Hybrid data assimilation system for HWRF

Development team
Bachir Annane and Tomislava Vukicevic, HRD/AOML
Jeff Whitaker and Henry Winterbottom, PSD/ESRL
Mingjing Tong (EMC)

Collaborators
Altug Aksoy, Sundararaman Gopalakrishnan and Sylvie Lorsolo (HRD/AOML)
Vijay Tallaprragada (EMC)

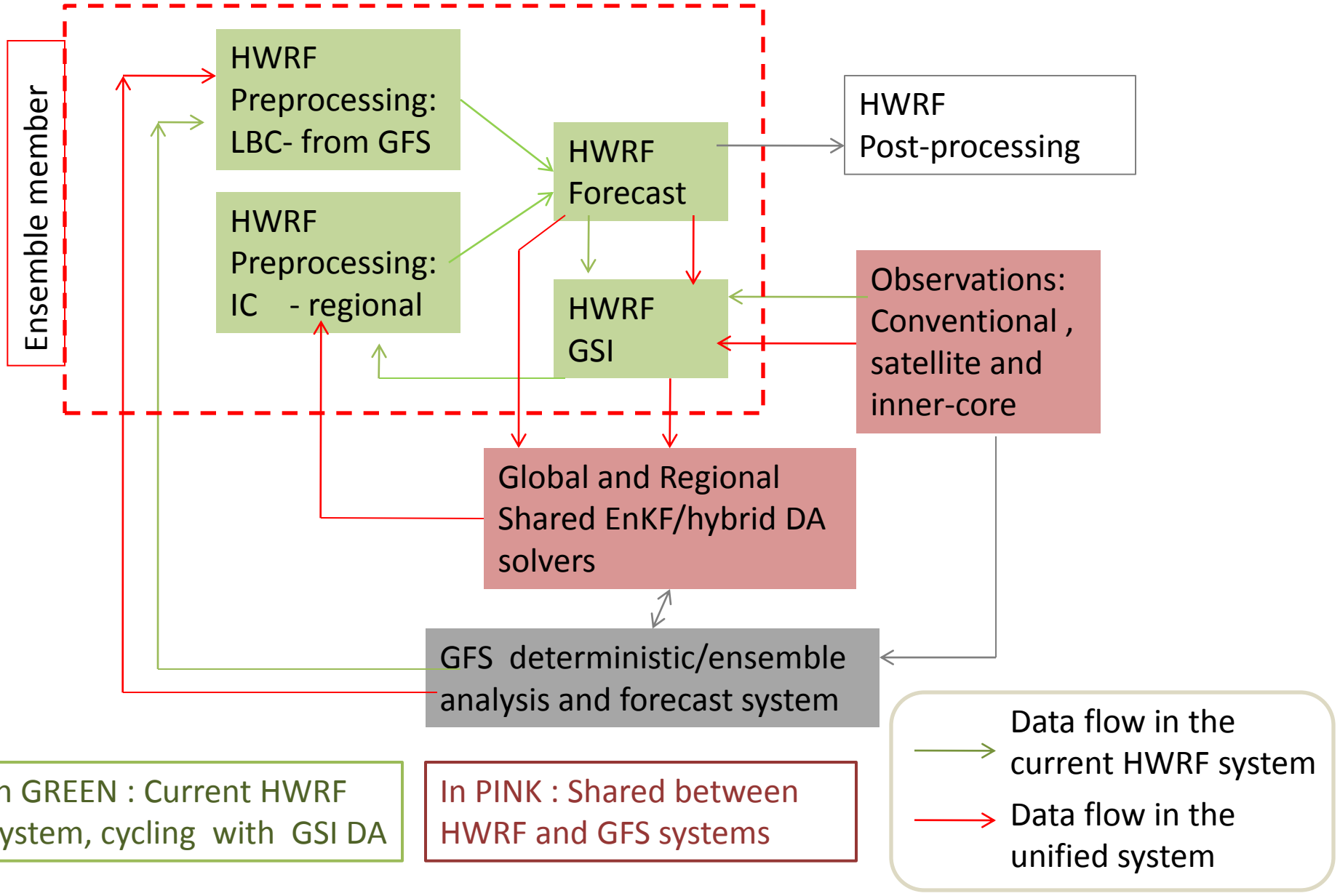
Objectives

- Develop hybrid data assimilation capability for possible operational use with HWRF system

- Integrate global and regional hybrid DA
  - Shared data assimilation algorithms : GSI and EnKF
  - Shared observation base

- Cycled data assimilation capability at all scales resolved by HWRF: synoptic, meso and inner-core

Schematic of the unified hybrid system



Strategy for grid configuration and cycling

I. Fixed location outer grid with one of the following options

a) Basin scale at 27 km or finer resolution

- Continuous cycling with a periodic restart using GFS analysis

b) Standard per storm large outer domain with 27 km or finer resolution

- Cold start from GFS analysis at domain generation
- Cycled till end of storm

II. Moving nest(s) options

a) Fixed location per outer domain cycle (6 h)

- Full cycling with a finer time interval (1 h)
- Partial cycling at advancing to new location : blending with coarser grid analysis outside of overlap region

b) Nest moving at a fine interval (1h)

- Partial cycling at advancing to new location : blending with upper grid analysis outside of overlap region

Strategy for using observations

I. Fixed location outer grid
   - Same set of observations as the global analysis
   - If finer resolution than the global, possibly use less thinning of satellite observations with a finer scale decorrelation length

II. Moving nest options

a) If intermediate nest, add unused finer resolution satellite observations after update of coarser grid (outer domain)

b) If single nest the same as (a) plus inner core observations

c) If second nest, use only inner core observations after upgrade from coarser grid

What has been accomplished, so far ?

- Implementing the latest version of HWRF with EnKF and GSI algorithms within the framework of the global hybrid system
  - Almost completed “wiring”
  - Slow progress during the hurricane season 2011 due to limited availability of “jet” for the development project
  - Difficulties with using “netcdf” option in the interface between HWRF and GSI
  - Getting familiar with the operational version of HWRF system

Credit to Henry Winterbottom (PSD/ESRL) and Bachir Annane (HRD/AOML)

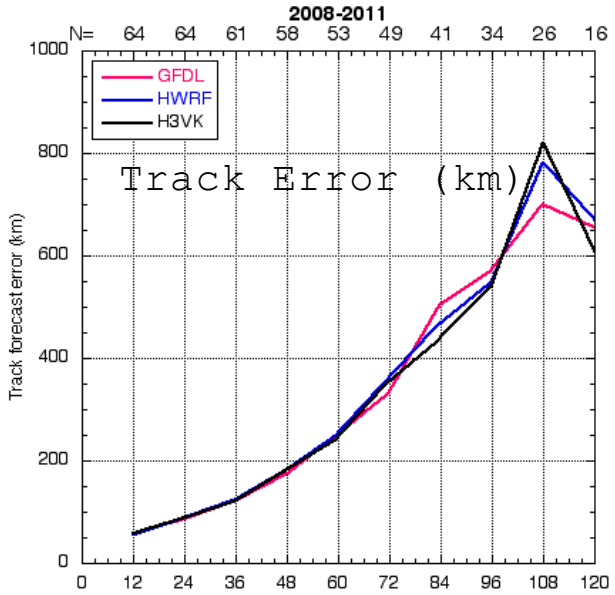
Other progress related to developing the HWRF multi-scale (multi-grid) hybrid data assimilation system

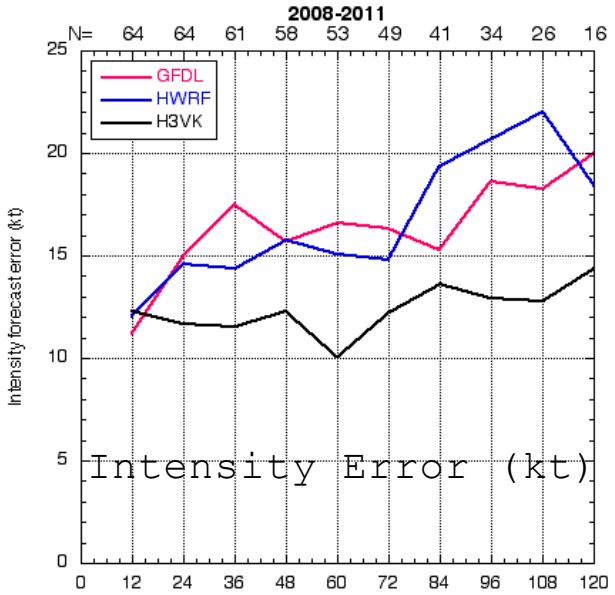
- Experimental HWRF Enseble Kalman Filter (HEDAS) was used to demonstrate benefits of the inner-core data assimilation on forecast skill (2008-2011 seasons)

- The experience with HEDAS revealed the outstanding challenges and paths to resolution that are relevant to the hybrid data assimilation with HWRF forecast system at vortex scale

Results using HEDAS

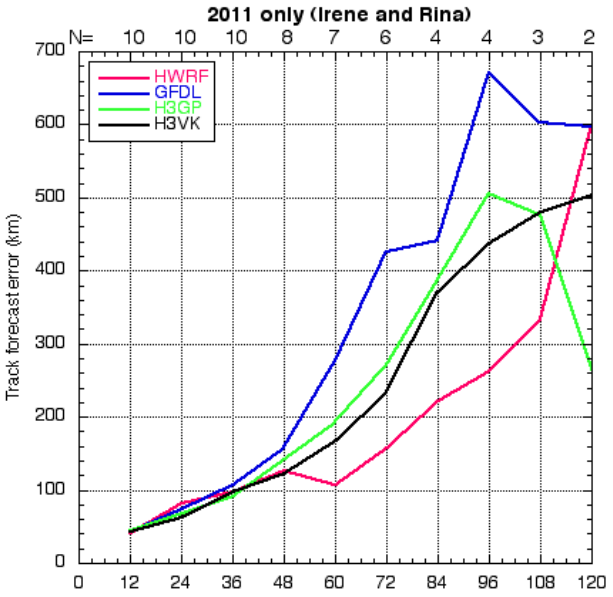
2008 to 2011

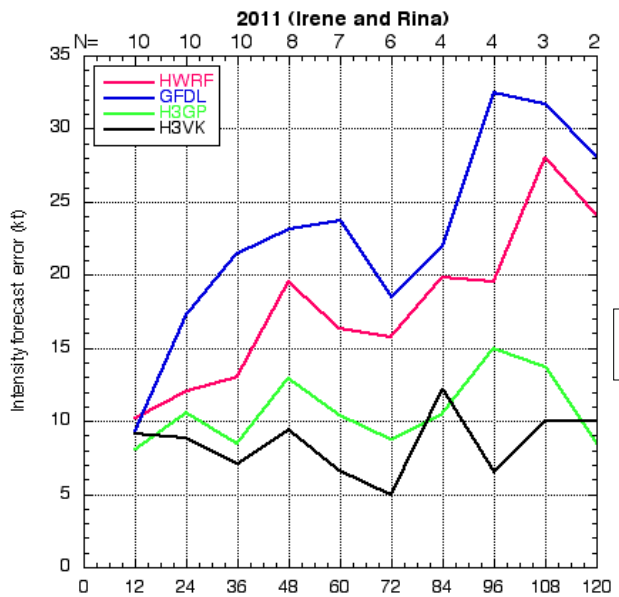




H3VK = HEDAS

2011 only





H3GP = HWRF strm 1.5

H3VK = HEDAS

Outstanding issues

- Short-term forecast bias
  - Short-term spin-down tendency for high intensity cases reduces impact of inner-core wind observations
- Impact of model physics on the assimilation
  - Estimates of secondary circulation strongly affected by the model PBL structure
- Lack of vertical circulation in the analysis
  - Initial imbalance and vortex adjustment

New research using HEDAS complementary to the hybrid system development

- Evaluate impact of improved model
  - HEDAS upgrade to 3-km HWRF 3.2
- Access benefits of extended control state
  - Evaluate impact of including the microphysical prognostic variables and vertical velocity in the analysis
- Optimize use of observations
  - Best use of thermodynamic observations
  - Explore different strategies for temporal distribution of observations during the assimilation
  - Improve superobing of Doppler radar observations : finer vertical resolution
- Optimization of vertical correlations and localization in EnKF