Preliminary Testing and Evaluation of the GSI Data Assimilation System

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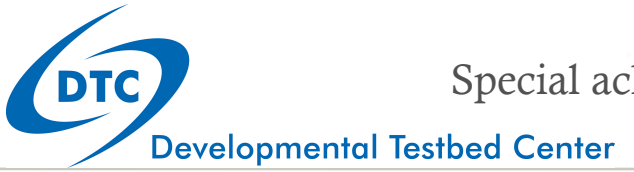


Special acknowledgement AWFA and NSF

Objectives

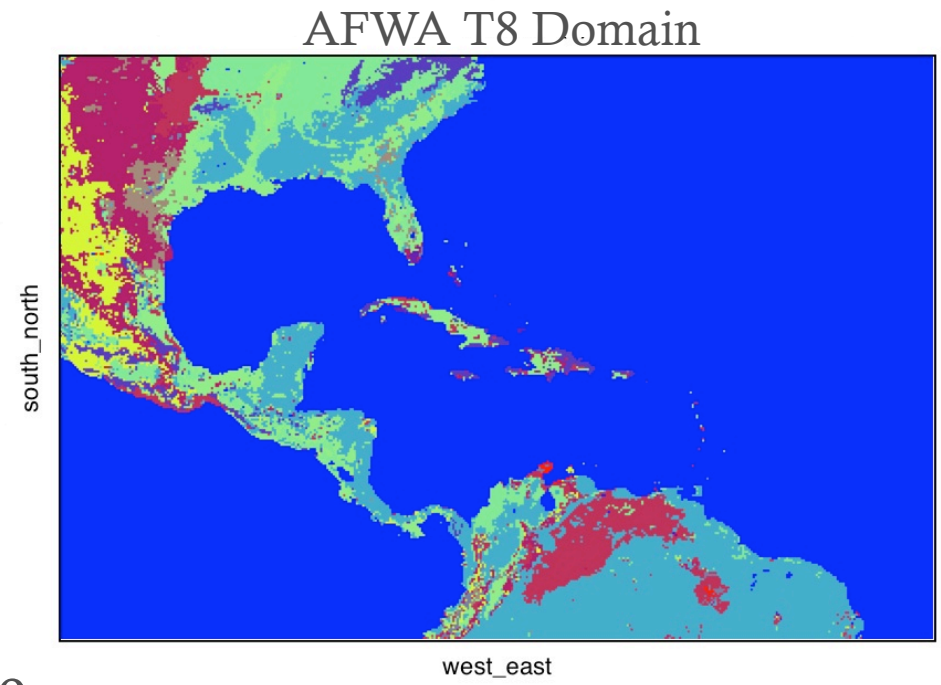
- Perform GSI + WRF-ARW configuration runs
  - Determine the capability and robustness of the GSI+ARW in regional applications
  - Evaluate impact from a variety of existing and proposed new operational data types
- Provide rational basis for operational centers and the research community for advancements of NWP systems

Gridpoint Statistical Interpolation

- Developed at EMC, GSD, and MMM
  - Community code supported through the DTC
- 3D-variational technique including dynamical constraints
  - Minimize cost function via iterative technique
  - Convergence when gradient in cost function minimizes
- GSI V2.0 GPS Quality Control (QC) Changes (Cucurull 2010)
  - Improve QC statistics
    - Seasonal statistics to account for model skill score changes, smoothed QC altitude transitions
    - Fixed code errors
  - Reduce approximations in refractivity forward operator and improved assumptions
  - Improved observation errors
    - New ob errors are nearly always smaller than previous in tropics
    - Not much change in extratropics
  - These changes increase data usage in tropics

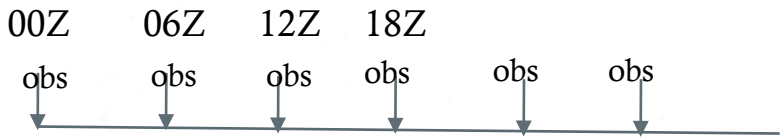
Extended Tests

- GSI v2.0 coupled with WRF-ARW v3.2
- 15 August 2007 (12 UTC) – 15 September 2007 (12 UTC)
- 15 km horizontal resolution
- 57 vertical levels
- 10 mb model top
- AFWA T8 domain
- Verification using Model Evaluation Tools (MET) v2.0



Experimental Design

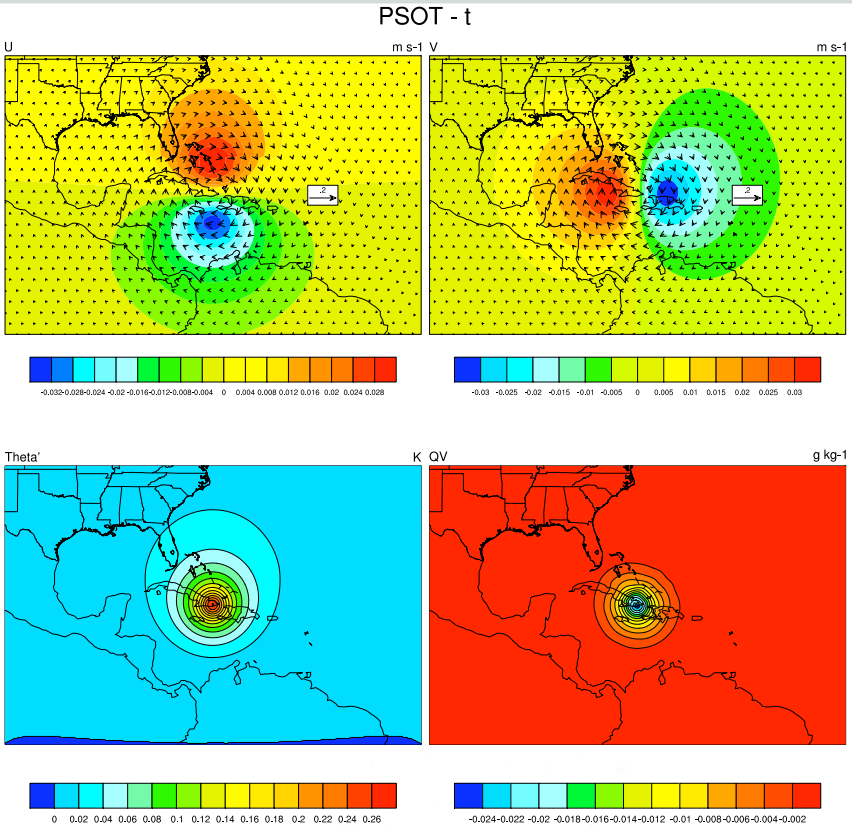
- GFSWRF: ARW runs started from GFS analysis every 6 hours
- CYC_CONV: GSI + ARW runs in full cycling mode (6hrs). PREPBUFR data were assimilated
- CYC_GPS: GSI + ARW runs in full cycling mode (6 hrs). PREPBUFR and GPS RO data were assimilated



Observations

- PREPBUFR observations:
  - Contains conventional observations such as soundings, surface observations (land and ocean), profilers, aircraft, etc
    - Pressure, wind, temperature, moisture
- GPS RO (COSMIC):
  - GPS Radio Occultation limb soundings. Independent from radiosonde observations, high accuracy, high vertical resolution
    - Temperature, moisture, pressure

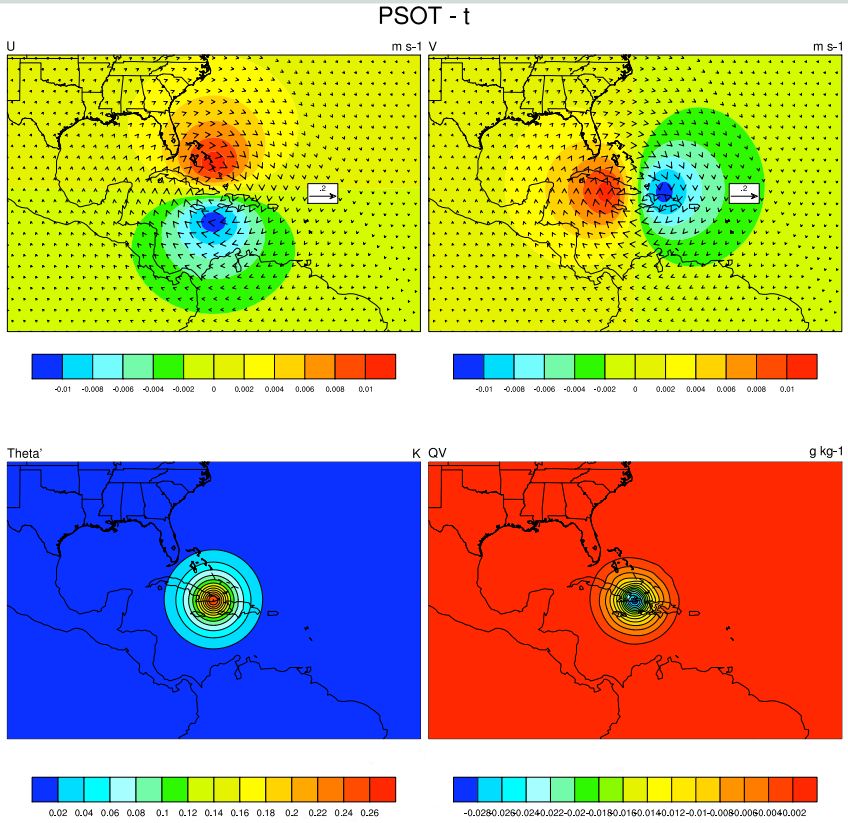
Pseudo Single Observation Test



Global Background Errors

- 1 K temperature observation increment with 1 K observation error
- Global background errors (BE) give more weight to observation as compared to regional BE
- Isotropic error covariance in xy directions
- Response in wind field due to temperature perturbation being projected onto balanced flow (geostrophic adjustment)

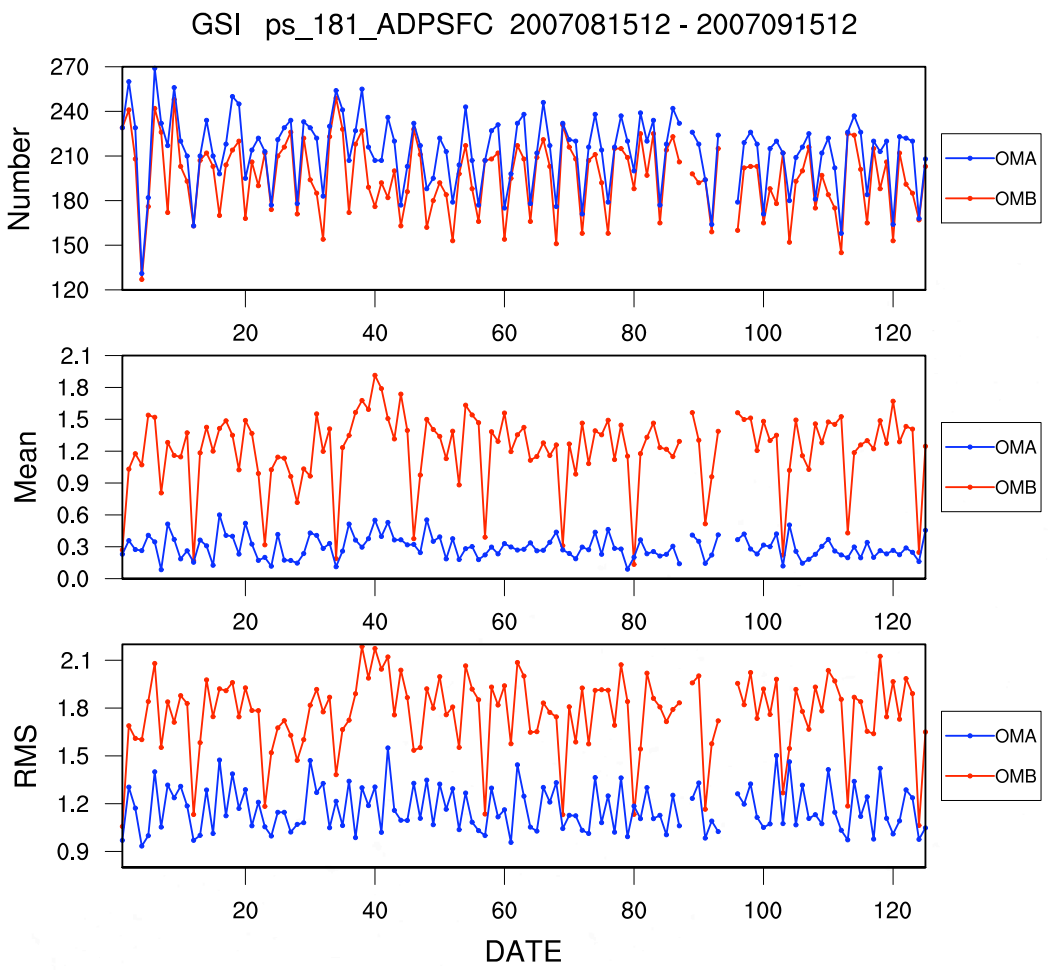
Pseudo Single Observation Test



Regional Background Errors

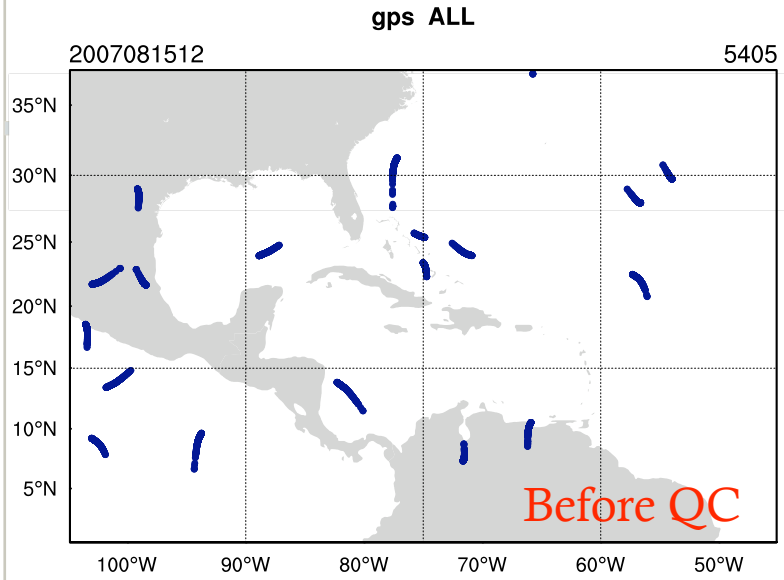
- Regional BE give less weight to observation as compared to global BE
- Isotropic error covariance as well
- Response in wind field smaller due to smaller ob increment area
  - Less response projected onto balanced flow
- Global BE used in extended runs

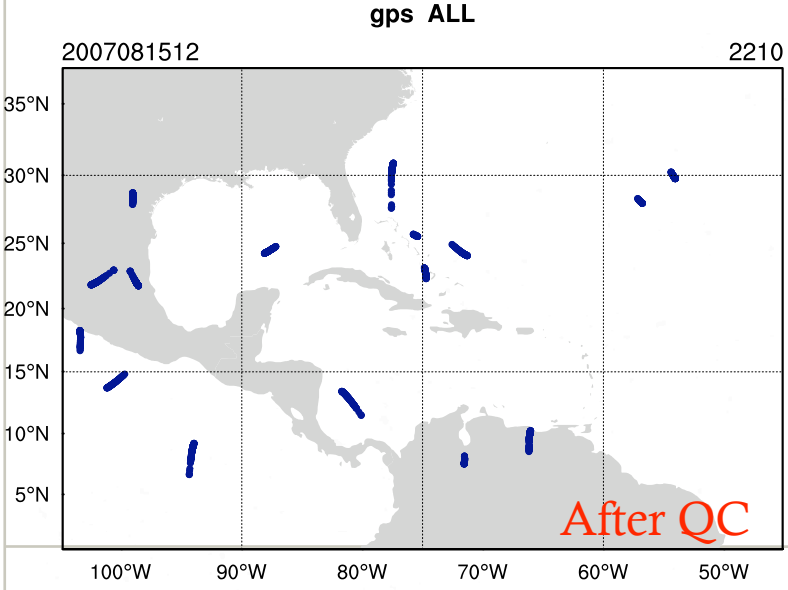
PREPBUFR assimilation

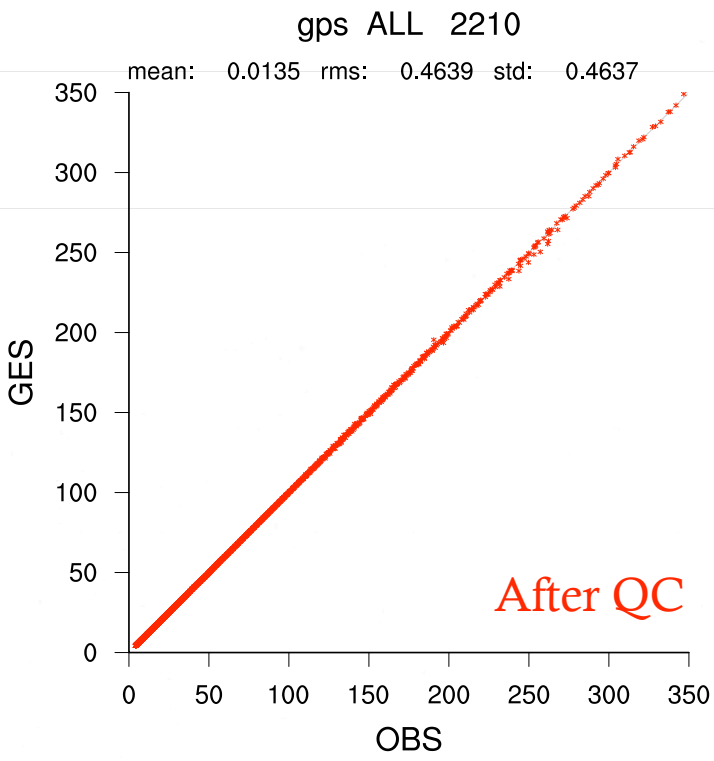


- Surface synoptic stations
- GSI properly assimilating conventional observations
- Analysis increment improvement over background innovation
- Analysis increment has lower RMS value than background

GPS RO assimilation



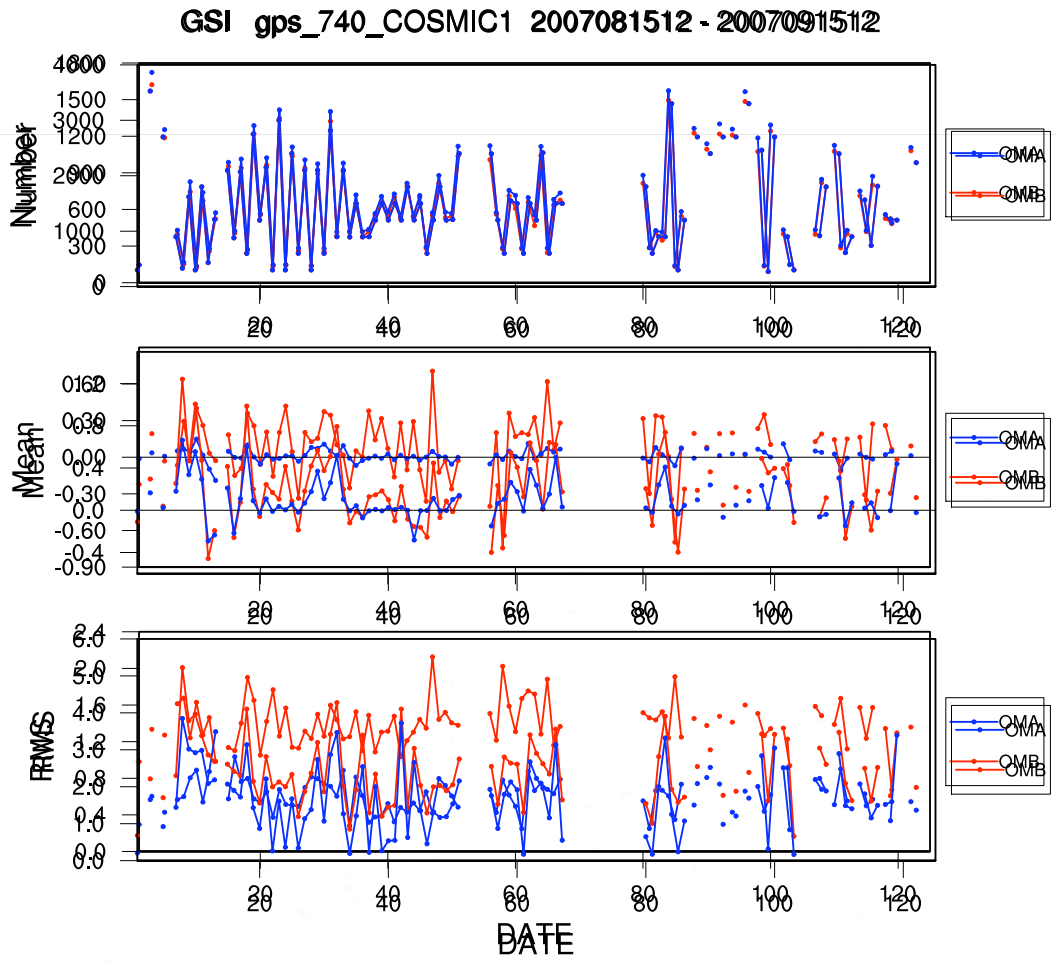




	Ob Rejection	RMS	STDEV
FY 2009	61.2%	1.1558	1.1557
FY2010	59.1%	0.4639	0.4637

** Results for 2007081512*

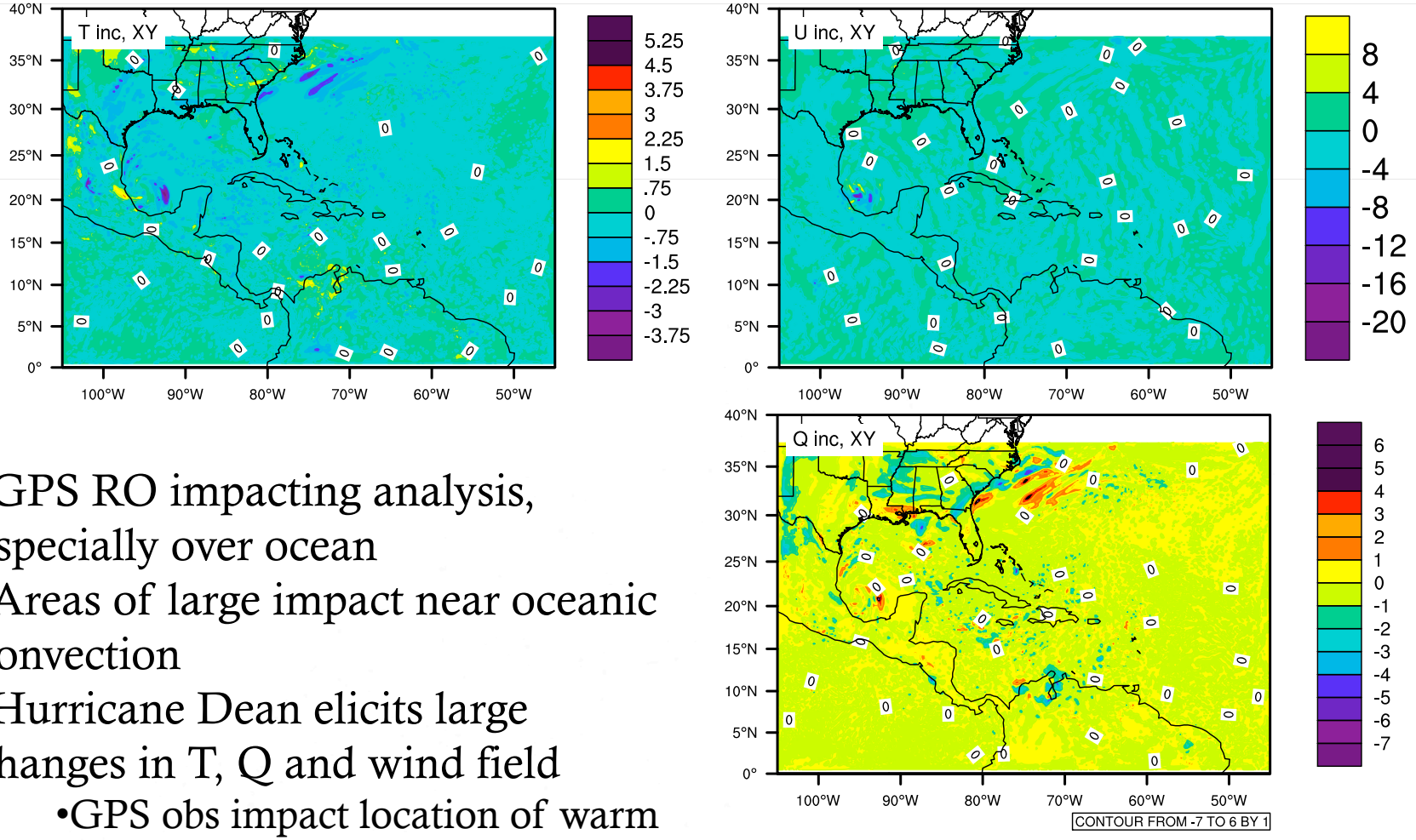
GPS RO assimilation



- COSMIC 1
- GSI properly assimilating GPS observations
- Analysis increment improvement over background innovation
- Analysis increment has lower RMS value than background

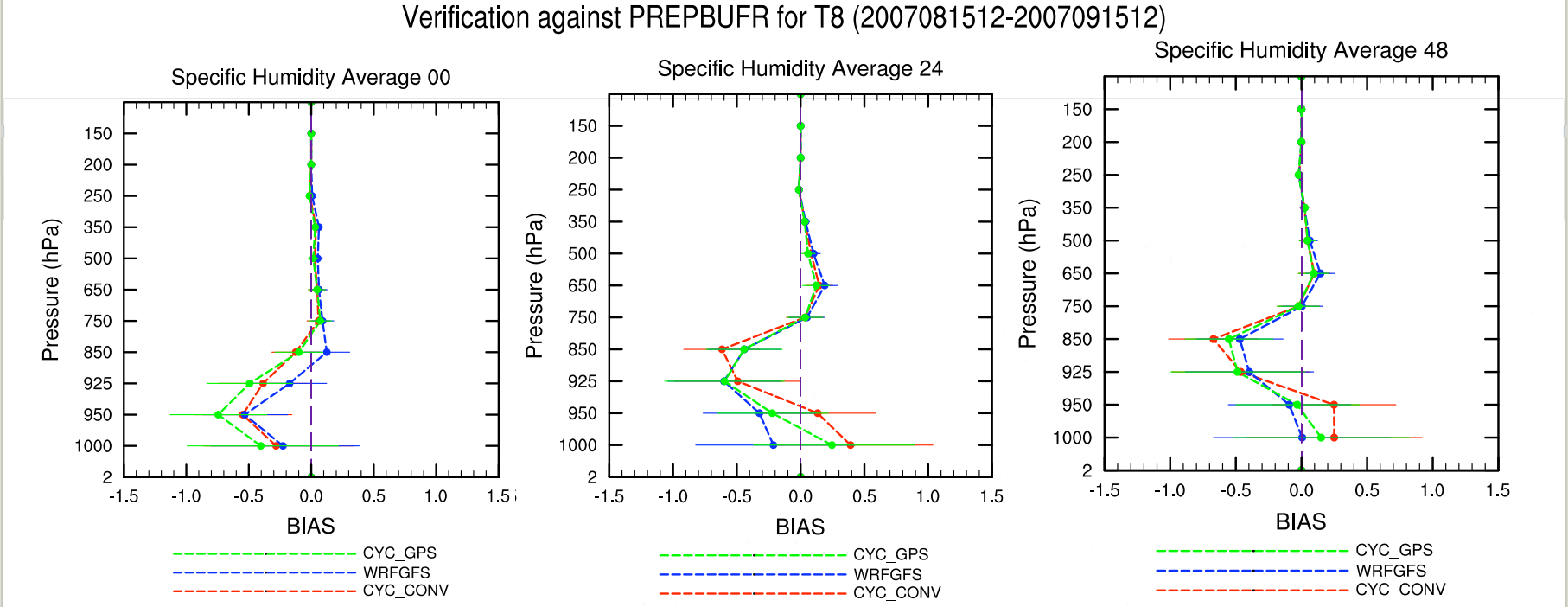
Impact of GPS RO assimilation

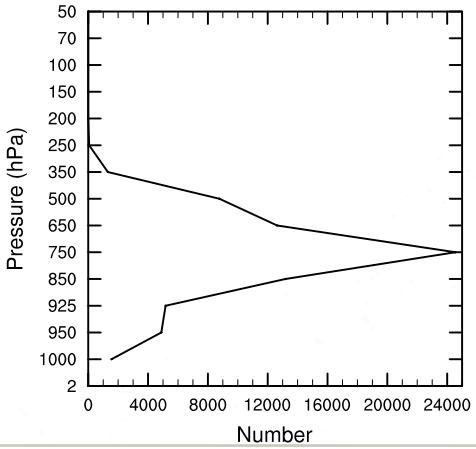
Analysis+CYC_CONV – Analysis+CYC_GPS



- GPS RO impacting analysis, especially over ocean
- Areas of large impact near oceanic convection
- Hurricane Dean elicits large changes in T, Q and wind field
  - GPS obs impact location of warm core (and thus wind field)

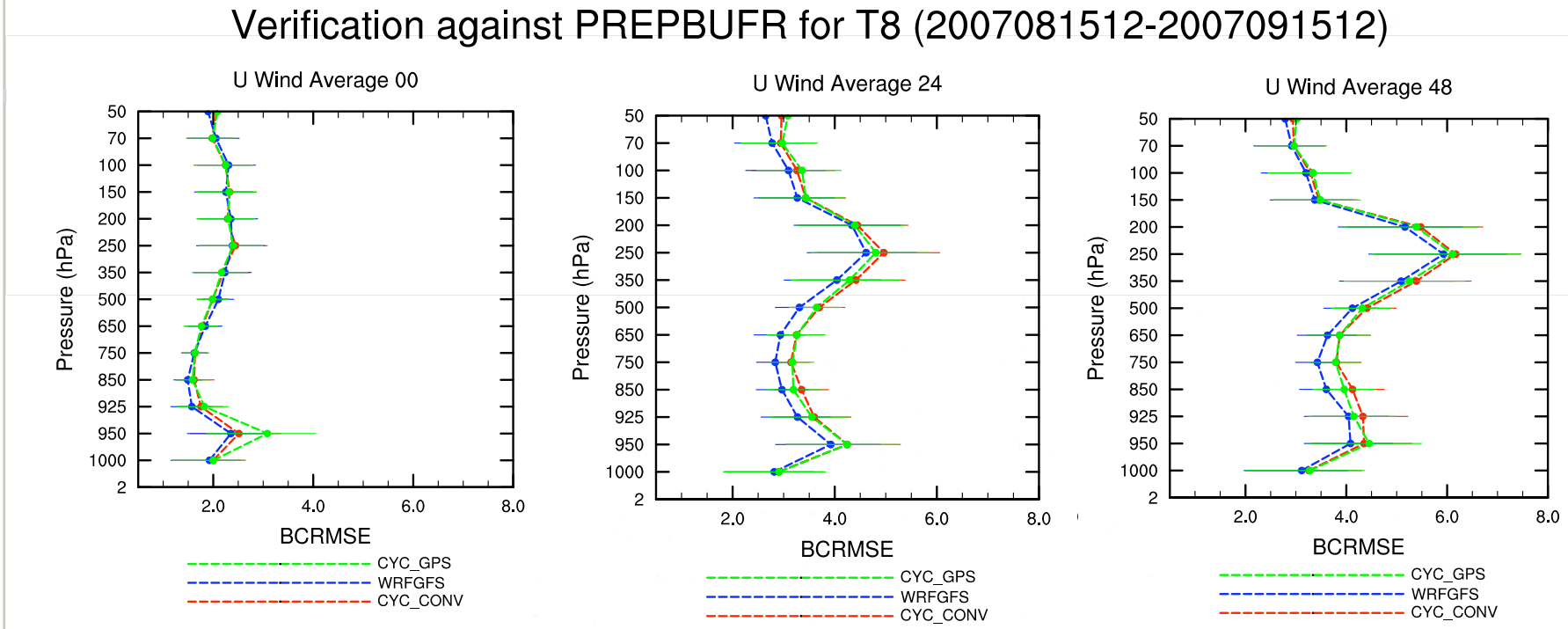
Verification against PREPBUFR obs





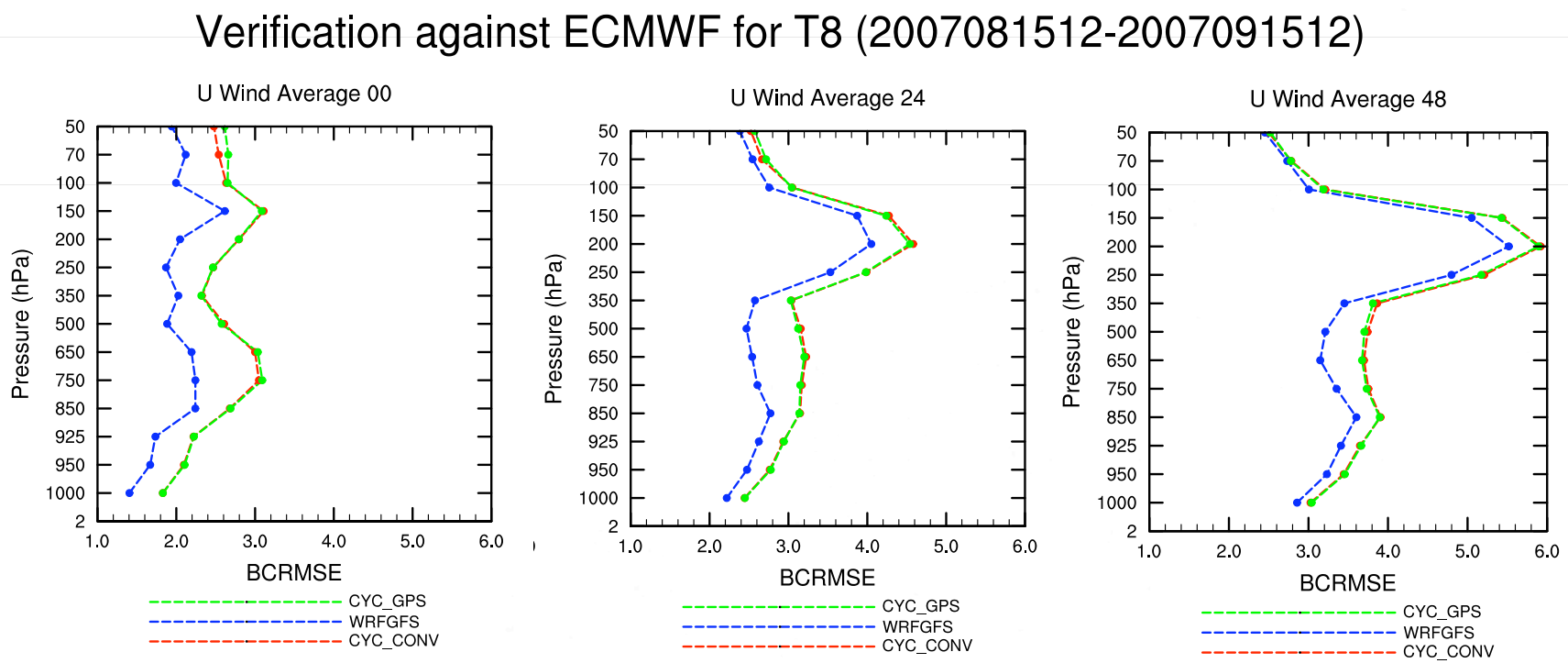
- GFSWRF run has smallest biases below 750 mb initially and through out fcst
  - Uses global analysis as background, assimilating all available obs
- Cycling runs have smaller bias in upper levels initially and through out fcst

Verification against PREPBUFR



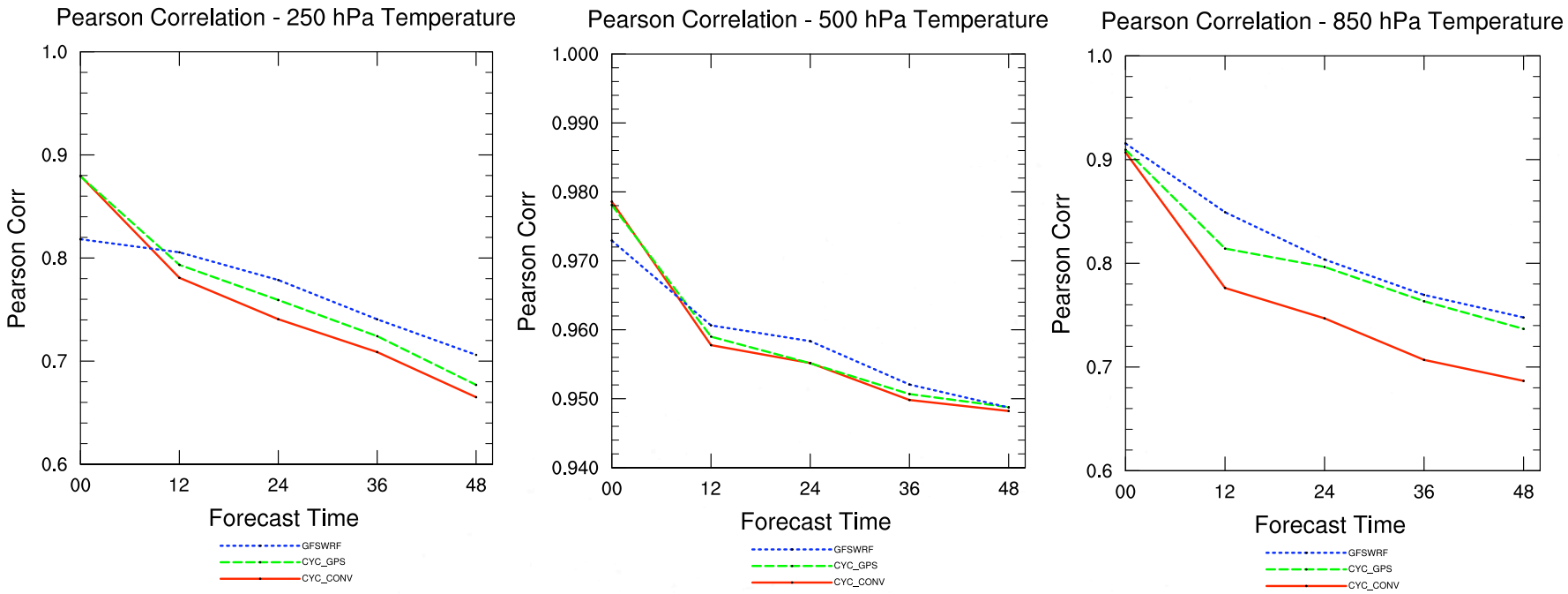
- Wind field initialization quite similar, GFSWRF run slightly smaller BCRMSE
  - Cycling runs assimilating significantly less data than GFSWRF
- Slight improvement in GPS forecast wind fields over conventional observations

Verification against ECMWF



- Verification against ECMWF similar to that of PREPBUFR observations
  - Not expected to be the same since ECMWF is a model analysis
- Largest BCRMSE in upper troposphere
  - High winds associated with jet stream
  - Small differences in placement (both vertically and horizontally) lead to large errors

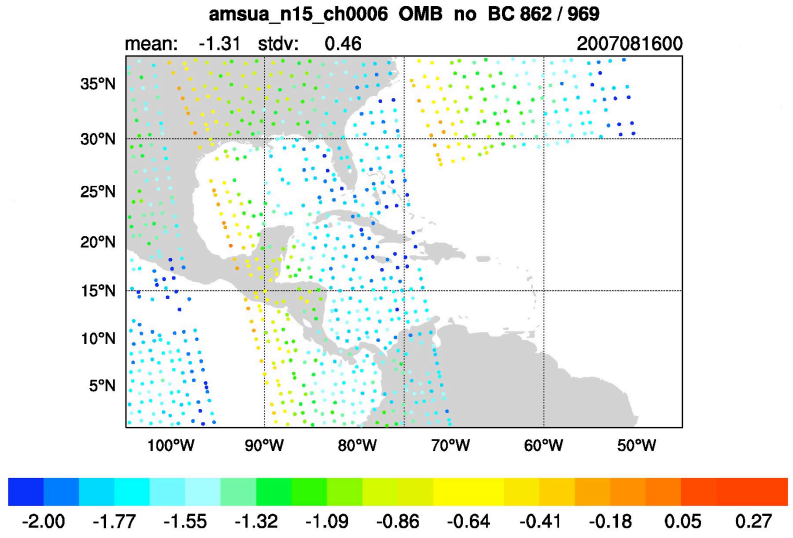
Forecast skill



- Decay in forecast correlation in time and greatest near surface as expected
- Prepbufr and GPS RO impacting initial analysis at all levels
- Forecast improvement seen in CYC_GPS over CYC_CONV

Ongoing work

- Addition of AMSU-A radiance assimilation for full cycling extended runs. Testing of new CRTM2 libraries in GSI.
- Test on additional domain similar to RR (extended CONUS) to test full capabilities of GSI.



Summary and Conclusions

- GSI v2.0 assimilated conventional and GPS data properly
  - Improved GPS QC algorithm (Cucurull 2010)
- GPS data helps initialization over ocean
- Impact studies preformed using verification against PREPBUFR obs and ECMWF analysis
  - Slight improvement in GPS over conventional observations in fcst wind fields
- Pearson Correlation shows decay in forecast skill over time, particularly in lower atmosphere
  - GPS and PREPBUFR assimilation impacts upper air analysis
  - GPS shows fcst improvement over PREPBUFR

Questions?