The Developmental Testbed Center:
Update on Data Assimilation System Testing and Community Support

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To serve as a bridge between research and operations to facilitate the activities of both halves of the NWP Community

- Research: functionally similar operational environment to test and evaluate new NWP methods over extended retrospective periods
- Operational: benefits from DTC testing & evaluation of strengths and weaknesses of new NWP advances prior to consideration for operational implementation

DTC Director, Bill Kuo: DTC Model Testing and Evaluation Activities in Support of R2O in NWP, Ballroom A, 11:00am, Thursday
DTC Webpage at http://www.dtcenter.org/
Where is the DTC?

NOAA Earth System Research Laboratory (ESRL), NOAA DKRC Center

NCAR Research Applications Laboratory (RAL), NCAR Foothill Lab

DTC "BASE"

NCEP Environmental Modeling Center (EMC), NOAA Center for Weather and Climate Prediction

DTC Remote Location

Map data @Google
DTC Data Assimilation Mission

- Provide code management for operational code and coordinate distributed developers
- Bring operational code to community and provide technical support
- Conduct objective tests and evaluation for sponsors, operational centers, and community users
- Assist community research to operation transitions
Unified variational (var) data assimilation (DA) system with hybrid ensemble-var capability

- Global and regional applications
- Weather and climate

Operational system being used by
- NOAA (GFS, NAMS, RTMA, HWRF, RR…)
- NASA (GMAO global)
- and to be used by AFWA

Distributed development:
- NCEP/EMC, NASA/GMAO, NOAA/ESRL, NCAR/MMM, …

A community model, supported by DTC and overseen by the GSI Review Committee
- Well documented
- User friendly interface and modularized code
- Multi-platform compatibility
- Training and support for developers and users
- Coordinated distributed community contributions

Community GSI Milestone
2009:
- First GSI release V1.0
- First GSI User’s Guide
- Started the GSI Helpdesk (gsi_help@ucar.edu)
2010:
- First Community GSI Tutorial
- Formed GSI Review Committee
- Near real-time syncing of the trunks of DTC GSI community and NCEP operational GSI repositories
2011: First Community GSI Workshop
GSI Code Management

GSI Review Committee (GRC)

- NCEP/EMC
  - John Derber
- NOAA/ESRL
  - Stan Benjamin
- NASA/GMAO
  - Ron Gelaro
- NCAR
  - Tom Augline
- NESDIS
  - Brad Pierce
- AFWA
  - Steve Rugg

DTC
- Hui Shao (chair)

DTC GSI code repository/release contains the same GSI source code plus:
- Source code for the required NCEP GSI libraries
- Multi-platform configure/compilation utility
- Additional DTC diagnostic/plotting tools

- GRC mission:
  - GSI development planning and coordination
  - GSI code review
- DTC represents general community researchers in the GRC. Community requests come in via the GSI Helpdesk (gsi_help@ucar.edu)
GSI V3.1 released in July 2012
Upcoming annual release/tutorial in ~Summer 2013

GSI V3.1 Release Note:
- Updated GSI-hybrid capability. Add dual resolution capability for regional hybrid applications
- Added 4d capability for ensembles to allow several flavors of 4dvar using ensembles

Peek at GSI V3.2:
- New radiance bias correction scheme by direct use of global satellite bias correction coefficients and ozone profiles from GFS in regional models
- Enhanced capability of GSI-hybrid in regional applications
- Updated radiance data assimilation (new data type, ongoing cloudy radiance assimilation, updated satellite fixed files, …)
- Updated conventional/retrieval data assimilation (e.g., radar, satellite wind, …)
- Enhanced GSI 2D-var capability (RTMA)
- Enhanced Rapid Refresh GSI capability

http://www.dtcenter.org/com-GSI/users/
GSI Based Hybrid Ens-Var DA System

- **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**
  \[ J(x, \alpha) = \beta_1 J_b + \beta_2 J_e + J_o \]
  \[ = \beta_1 \frac{1}{2} (x - x_b)^T B^{-1} (x - x_b) + \beta_2 \frac{1}{2} \alpha^T A^{-1} \alpha + \frac{1}{2} [y - H(x + x_e)]^T R^{-1} [y - H(x + x_e)] \]

- Capability is available in the current released code (v3.1):
  - Global capability (direct ingest of spectral GFS ensembles) was fully tested (implemented at NCEP, May 2012)
  - Regional capability (ingest of regional ensembles processed by WPS or generated by running WRF ensembles) was not tested (Please use the upcoming version)
BUFR/PrepBUFR Data Format Support (Limited)

Operational-equivalent Testing and Evaluation

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

Kathryn Newman’s Poster: IOAS-AOLS 620
Switching on GFS BE and inclusion of GPSRO

AFWA GO Index

Contribution from NAM BE

Contribution from GPSRO

Analysis Increments from Single Obs Test

Global BE

Regional BE
Involvement in Developing the Next-phase Operational DA System

GSI Hybrid test by Chunhua Zhou

- Horizontal localization scale 600km
- Vertical localization scale -0.5 (lnP)
- 80 global ensembles
- The single observation is around storm center: AMSU-A radiance profile
- Background: 2012082900
**Plans and Future**

A Complete Community Forecast-DA System

- **Data pre-processing**
  - GSI-preprocessing
  - background pre-processing
  - WPS
- **Data Assimilation**
  - GSI
  - GSI-hybrid
  - EnKF
- **Forecast**
  - WRF-ARW
  - WRF-NMM
  - WRF-NMM-B
  - Hurricane WRF
- **Verification**
  - DTC Model Evaluation Tools (MET)

- **Community DA Pre-processing System**
  - Operational capability of conventional data quality control (QC)
  - Data conversion/BUFR format support
  - User friendly interface (background plug in, optional setup, …)
  - Documentation
Plans and Future

✓ Community Ensemble Kalman Filter (EnKF) system (ongoing effort): To be used alone or for the GSI-hybrid

  • Community system following the protocol set up by the GSI community model
    • Multi-platform capability
    • Modularized code
    • User friendly interface

  • Documentation
  • Code management
  • Shared version controlled repository with regular regression tests
  • Coordinated distributed development
  • Community test benchmark