Design and Development of Regional EnKF-3DVAR Hybrid DA System for Operational HWRF Model

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Analysis Domain

Intermediate and inner most domains (9km and 3km, movable)
Eliminate the need for bogusing TCs through improved DA techniques and inner core observations

(Flow chart drawn by Ligia Bernardet)
NCEP Global Hybrid DA System

- NCEP will be implementing Hybrid EnKF-GSI Variational Data Assimilation System for Global Forecast System (GFS) in April 2012
- A centralized framework and repository for hybrid GSI is established at EMC and DTC towards unification of developmental efforts from various groups and organizations.
- Extension of Global Hybrid GSI system for regional scale operational HWRF model is a step towards improving vortex initialization
One-Way Hybrid System for HWRF

- GDAS forecast
- Global hybrid EnKF-3DVAR ensemble forecast member 1
- Global hybrid EnKF-3DVAR ensemble forecast member 2
- Global hybrid EnKF-3DVAR ensemble forecast member $N$
- HWRF 6 hr forecast
- GWRF modified vortex
  - Relocation, size correction, intensity correction, adjust mass fields
- First guess

Data assimilation

- GSI
- Data thinning, quality control
- Iterative minimization
  \[ J = x^T B^{-1} x + (Hx - y)^T R^{-1} (Hx - y) + J_c \]
  \[ x = x_1 + \sum_{n=1}^{N} a_n x_n^g \]
  \[ J = \beta_1 x_1^T B_1^{-1} x_1 + \beta_2 (a)^T A^{-1} (a) + (Hx - y)^T R^{-1} (Hx - y) + J_c \]

- Observation

126 hr forecast
A pseudo-ensemble hybrid data assimilation system (PEDA) for HWRF

First guess: GFS analysis

80 ensemble perturbations generated from B of WRF-Var

Replace TC vortex

TC Vortex Library

Pseudo-ensemble members

Flow-dependent multivariate B for inner core (through Alpha control)

3DVAR
Schematic of the unified hybrid system

**HWRF**
- Preprocessing: LBC - from GFS
- Forecast
- GSI

**Global and Regional**
- Shared EnKF/hybrid DA solvers

**Observations:**
- Conventional, satellite, and inner-core

**Data flow in the current HWRF system**

**Data flow in the unified system**

In **GREEN**: Current HWRF system, cycling with GSI DA

In **PINK**: Shared between HWRF and GFS systems
Operational Requirements for regional hybrid system

- Regional Modeling Framework
  - Triple nested (27/9/3) high-resolution HWRF

- Unified Ensemble generation method (EnKF):
  - Perturbations for large-scale (outer domain)
  - Perturbations for vortex-scale (9km and 3km domains)

- Observational operators:
  - Should be supported by operational GSI
  - Meet the requirements

- Development and T&E
  - Integrated Global-Regional system with support from DTC
  - Collaborators working on the unified system through shared repository
  - EMC will provide guidance on test cases and evaluation metrics for hurricane applications
Timelines

• Concept
  • Agree upon the common approach for Global-Regional Unified Hybrid System

• Design
  • Identify “methodologies” and “tools” required for regional applications (e.g., how to handle moving nests)

• Experimentation
  • Have a prototype system ready for retrospective testing (Stream 1.5)

• Real-time Demo
  • Participate in Real-Time Demo during 2012 hurricane season