



Testing and Evaluation of the GSI-Hybrid Data Assimilation at DTC and its Applications for Hurricane Forecasts



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Abstract

In collaboration with various research and operational centers, the Developmental Testbed Center (DTC) conducts testing and evaluation of the GSI (Gridpoint Statistical Interpolation) based hybrid variational-ensemble Data Assimilation (DA) system for hurricane forecast applications. Multiple cases of tropical storms are run to investigate the various aspects of the GSI-Hybrid DA system, including the cross covariance feature, cycling scheme, background error tuning and data impact, in the framework of the NCEP/EMC (Environmental Modeling Center) GSI-Hybrid DA system for basin scale HWRF (Hurricane Weather Research and Forecast) model. Diagnostics are performed to study the configurations of this developing system and its impact on hurricane forecasts, as part of the effort of operational implementation of the GSI-Hybrid DA system in HWRF.

What is GSI-Hybrid 3DVAR?

■ GSI-3DVAR (static BE)

$$J(x) = \frac{1}{2} (x - x_b)^T B^{-1} (x - x_b) + \frac{1}{2} [y - H(x)]^T R^{-1} [y - H(x)]$$

■ GSI-Hybrid 3DVAR

$$J(x, \alpha) = \beta_1 J_1 + \beta_2 J_2 + J_3$$

$$J_1 = \frac{1}{2} (x - x_b)^T B^{-1} (x - x_b)$$

$$J_2 = \frac{1}{2} (x - x_e)^T A^{-1} (x - x_e)$$

$$J_3 = \frac{1}{2} [y - H(x)]^T R^{-1} [y - H(x)]$$

3DVAR → GSI Hybrid 3DVAR → Control analysis

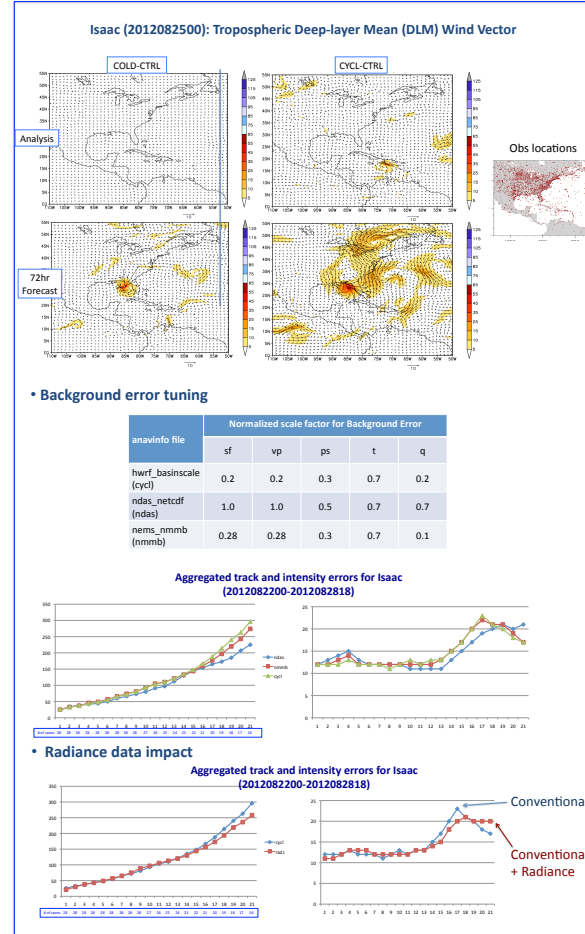
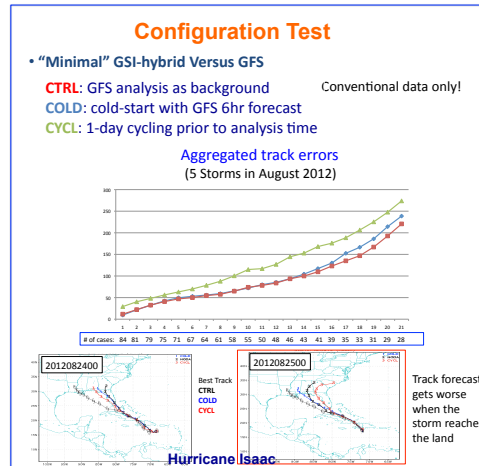
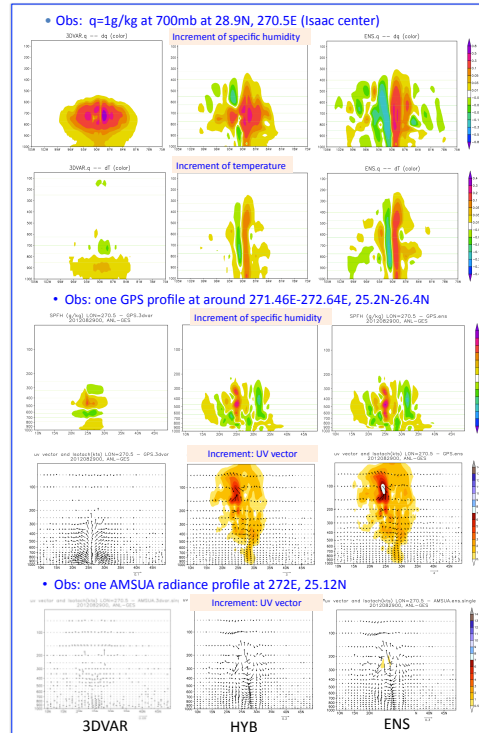
member 1 forecast, member 2 forecast, Member N forecast, Control forecast

Model Configuration

- HWRF: basin scale branch from EMC, 61 vertical levels, model top at 2mb, horizontal grid spacing=27km
- GSI: basin scale branch from EMC
- Background: GFS

Cross-covariance investigation

- 3DVAR:** $\beta_1=1.0$, $\beta_2=0.0$
 - 80 global ensembles
 - Horizontal localization scale 600km
- HYB:** $\beta_1=0.25$, $\beta_2=0.75$
 - Vertical localization scale -0.5 (lnP)
 - Single observation is at or around storm center of Isaac (28.9N, 270.5E)
- ENS:** $\beta_1=0.0$, $\beta_2=1.0$
 - Background: 2012082900



Discussion

- Single observation tests show reasonable cross covariances from ensembles;
- Data assimilation (GSI-Hybrid) with only conventional data in Basin scale HWRF doesn't seem to add value to the model performance in TC forecasts;
- Tuning background error and adding radiance data help improve the track and intensity forecasts;
- Future work: Better error representation; Radiance DA (new bias correction scheme, cloudy radiance); vortex scale DA.

Acknowledgments: This work is sponsored by the Hurricane Forecast Improvement Program (HFIP).