Hybrid DA Efforts at PSU and Possible Transition

HFIP Annual Review Meeting and HFIP Regional GSI-Hybrid Data Assimilation Workshop

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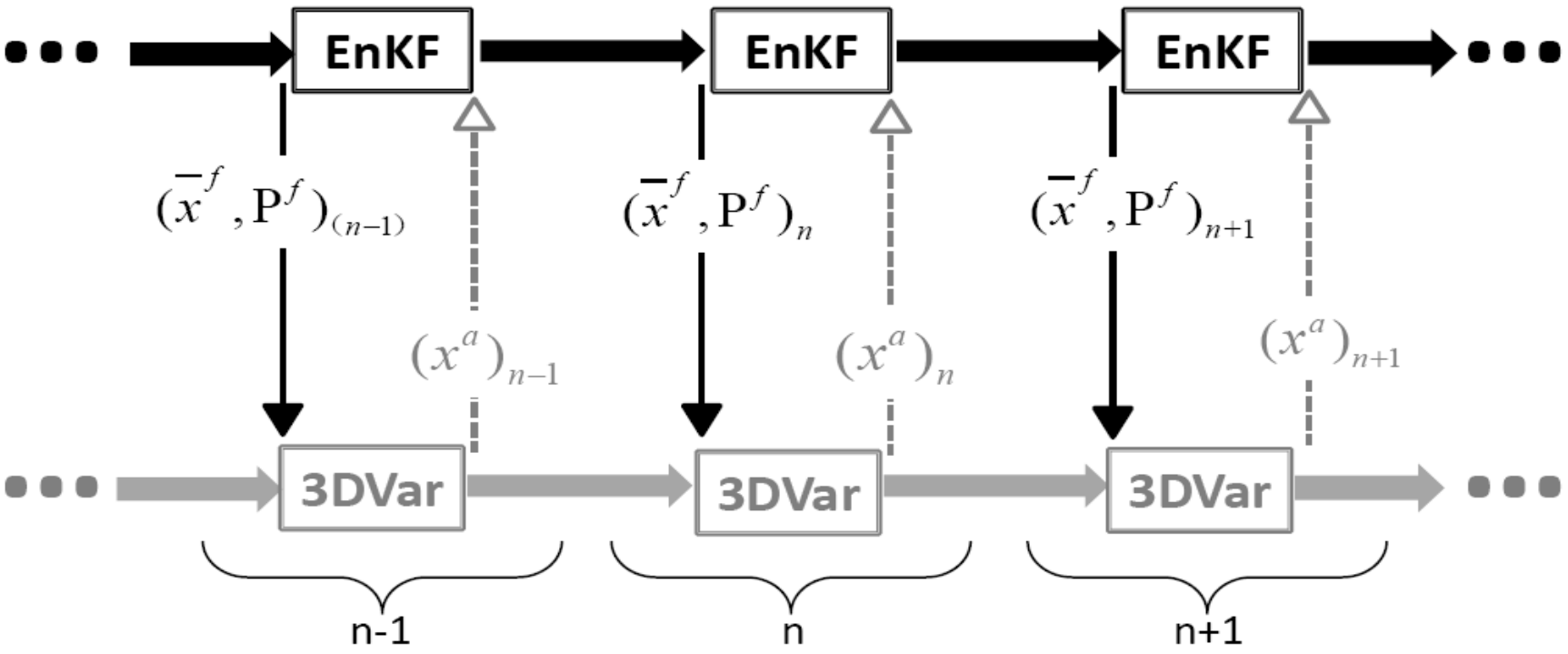
E3DVAR: 2-way Coupling of EnKF with 3DVar



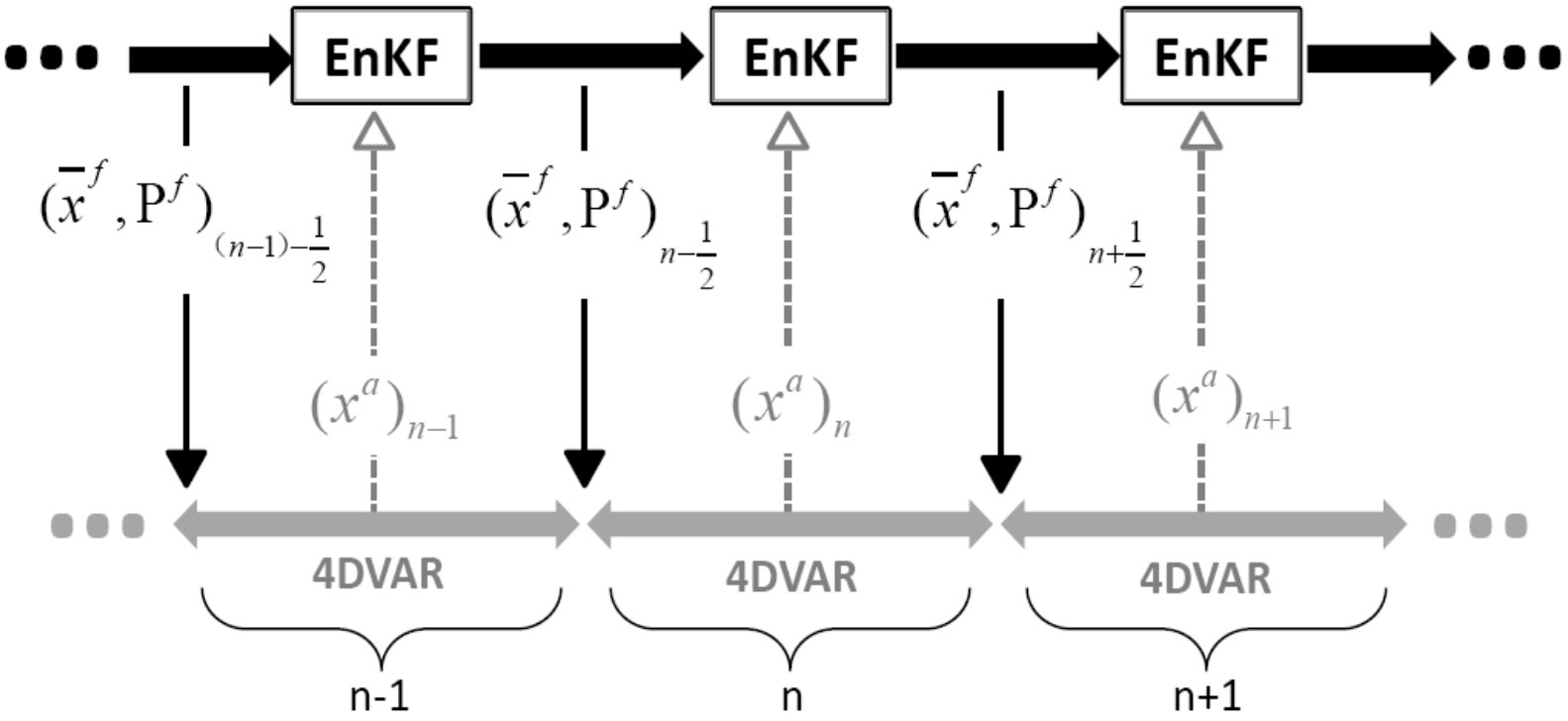
Necessary Variable Changes:

EnKF provides ensemble-based background error covariance ($\mathbf{P}^f$) for 3DVar

EnKF provides the prior ensemble mean ($\bar{x}^f$) as the first guess for 3DVar

3DVar provides deterministic analysis ($\bar{x}^a$) to replace the posterior ensemble mean for the next ensemble forecast

E3DVAR: 2-way Coupling of EnKF with 4DVar



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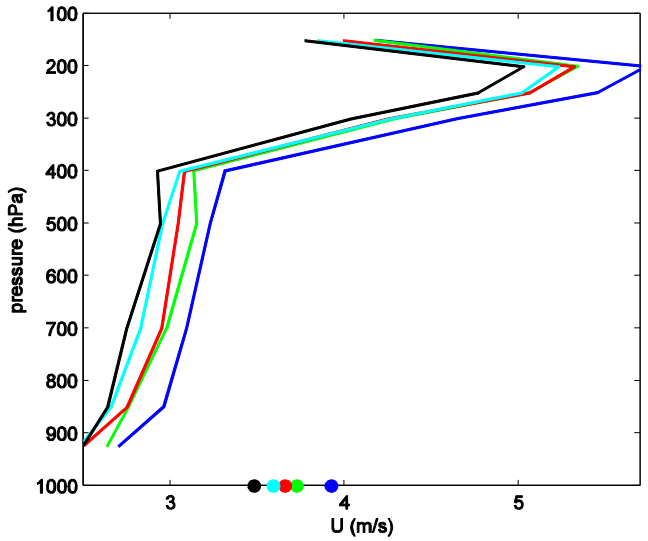
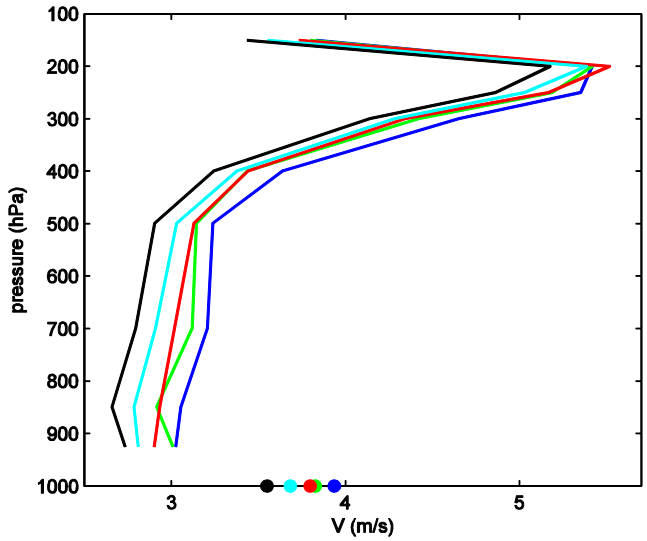
4DVar provides deterministic analysis ($\bar{x}^a$) to replace the posterior ensemble mean for the next ensemble forecast

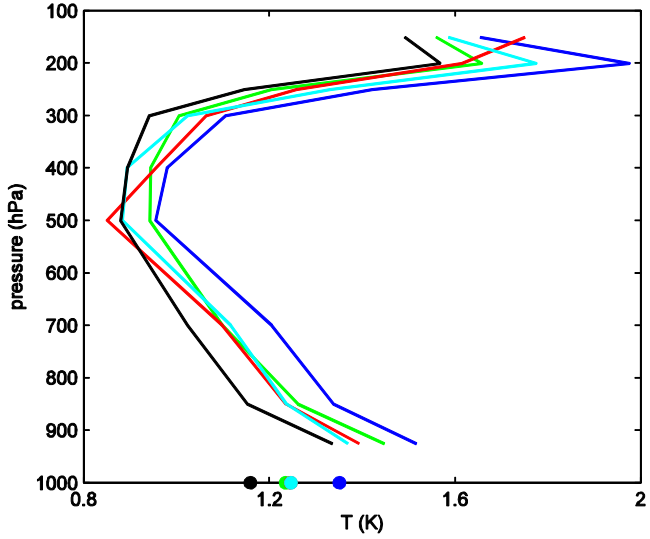
Zhang et al. (2009), Zhang and Zhang (2011a)

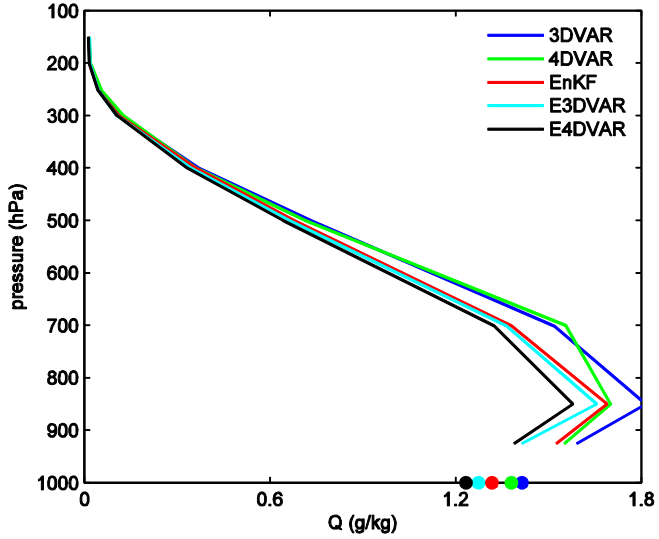
Month-long Performance of E4DVar

Mean vertical profiles of month-averaged 12-h forecast RMSE



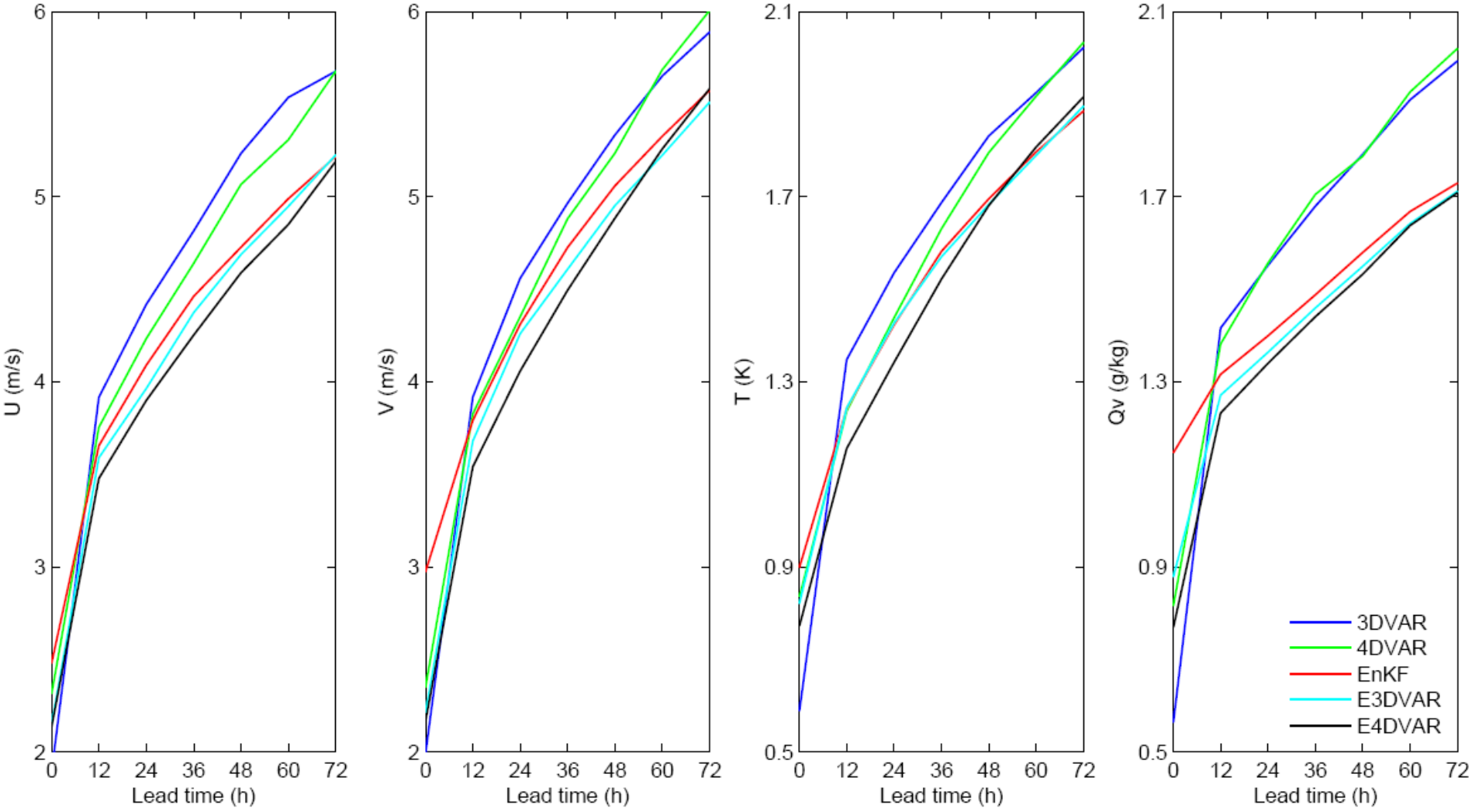




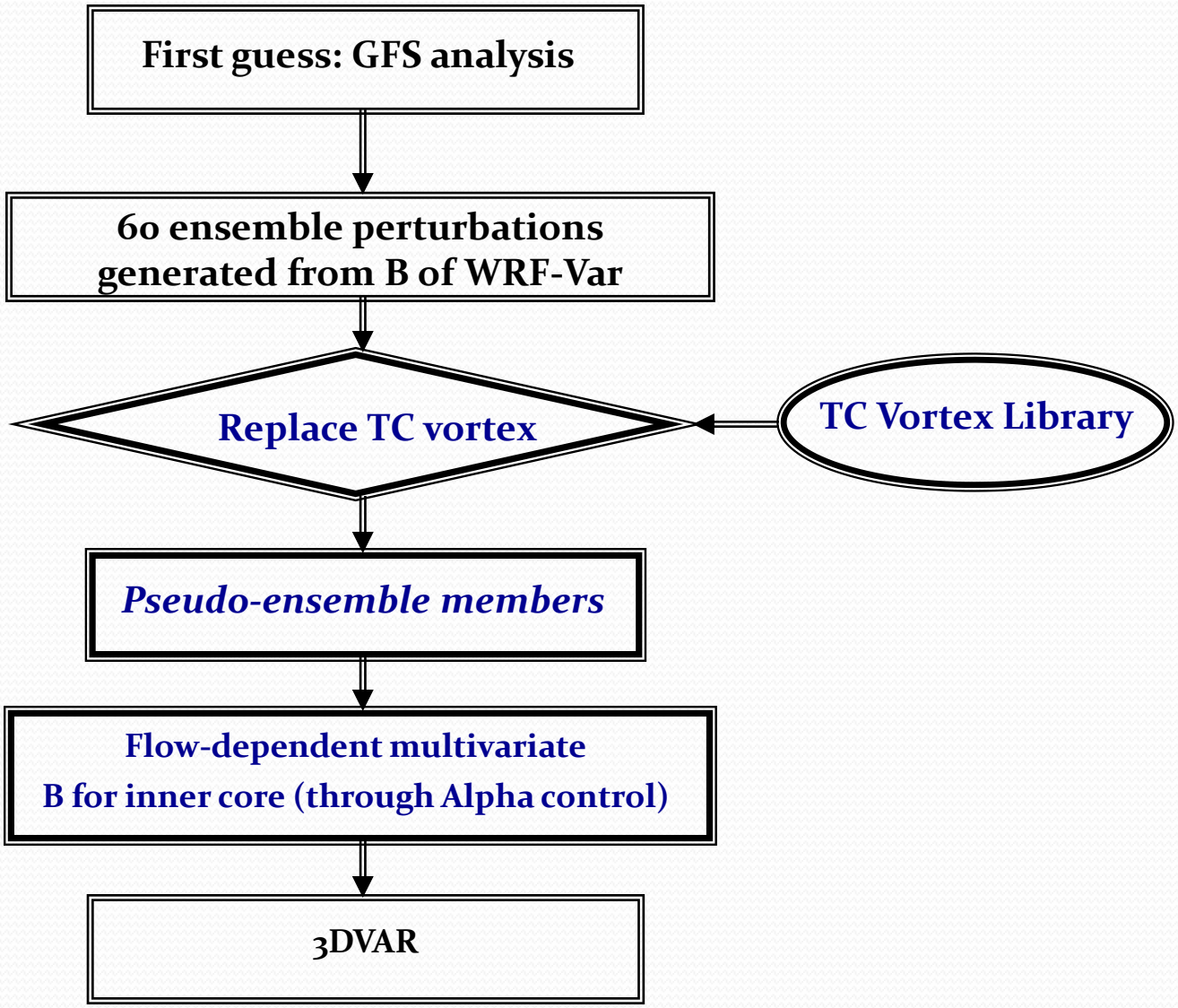


Month-long Performance of E4DVar

Total RMSE of U, V, T and Q with 0~72 lead time



A pseudo-ensemble hybrid data assimilation system (PEDA) for TC initialization with airborne Doppler radar data



Pseudo-ensemble: Establish a TC Vortex Library

- **WRF-ARW 3.1**

  ***f*-plane in a resting environment with constant SST**

  Alternative: thousands of real-case TC vortex from HFIP

- **Initial conditions for the idealized WRF runs:**

  1) initial vortex size/Rmax

  2) perturb sounding profile (i.e., moisture field)

  3) latitude effect

  4) physics options

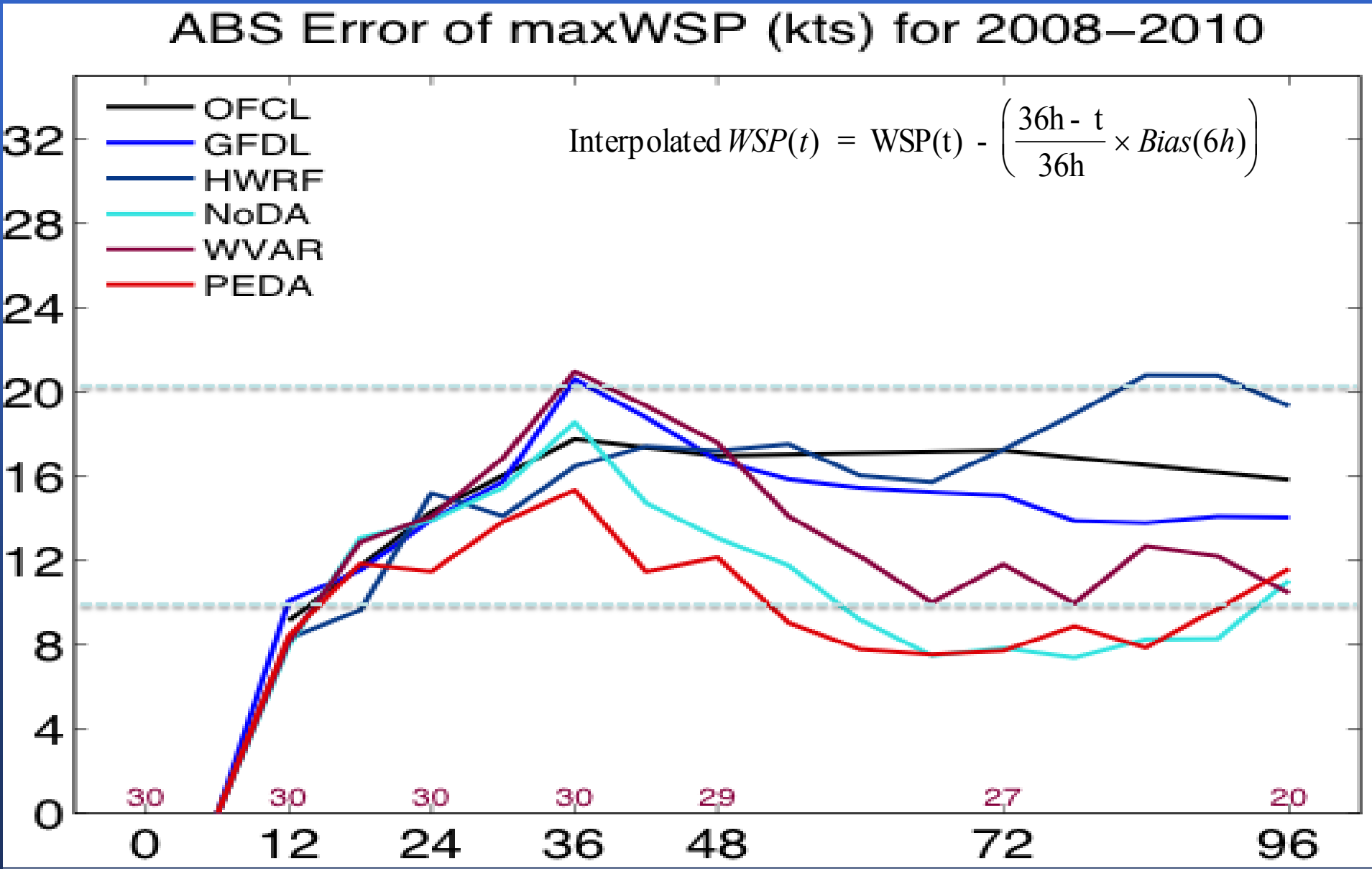
TC Vortices at different output times are binned according to *Vmax*

(more binning criteria to be added: size, …)

12.5<Vmax ≤17.5m/s	17.5<Vmax ≤22.5m/s	22.5<Vmax ≤27.5m/s	27.5<Vmax ≤32.5m/s	32.5<Vmax ≤37.5m/s	… …

WRF-PEDA Performance Airborne Vr for 2008-2010

Mean Absolute intensity error with bias correction (NHC variable interpolator)



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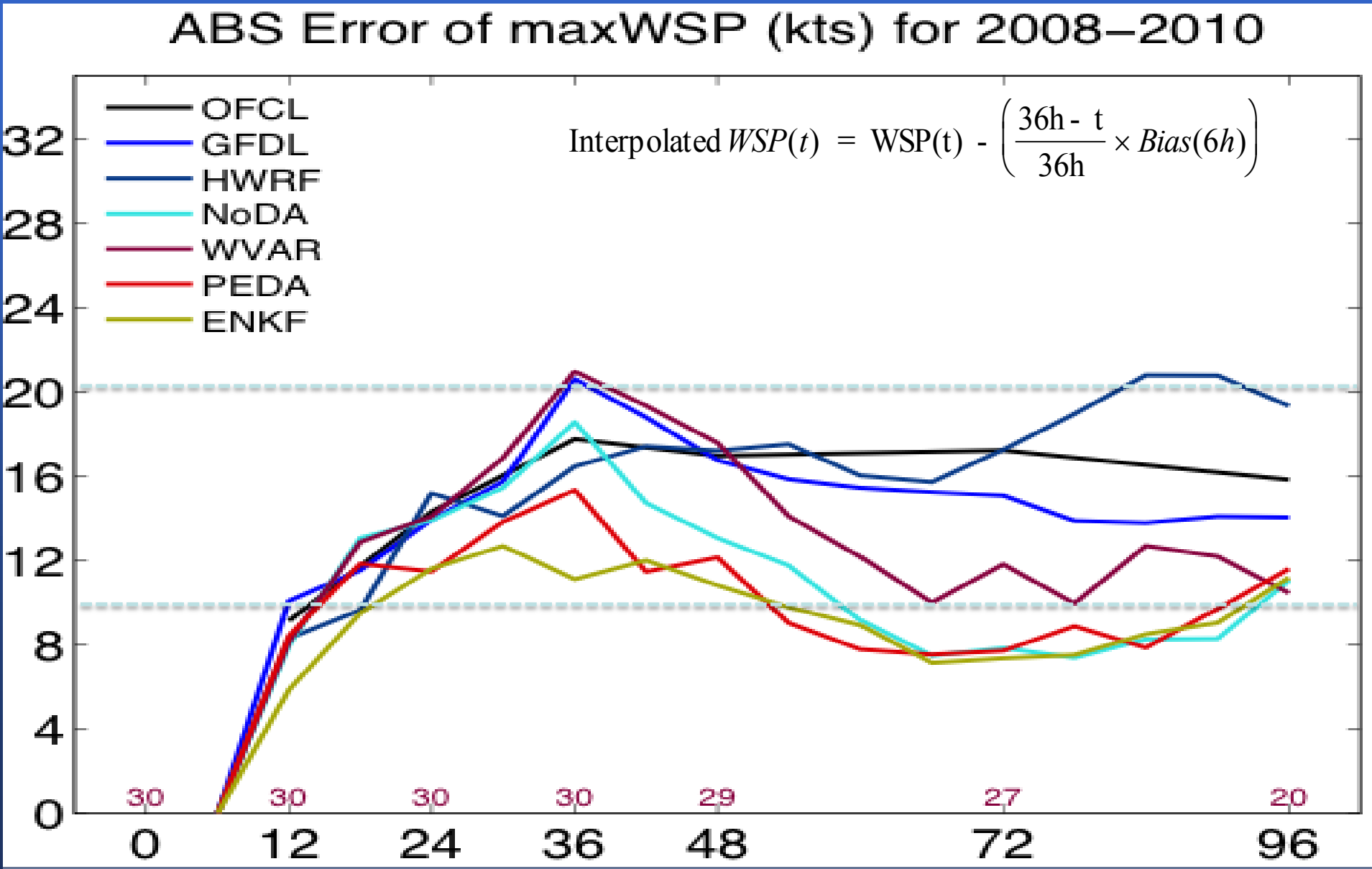


WRF-PEDA Performance with Sat-Winds from John Knaff

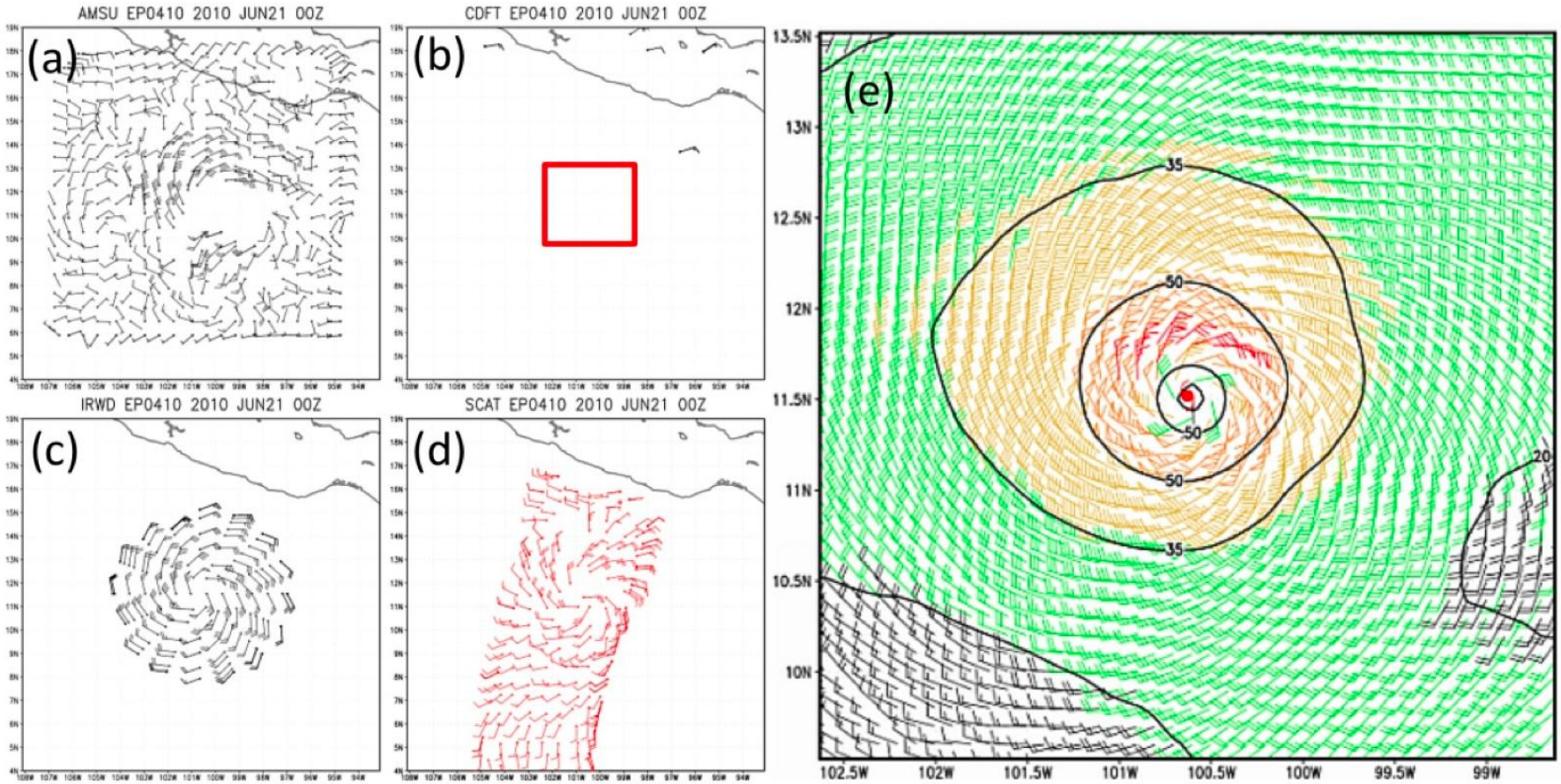
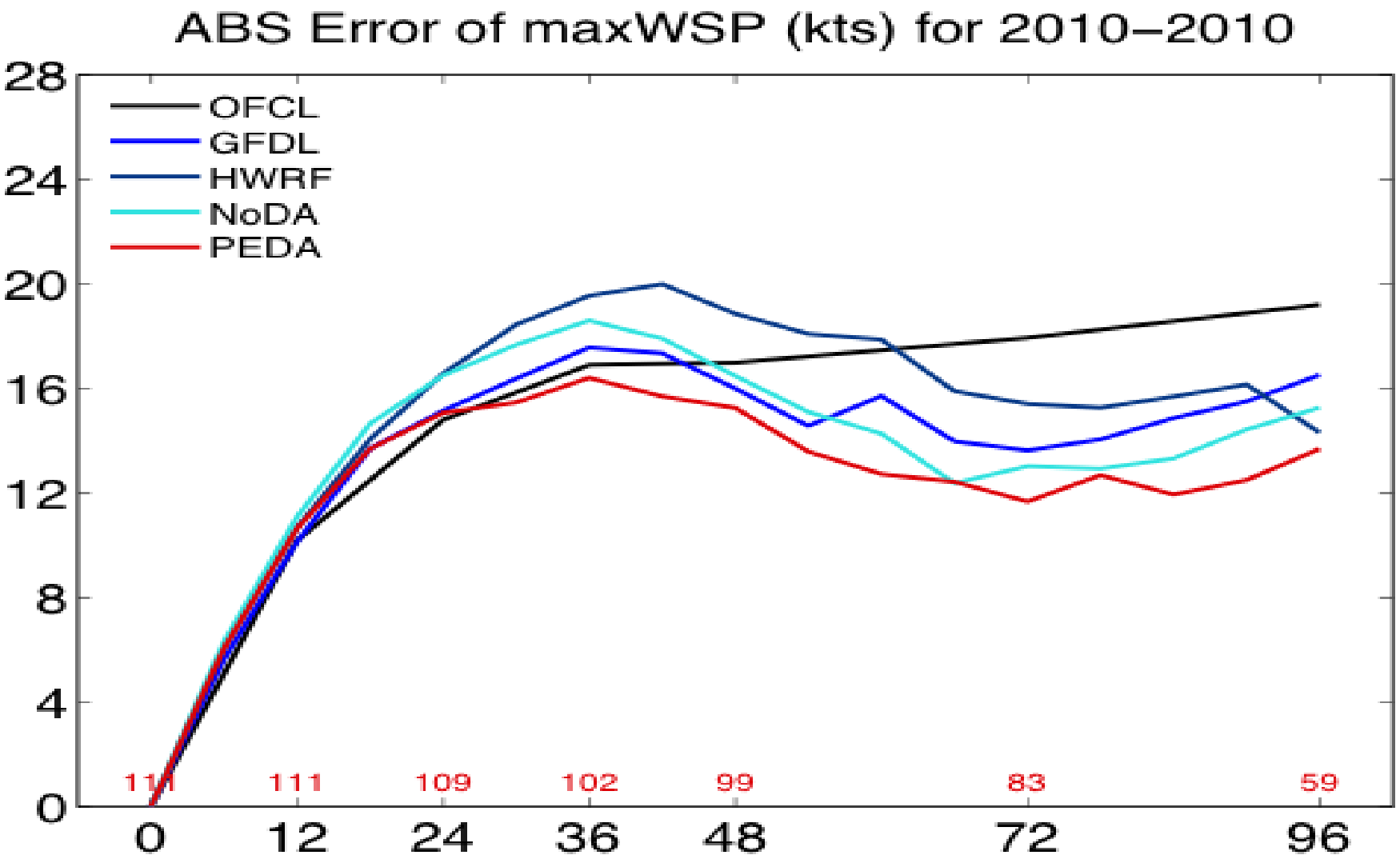


Figure 9. Examples of wind products generated for Hurricane Celia (EP0410) on 21 June 2010 at 00UTC (a) AMSU, (b) CDFT, (c) IRWD, (d) ASCT and (e) MTCSWA. The red frame shown in (b) is the plotted area of MTCSWA wind in (e). (J. Knaff, 2011)

WRF-PEDA Performance with MTCSWA winds from John Knaff for all 2010 Atlantic hurricanes (>=Cat 1) every 6 hr

Mean Absolute intensity error with 60-h bias correction



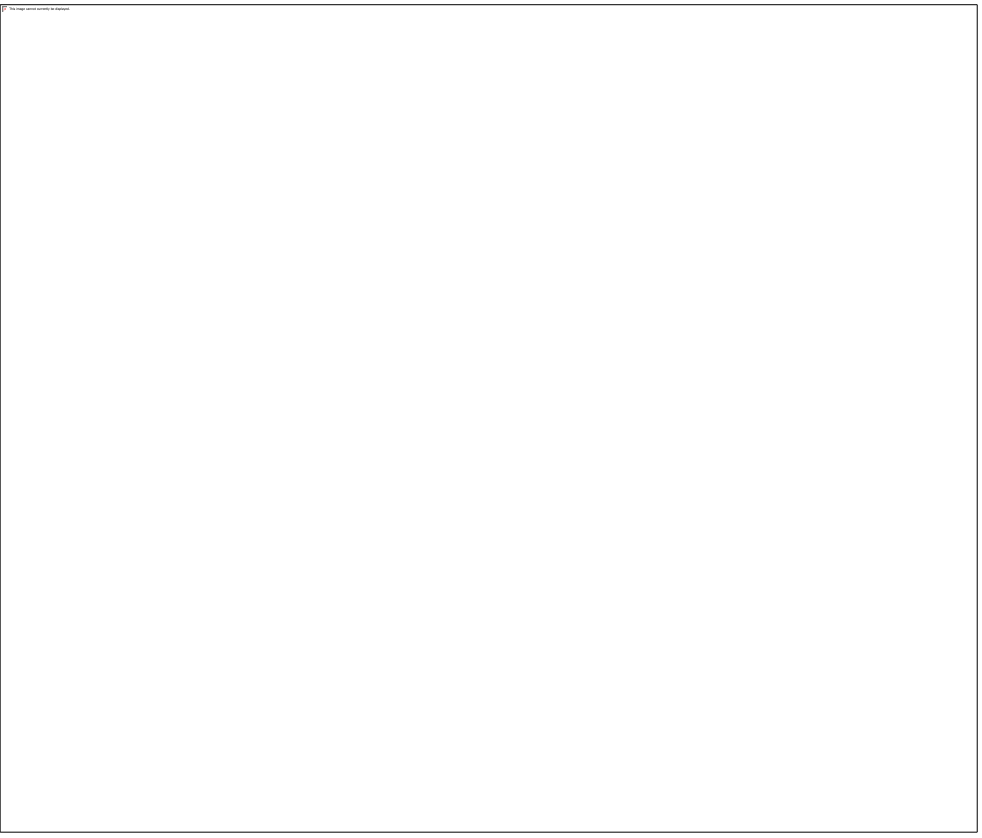
Hybrid DA Efforts at PSU and Possible Transitions

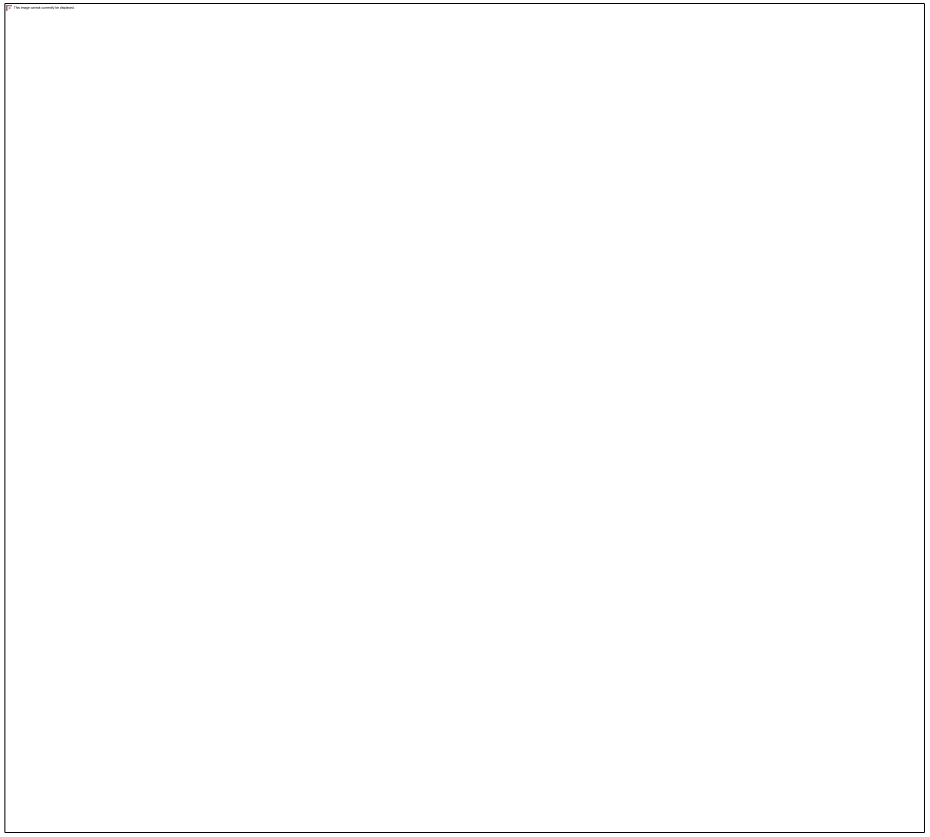
Our version of EnDA (EnKF, E3DVAR and E4DVAR) in ARW

Psedo-ensemble hybrid data assimilation for both ARW and HWRF (including the TC vortex tape library)

WRF-PEDA Performance with MTCSWA winds from John Knaff for all 2010 Atlantic hurricanes (>=Cat 1) every 6 hr

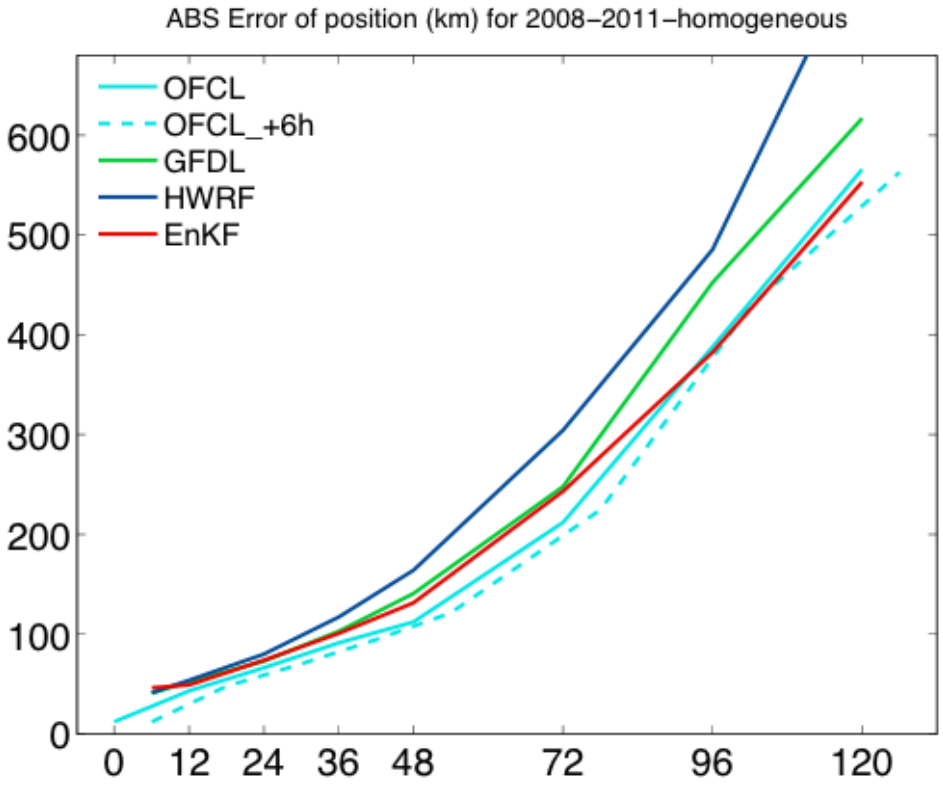
Mean Absolute error without bias correction

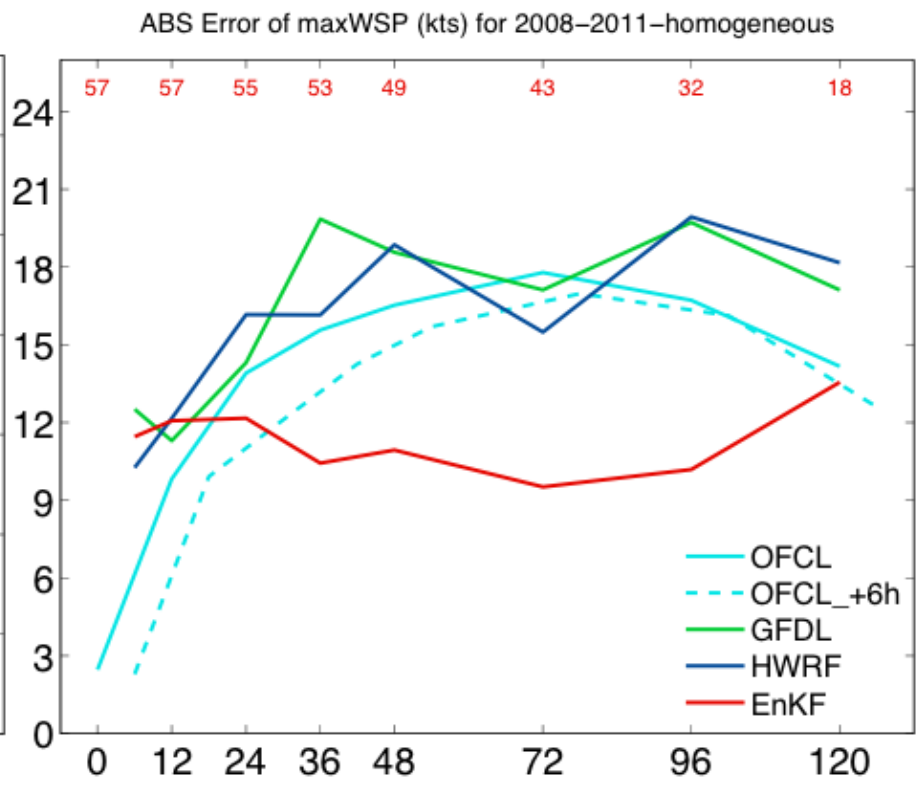




EnKF Performance Assimilating Airborne Radar OBS

Mean Absolute Error and Ensemble Spread for 66 missions during 2008-2011





A4PS: PSU 4.5km single forecast initialized with EnKF analyses