GSI Background Error Sensitivity for AFWA Pre-operational Implementation Testing

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Introduction

- The Developmental Testbed Center (DTC) has developed a functionally similar end-to-end testing environment constructed to follow the Air Force Weather Agency (AFWA) pre-operational testbed
- Testing and Evaluation efforts are to help test and assist in Grid Point Statistical Interpolation (GSI) configuration, aiming for a summer 2013 implementation
  - *GSI is a 3D-var data assimilation system developed at NCEP/EMC, NOAA/GSD, NASA/GMAO, and NCAR/MMM. The GSI community code is maintained and supported through the DTC*

Experimental Design

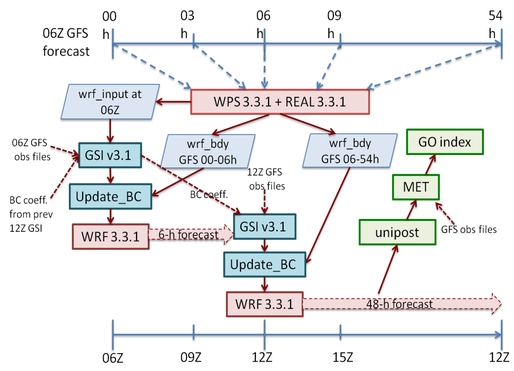


Figure 1: Schematic of DTC real-time system following the AFWA pre-operational configuration

- Full end-to-end system runs 1x/day
  - WPS (v.3.3.1)
  - comGSI (v3.1)
  - update_BC (2012)
  - WRF-ARW (v.3.3.1)
  - UPP (v.1.0)
  - MET (v4.0)
- 06 Z cold start, 12 Z continuous cycle
- Continuous cycling bias correction coefficients
- 20-km horizontal resolution
- 57 vertical levels, 10 hPa model top

- Parallel real-time tests
  - *Primary*: consistent baseline test following the AFWA pre-operational configuration
  - *Developmental*: AFWA pre-operational configuration with incremental changes to test and monitor DA system development activities
- Short-term retrospective testing
  - *Retrospective tests* (2 wks) performed to test impacts of individual changes to the primary configuration

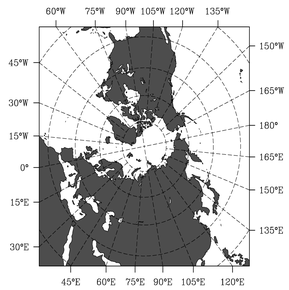


Figure 2: Northern Hemisphere (NH) computational domain

Data File Linked	Data Type Read
PREPBUFR	Ps, t, q, uv
AIRS	AQUA
AMSU-A	n18,AQUA,n19
HIR4	n19, METOP-A
GPSRO	gps_ref

Methodology

GO Index

General Operations (GO) Index is used for quantitative assessment of forecast performance

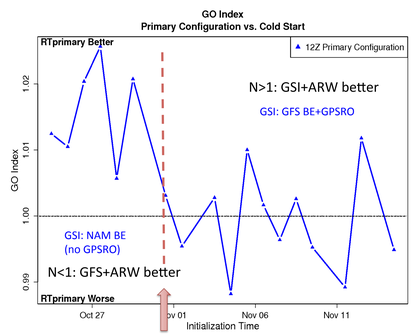
- Skill scores (S) computed for specific variables, levels, and lead times $S = 1 - \frac{(RMSE_{FCST})^2}{(RMSE_{REF})^2}$
- For each variable, level and lead time, predefined weights (w) are applied and a weighted sum (S_w) is computed $S_w = \frac{1}{\sum_i w_i}\left(\sum_i (w_i S_i)\right)$
- Given S_w, the index value is defined as $N = \sqrt{\frac{1}{1 - S_w}}$

Values N < 1 indicate the reference forecast has higher skill, and values N > 1 indicate the developmental forecast has higher skill

Results – Background Error (BE) Sensitivity

Operational BEs

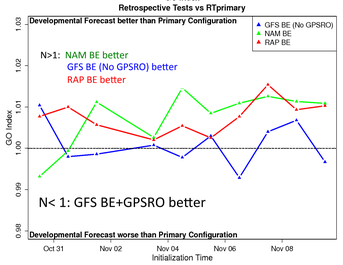
Real-Time Run



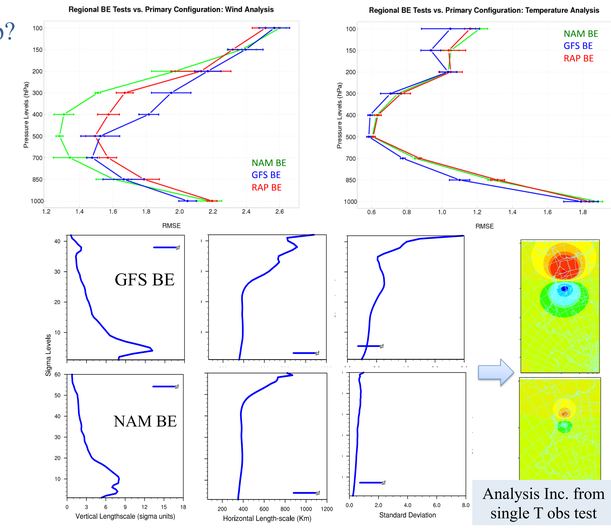
GSI+ARW runs switched to AFWA parallel run configuration

- ✓ During initial 2 weeks for real-time tests, Developmental experiment was cold-start (GFS)
- ✓ Retrospective testing was performed to determine the cause of the forecast skill drop

Retrospective Runs: What caused the drop?

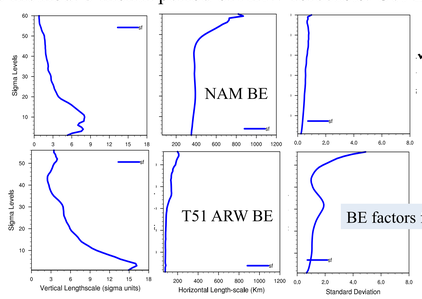


- ✓ NAM BE: Northern Hemisphere BE computed based on NAM forecasts.
- ✓ GFS BE: Global BE computed based on GFS forecasts.
- ✓ RAP BE: Global BE tuned for the RAP. combination of global/regional *(balance = GFS, Lengthscales/ variance = NAM)*



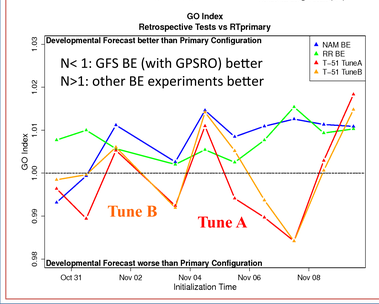
Domain Specific BEs

- NCAR GEN_BE-GSI code used (based on the NCEP BE code).
- NMC method: 3 month period of ARW forecasts: Oct-Dec, 2012



- ✓ Horizontal lengthscales of T51 ARW BE are significantly smaller than those of the NAM BE.

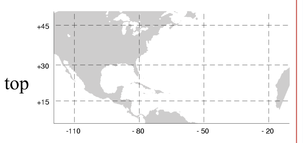
BE factors for Stream Function



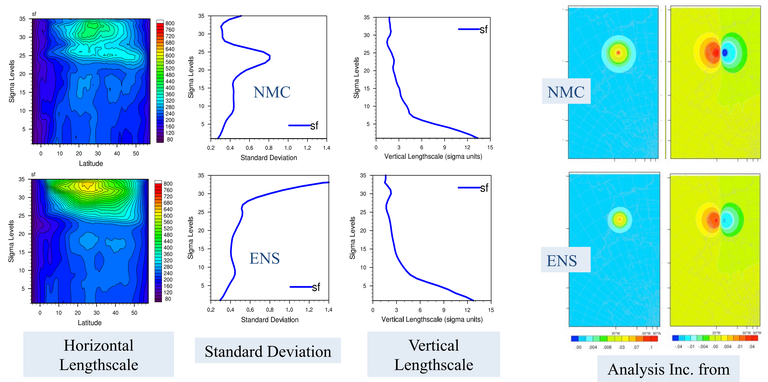
- ✓ T51 ARW BE: Northern Hemisphere BE computed based on ARW forecasts.
- ✓ Tune A: Tuned T51 ARW BE (*balance*=T51 ARW, *Lengthscales/ variance = NAM)*
- ✓ Tune B: NAM BE interpolated onto the T51 grid

NMC vs. ENS method

- Experiments:
  - Caribbean Domain
  - Ensembles generated using the NCAR DART system
  - Configuration: 36-km horiz res, 45 vert levels, 20 hPa model top
  - Testing period: 2008081100-2008091312



- ✓ Perturbations for static BE generation come from forecast differences ⇨ "NMC" method
- ✓ Ensemble perturbations ⇨ "Ensemble Perturbation (ENS)" method



Conclusions

- For NH, NAM BE or tuned global BE w/ regional scaling is recommended at current stage. For SH, BE should be examined separately since the model errors are expected to be larger than those in NH.
- Domain specific BE still needs further tuning and investigation.
- The BE statistics computed using the ensemble perturbations resulted in slightly smaller spatial increments for all fields, and smaller magnitude increments in T,U,V compared with the NMC.

Future Work

- Additional tuning on domain specific BE to produce better NH domain forecasts.
- Utilize new gen_be code for domain specific BE generation.

Acknowledgments

This work is funded through the DTC by the Air Force Weather Agency (AFWA).
The DTC is funded by NOAA, AFWA, NCAR and the National Science Foundation (NSF). NCAR is supported by NSF.