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DTC Data Assimilation System Community Support and Tests: Status Report

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Collaborators:

Air Force Weather Agency

NOAA's Environmental Modeling Center

NOAA's Earth System Research Laboratory

NASA's Global Modeling and Assimilation Office

NCAR's Mesoscale and Microscale Meteorology Division



Developmental Testbed Center

Goals of Community GSI Efforts

- Provide current operational GSI capabilities to the research community (O2R)
- Provide a framework for distributed development of new capabilities & advances in data assimilation
- Provide a pathway for data assimilation research to operations process (R2O)
- Provide rational basis to operational centers and research community for enhancement of data assimilation systems



Community Gridpoint Statistical Interpolation (GSI)

✓ Unified variational data assimilation (DA) system

- 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

- Created GSI community (Boulder) repository
- Released the 1st community code (GSI V1.0)
- Started to provide complete community user support (documentation, website and helpdesk)

2009

- Released GSIV2.0 and V2.5
- Formed GSI Review Committee
- Hosted the 1st community GSI residential tutorial
- Started R2O transition procedure
- Syncing of the trunks of GSI community (Boulder) and NCEP/EMC GSI repositories

2010

- ✓ A community operational and research model
 - Supported by DTC

- Released GSIV3.0
- Hosted the 2nd community GSI residential tutorial
- Hosted the 1st Community GSI Workshop
- Co-hosted the HFIP GSI-hybrid workshop
- Hosted the 1st BUFR/PrePBUFR website tutorial (with Users' Guide)

2011

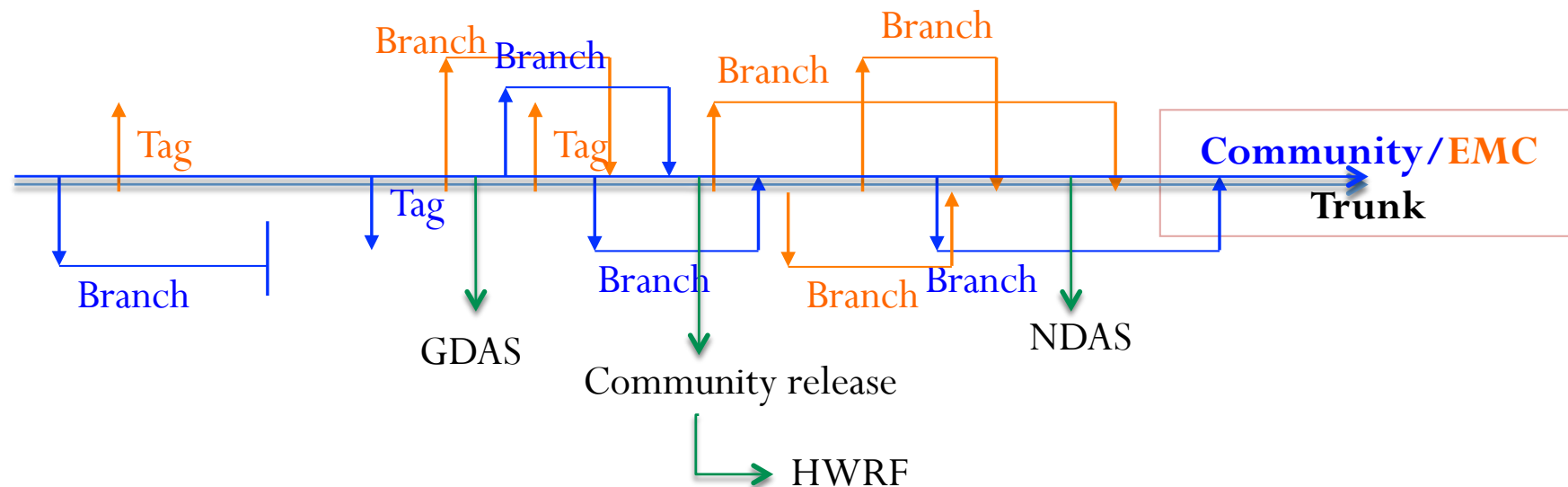
GSI Code Management

- GSI development and support is ordained through the **GSI Review Committee**.
- A advisory committee to shepherd and coordinate new GSI development, and advise community support activities.
- A code review committee to review proposed modifications to the GSI code routinely.
- Formed of representatives from multiple agencies, which have been actively involved in the GSI development and support work.
 - NCEP/EMC
 - NOAA/ESRL
 - NASA/GMAO
 - NCAR/MMM
 - NOAA/NESDIS (new member added in 2011)
 - **DTC – representing community users** (please send your code change proposal to DTC_gsi_help@ucar.edu)



GSI Code Management

- GSI code is shared through the **GSI repository** with dual GSI trunk structure.

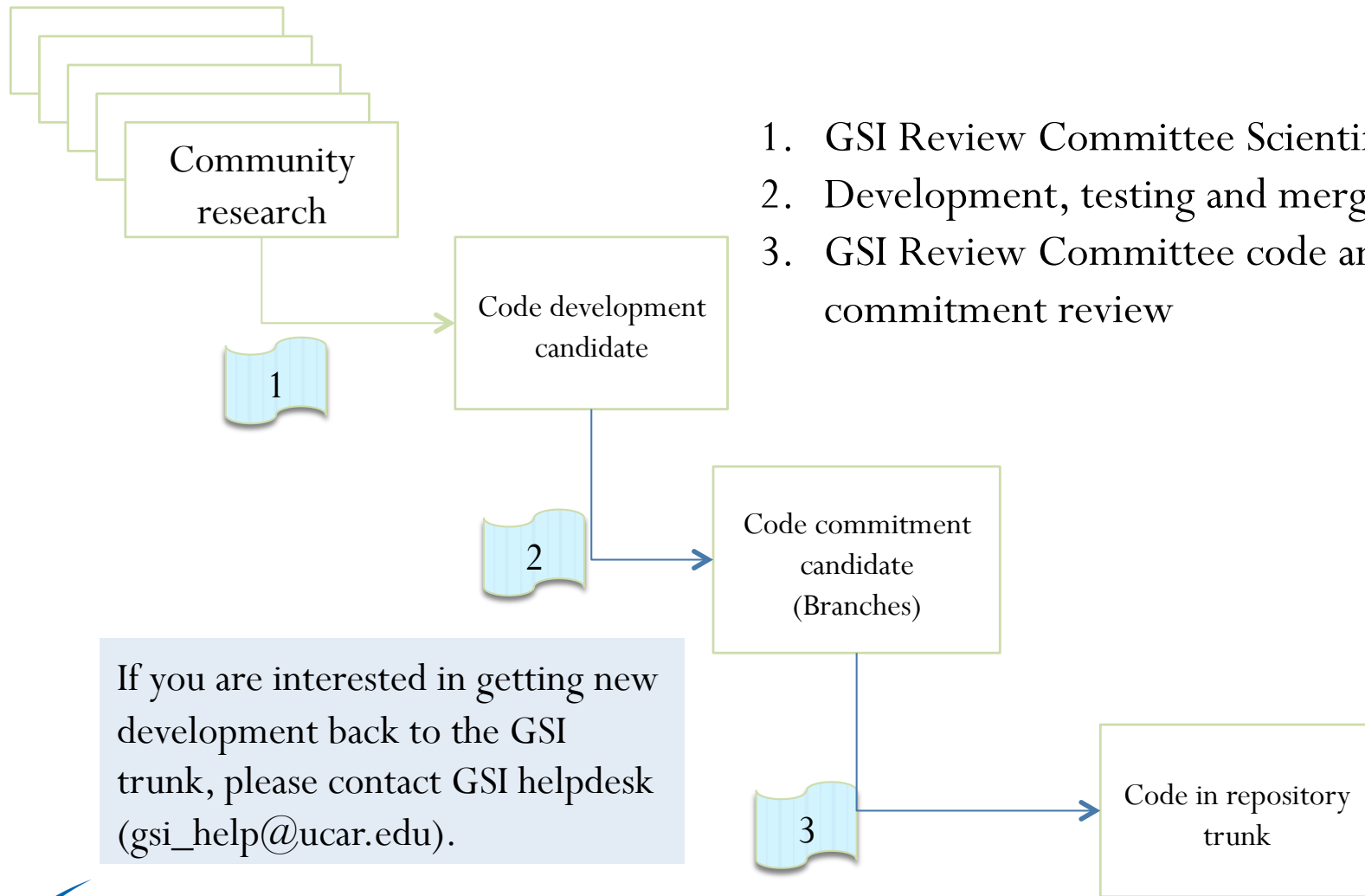


- The DTC GSI repository is synced with NCEP/EMC repository at least weekly.
- The DTC GSI repository also contains some community feature including multiple platform compilation utility released to public annually.
- Applications may use different revisions in the trunk (“snapshot”).
- Use tags or branches for: Release, new development, bug fix ...

✓ “Which GSI should I use ?”

There is no “DTC GSI”, “EMC GSI”, “community GSI”, or “global GSI”. There are only different versions of **GSI** from the GSI repository.

GSI R20 Transition Procedure (2011 Implementation)



Community GSI Release

Release Version	GSI Tag/ Revision	Release Time	Documentation	Residential Tutorial	Helpdesk
Beta release v1.0	Com-r41 EMC-Q1FY09	Jun, 2009	No	No	Friendly users only
Official release v1.0	Com-r41+ EMC-Q1FY09	Sep, 2009	GSI Users' Guide v1.0	Lectures in WRFDA tutorial, July, 2009 Instructional session during WRF workshop, June, 2009	All users
Beta release v2.0	Com-r101 EMC-Q1FY10	Feb, 2010	No	No	Friendly users only
Official release v2.0	Com-r101+ EMC-Q1FY10,	Apr, 2010	GSI Users' Guide v2.0	June 28-30, 2011	All users
Beta release v3.0	Com-r593 EMC-r12534	Feb, 2011	No	No	Friendly users only
Official release v3.0	Com-r593+ EMC-r12534+ (EMC)	Apr, 2011	GSI Users' Guide v1.0	June 29-July 1, 2011	All users

Code changes are reviewed and tested before being committed.

GSI User Guide

Chapter 1: Overview	
Chapter 2: Software Installation	V2.0 (FY10)
2.1 Introduction	
2.2 Software Overview	
2.3 GSI Build Environment and Libraries	
2.4 Compiling GSI and Libraries	
2.6 Porting the GSI to a New System	
Chapter 3: Running GSI	
3.1 Data Needed	
3.2 Observations Available for Comr	
3.3 GSI Run Script	
3.3.1 Steps in the GSI run script	
3.3.2 Customization of the GSI run script	
3.3.2.1 Setting up the machine environment	
3.3.2.3 Setting up the running environment	
3.3.2.2 Setting up an analysis case	
3.3.3 Description of the sample script to run GSI	
3.4 GSI Namelist	
3.5 Results	
Chapter 4: GSI Diagnostics and Tuning	
4.1 Understanding stdout	
4.2 Single Observation Test	
4.2.1 Setup a single observation test:	
4.2.2. Examples of single observation tests for GSI	
4.3 Control Data Usage	
4.4 Domain Partition for Parallelization and Observation Distribution	
4.5 Observations and Corresponding Innovations	
4.6 Convergence Information	
4.7 Analysis Increments	
4.8 Running Time and Memory Usage	
Chapter 5: GSI Theory	
5.1 3DVAR Equations Used by GSI:	
5.2 Iterations to Find the Optimal Results	
5.3 Analysis Variables	
Chapter 6: GSI Code Structure	
6.1 Main Process	
6.2 GSI Background IO (for 3DVAR)	
6.3 Observation Ingestion (read_obs.f90)	
6.4 Innovation Calculation (setuprhsall)	
6.5 Inner Iteration	

Chapters are updated/extended

Chapter 1: Overview	V3.0 (FY11)
Chapter 2: Software Installation	
2.1 Introduction	
2.2 Obtaining the Source Code	
2.3 System Requirements and External Libraries	
2.3.1 Compilers	
2.3.2 NetCDF and MPI	
2.3.3 LAPACK and BLAS	
2.4 Supplemental Libraries	
2.5 Compiling GSI	
2.5.1 Environment Variables	
2.5.2 Configure and Compile	
2.6 Getting Help and Reporting Problems	
2.7 Porting the GSI to a New System	
Chapter 3: Running GSI	
3.1 Input Files	
3.2 GSI Run Script	
3.2.1 Steps in the GSI run script	
3.2.2 Customization of the GSI run script	
3.2.2.1 Setting up the machine environment	
3.2.2.2 Setting up the running environment	
3.2.2.3 Setting up an analysis case	
3.2.3 Description of the sample script to run GSI	
3.3 Introduction to Most Often Used GSI Namelist Options	
3.4 Files in GSI Run Directory	
Chapter 4: GSI Diagnostics and Tuning	
4.1 Understanding Standard Output (<i>stdout</i>)	
4.2 Single Observation Test	
4.2.1 Setup a single observation test:	
4.2.2. Examples of single observation tests for GSI	
4.3 Control Data Usage	
4.4 Domain Partition for Parallelization and Observation Distribution	
4.5 Observation Innovation Statistics	
4.5.1 Conventional observations	
4.5.2 Satellite radiance	
4.6 Convergence Information	
4.7 Analysis Increments	
4.8 Running Time and Memory Usage	
Chapter 5: GSI Applications	
5.1 Assimilating Conventional Observations with GSI:	
5.1.1: Run script	
5.1.2: Run GSI and check the run status	

New chapters are added



Community GSI – Tutorial/Workshop

- 2010 summer tutorial:
 - 14 lectures
 - 8-h practice session
- 2011 summer tutorial 28-30 June, 2011:
 - 28-30 June
 - 13 Lectures (speakers from NCEP, NASA, NCAR, ESRL and DTC)
 - 4-h basic practice
 - Optional advanced practice
 - Full day on 30 June
- 2011 GSI Workshop 28 June, 2011

Upcoming events:

Tutorial: August 21-23, 2012, Boulder, CO

Workshop: Spring 2013 (TBD)

Wednesday, June 29, 2011

- 8:00 Registration
- 8:30 Welcome, Background and Participants' Introduction - Hans Huang (NCAR)
- 9:00 Fundamentals of Data Assimilation - Tom Auligne (MMM/NCAR)
- 10:00 Coffee Break (Group photo)
- 10:30 Overview of GSI - John Derber (NCEP/EMC)
- 11:30 GSI management and collaboration - Hui Shao (DTC/NCAR)
- 11:45 Lunch (Provided)
- 1:00 GSI Fundamentals (1): Setup and Compilation - Don Stark (DTC/NCAR)
- 1:30 GSI Fundamentals (2): Run and Namelist - Ming Hu and Hui Shao (DTC)
- 2:00 Community Tools (1): PrepBUFR/BUFR: Basic tools, NCEP data tank, and Obsproc - Ruifang Li (MMM/NCAR)
- 2:45 Introduction to Practice Session - Ming Hu (DTC - NOAA/ESRL/GSD)
- 3:00 Coffee Break
- 3:30 Practice session (COMET classroom)
- 5:30 Adjourn

Thursday, June 30, 2011

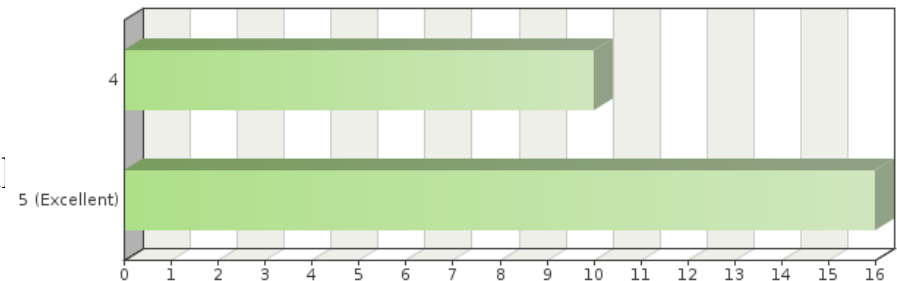
- 8:30 Background and Observation Error Estimation and Tuning - Daryl Kleist (NCEP/EMC)
- 9:30 Community Tools (2): GEN_BE - Syed Rizvi (MMM/NCAR)
- 10:00 Coffee Break
- 10:30 GSI Fundamentals (3): Diagnostics - Chunhua Zhou (NCAR/DTC)
- 11:00 GSI Fundamentals (4): Applications - Kathryn Newman (DTC/NCAR) and Ming Hu (DTC - NOAA/ESRL/GSD)
- 11:30 Lunch (Provided)
- 1:00 Satellite Radiance Assimilation - John Derber (NCEP/EMC)
- 2:00 GSI Code and Interface - Ricardo Todling (GMAO/NASA)
- 2:30 GSI/ETKF Regional Hybrid Data Assimilation - Arthur Mizzi (MMM/NCAR)
- 3:00 Coffee Break
- 3:30 Practice session (COMET classroom)
- 5:30 Adjourn

Friday, July 1, 2011

- 9:00 Optional Practice Session - Advanced topics (COMET classroom)
- 10:30 Coffee Break
- 11:00 Optional Practice Session - Advanced topics (COMET classroom)
- 2:30 Adjourn

Extended BUFR/PrepBUFR Support*

- A new website dedicated to the BUFR/PrepBUFR support:
<http://www.dtcenter.org/com-GSI/BUFR/index.php>
- BUFR/PrepBUFR User's Guide for both beginners and advanced players (Beta version)
<http://www.dtcenter.org/com-GSI/BUFR/docs/index.php>
- A new webpage for sharing the BUFR/PrepBUFR processing code from both DTC and community users:
<http://www.dtcenter.org/com-GSI/BUFR/examples/index.php>
- Extended on-line practices that give users more hands-on experiences:
<http://www.dtcenter.org/com-GSI/BUFR/tutorial/index.php>
- First webcast tutorial, Dec 13, 2011
 - ~15 onsite
 - 39 via remote access (US: 37, international)



* To HFIP community and registered GSI users



GSI Testing and Evaluation: GSI and WRFDA Comparison

	GSI	WRFDA
Applications	Global, Regional- North American domain (extended)	Regional-AFWA theater all over world
Configuration	Following NAM configuration, AFWA partial cycling	AFWA configuration, AFWA partial cycling
Observations	GFS prepBUFR files (extended QC flags for global applications)	AFWA “little_r” data files (coarse QC flags for specific domains)
Background	Background errors generated using GEN_BE-GSI	Background errors generated using GEN_BE-WRFDA

For DTC sponsors and community users, can they just use GSI with public accessed global data for regional applications?



Data

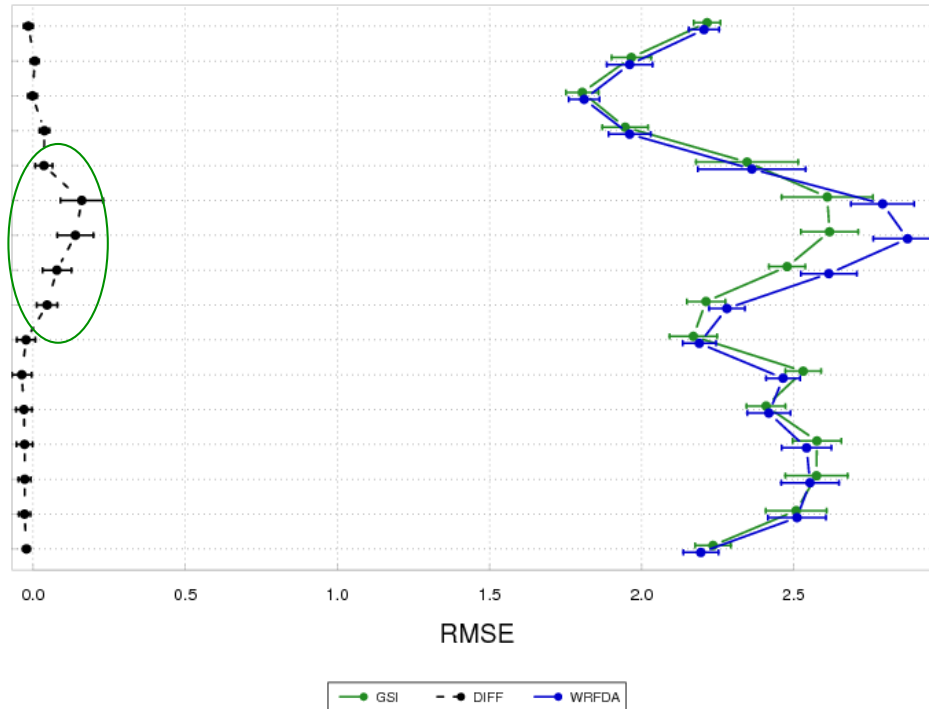
- GSI has much more sounding data at 00/12 (*cut-off time*)
- GSI missing SSMI/airep/geoamv data
- WRFDA missing pibal/sat winds/gpsrf*
- No METAR data for GSI (*GSI QC on GFS*)

Observation type and variable		2010090918		2010091000	
		WRFDA	GSI	WRFDA	GSI
sounding	U	162	83	459	3068
	V	158		459	
	T	54	58	319	1870
	Q	42	29	301	910
metar	U	468		402	
	V	463		401	
	T	561		549	
	Q	270		281	
	P	364	641	365	635
geoamv	U	1833		1464	
	V	1833		1464	
airep	U	307		450	
	V	306		450	
	T	303		450	
ships	U	15	15	8	12
	V	14		10	
	T	16	16	11	13
	Q	0	15	0	13
	P	16	19	11	16
Ssmi retrieval	TPW			1353	
	Wind speed			1353	
pibal	U		40		21
	V				
Sat wind	U		155		116
	V				
gpsrf			565		640

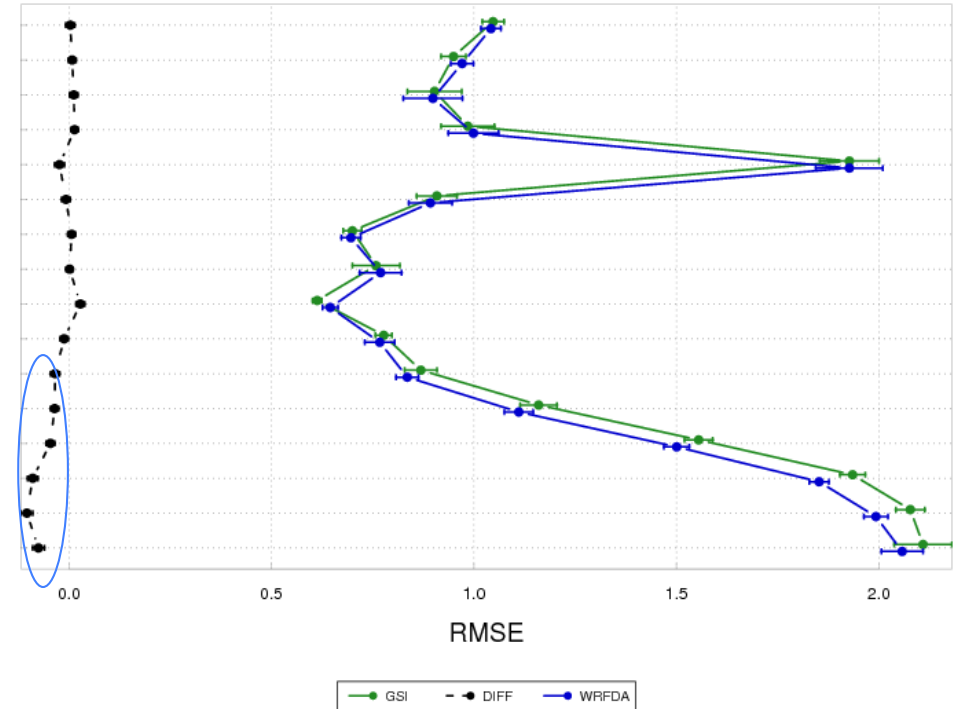


Verification against ECMWF

24 h V-Wind RMSE Against ECMWF Analysis



24 h Temperature RMSE Against ECMWF Analysis

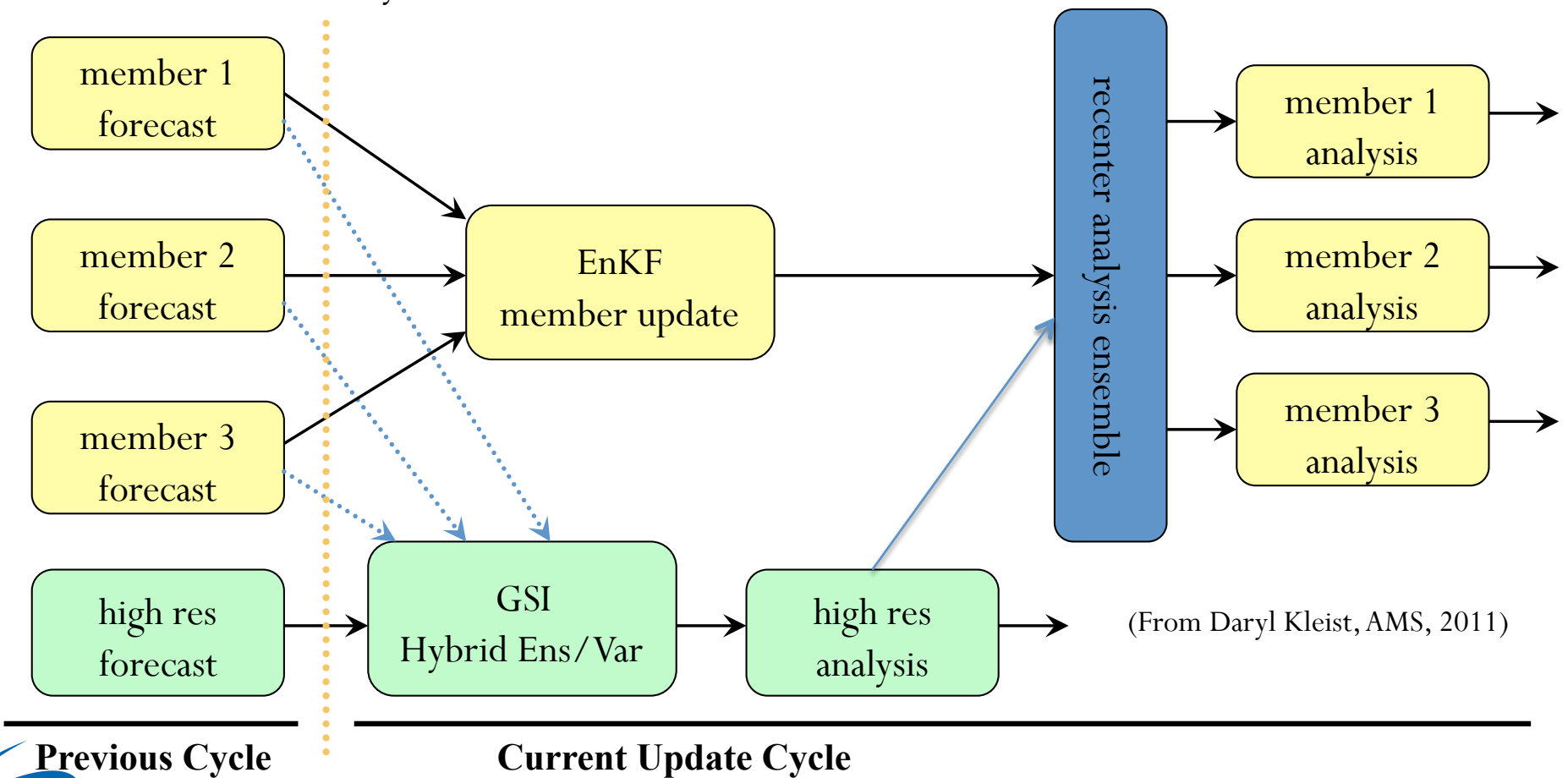


- GSI is superior in wind forecasts, while WRF-DA is better in temperature forecasts (especially at near surface layers).
- PrepBUFR data (e.g, surface data) QC flags should be appropriately set up for regional applications using GSI.
- Usage of regional background errors improves regional DA performance (separate study in 2010).



HFIP EnKF-GSI Hybrid DA Testing and Evaluation

- Regional code (including interface and scripts) is under development primarily by NCEP/EMC and NOAA/PSD based on the global GSI based hybrid system at NCEP.
- Testing and evaluation are collaborated among NCEP/EMC, NOAA/PSD, AOML, DTC and other HFIP community.



Objectives of DTC:

- Work with EMC and HFIP teams to coordinate distributed GSI-hybrid efforts, especially for regional applications.
- Encourage and help focus the ensemble communities (HFIP and others) to transition their new techniques to one unified regional GSI-hybrid system for regional forecast operations.
- Initiate and therefore provide repository support to HFIP community for hybrid development.
 - Prepare for potential general community support
- Set up a testbed for GSI-hybrid and test and evaluate the prototype GSI-hybrid system for HWRF.

Status:

- HFIP GSI-hybrid Workshop, Dec 9, 2011
 - NOAA (AOML, NWS, EMC, ESRL), Navy (NRL, Naval postgraduate school), universities, NCAR, DTC, ...
 - Initiate the collaboration between DTC and developers
- Set up repository to share code for HWRF-GSI-hybrid package development and testing and evaluation among EMC, NOAA/AMOL and NOAA/PSD
- Started to test the initial capability of GSI-hybrid-ensemble component



Data Assimilation Research Test (DART) System Testing and Evaluation

- Ensemble DA system developed and maintained by the NCAR Data Assimilation Research Section (DAReS)
- DART is compared with GSI in AFWA applications
- Ongoing...

Future Plans:

- GSI Code Management and coordination
 - Administrative structure maintenance
 - Quarterly GSI Review Committee meeting
 - Collaboration with other partners
 - Repository maintenance
- GSI Code Releases
 - Beta: ~February, 2012
 - Official: ~ June, 2012 (with complete user support and documentation)
- General GSI User Support
 - Answer helpdesk inquiries
 - Update GSI documentation
 - Update GSI Users' website/online support
- Tutorial
 - August 21-23, 2012
- GSI and GSI-hybrid testing and evaluation



Thank You!

- GSI webpage
<http://www.dtcenter.org/com-GSI/users/>
- GSI helpdesk gsi_help@ucar.edu
- GSI email list gsi_users@ucar.edu

