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NOAA/NWS/NCEP/EMC

RECONNAISSANCE DATA ASSIMILATION IN HWRF

Outline

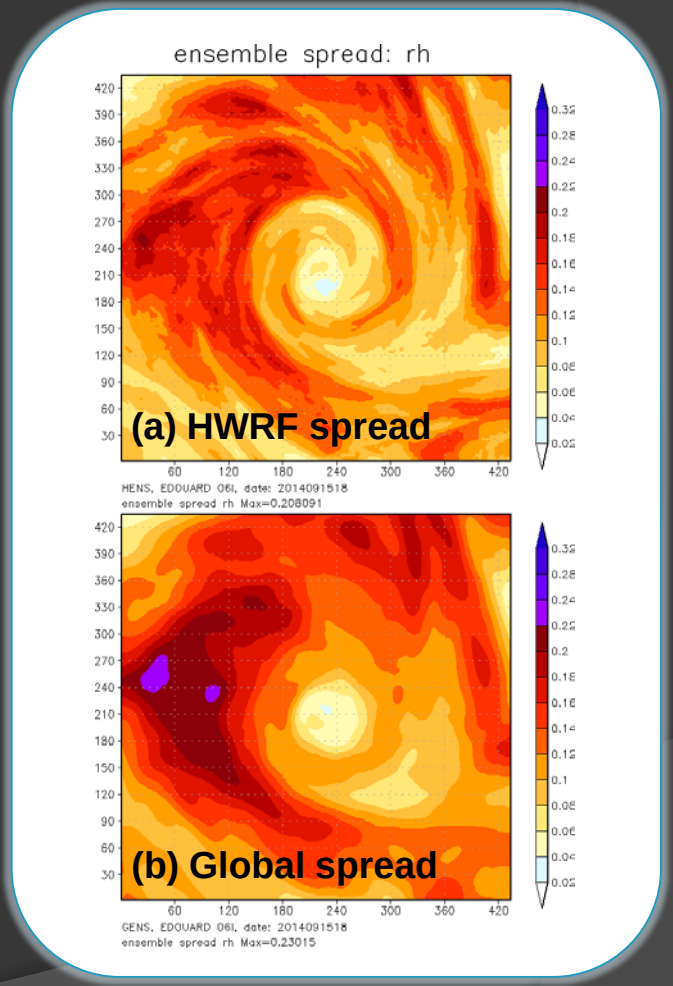
- Current status & Milestones
- Key Results (the good, bad and ugly)
- Path forward: Short-term needs
- Plans for 2016 / Conclusion

2015 HWRF: DA Status

- GSI-based hybrid system assimilates conventional obs, satellite radiances and winds, dropsondes, and TDR
- Flow dependent covariance is supplied by 6-h ensemble, weighted 80%
- Vortex initialization provides inner core size/intensity updates

2015 HWRF: DA Milestones

- Warm-start HWRF ensemble for covariance when TDR is available
- Real-time assimilation of Global Hawk dropsondes
- Assimilation of min SLP from TCVitals
- Important results from our HFIP partners



RH spread: Global vs. HWRF ensembles

Outline

- Current system and upgrades
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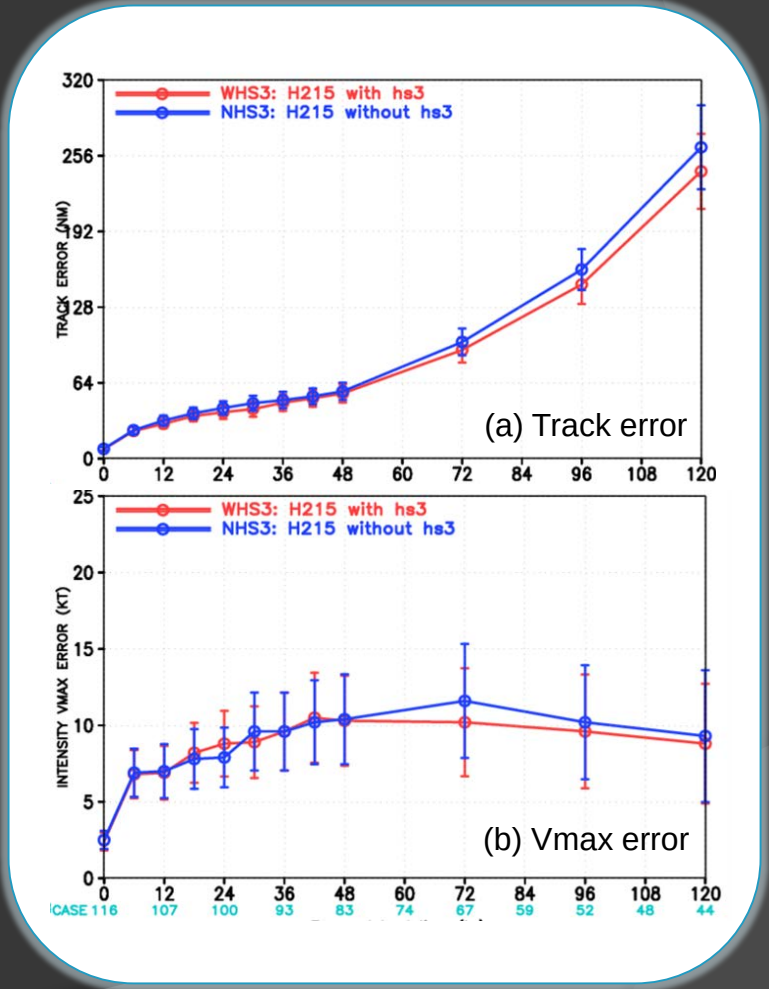
Results: GH dropsonde benefit

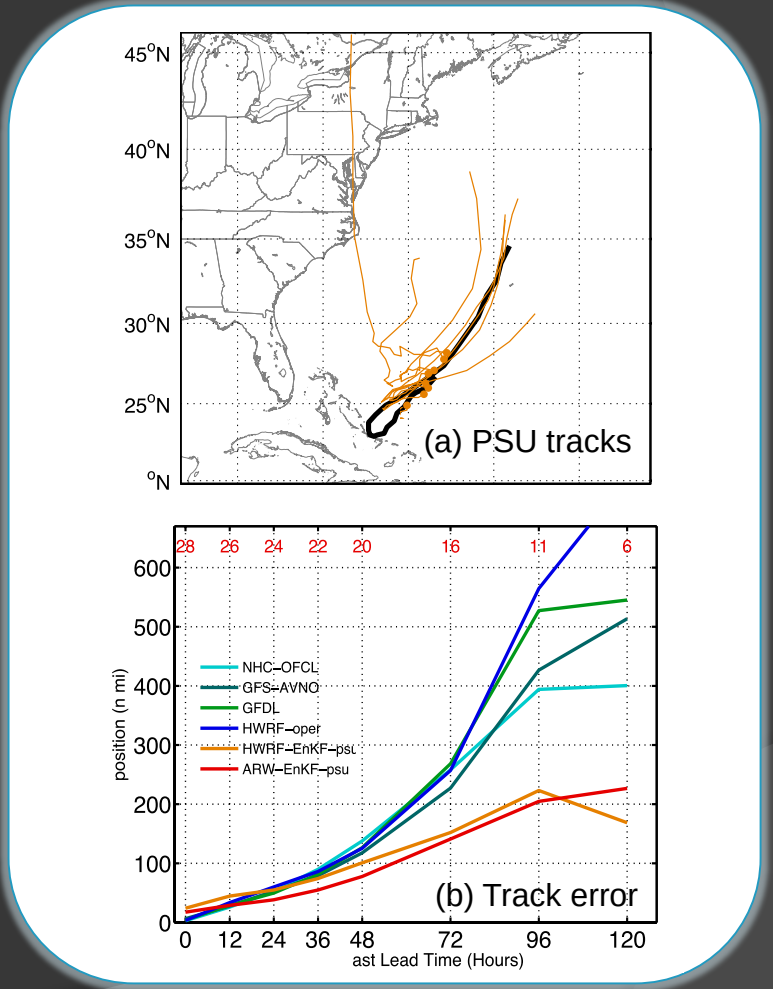
- Assimilating GH dropsondes results in small track improvements
- Intensity improvements are confined to long-term forecast
- Short-term improvements probably limited by sub-optimal DA
- Most benefit when other data is sparse



H215 GH denial experiments

Results: PSU HWRF system

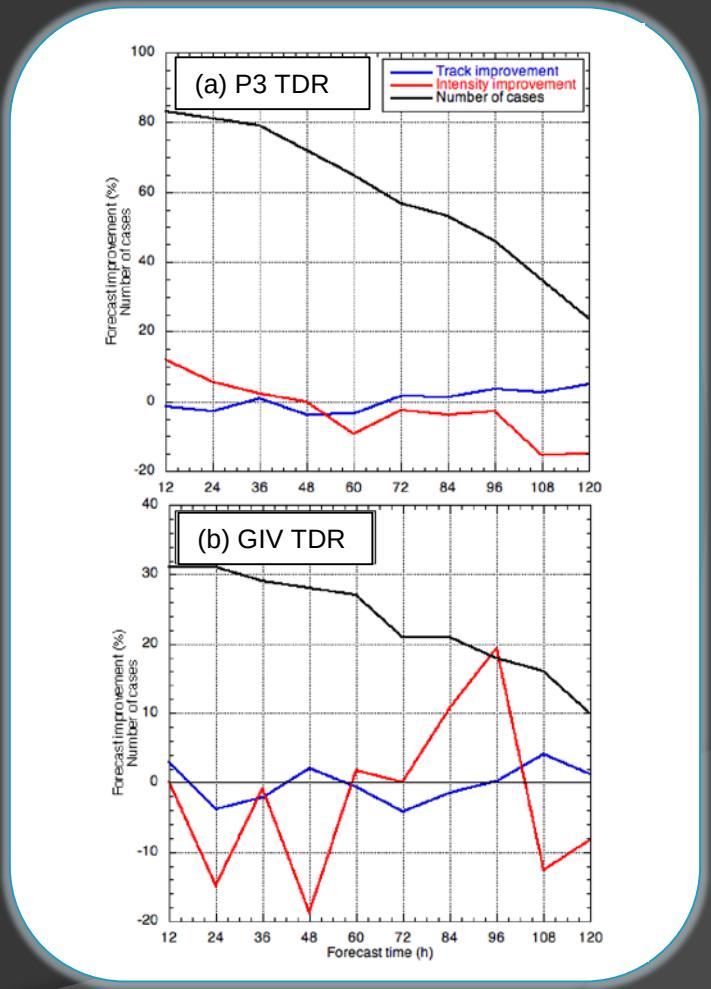
- PSU HWRF-EnKF system functions the same as PSU ARW-EnKF system
- Cycling initialized with GDAS-EnKF 80 members
- After spin-up, assimilates conventional obs + recon every 3 h until end of storm



PSU-HWRF results for Joaquin

Results: HRD HWRF system

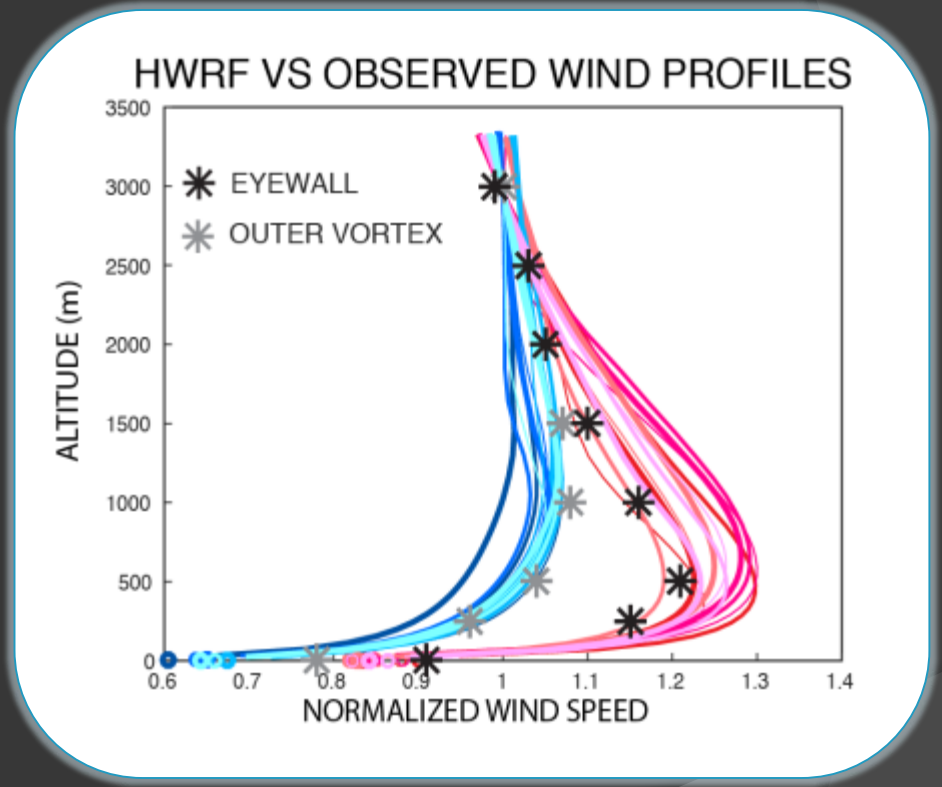
- P-3 RDITT rerun:
  - 12-h intensity forecasts statistically improved (90%) with Doppler data
  - No significant track differences
  - About 1/2 complete
- G-IV Doppler test:
  - No statistically significant differences with Doppler data
  - About 2/3 complete



Improvement/Degradation associated with TDR assimilation

Results: Model error & DA

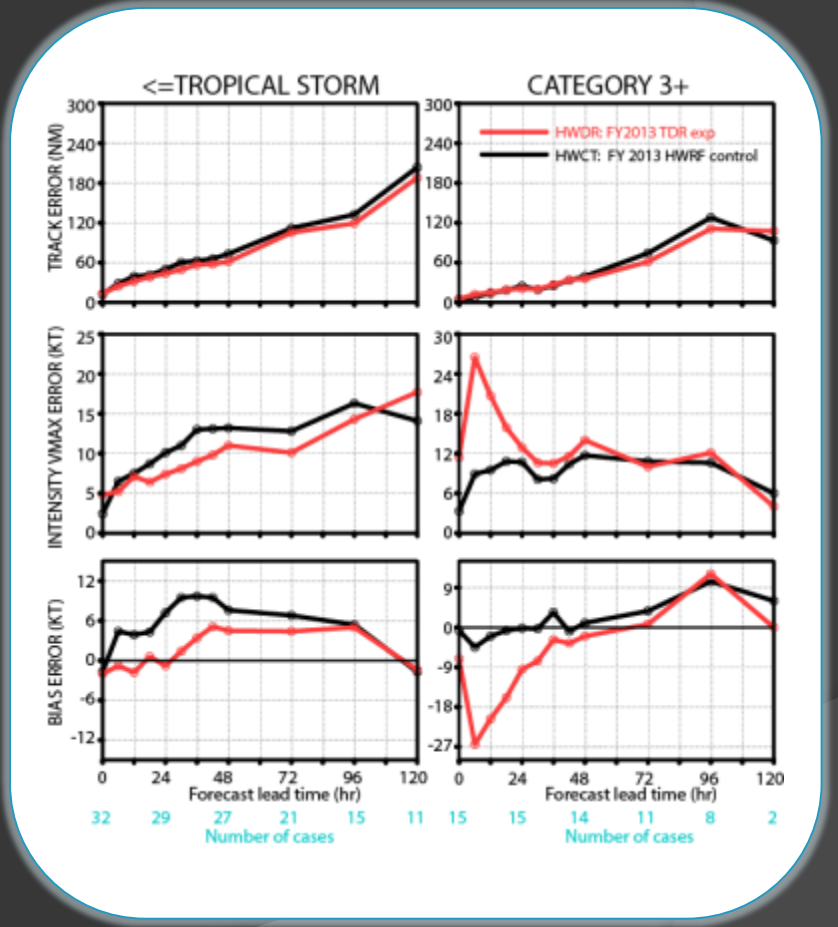
- HWRF produces near-surface winds that are 10-20% too weak compared to the PBL
- Observed surface winds are used to adjust ENTIRE vortex
- To get “good” surface wind forecasts, we have to have vortices that are too strong aloft



Wind profiles in HWRF as compared with observations from Franklin et al (2003)

Results: Model error & DA

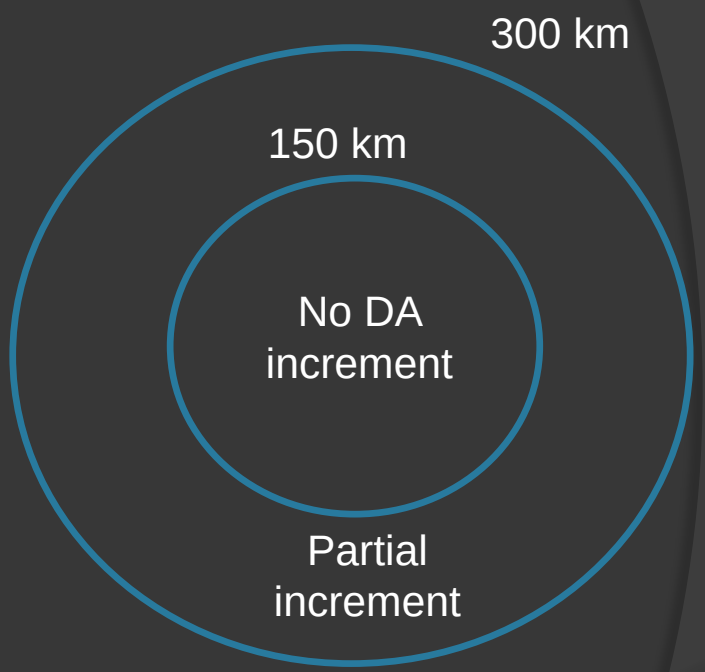
- Model bias + vortex initialization = strong upper-level vortex
- Biases aloft + DA = Negative Vmax bias
- Imbalance and spindown (bias/covariance)
- For now we *don't use* DA increments within 150 km of center below 400 hPa



TDR assimilation: Forecast error for weak vs. strong storms in H213 (Tong et al. 2015)

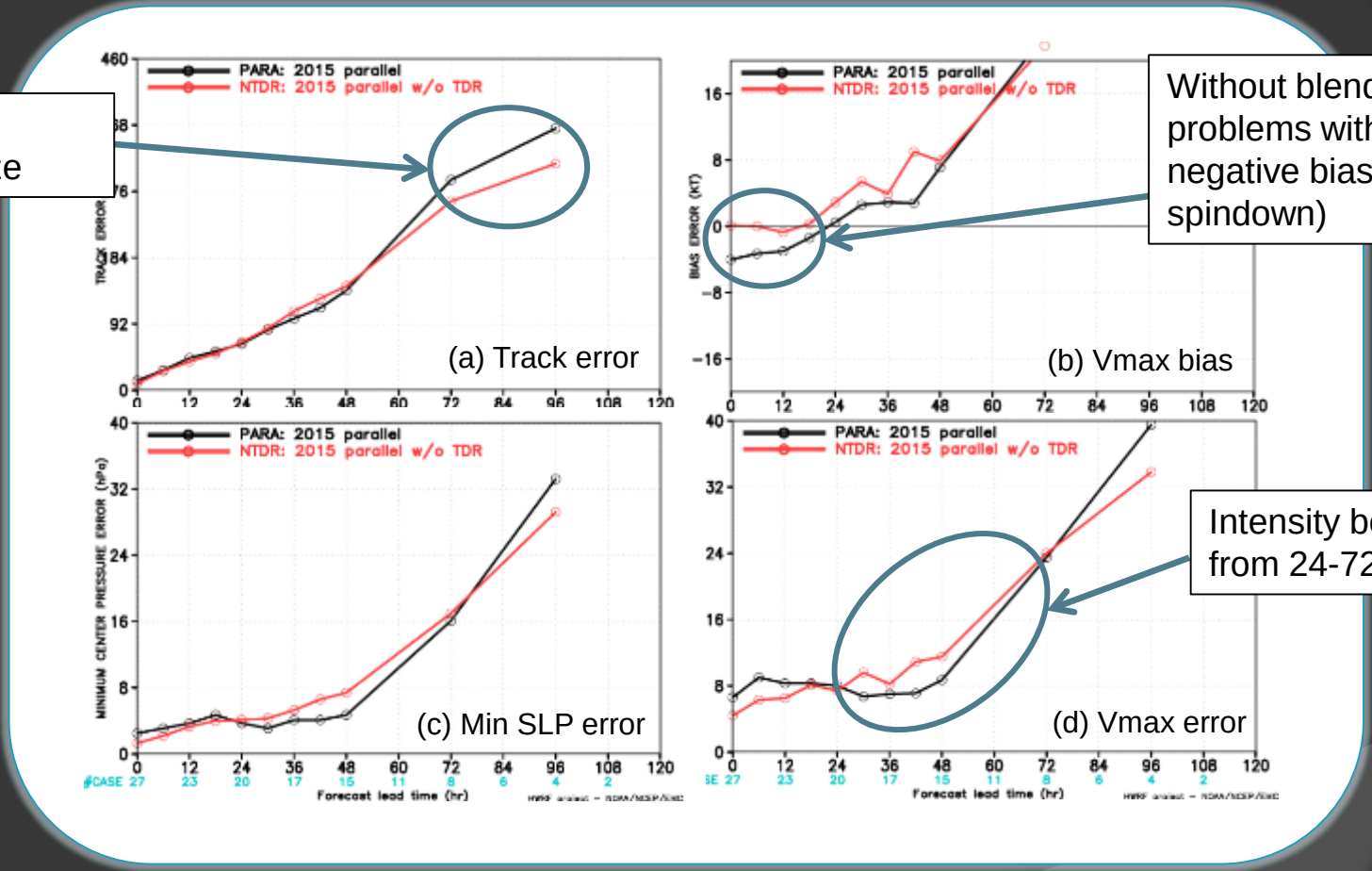
Results: Model error & DA

- Model bias + vortex initialization = strong upper-level vortex
- Biases aloft + DA = Negative Vmax bias
- Imbalance and spindown (bias/covariance)
- For now we don't use DA increments within 150 km of center below 400 hPa



"Blending" initialization

Results: TDR impact (parallel)



Very small sample size

Without blending, problems with initial negative bias (and spindown)

Intensity better from 24-72 h

H215 parallel experiment with no blending used to assess TDR impact

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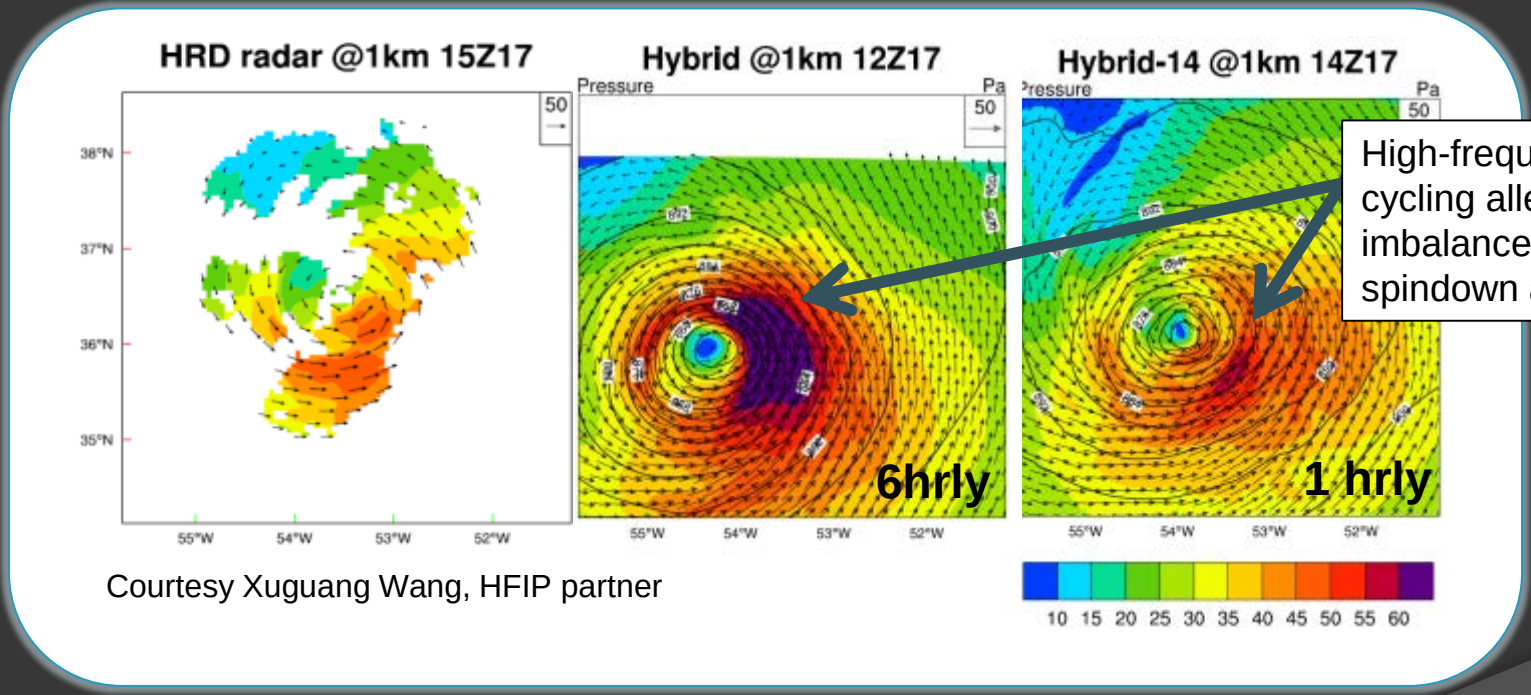
Short-term needs

- Resolve surface-layer issues
- Covariance cycling – Covariance from GDAS (no TDR) or uncycled HWRF covariance (TDR) not good for strong/small storms
- High-frequency cycling - 6-h cycling is WAY too long when the flow is rapidly changing

6-h vs. 1-h cycling in experimental OU HWRF system



Courtesy Xuguang Wang, HFIP partner

A comparison of the HRD TDR analysis with the OU hyrbrid HWRF analysis from Eduoard with 6-h and 1-h cycling.

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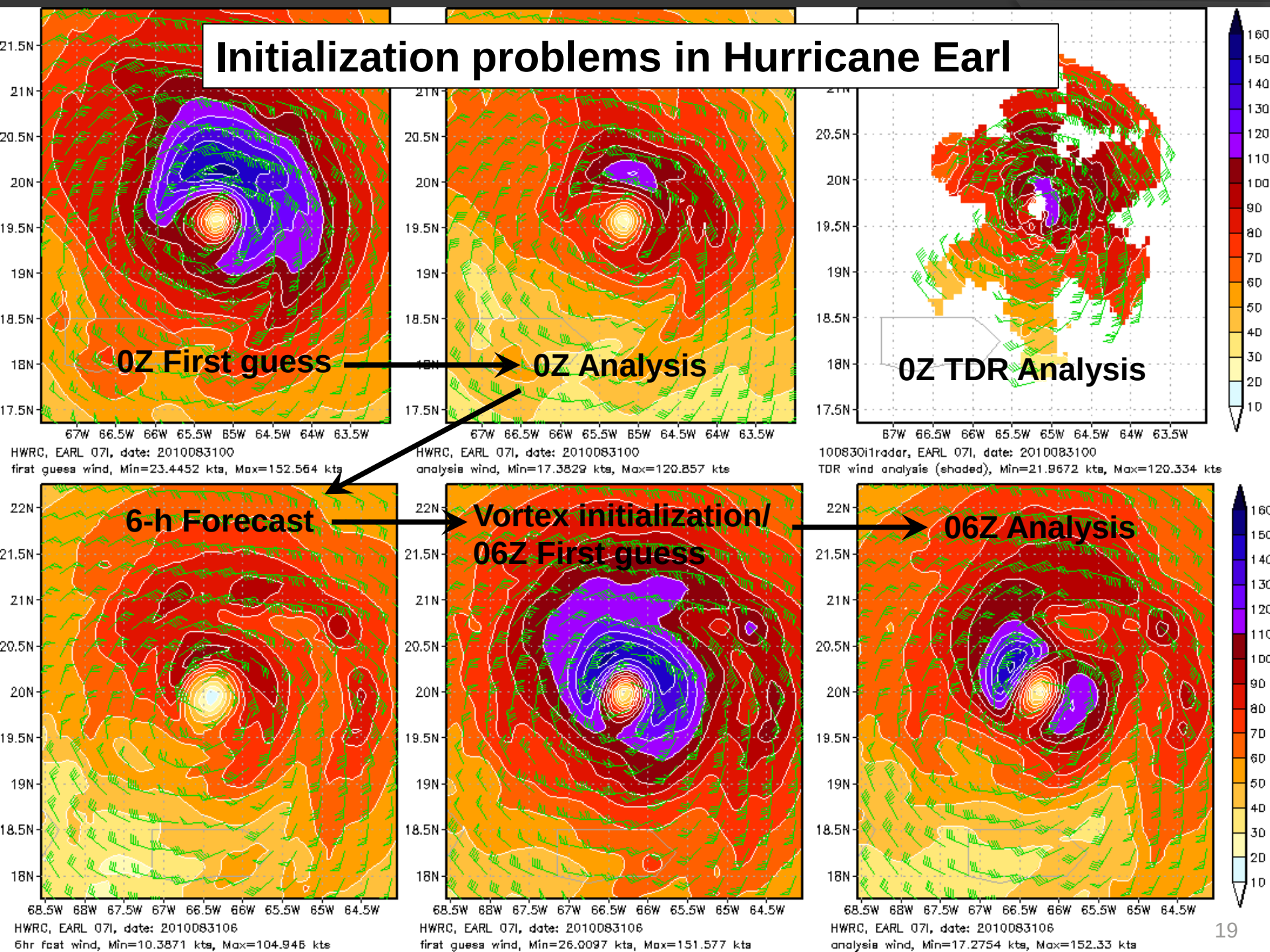
2016 HWRF DA plans

- Likely to be in H216:
  - Relocation of ensemble members
  - Incremental analysis updates (IAU)
- To be tested in parallel:
  - Cycle covariance
  - Configurable cycling interval (?)
  - Assimilate other data types (NOAA49 TDR, GH-based HIWRAP Vr & VWP, HIRAD, synthetic u/v)
- Farther out… 2017?
  - Hybrid 4dVar

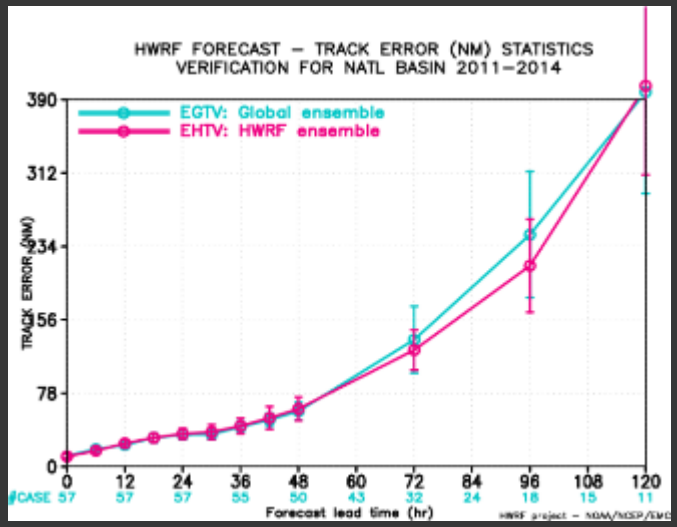
Conclusions

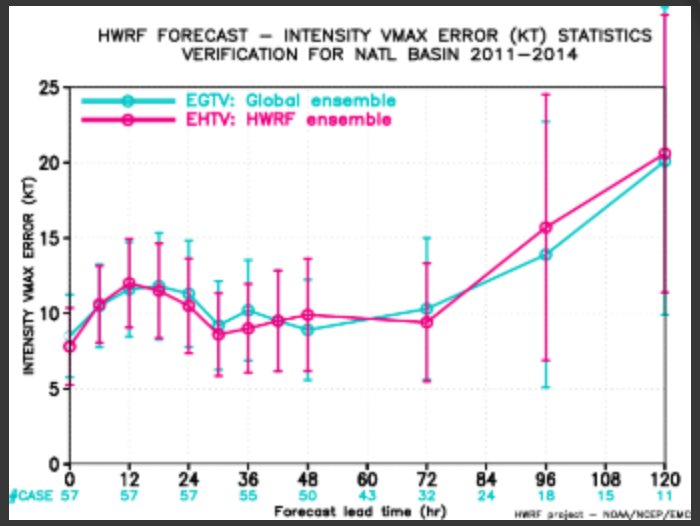
- Recent DA upgrades are taking HWRF in the right direction, but additional DA and model upgrades are needed to take full advantage of currently available data
- Important and encouraging results coming in from HFIP partners
- Major DA advancements upcoming will help us achieve even greater recon impact in the future

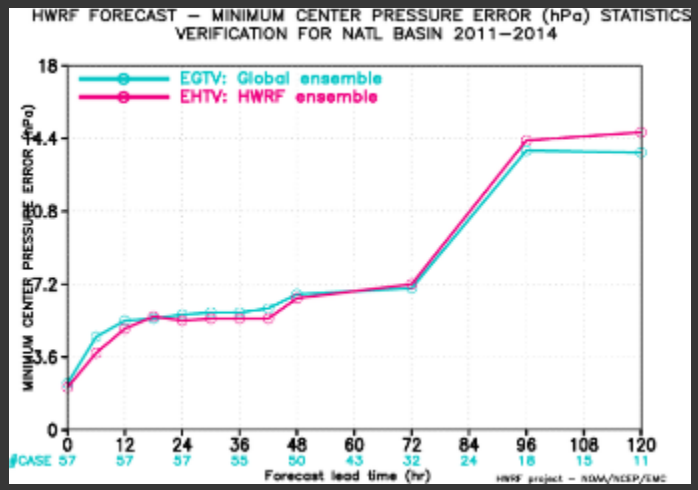
Initialization problems in Hurricane Earl

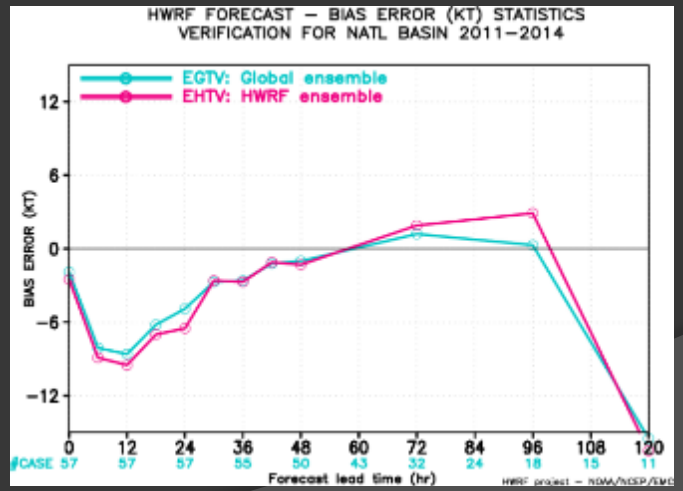


Using HWRF vs global ensemble to estimate B in GSI cycles with TDR data assimilated









Better track forecast, neutral intensity forecast

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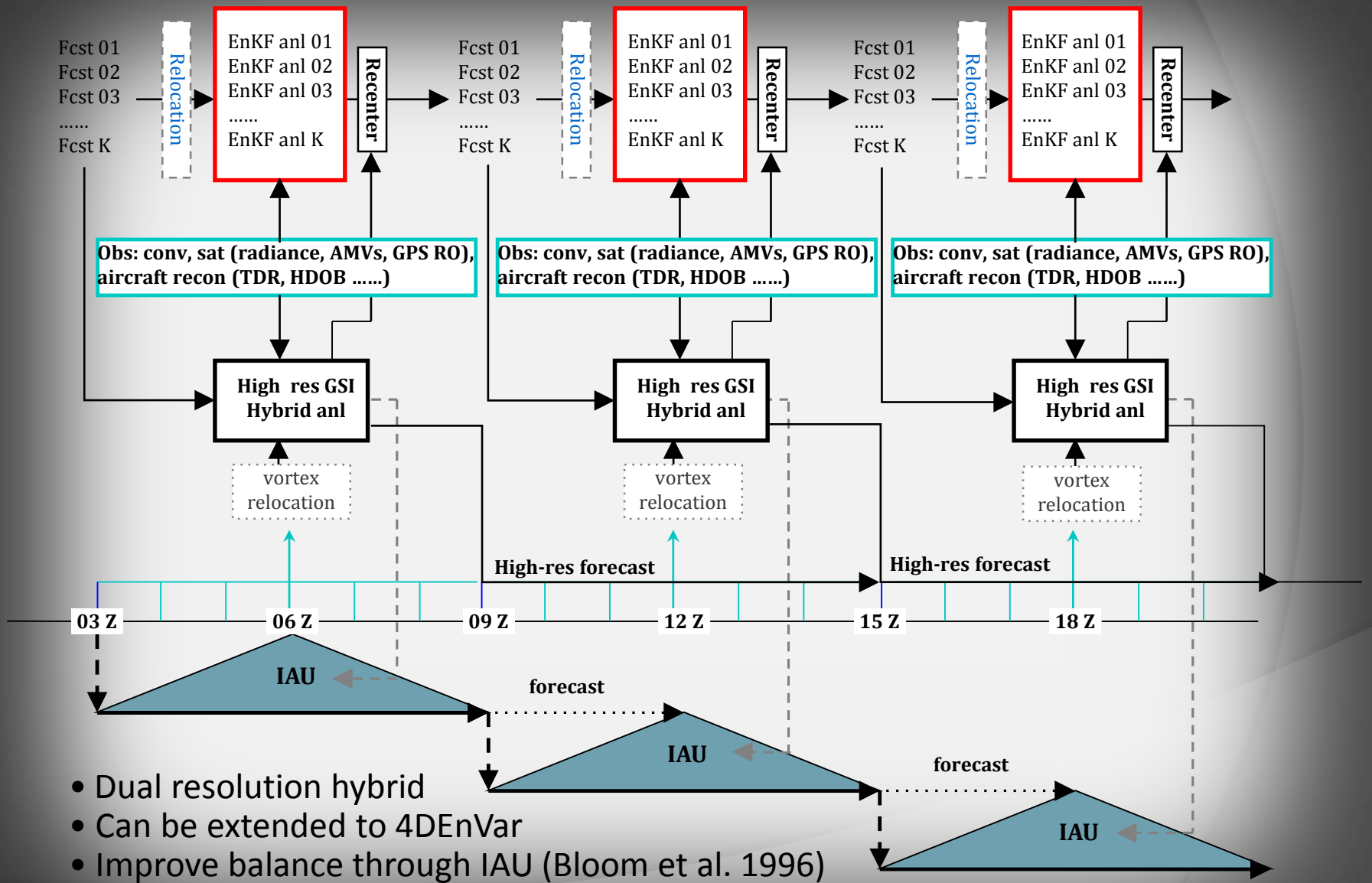
Needed HWRF workflow



- Dual resolution hybrid
- Can be extended to 4DEnVar
- Improve balance through IAU (Bloom et al. 1996)