

Task 3.3: Code Management, testing and support for the GSI data assimilation system

3.3.1: Community Coordination and Support

Hui Shao, Hans Huang

Shared costs with other partners: Ming Hu, Don Stark (*funded by NOAA*)

3.3.2: Testing and evaluation of DA systems in AFWA regional applications

- a. Perform baseline GSI tests
- b. Perform baseline EnKF tests (SOW Appendix 1)

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GSI Code Management

- GSI development and support is ordained through the **GSI Review Committee**.
- **Development and community effort coordination-** committee meetings
 - Dec 9, 2011, Camp Springs, MD
 - ✓ New membership approved: NESDIS
 - Sept 22, 2011, telecon
 - June 28, 2011, Boulder, CO
- **Code review**-email alias (gsi_review_committee@rap.ucar.edu)
 - ~1 week for review, ~1-2 days for code commit
 - 29 code change tickets (Mar, 2011-Feb, 2012)
 - 6 tickets from non-EMC developers
 - 1 ticket returned to developer for further tests

GSI Code Review Request Ticket

Added by [huishao](#), last edited by [huishao](#) on Feb 23, 2012 ([view change](#))

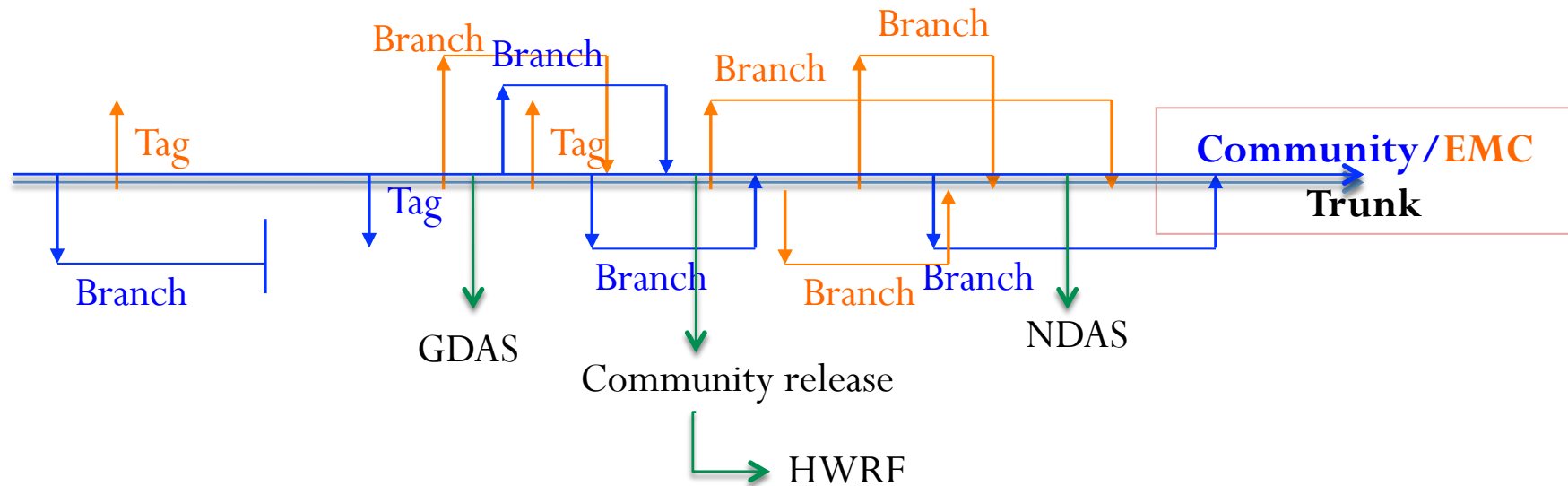
1. GSI review ticket 02232012-2: ticket #236 due on **Mar 2, 2012**. Add nemsio routines for nsst files
2. GSI review ticket 02232012: ticket #224 due on **Mar 1, 2012**. Use of significant levels of Radiosonde.
3. GSI review ticket 01312012: ticket #154 due on **Feb 12, 2012**. Inclusion of time-dependent climatological CO2.
4. GSI review ticket 01272012: ticket #166 due on **Feb 6, 2012**. Cloudy radiance assimilation updates.
5. GSI review ticket 01232012: ticket #233 due on **Jan 31, 2012**. Final-Final changes to the GSI for Q3FY12 global implementation.
6. GSI review ticket 01102012: ticket #223 due on **Jan 17, 2012**. Extend FGAT capability for nmm netcdf interface.
7. GSI review ticket 12062011: ticket #226 due on **Dec 14, 2011**. Additional modifications for NEMSIO from EMC
8. GSI review ticket 12052011: **ticket #226 due on Dec 12, 2011. Enhancement and fix to the PM2.5 analysis from GSD.**
9. GSI review ticket 11282011: ticket #154 due on **Dec 5, 2011**. Inclusion of time-dependent climatological CO2 (**returned to the developer due to code issues found during the commit stage on Dec 15, 2011**)
10. GSI review ticket 10212011: ticket #204 due on **Oct 27, 2011**. Final Q3FY12 Implementation changes
11. GSI review ticket 09302011-2: **ticket #194 due on Oct 11, 2011. Add NCAR AOD data assimilation function in GSI by DTC (NCAR/MMM)**
12. GSI review ticket 09302011: ticket #205 due on **Oct 6, 2011**. Allow inclusion of ncep 4dvar code into GSI
13. GSI review ticket 09292011: ticket #206 due on **Oct 6, 2011**. or GSI-2DVAR, add analysis variables, expand diagnostic file, add Hilbert-Curve cross-validation, fix bugs in use of anisotropic RF
14. GSI review ticket 09012011: ticket #39 due on **Sep 14, 2011**. Appended Request - Revisited Hybrid Ensemble Capability. This ticket replaced ticket #190 due on 29, 2011, since more changes should have been included in the previous ticket. Originally due on **Sep 8, 2011**. DTC requested to extend the review deadline.

✓ Meeting minutes and code review tickets can be found at the GRC wiki (committee members only).



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 ...



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, 2010	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 v3.0	June 29-July 1, 2011	All users

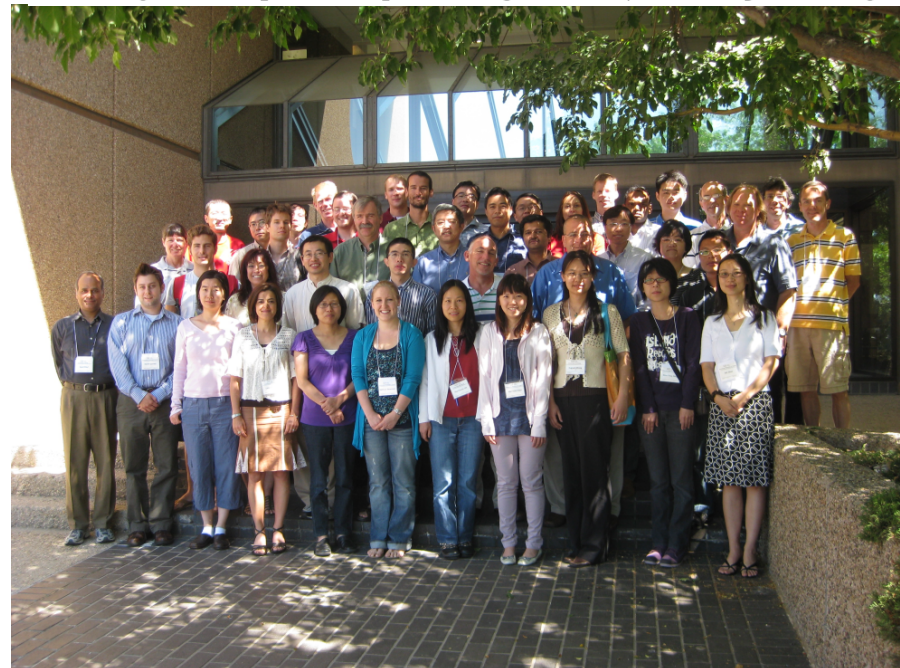
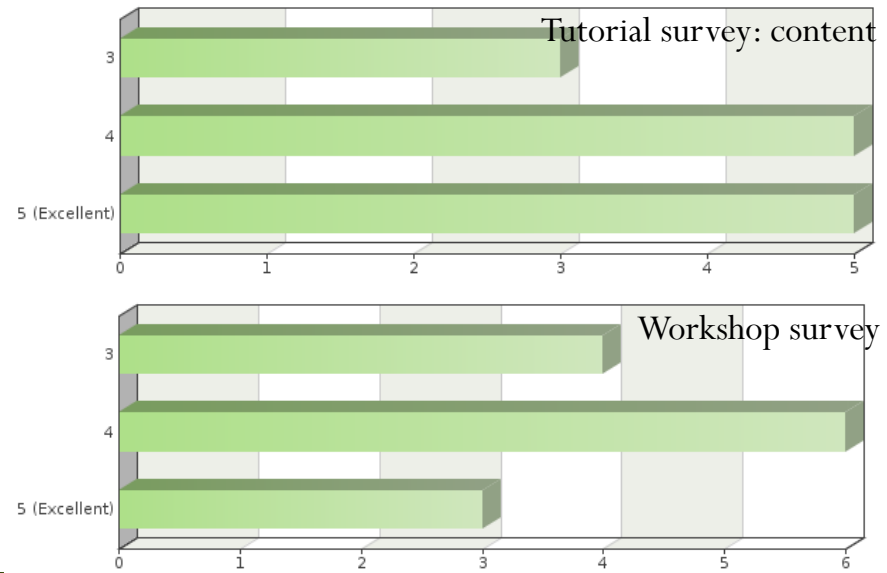
- Starting from 2011, community GSI release uses the latest trunk code:
 - Code is well tested before being committed, due to the implementation of the GRC review procedure
- Critical update to GSI Users' Guide:
 - Expanded existing contents
 - Two new chapters: *GSI Applications* and *BUFR and PrepBUFR*



Community GSI Support

- 2011 summer tutorial 28-30 June, 2011:
 - 31 participants
 - 13 Lectures (speakers from NCEP, NASA, NCAR, ESRL and DTC)
 - 4-h basic practice
 - 1-day optional advanced practice
- First GSI Workshop 28 June, 2011
 - 50 participants
- GSI-hybrid Workshop*, Nov 11, 2011, Miami, FL
- BUFR/PrepBUFR webcast Tutorial*, Dec 13
 - Extended data format support to general GSI users and HFIP community

* Supported by HFIP



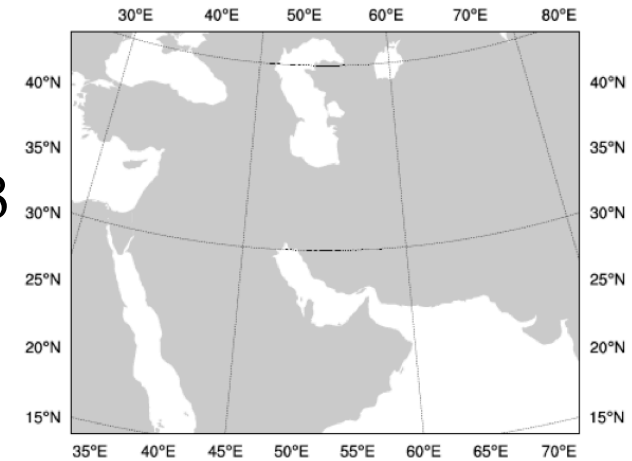
GSI – WRFDA Comparison

- GSI:
 - Current NCEP operational DA system (global/regional)
 - Following NAM configuration, AFWA partial cycling
 - Conventional Data: GFS PrepBUFR files (NCEP QC)
 - Background errors generated using GEN_BE-GSI
 - ~NCEP BE code for NAM but more user friendly
- WRFDA:
 - Current AFWA operational DA system
 - AFWA configuration, AFWA partial cycling
 - Conventional Data: AFWA “little_r” data files
 - Observation numbers vary due to cut-off time difference at spin-up (-6h) and analysis time.
 - Background errors generated using GEN_BE-WRFDA



Setup

- WRFv3.3 + comGSI v3.0 or WRFDA v3.3
- T44 domain (right)
- Aug. 18, 2010 – Sept 18, 2010
- Data: conventional data including GPS RO refractivity
- 15km horizontal resolution, 57 vertical levels, 10 hPa model top
- 3 hour time window
- Verification: METv3.0.1
- Background Errors generated using gen_be tool
 - Generated from 1 mo WRF ARW v3.3 run using GFS input, 48 h WRF fcst w/no DA.
 - BE generated from 24h-12h, using NMC method
 - ✓ gen_be for GSI vs. WRFDA use different methods for BE generation – leading to difficult straight comparison of parameters



Data

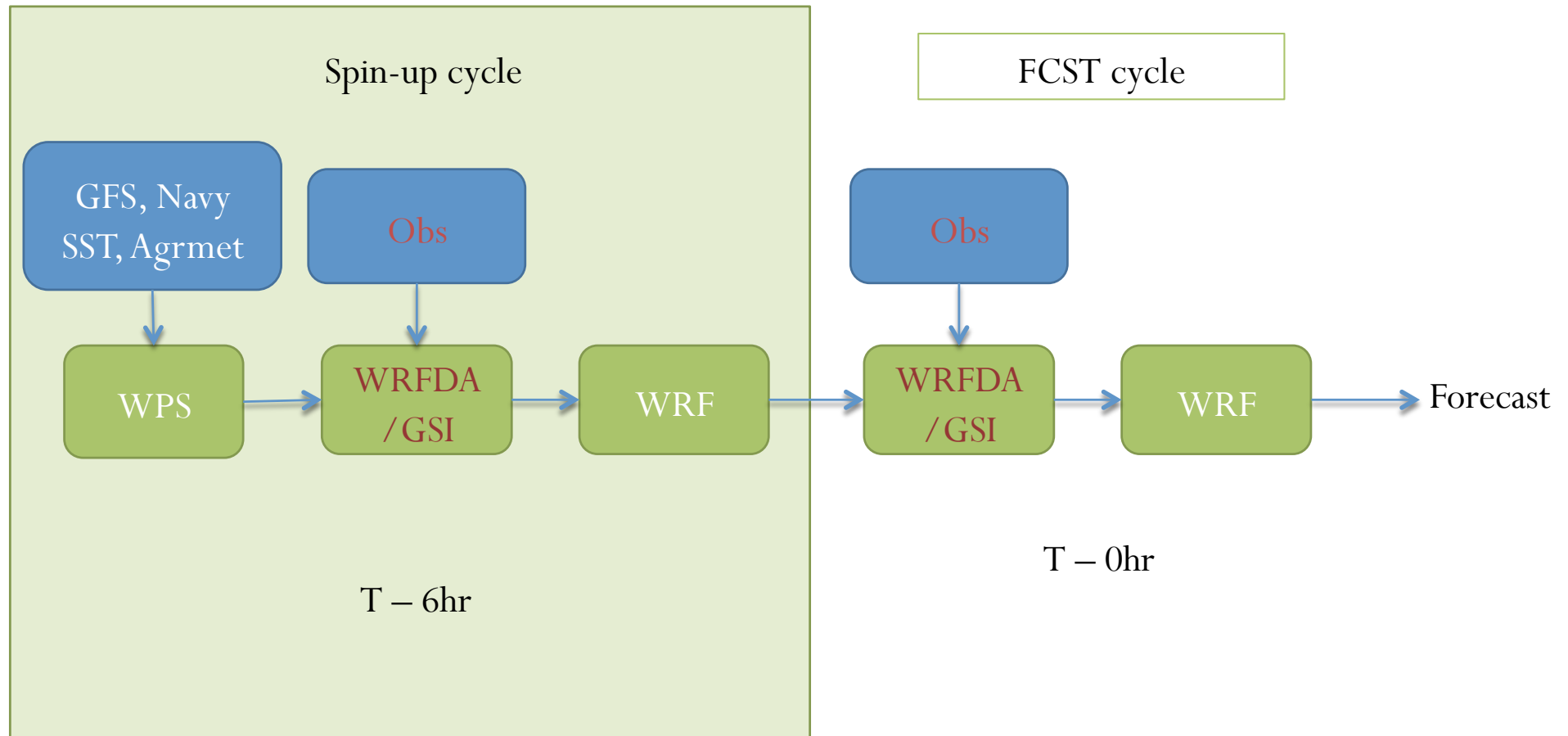
- GSI has much more sounding data at 00z & 12z (*cut-off time*)
- GSI missing SSMI/airep/geoamv data
- WRFDA missing pibal/sat winds/gpsrf*
- No METAR data for GSI (*GSI QC on GFS*)

Assimilated Observations for GSI/WRFDA for 090918 (Spin-up) and 091000

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



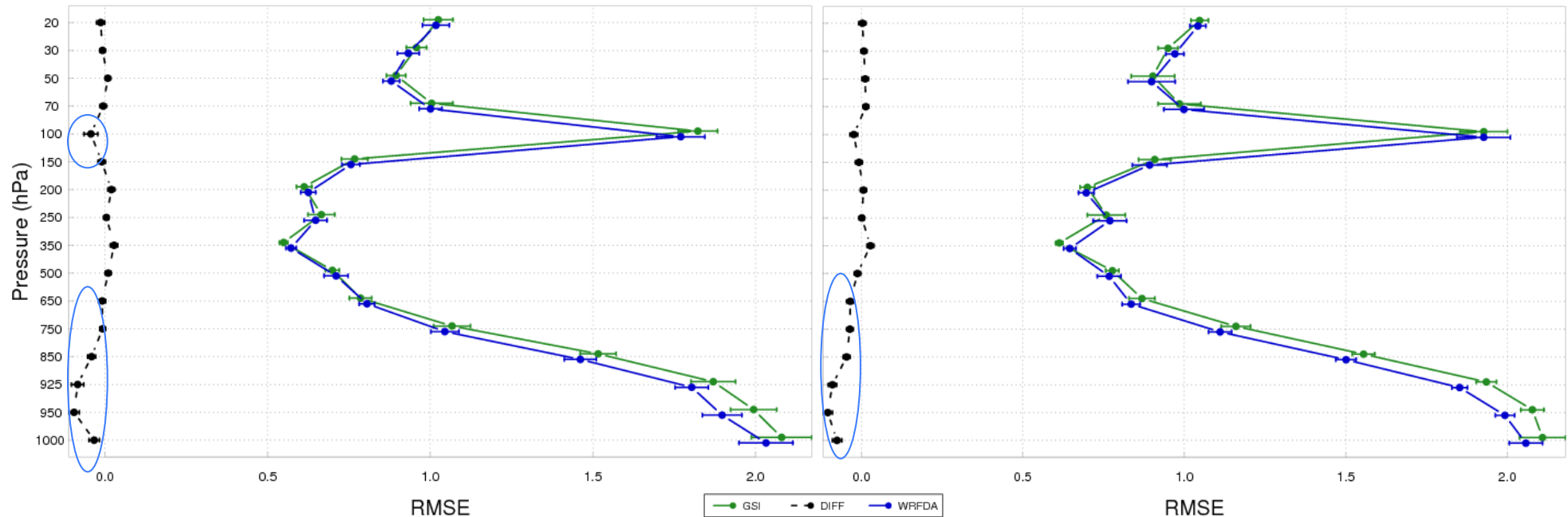
Partial Cycling Scheme



Verification against ECMWF

12 h Temperature RMSE Against ECMWF Analysis

24 h Temperature RMSE Against ECMWF Analysis

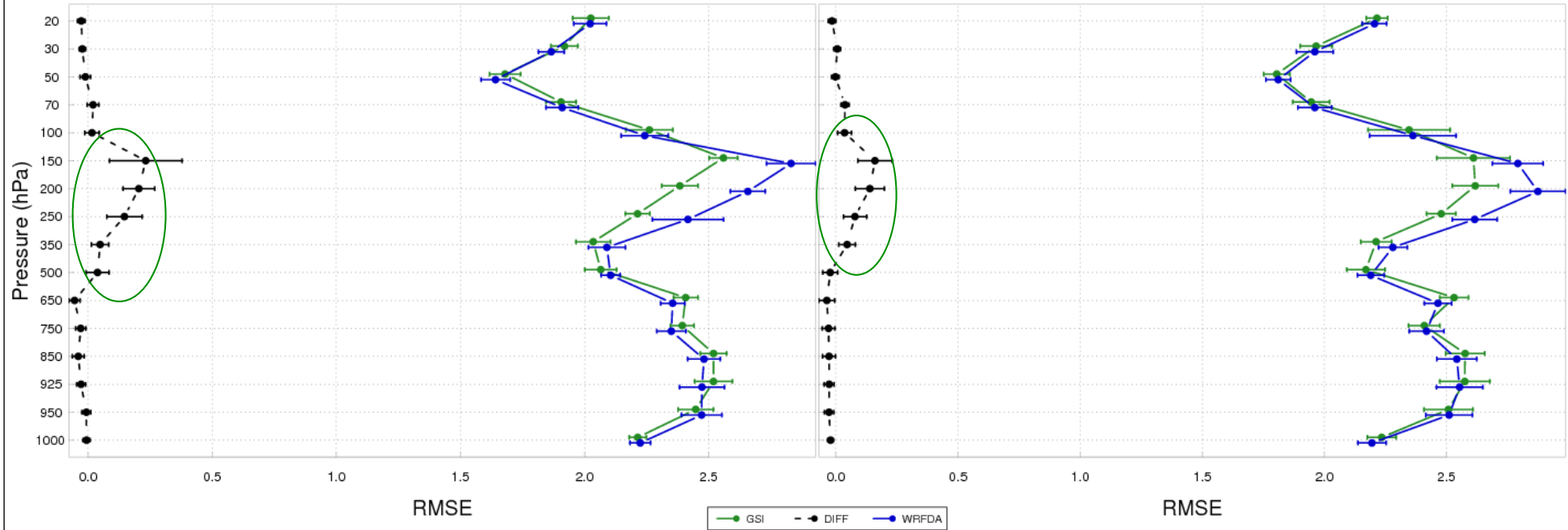


- Pair-wise differences favor WRFDA over GSI for low level TMP and Q (*not shown*) RMSE and Bias.
- SS differences favor WRFDA at lowest levels for all forecast times up to 48 hrs.
- ✓ Verification of forecasts generated during spin-up cycle show similar results (*not shown*)
 - ✓ SS differences favoring WRFDA for low level T and Q (significantly more sfc data during WRFDA spin-up cycle than GSI)
 - ✓ SS differences present for all forecast times (06-54 hr)

Verification against ECMWF

12 h V-Wind RMSE Against ECMWF Analysis

24 h V-Wind RMSE Against ECMWF Analysis



- Pair-wise differences favor GSI over WRFDA for upper level winds V and U (*not shown*) RMSE.
- SS differences present through 36 hr forecast (no SS differences at 48 hr).
- Analysis time shows WRFDA is SS favored compared to ECMWF analysis for low level winds, however GSI is SS favored for 250-70 hPa (*not shown*).
- ✓ Verification of forecasts generated during spin-up cycle show similar results (*not shown*).
 - ✓ SS differences favoring GSI for upper level winds (U and V) present through 30 hr forecast.



WRFDA vs GSI: Conclusions

- Observation data differences as well as differences in BE generation methods between GSI and WRFDA lead to significant differences between the systems, therefore making an ‘apples to apples’ comparison impossible.
- PrepBUFR observations vs. filtered AFWA observations verification showed similar results, with slight favor toward DA system assimilating the observations used in the verification.
- ECMWF analysis verification showed WRFDA was SS favored for low level T and Q, whereas GSI was SS favored for upper level winds.
- Spin-up verification results echoed results of ECWFMF for 00Z/12Z.
 - Eliminating cut-off time issue does not greatly impact results.
- ‘Mixed bag’ of results show neither DA system stands out, but rather depends on application and available data.

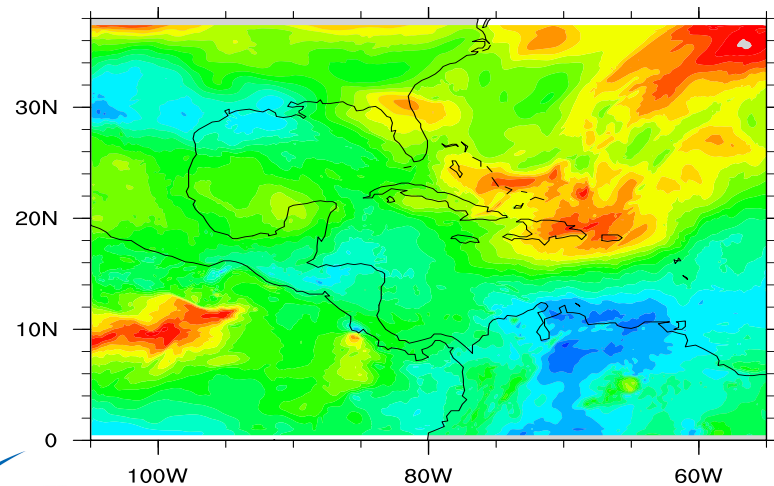


Regional EnKF Baseline Tests

Period of performance: July 1, 2011-June 30, 2012

Ongoing efforts:

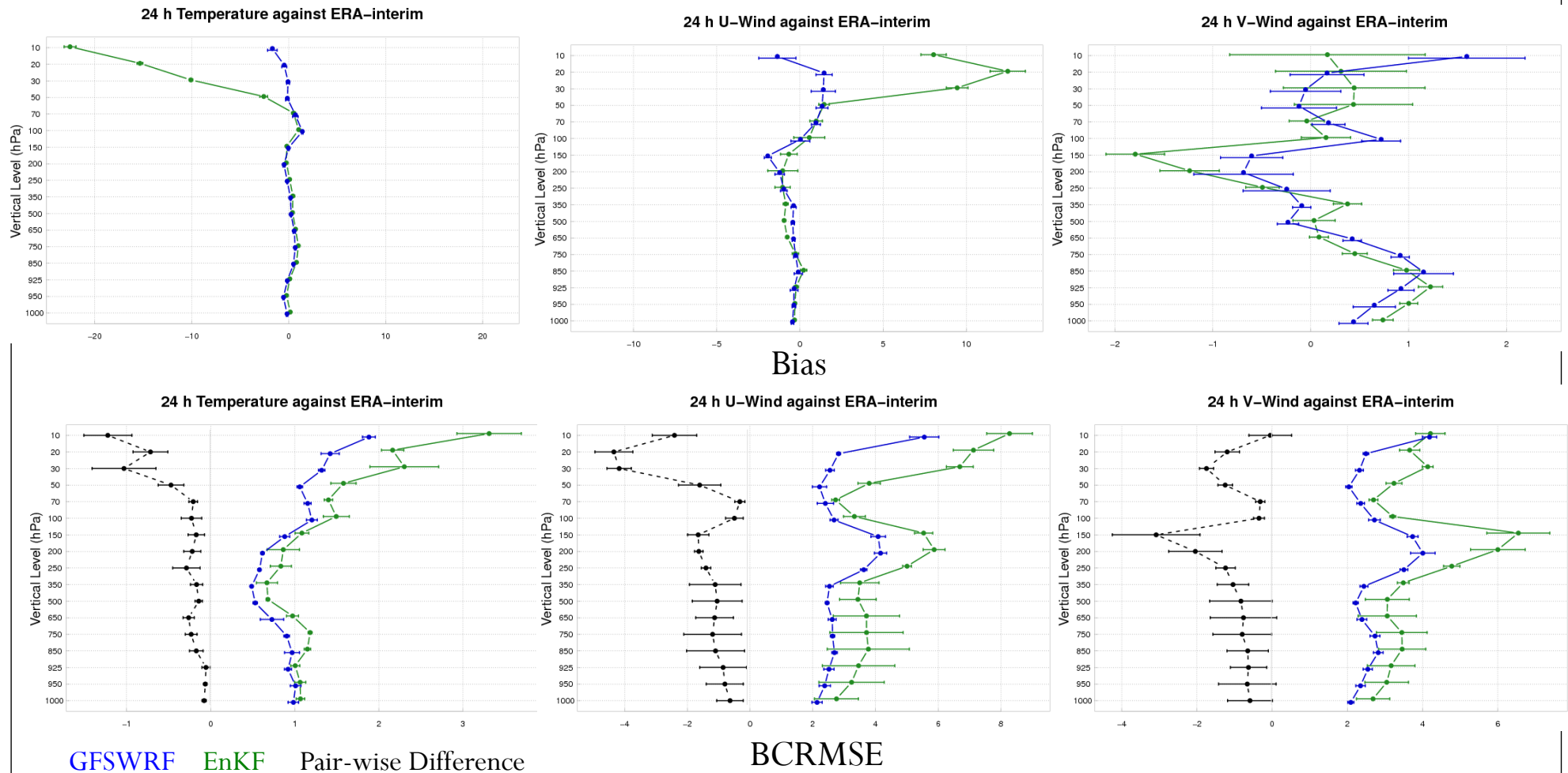
- DART-EnKF benchmark conventional run
- Case Study: Hurricane Dean
 - 2007081512-2007082500 (10 da)
- Domain: T8 (see below)
- Horizontal resolution: 45km



Conventional observations assimilated
Centered at 2007081512

	DART-EnKF				
	U	V	T	DP	P
RADIOSONDE	662	662	2482		
SAT	4744	4744			
METAR	271	271	712	2950	
SHIP	78	78	83	52	
SYNOP	102	102	182	182	77
AIREP	5	5	4		
PILOT	1385	1385			

Preliminary Results - 24hr FCST vs. ERA



- Benchmark DART-EnKF tests show system is working and verification shows reasonable forecast scores below 70 hPa (T & U above 70 hPa needs more investigation).
- DART-EnKF assimilating conventional data only does not beat the WRF GFS benchmark... Future work to assimilate more observations

EnKF Baseline: Ongoing Efforts

- Collaborating with NCAR/MMM to set up a test plan to assimilate radiance data with DART-EnKF
 - Added capability to assimilate additional sensors beyond AMSU-A
 - AMSU-B
 - MHS
- Sensitivity testing of DART-EnKF runs with and without additional radiance data against:
 - Variational data assimilation runs with same radiance data assimilated
 - ECMWF reanalysis (ERA-interim)

FY2012 Proposed Work (appendix)

- Code management
 - Continue to facilitate R2O transitions
- Boulder GSI Repository maintenance
- Community support
 - Code release
 - Tutorial
- DA benchmark testing
- Comparison of NOAA EnKF and DART EnKF