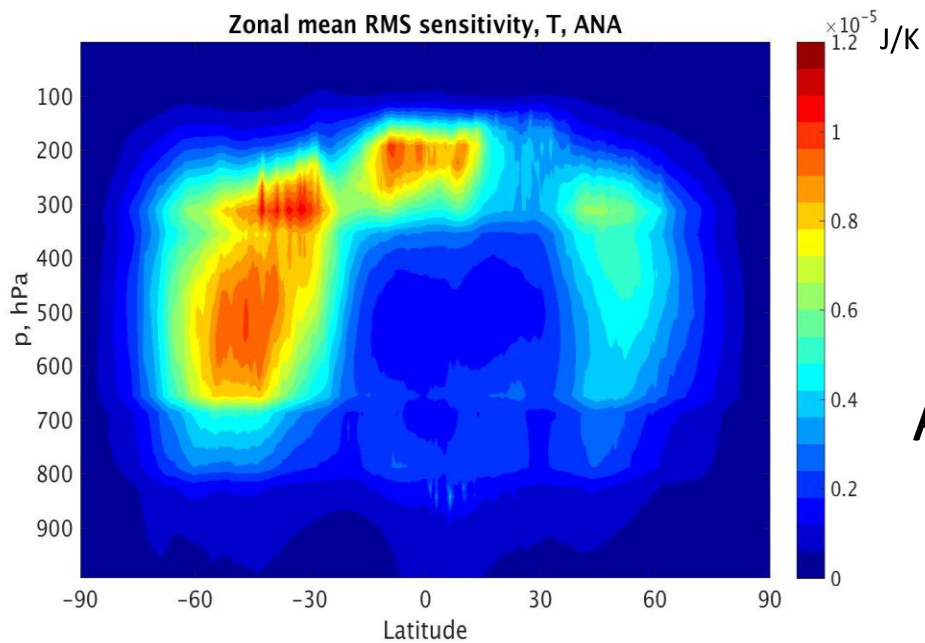
Zonal mean RMS analysis error, T (K)



Zonal mean RMS analysis increment, T (K)



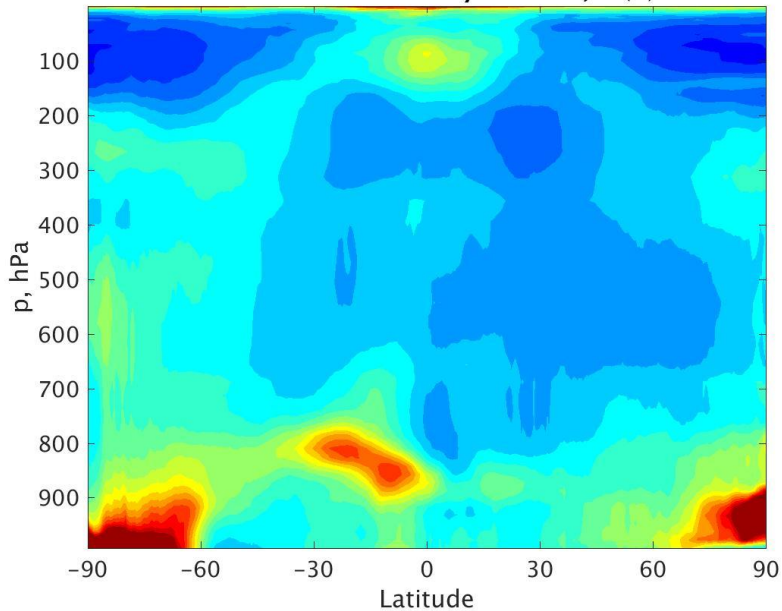
Zonal mean RMS sensitivity, T, ANA



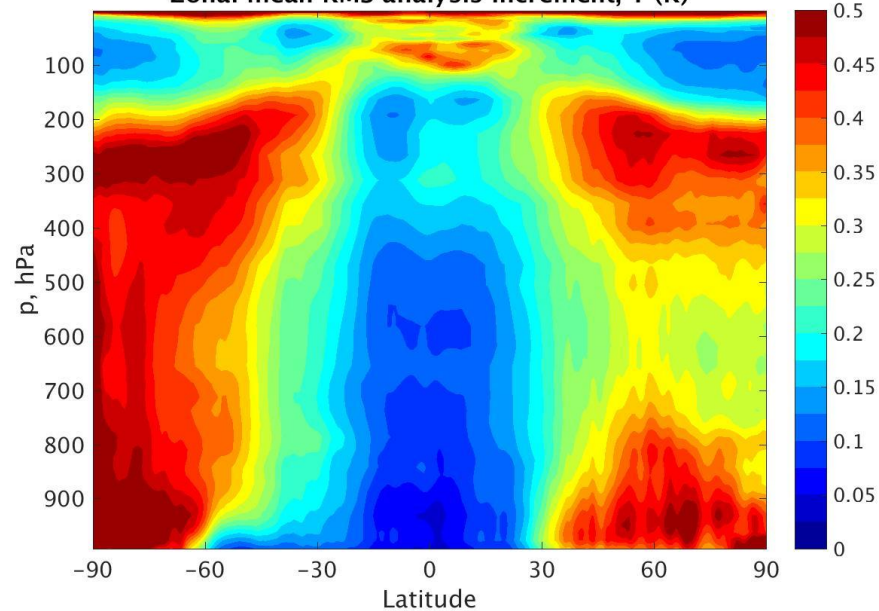
Analysis Verification

Analysis Increment * Sensitivity

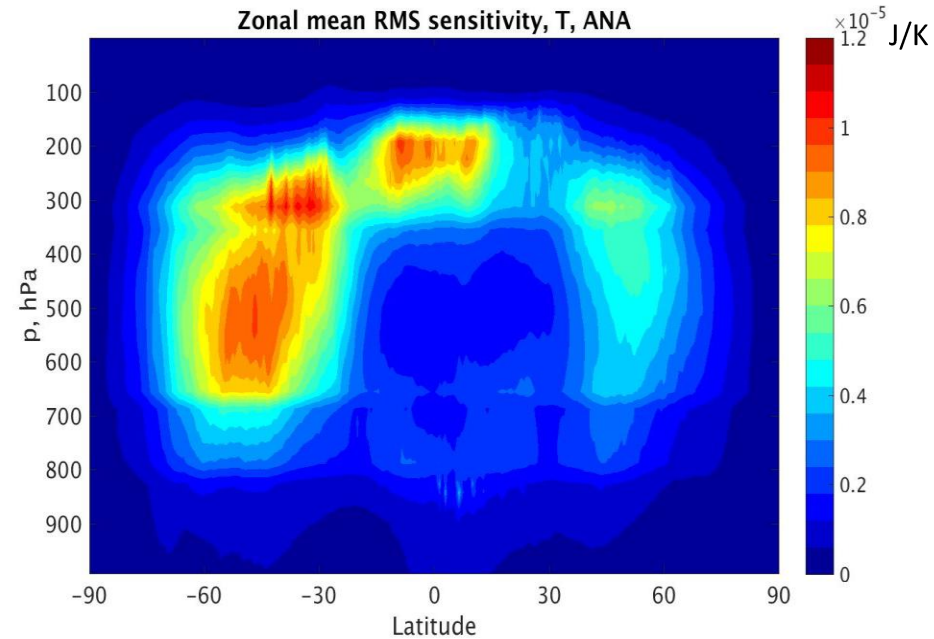
Zonal mean RMS analysis error, T (K)



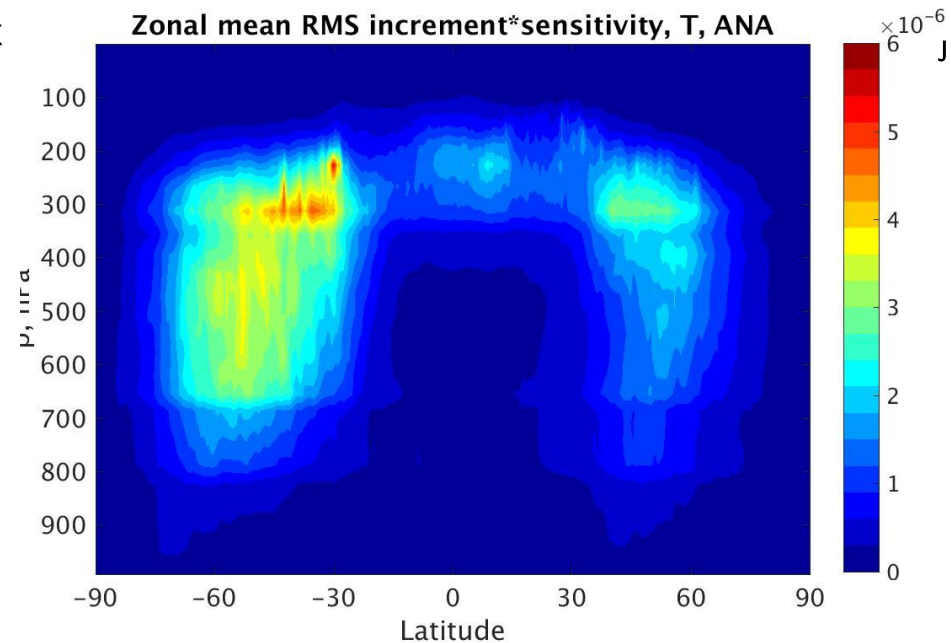
Zonal mean RMS analysis increment, T (K)



Zonal mean RMS sensitivity, T, ANA

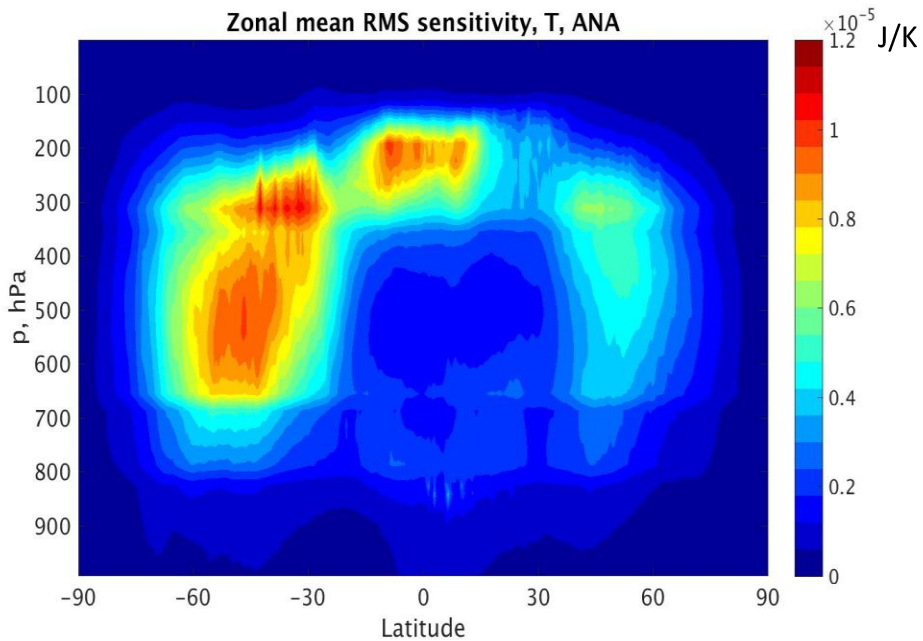


Zonal mean RMS increment*sensitivity, T, ANA

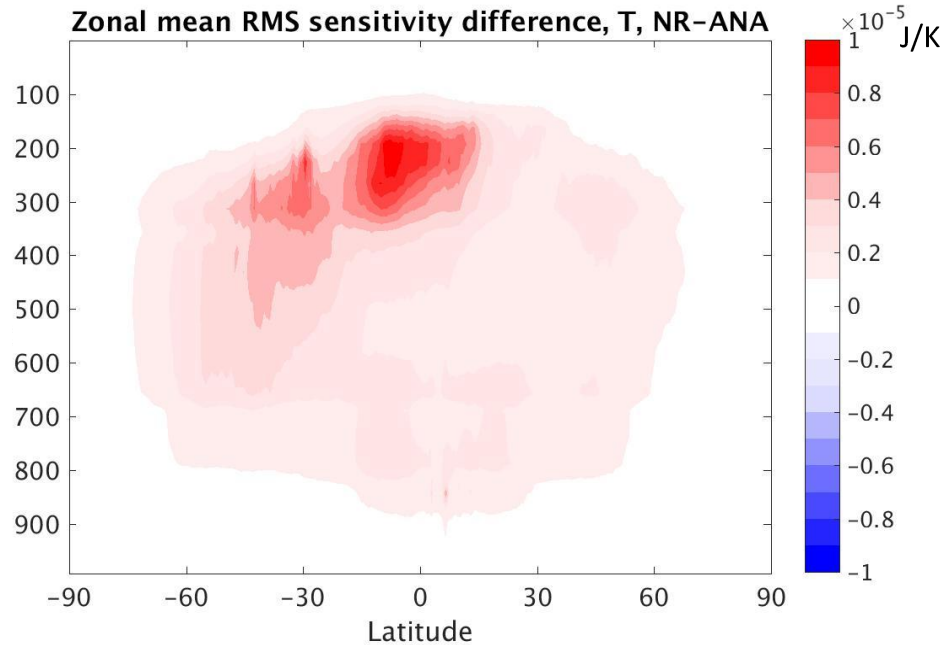


Sensitivity: Analysis vs NR Verification

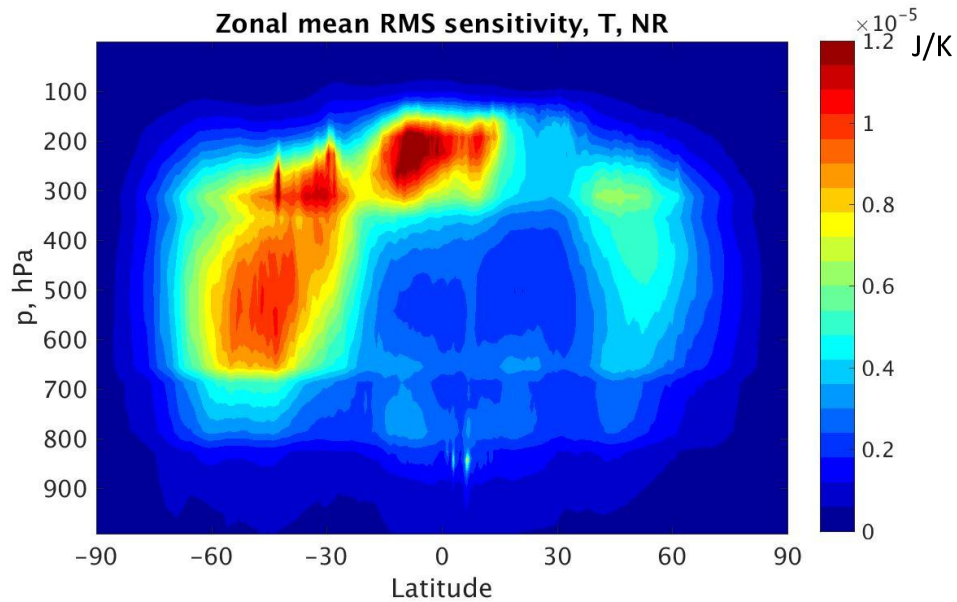
Zonal mean RMS sensitivity, T, ANA



Zonal mean RMS sensitivity difference, T, NR-ANA

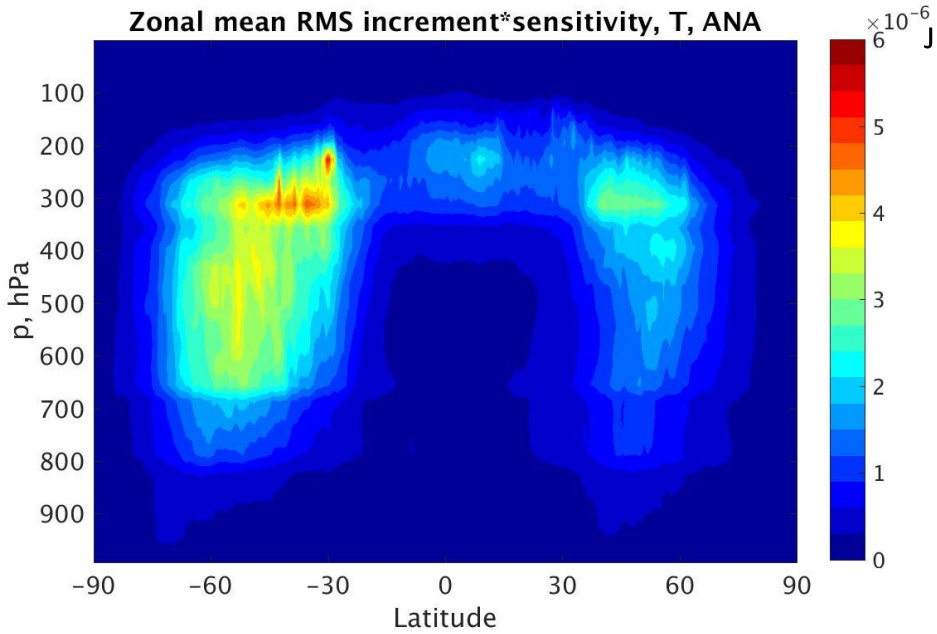


Zonal mean RMS sensitivity, T, NR

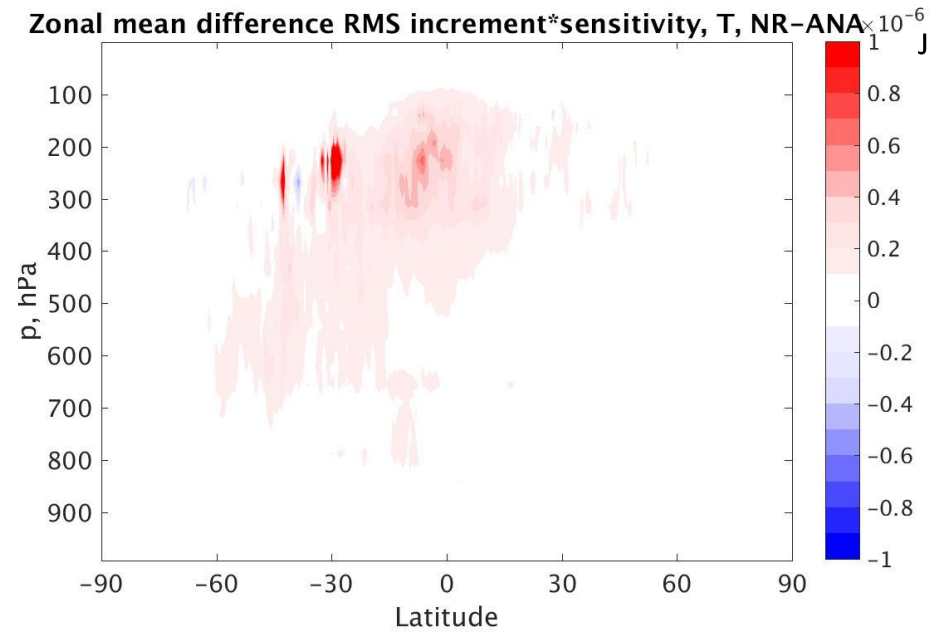


Increment *Sensitivity: Analysis vs NR Verification

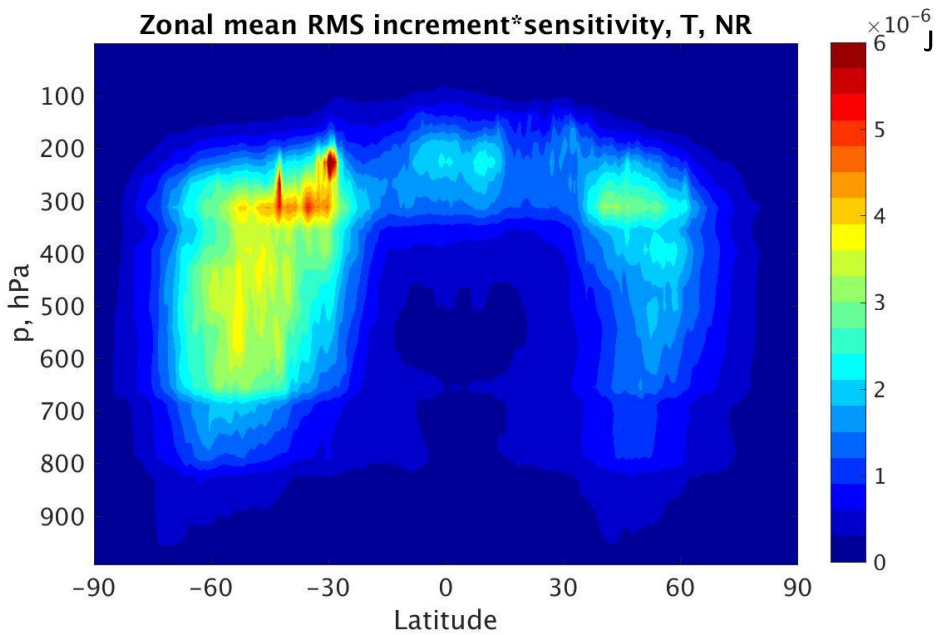
Zonal mean RMS increment*sensitivity, T, ANA



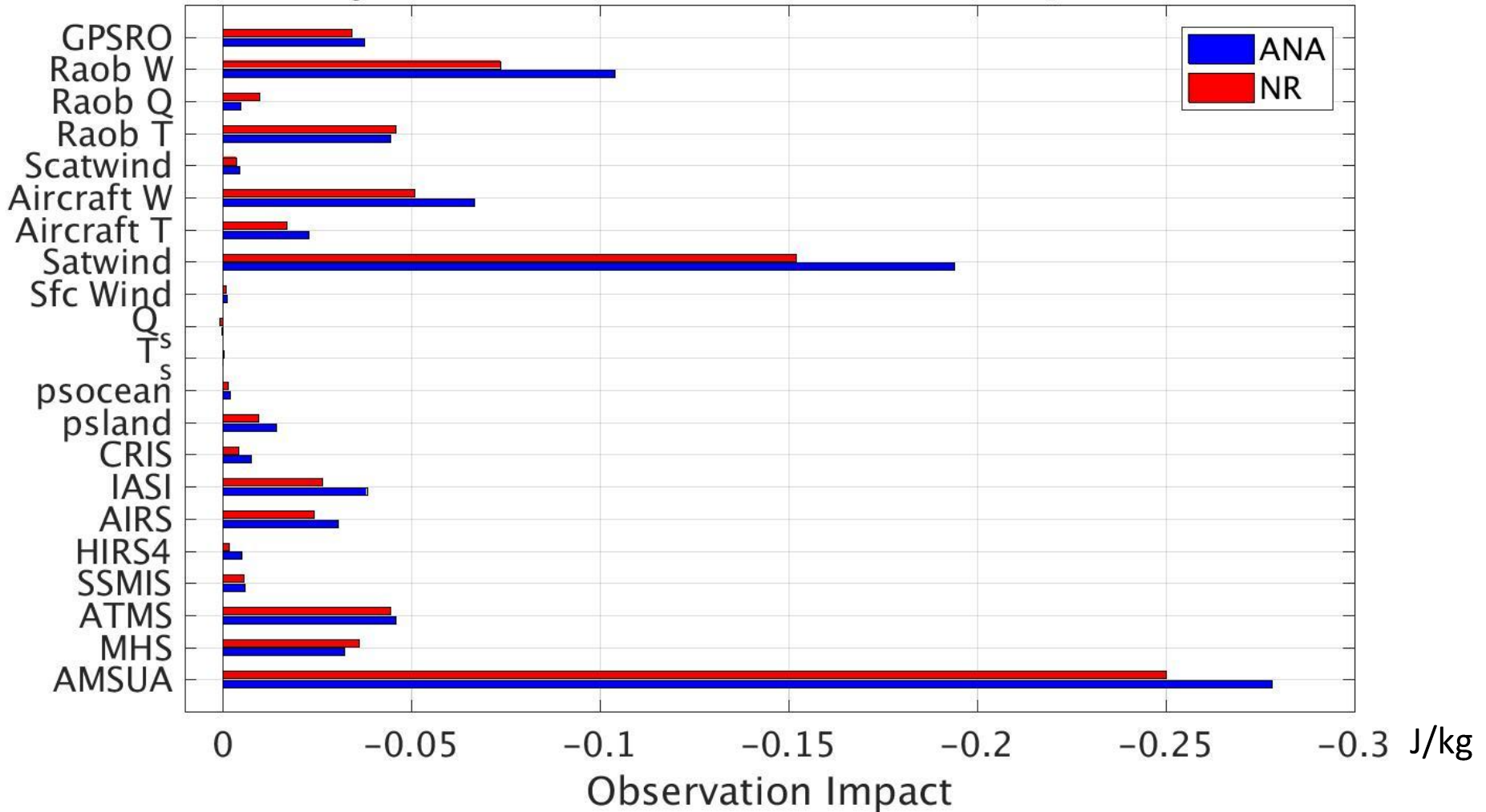
Zonal mean difference RMS increment*sensitivity, T, NR-ANA $\times 10^{-6}$ J



Zonal mean RMS increment*sensitivity, T, NR

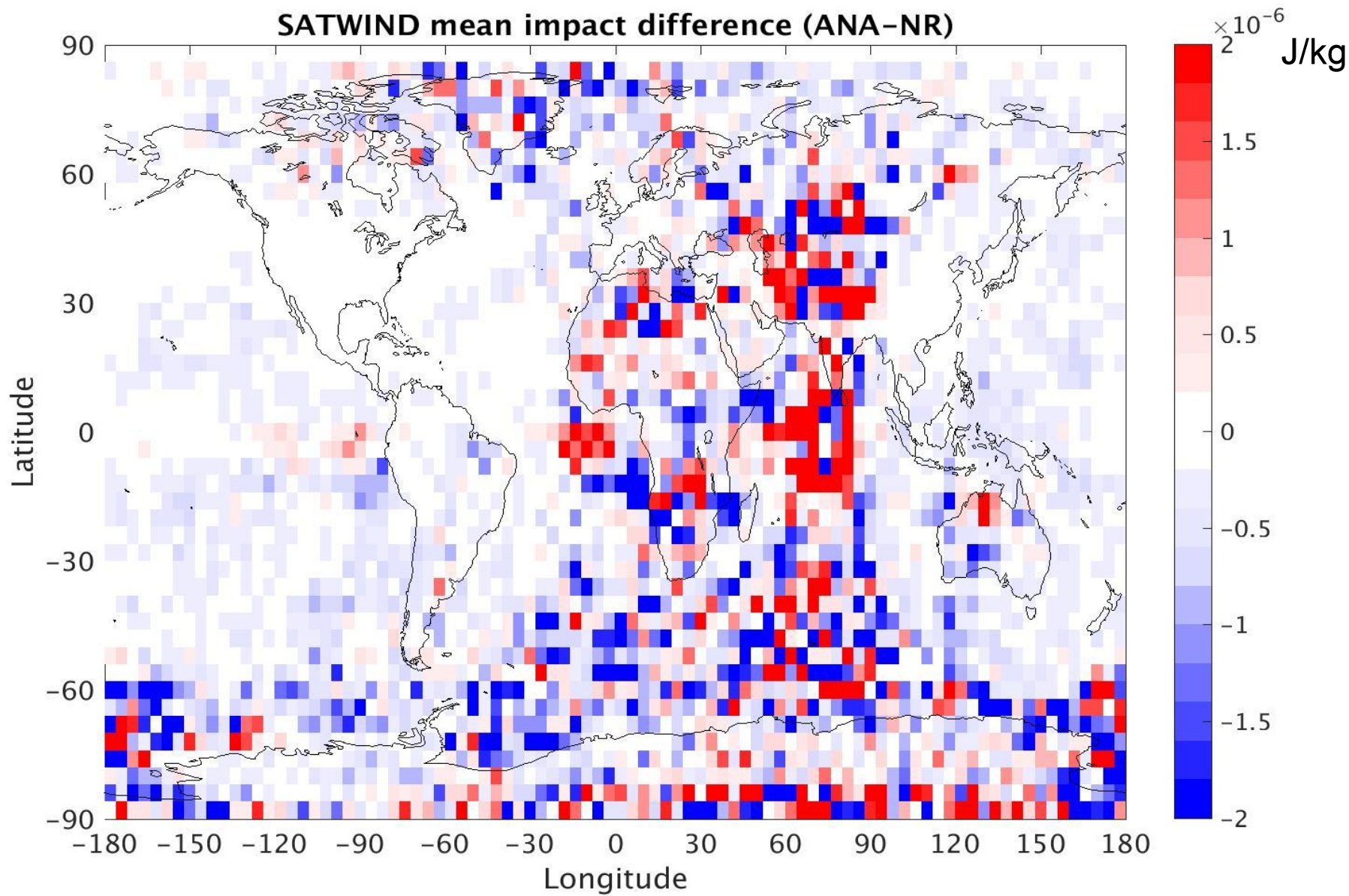


Adjoint Estimation of Observation Impact, TWE



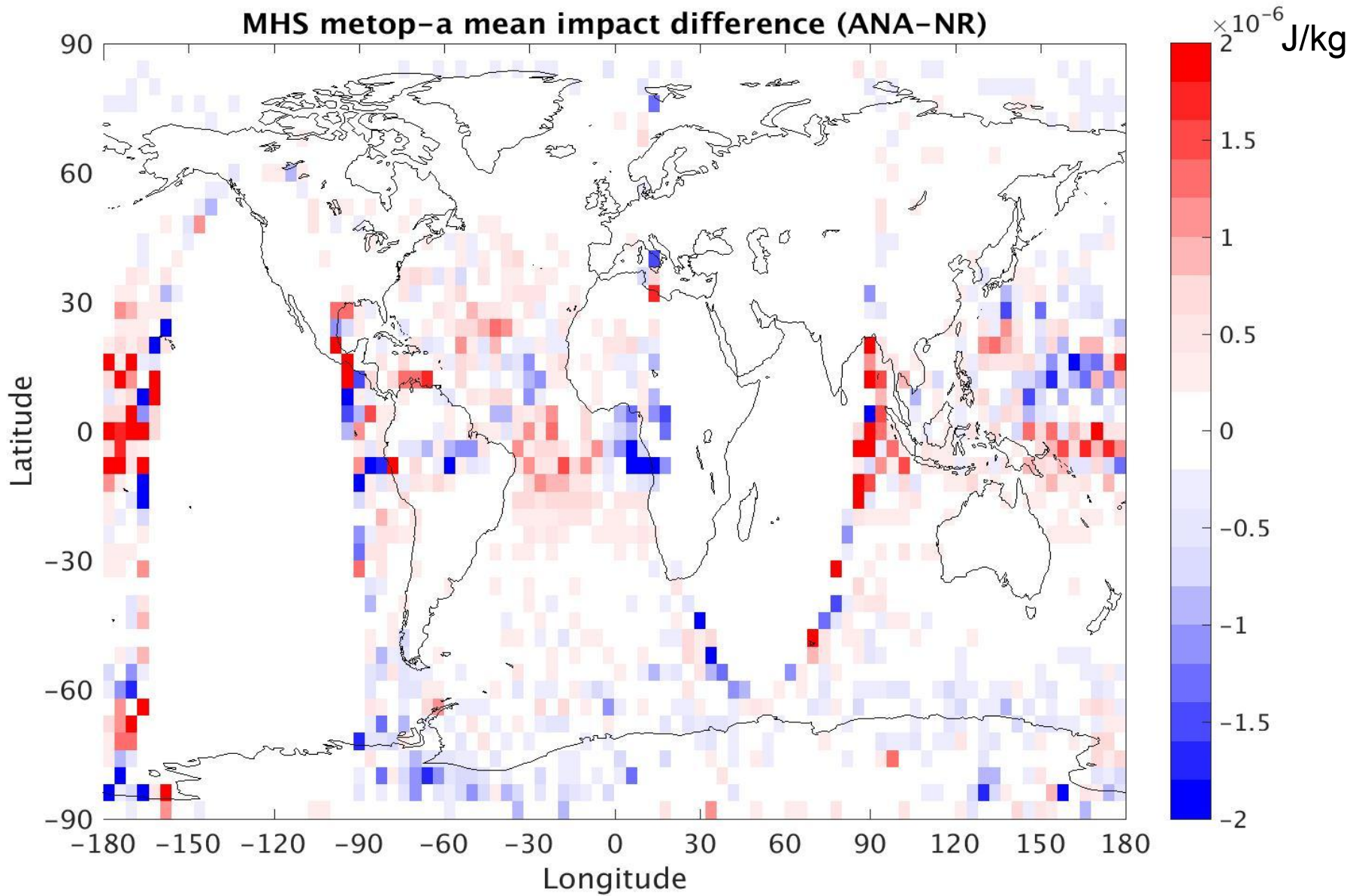
NR Verification has smaller impact overall, especially winds (AMVs, Raob, Aircraft).
Humidity obs have higher impact exception (MHS, Q)

SATWIND mean impact difference (ANA-NR)



Blue = weaker impact with NR verification

MHS metop-a mean impact difference (ANA-NR)



Blue = weaker impact with NR verification



Inconclusive Ideas

- Greater sensitivity with Truth verification
 - Projection onto norm
- Weaker impact with Truth verification
 - But not a huge difference, fidelity of rank largely maintained
 - Validity of using analysis verification supported overall
 - Incestuousness of analysis verification inflates impact even though sensitivity is less?
- What is different about wind vs humidity observations?
 - Humidity observations have equal or greater impact with Truth verification, while wind observation have less
 - Q field more incestuous than wind at synoptic scales in previous OSSE