# Configuration Testing of GSI within an Operational Environment

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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 2013 implementation
  - GSI is a 3D-var data assimilation system developed at NCEP/EMC, NOAA/GSD, NASA/GMAO, and NCAR/MMM. The GSI community is maintained and supported through the DTC

## Experimental Design

DTC GSI Testbed for AFWA T51 configuration

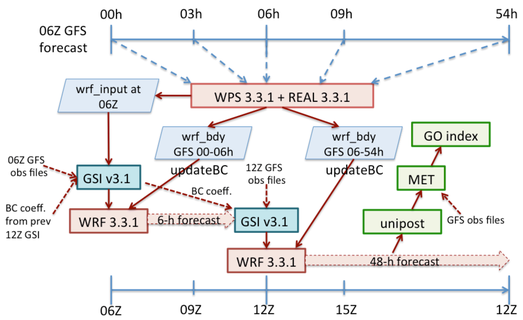



*Figure 1: Schematic of DTC GSI testbed*

- Full end-to-end system runs 1x/day
  - WPS (v.3.3.1), comGSI (v3.1), WRF-ARW (v.3.3.1), UPP (v.1.0), & MET (v4.0)
  - 06 Z cold start cycle
  - 12 Z continuous cycle; bkgd 6-hr forecast from 06 Z cold start cycle
  - Continuous cycling bias correction coefficients
  - 20-km Northern Hemisphere Domain
  - 57 vertical levels, 10 hPa model top
  - 48-hr forecasts initialized at 12 Z
  - Grid-to-point verification against conventional observations
- 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 activity
- Short-term retrospective testing
  - Multiple *retrospective tests* (2 wks) performed to test impacts of individual changes to the primary configuration

*Figure 2: Computational Domain*

### Observation Data and Usage

| Data File Linked | Data Type Read | Used in Analysis |
|---|---|---|
| PREPBUFR | Ps, t, q, uv | All used |
| AIRS | AQUA | Used |
| AMSU-A | n18,AQUA,n19 | All used |
| HIR4 | n19, METOP-A | Both used |
| SBUV/2 | sbuv2 from n16, n17, n18, n19 | None used |
| GPSRO | gps_ref | Used |

## 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

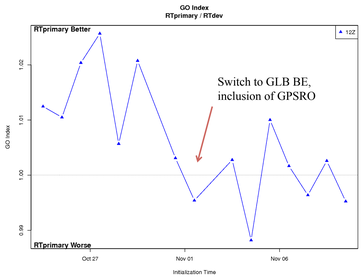



*Figure 3a: GO index of the primary configuration (RTprimary) compared to the corresponding cold-start (RTdev)*

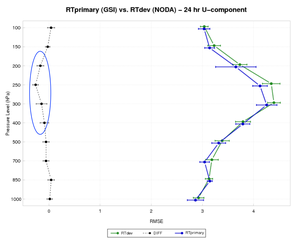



*Figure 3b: Vertical profile of 24-hr U-component wind. RTprimary (blue), RTdev (green), pair-wise difference (black). Difference is SS CI's do not encompass 0*

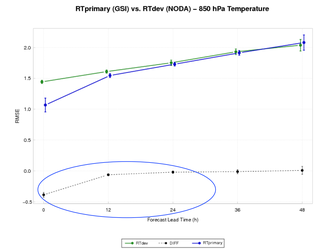



*Figure 3c: Same as 3b except timeseries of 850 hPa Temperature*

- Real-time tests of the primary configuration indicated degradation in forecast skill during the initial set-up. This drop corresponded to the change from regional NAM BE to global GFS BE as well as the inclusion of GPSRO data.
- Overall skill of the basic primary configuration showed SS improvement over a parallel cold start real-time test.

### Background Error

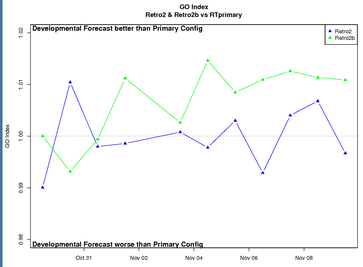



*Figure 4: GO index of Retrospective tests with Regional BE (Retro2b) and Global BE (Retro2) compared to the primary configuration*

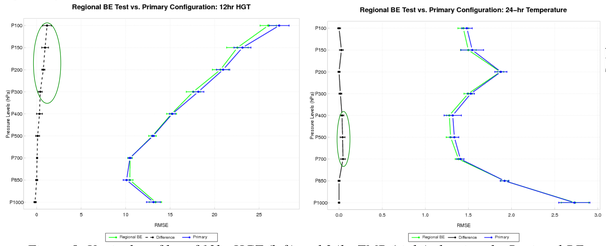



*Figure 5: Vertical profiles of 12hr HGT (left) and 24hr TMP (right) showing the Regional BE retrospective (green), the primary configuration (blue), and the pair-wise difference (black)*

- ✓ GO index shows improvement over primary configuration when using regional BE
- ✓ Forecast skill shows SS differences favoring regional BE retrospective test over primary configuration

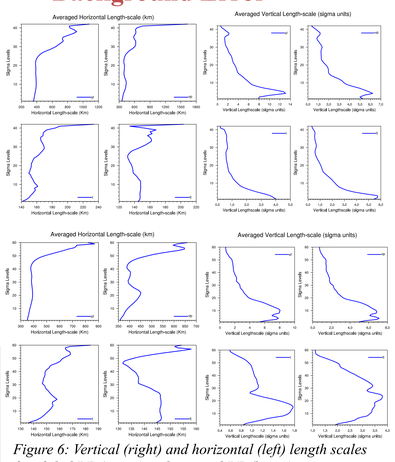



*Figure 6: Vertical (right) and horizontal (left) length scales for global BE (upper) and regional BE (lower).*

- ✓ Regional BE has small horizontal and vertical length scales, corresponding with improved forecast skill

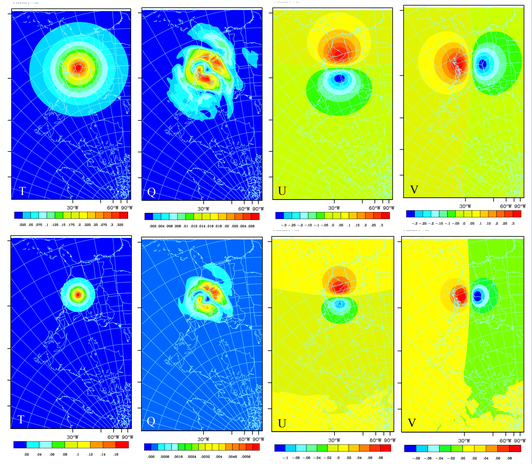


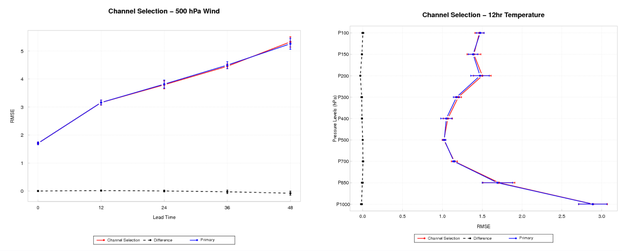

*Figure 7: Pseudo single observation (PSOT) test using the global BE (upper) and regional BE (lower) for a Temperature increment at 38°N, 81°W (domain is subset), 500 hPa at 2012103106. maginnov = 1.0, magoberr=0.8*

- ✓ Regional BE has smaller spatial extent and magnitude

### Channel Selection

| Radiance Data | | Channels Used |
|---|---|---|
| AMSU-A | noaa-17 | Ch1-10,15 |
| | noaa-19 | Ch 1-7,9-10,15 |
| | AQUA | Ch 6,8,9-10 |
| HIR4 | noaa-19 | Ch 4-8,10-15 |
| | METOP-A | Ch 4-8, 10-15 |
| AIRS | AQUA | 68 channels *(reduced from 120)* |

**following Lin et al 2012*




- ✓ Channel selection forecast skill is neutral over the primary configuration
- ✓ Current research from GSD colleagues suggests improvement in upper levels for channel selection
  - ✓ Neutral improvement may be due to cycling scheme differences (partial vs. continuous cycling)
  - ✓ May also be a result of domain (radiance data impact)

## Conclusions

- The DTC built a GSI testbed based on the AFWA pre-operational testing system
- Real-time tests showed the primary configuration showed more forecast skill than corresponding cold start runs, but indicated a reduction in skill stemming from the BE
- Retrospective testing focusing on BE suggested NAM BE produced more forecast skill over the primary configuration (Global BE)
- Developmental real-time testing using current channel selection research resulted in neutral impact

## Future Work

- Generate and tune domain-specific BE using 3-mo collected real-time forecasts from primary configuration.
- Test forecast skill using domain-specific BE against GFS, NAM, and RR BEs
- Further studies on impact of radiance data over operational domain and impact of cycling scheme on channel selection

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