Investigation of saturation of information from GNSS-RO with the GMAO OSSE

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GMAO OSSE Setup

- Nature Run: GEOS-5 2 year run, 7 km, 72 levels, 30 minute output
- Simulated Observations: conventional, radiance based on 2015
 - Radiance types: AMSU-A, MHS, ATMS, SSMIS, CrIS, IASI, AIRS, HIRS4
 - Conventional types: RAOB, AMV, aircraft, surface, scatterometer
 - Random correlated and uncorrelated errors added to match real var(O-F)
- DAS: Hybrid 4DEnVar GSI (replay ensemble to OSSE Control)
 - Modification of GSI GNSS-RO operator to omit one of two vertical interpolations and remove undesirable artifacts resulting from widely spaced vertical levels near the tropopause
- Forecast model: 25 km GEOS 5.17 (fraternal twin)
- Experiments: 1 July- 31 August



Simulated GNSS-RO Observations

- Simulated GNSS-RO from Nature Run fields
 - ROPP operator 2-D below 10 km
 - G5NR stratospheric T locally smoothed to correct remapping issue
 - GNSS-RO locations generated by combining multiple days of 2009 GNSS-RO data
- Random errors with vertical correlation, latitudinal and height dependent
 - Match var(O-F) of corresponding real observations



GNSS-RO OSSE Experiments

Spinup + July, August 7-day forecasts at 00z



100K GPSRO, 10 July 00z

- Control
- Control + 50k GNSS-RO soundings/day
- Control + 100k GNSS-RO soundings/day



Zonal Mean RMSE T, K

Analysis Impact

Zonal Mean RMSE U, m/s



Global RMSE T, K



Global RMSE U, m/s





100K GNSS-RO - Control

Blue = reduction in error vs Control

Adjoint Observation Impacts



Adjoint estimate using global Total Wet Energy norm for 24 hour forecast error

Increased GNSS-RO draws from (has some redundancy with) most radiance and conventional types

Diminishing returns from 50-100k

Takeaway

- Impacts are likely not saturated but beginning to see diminishing returns
- •Sensitivity to seasonal/humidity related observation errors in the troposphere
- •Swamping DAS with one observational type is a good way to find (and fix) problems with the operator or data handling
- Future Work:
 - 25k and 75k GNSS-RO experiments



Extra slides

Global Mean T, K





A-NR - B-NR

Control

Global Mean U, m/s





100K GNSS-RO

Blue = reduction in error vs BKG