Performance and Development of the UW-NMS in 2011

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Outline

- Stream 1.5 Configuration
- 2011 Demo Performance
- Stream 2.0 Modifications
- 2011 Stream 2.0 Performance
- Future Work

Stream 1.5 Configuration

- g1: 205x150 @ 40km spacing
- g2: 92x92 @ 8km spacing (storm-following)
- Kuo cumulus parameterization (g1 and g2)
- 1-moment bulk micro (rain, snow), 2-moment bulk micro (pristine crystals)
- RRTM LW and SW radiation
- NOAH LSM (CZIL=0.1, default)
- 1.5-layer ocean w/ bulk Richardson turbulence closure (à la Price, 1981).
- 1.5-order TKE closure w/ TKE production derived from filtered kinetic energy loss
- Kwon and Cheong (2010) bogus vortex initialization (only for TC intensity >= 34kt)*
- Andreas et al. (2008) sea-spray parameterization*

* more on these later

Datasets

- Deterministic GFS analysis (IC) and forecasts (BC)
- FNMOC GHRSST 9-km SST analysis
- Levitus 1° climatology (1982) for subsurface ocean thermal structure
- TCVITALS (lat, lon, vmax, rmv, r34 input to bogus generation routine)
- No data assimilation

Kwon and Cheong (2010)

- Alternative to GFDL bogus (timeliness issues) and simple, Rankine-vortex methods
- Created on UW-NMS grid at arbitrary resolution
- Spin-up less problematic than with GFDL vortices used previously (though not optimal by any means).
- Key difference b/w our implementation and KC's: use of Kurihara rather than spectral filter for background vortex removal.

KC Algorithm Briefly

1) Interpolate GFS fields to NMS grid(s)
2) Identify and remove background vortex
3) From TCVITALS inputs, compute A and B parameters and construct radial SLP profile using Holland (1980).
4) From SLP, compute ΔZ, Δv_T and ΔT (hydrostatic and gradient balances assumed).
5) Compute Δv_R in inflow layer from empirical formula, Δv_R in outflow layer by equating mass fluxes in the two layers.
6) Merge bogus with background, modify moisture in core region toward saturation.

Andreas et al. (2008)

The total surface flux is defined as the sum of the interfacial flux, F_{lo} (i.e. COARE 2.6), and the spray-modulated flux, F_{hi} (interfacial + spray):

$$F = (1 - f)F_{lo} + fF_{hi}. \quad \text{(B.2)}$$

where the weight f is a function of the 10-m wind speed:

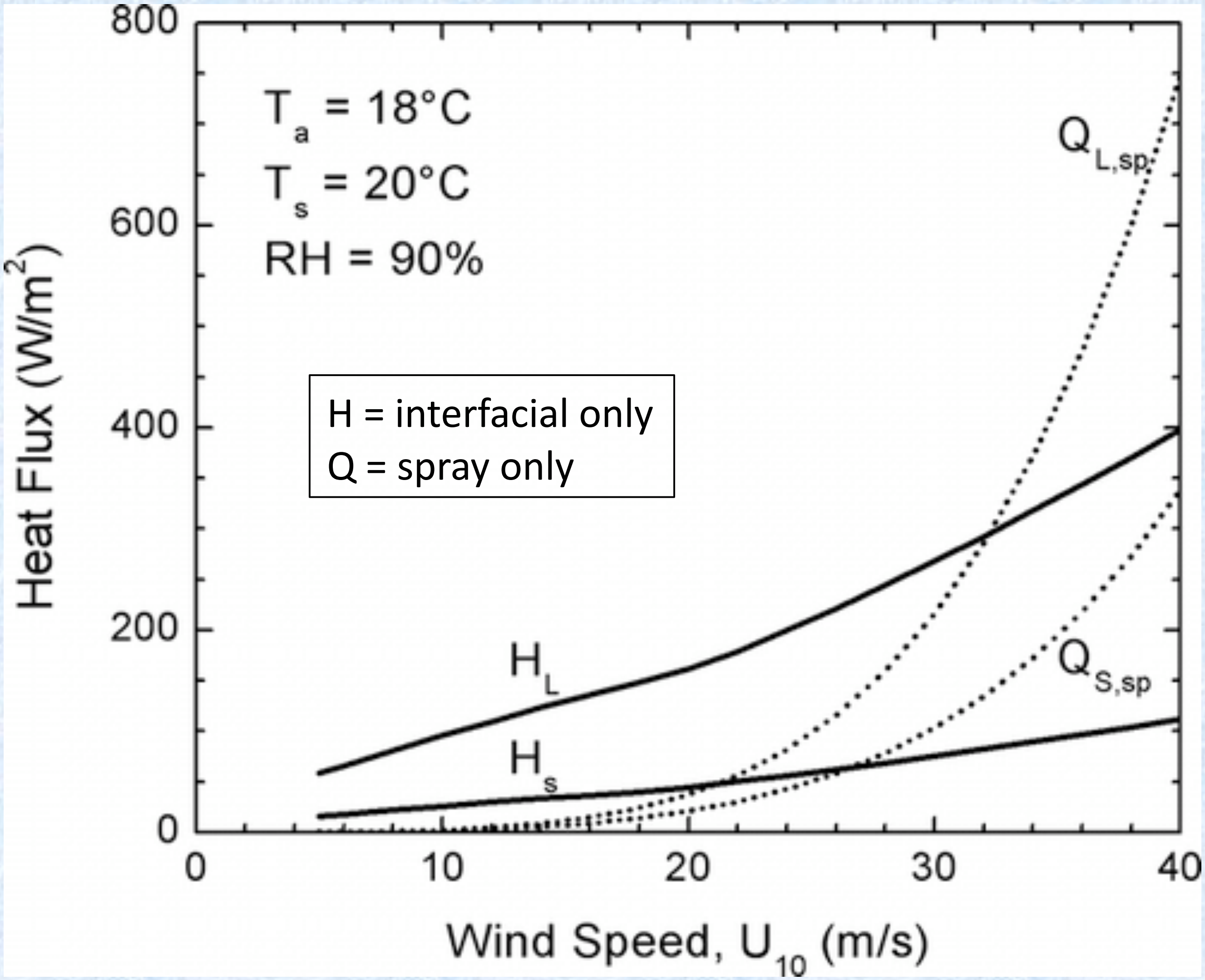
$$f = 0 \quad \text{for} \quad 0 \le U_{10} \le 8\ \mathrm{m\ s^{-1}}, \quad \text{(B.1a)}$$

$$f = (U_{10} - 8)/4 \quad \text{for} \quad 8 < U_{10} < 12\ \mathrm{m\ s^{-1}}, \quad \text{and} \quad \text{(B.1b)}$$

$$f = 1 \quad \text{for} \quad 12\ \mathrm{m\ s^{-1}} \le U_{10}. \quad \text{(B.1c)}$$

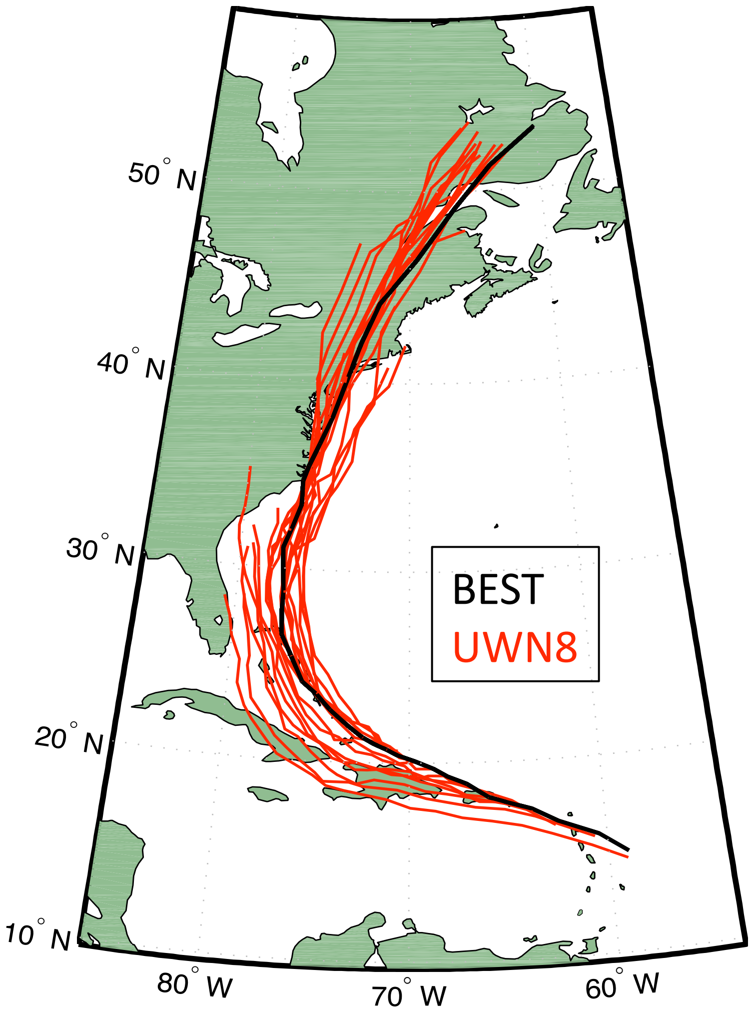
Upshot: no spray effect below about 15kt, spray fully included above 25kt.

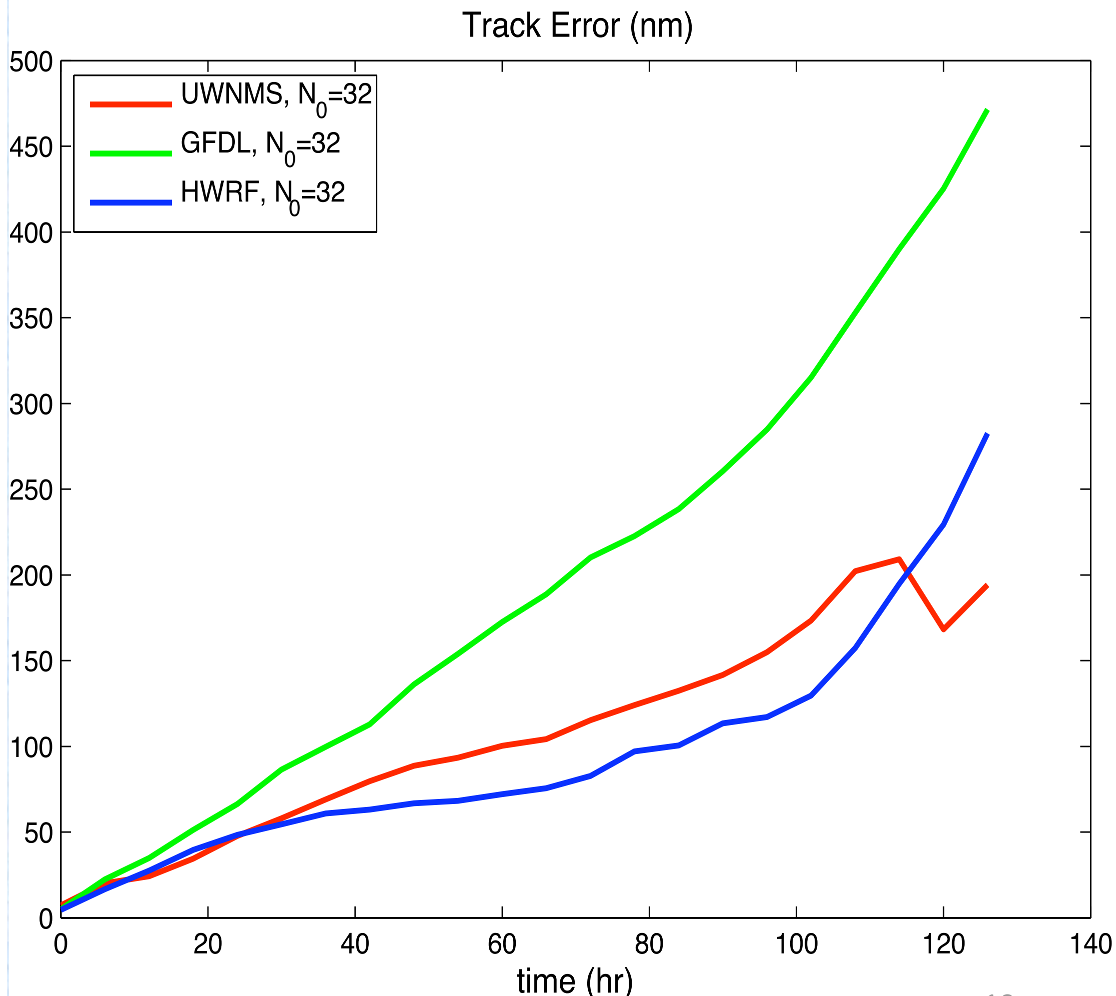
Andreas et al. (2008)



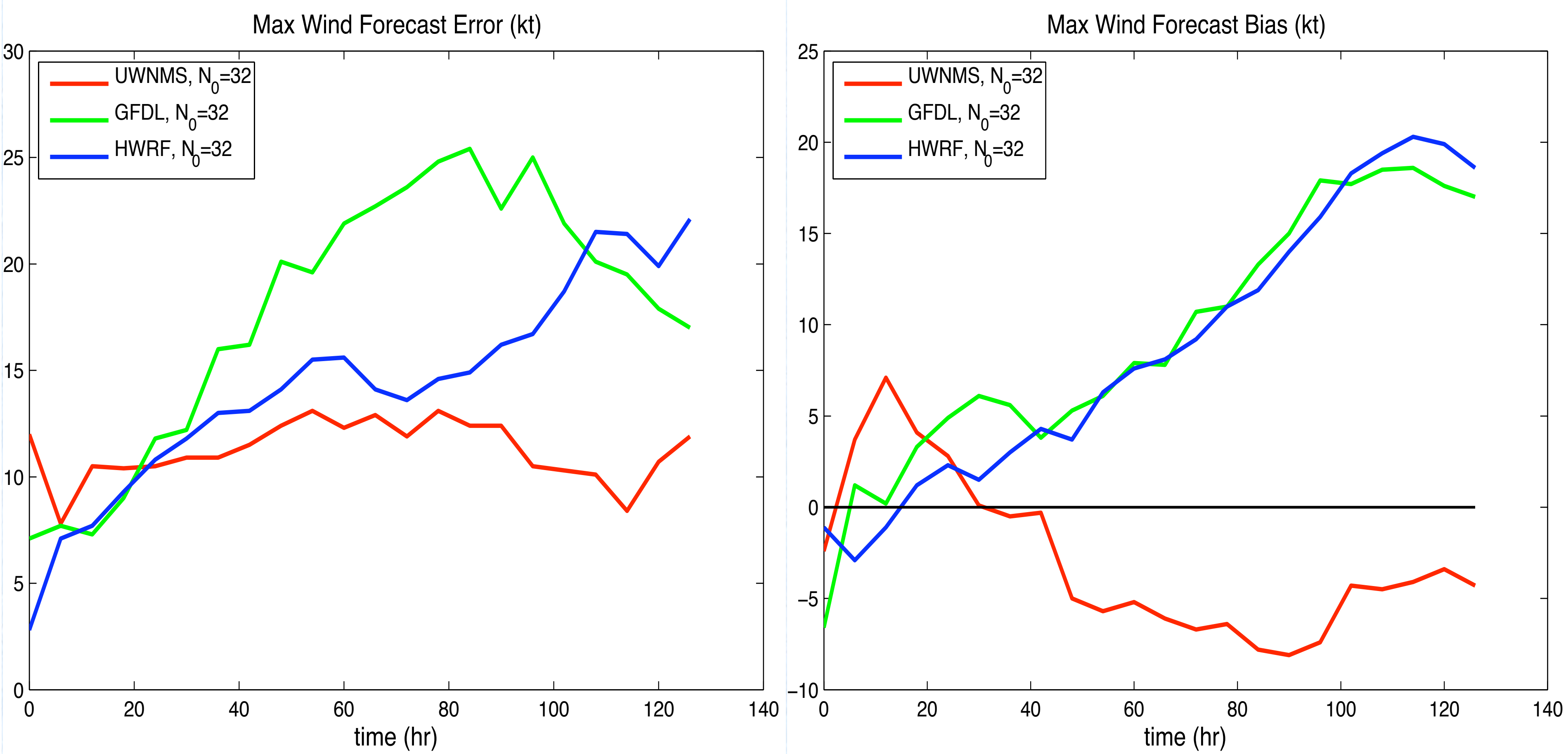
2011 Demo Performance

Hurricane Irene (09L)

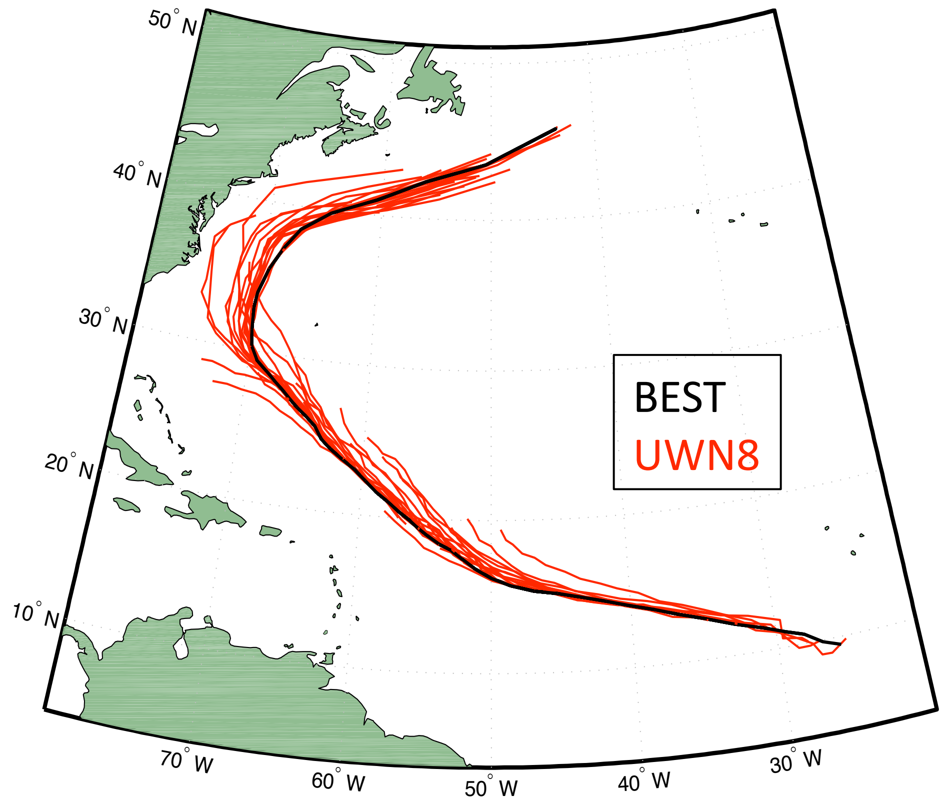


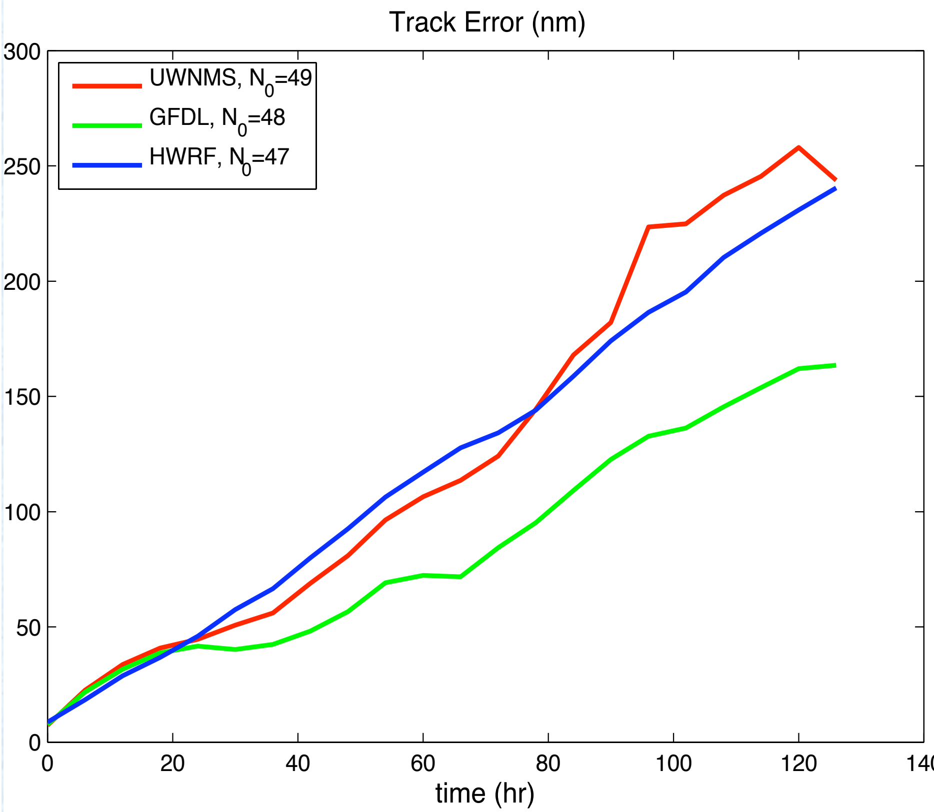


Hurricane Irene (09L)



Hurricane Katia (12L)





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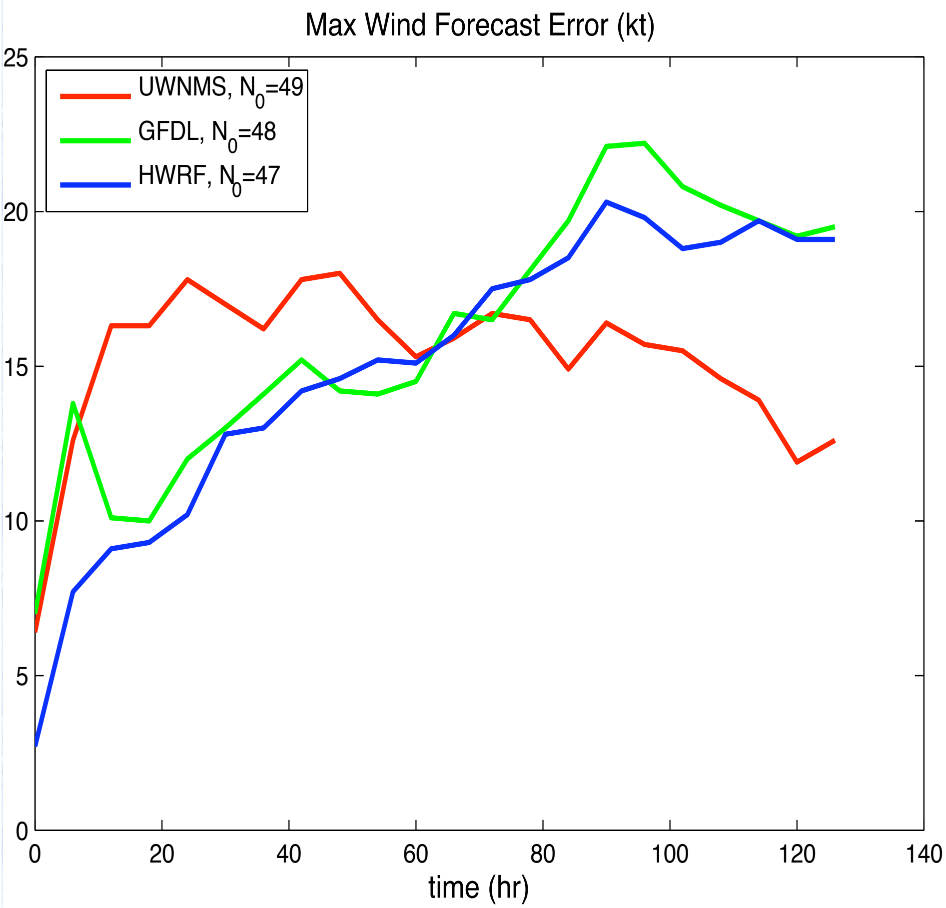
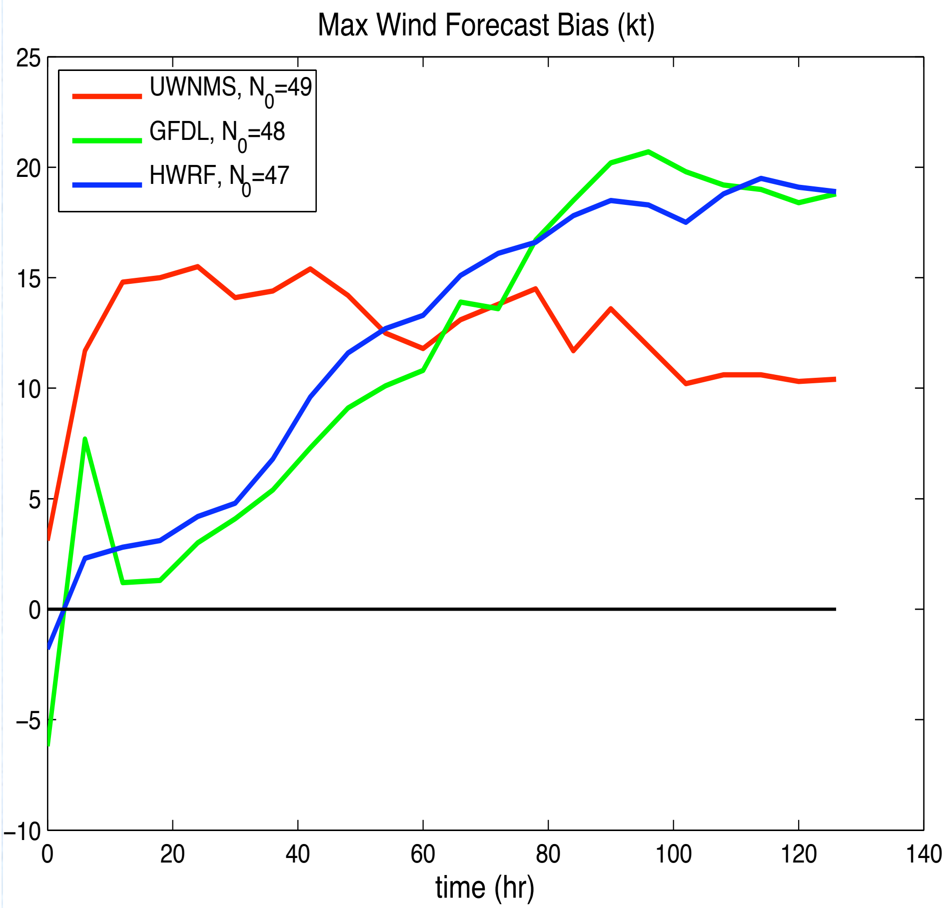
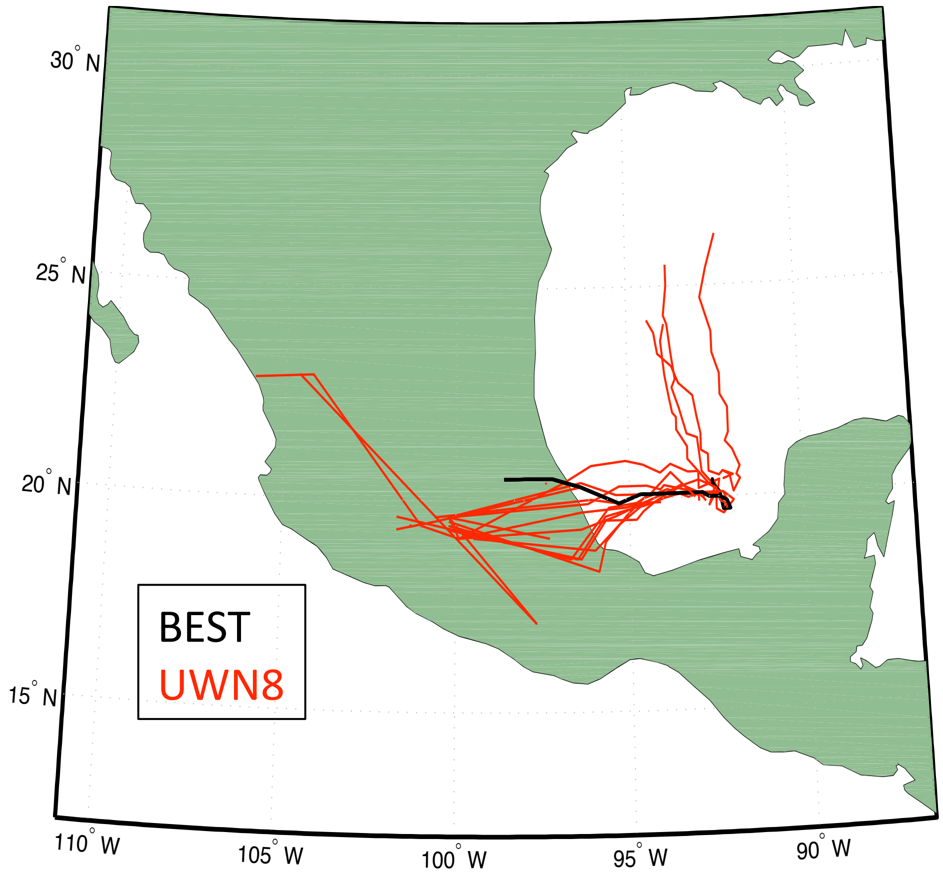
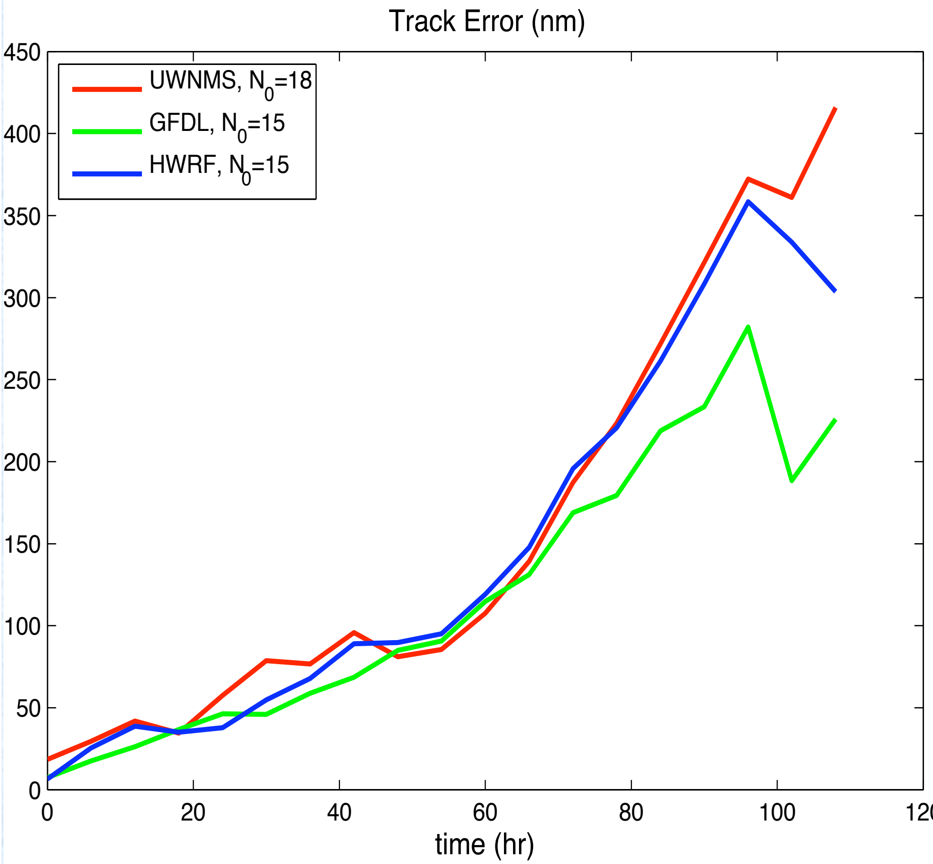




Tropical Storm Nate (15L)





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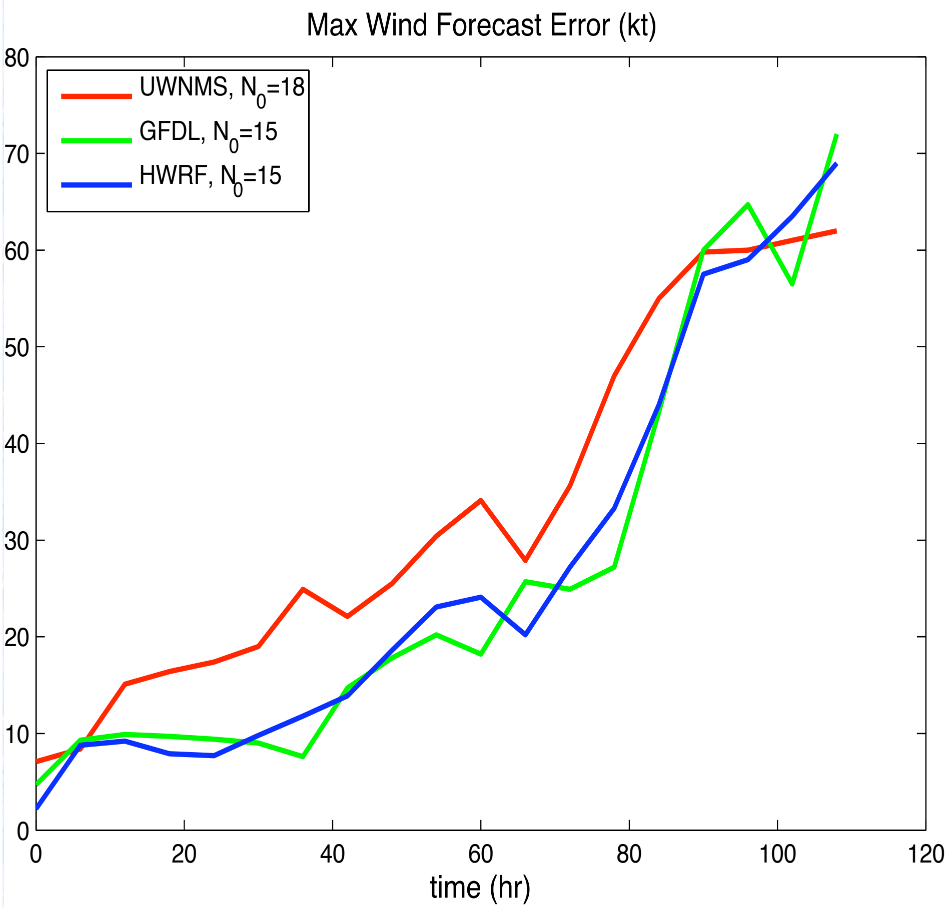
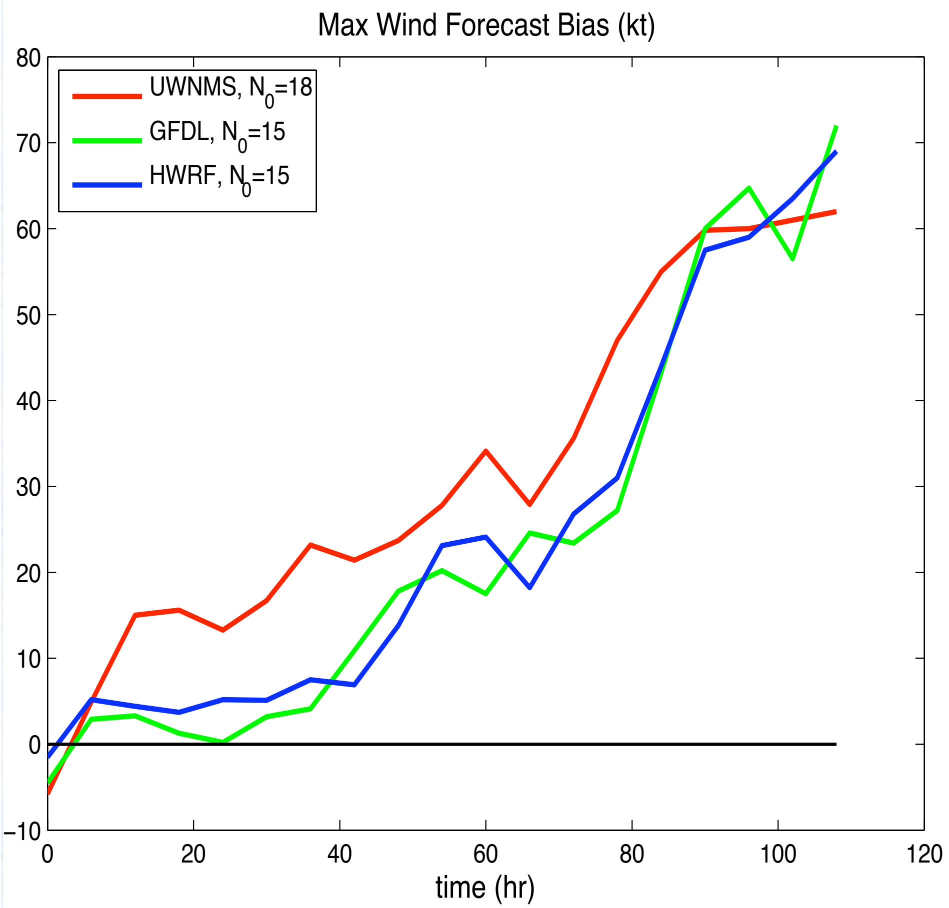
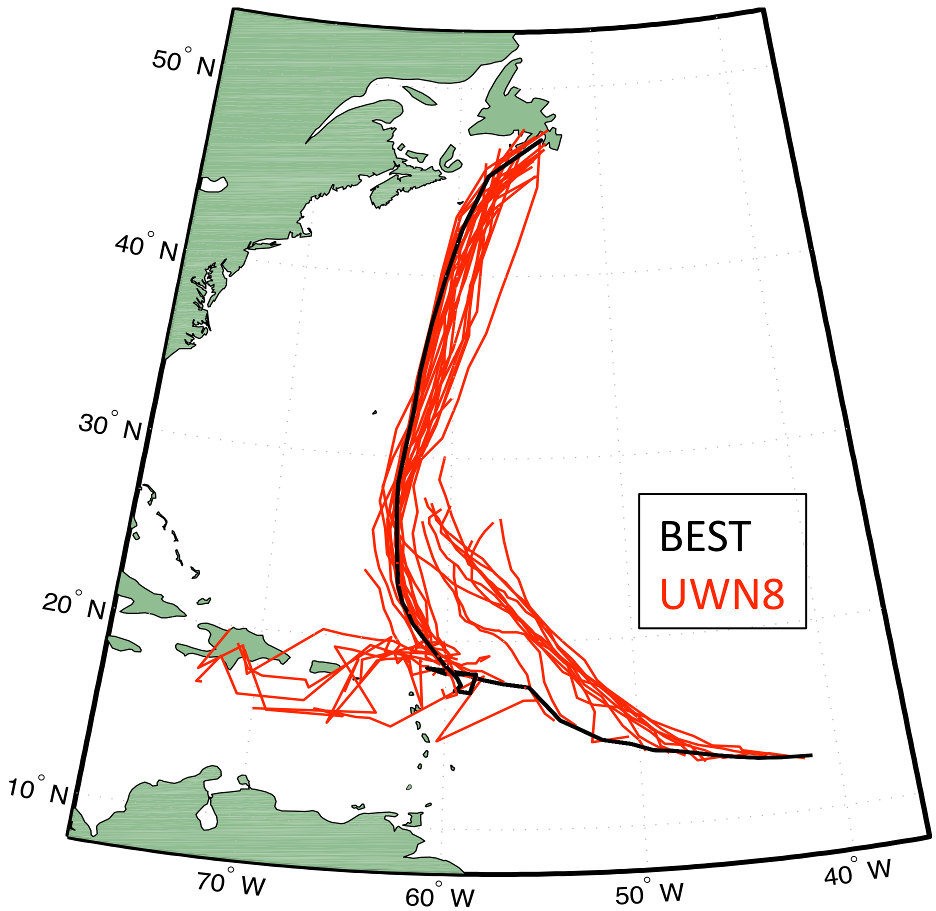
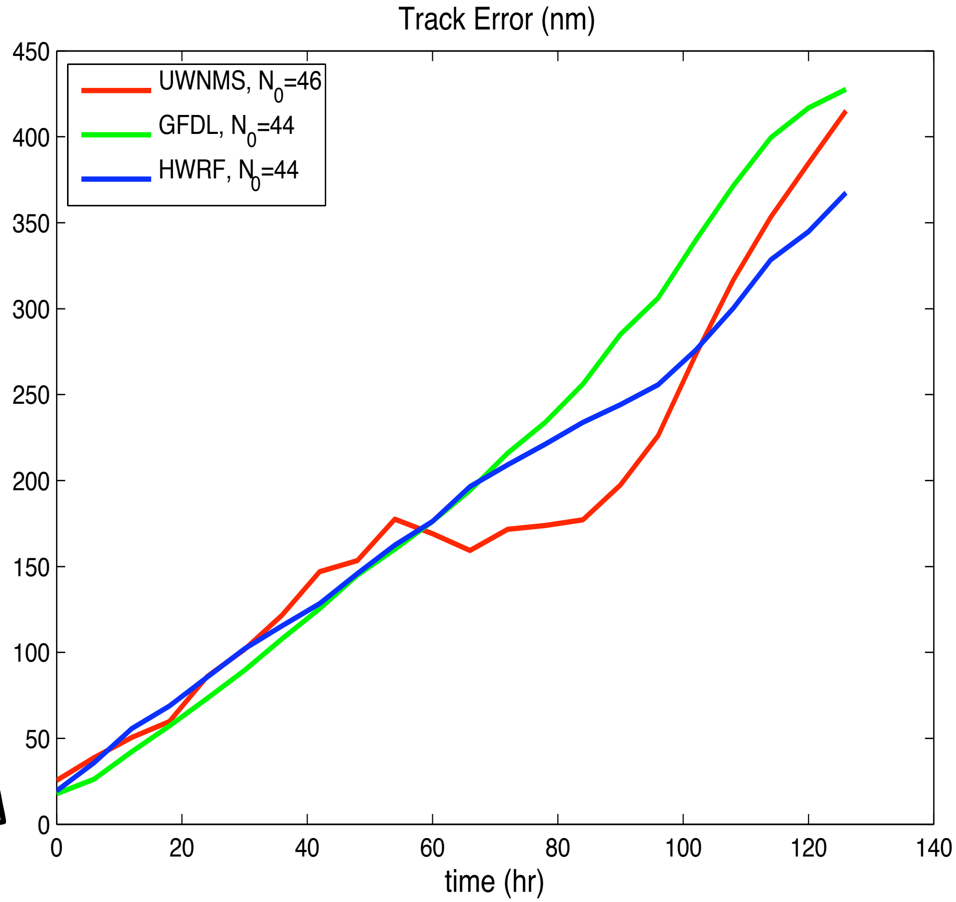




Tropical Storm Ophelia (16L)





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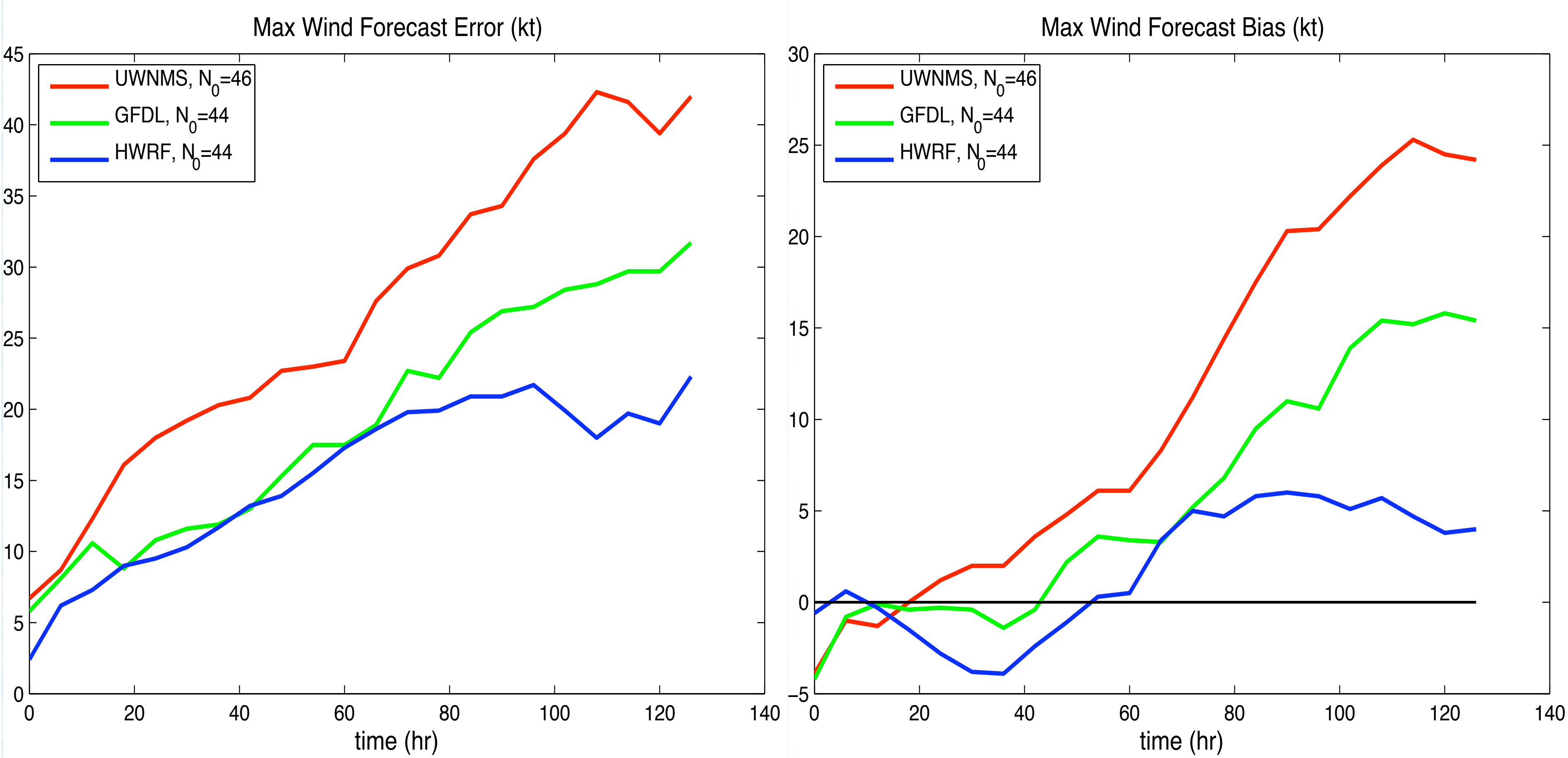
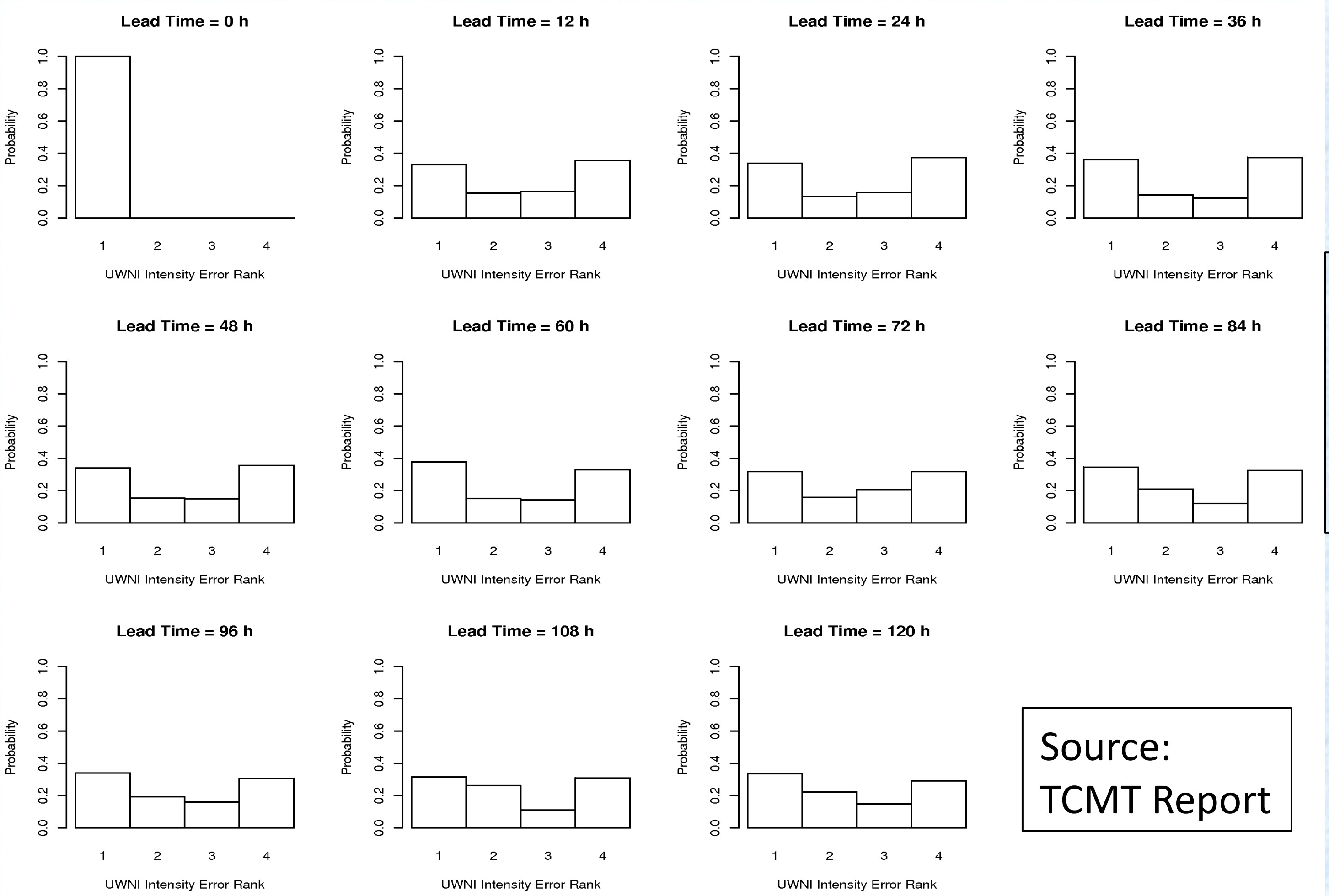


Retro Test Recap

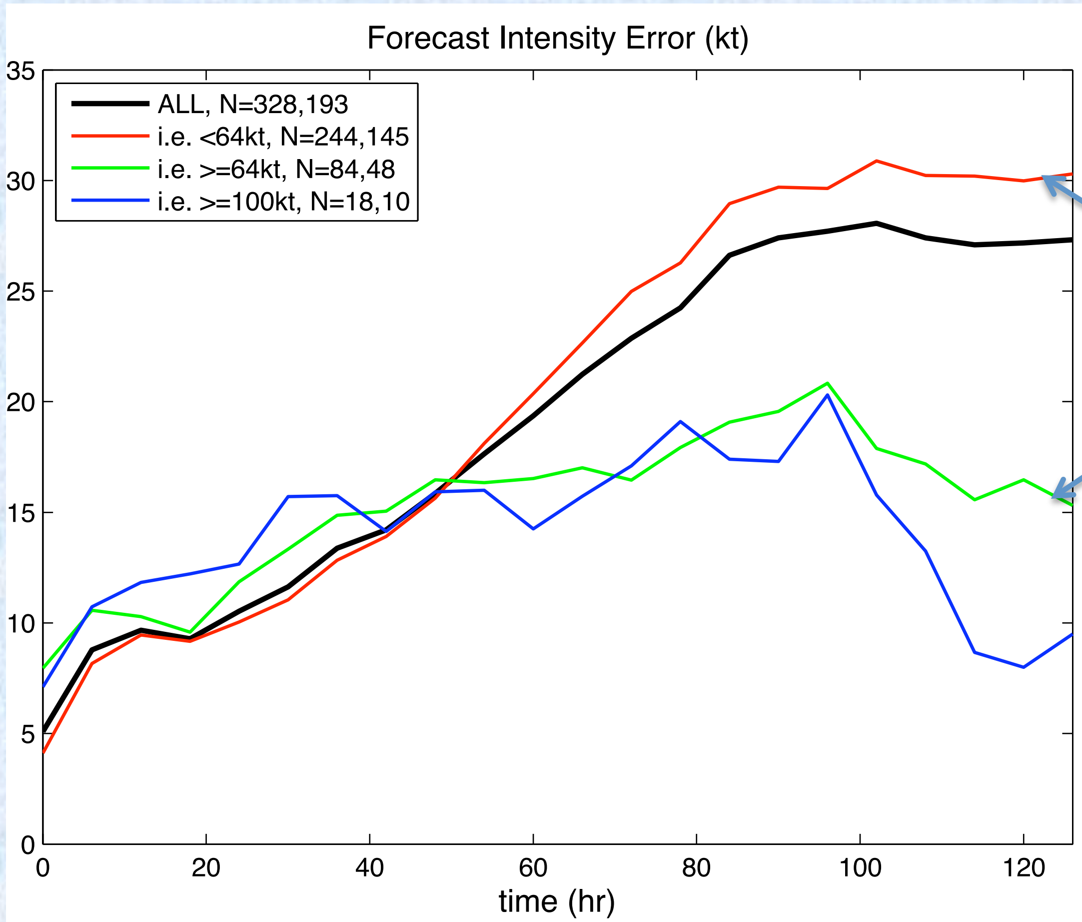


Source:
TCMT Report

UWNI tended to perform either best or worst vs. top flight models at all lead times.

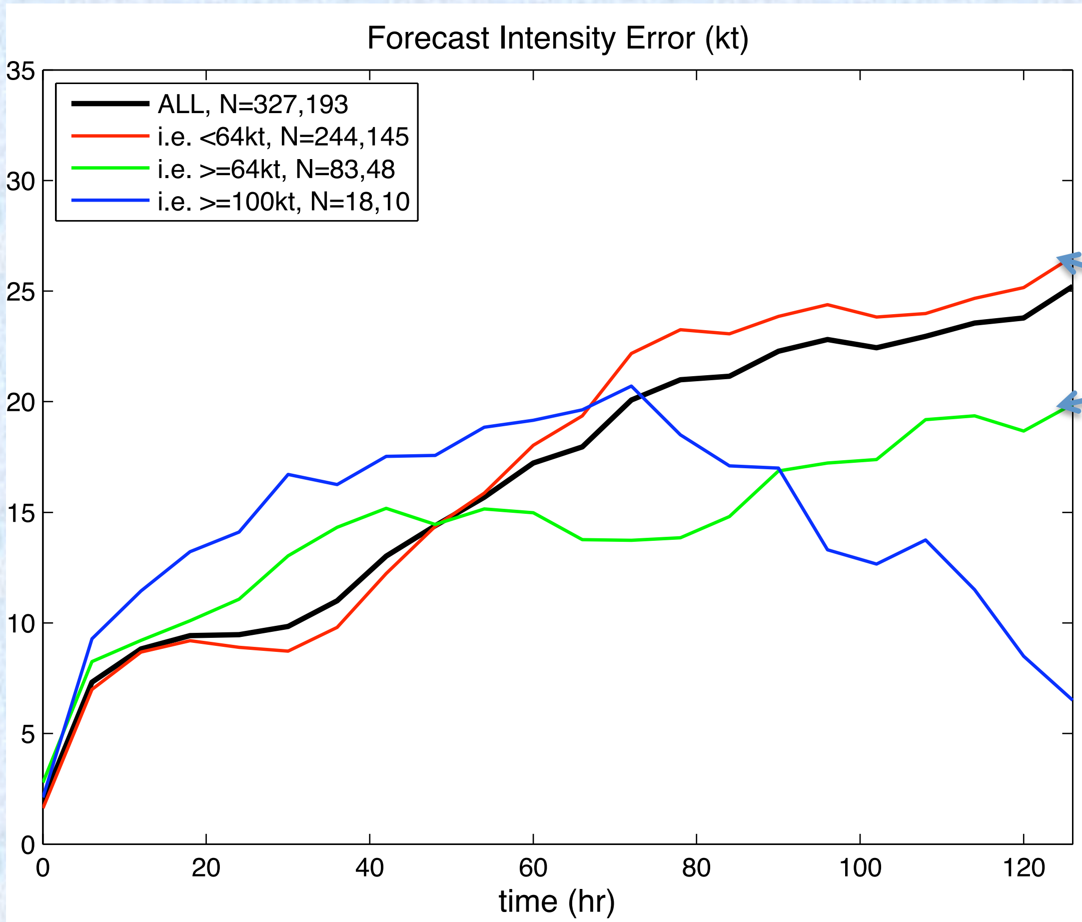
WHY????

GFDL YTD (thru Philippe)



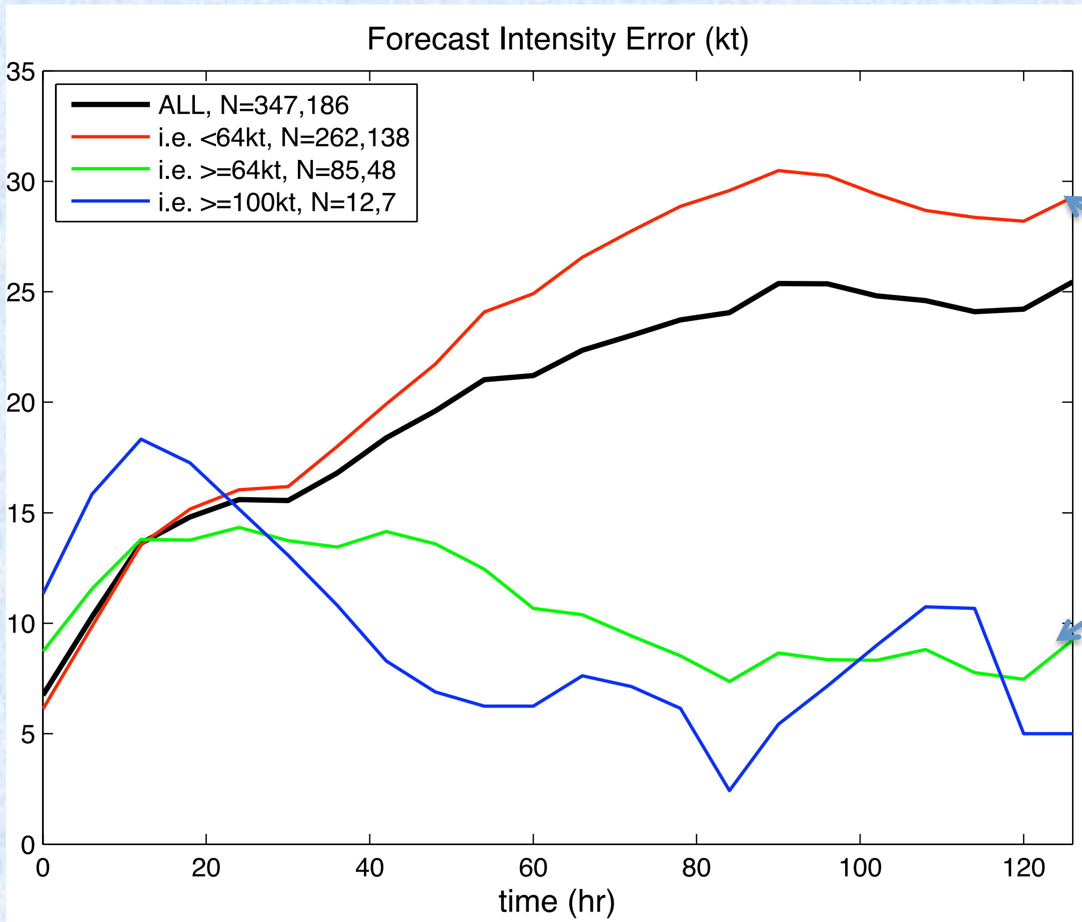
Large separation in performance after 48 hrs

HWRF YTD (thru Philippe)



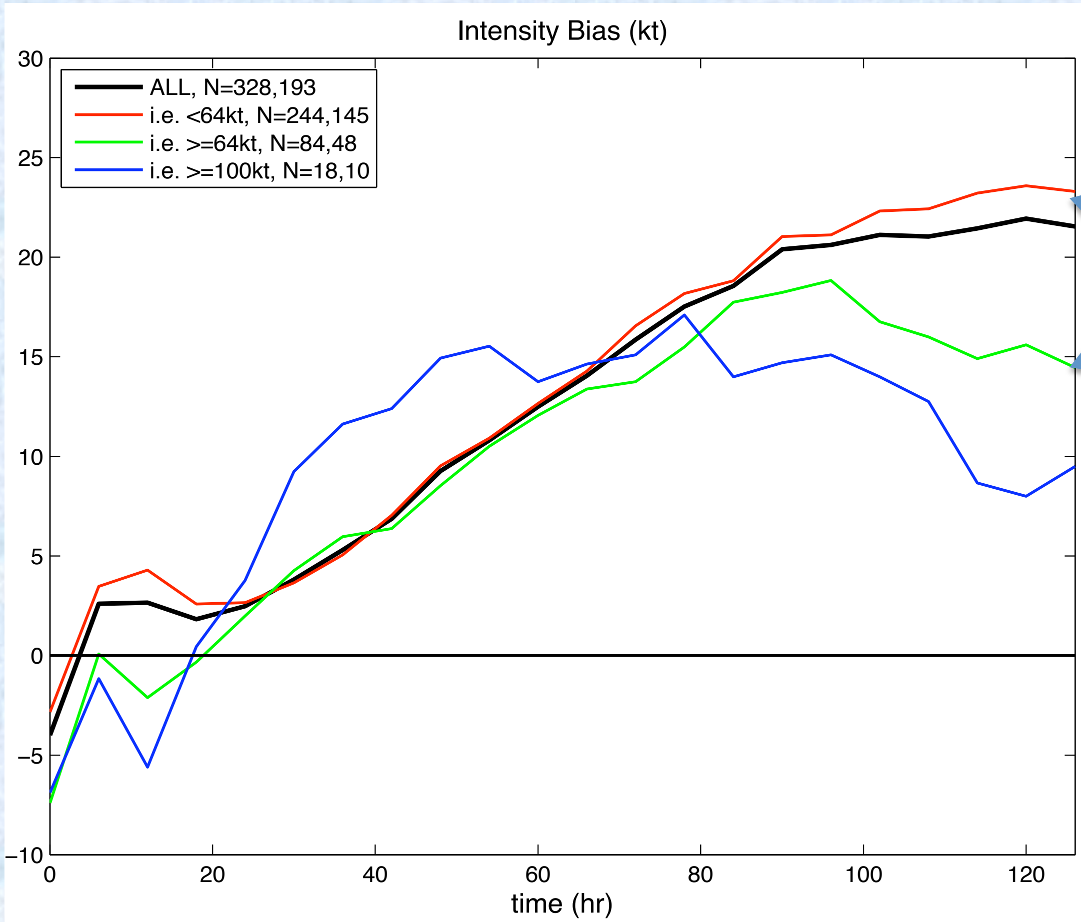
Little separation in performance throughout

UWN8 YTD (thru Philippe)



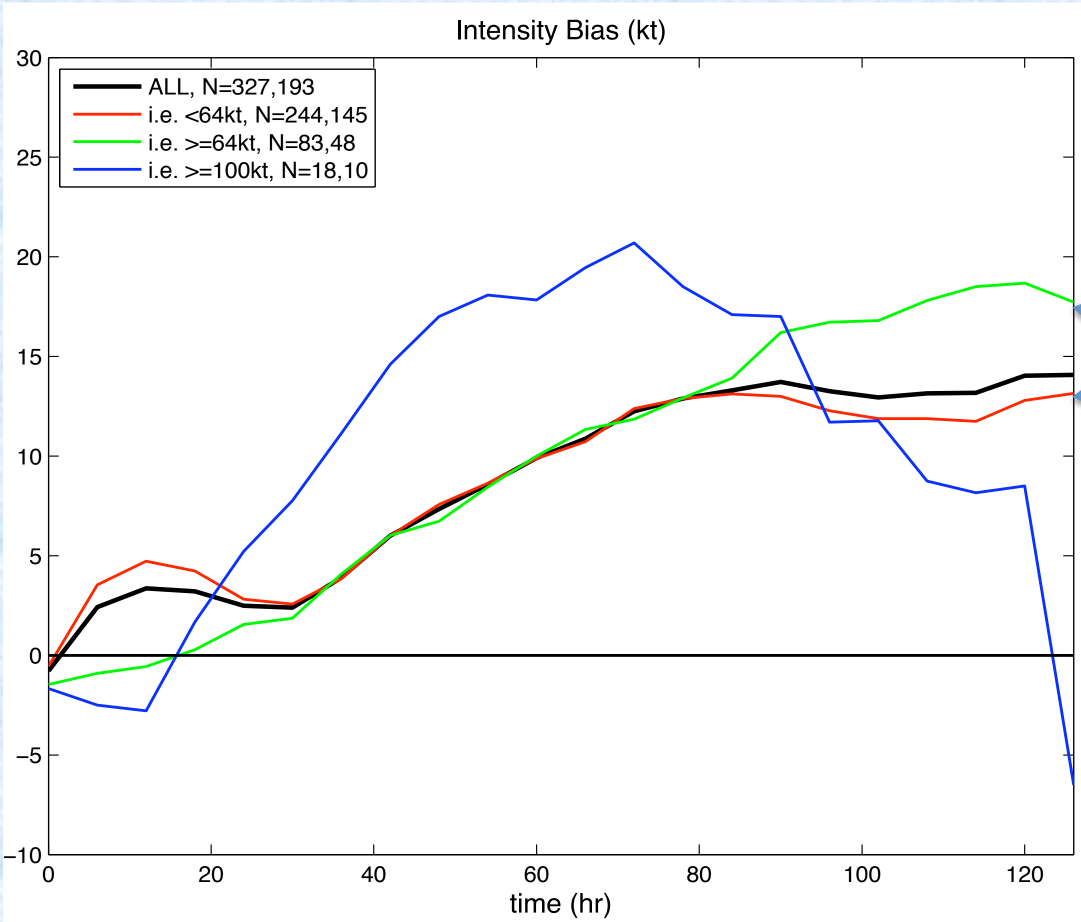
Very large separation in performance after 12 hrs

GFDL YTD (thru Philippe)



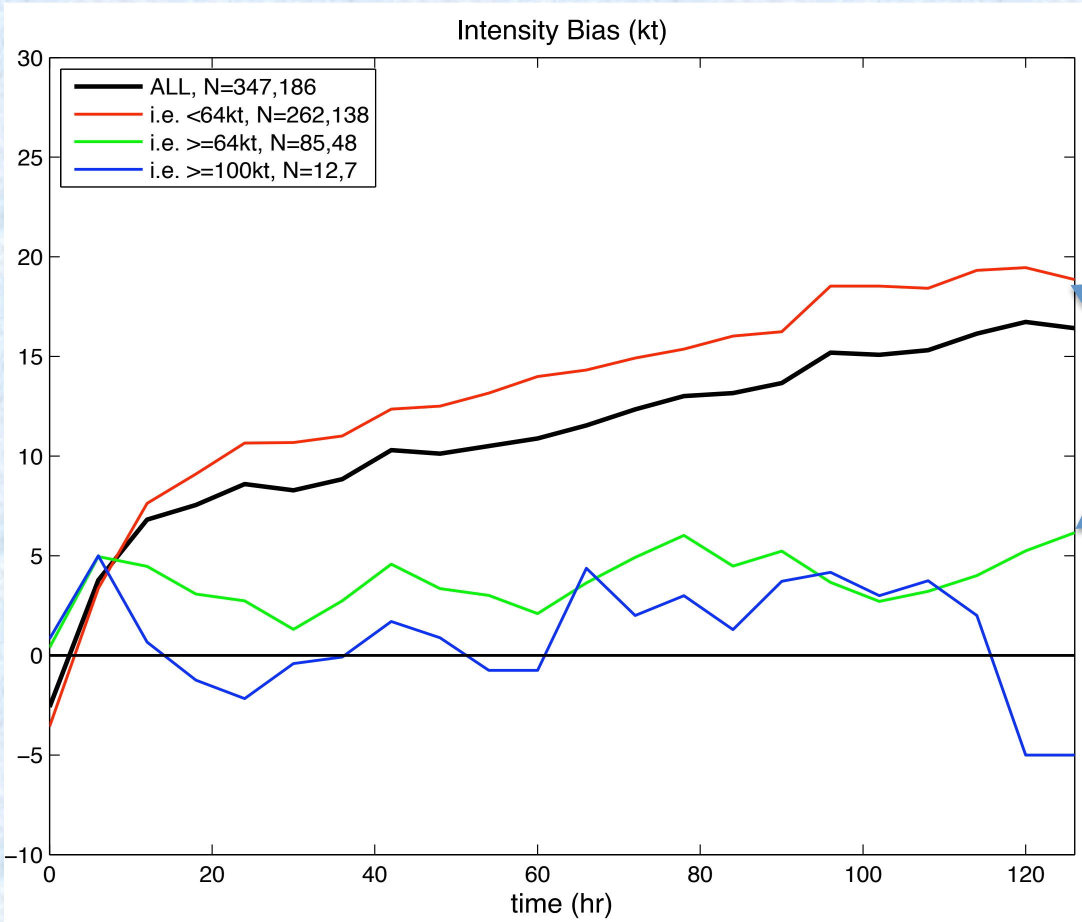
Small separation in performance after 60 hrs

HWRF YTD (thru Philippe)



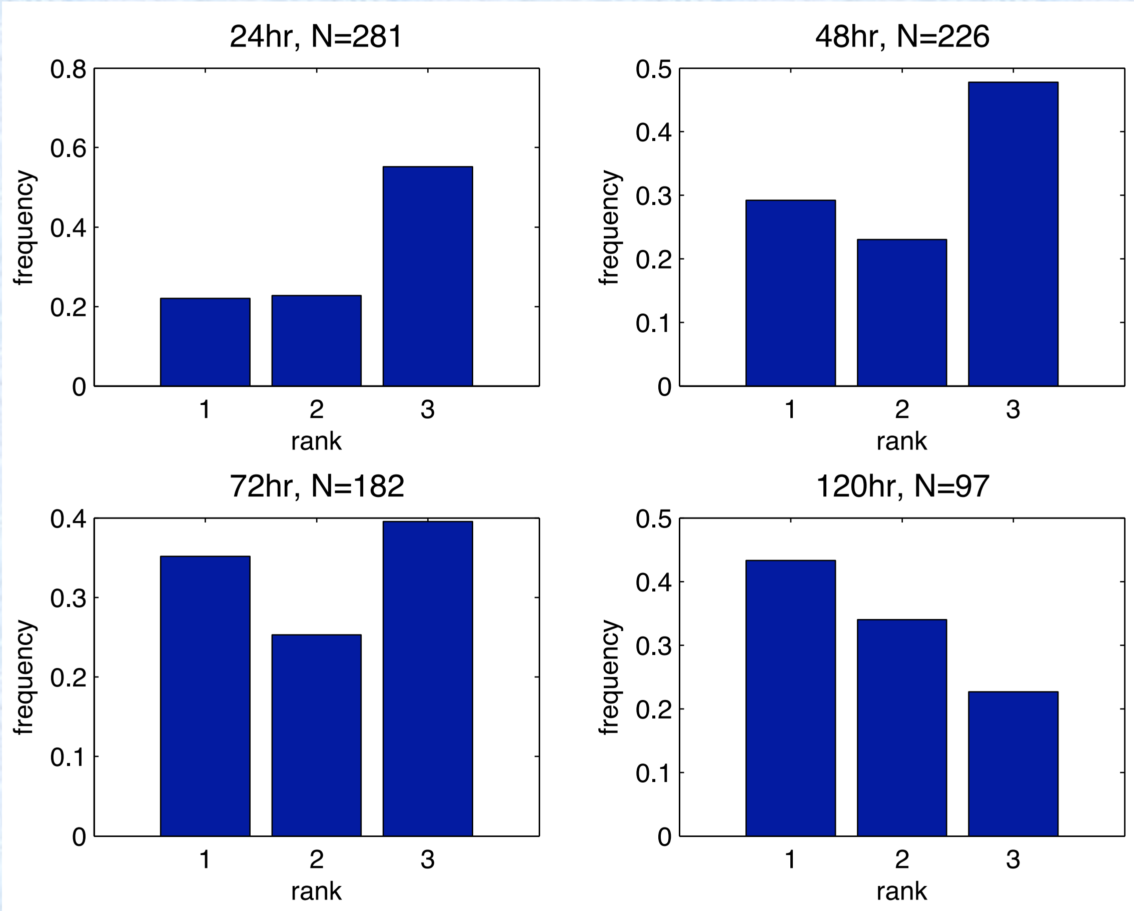
Small separation in performance after 80 hrs

UWN8 YTD (thru Philippe)

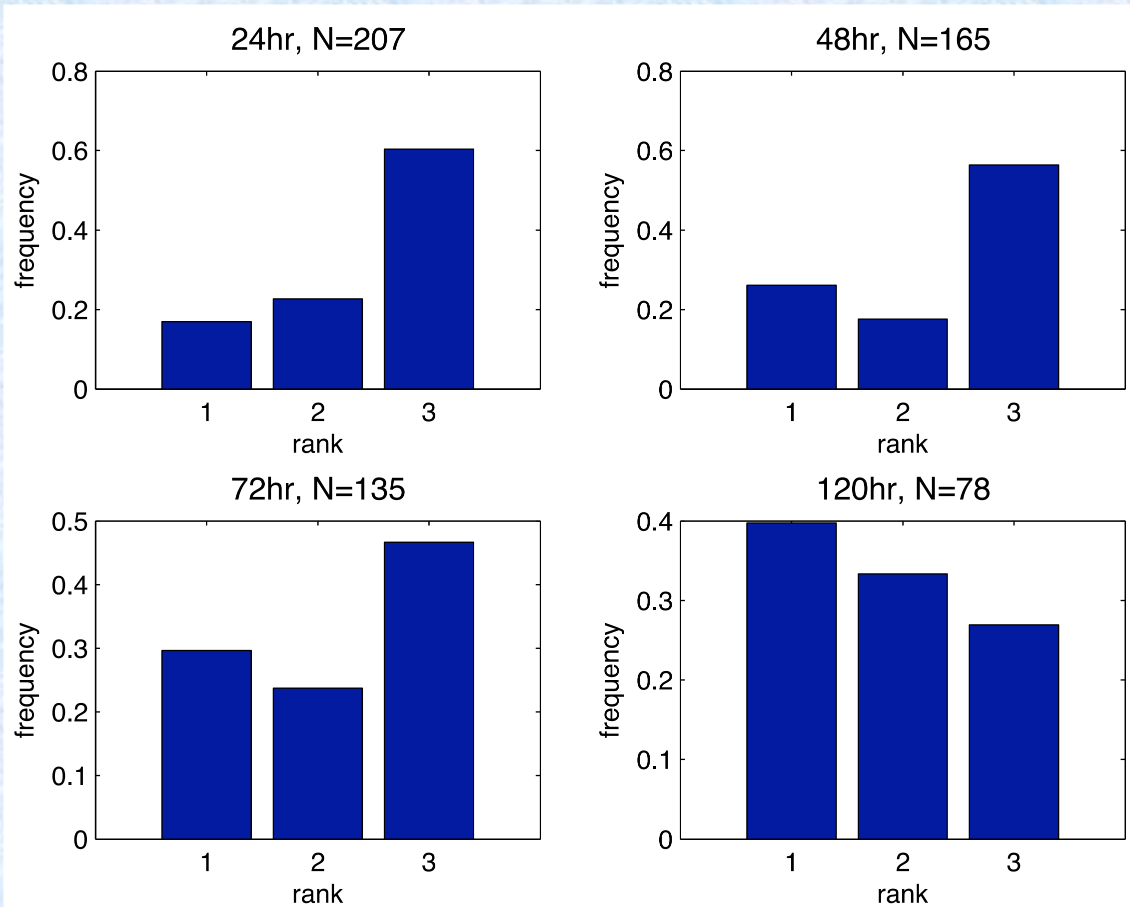


Very large separation in performance after 12 hrs

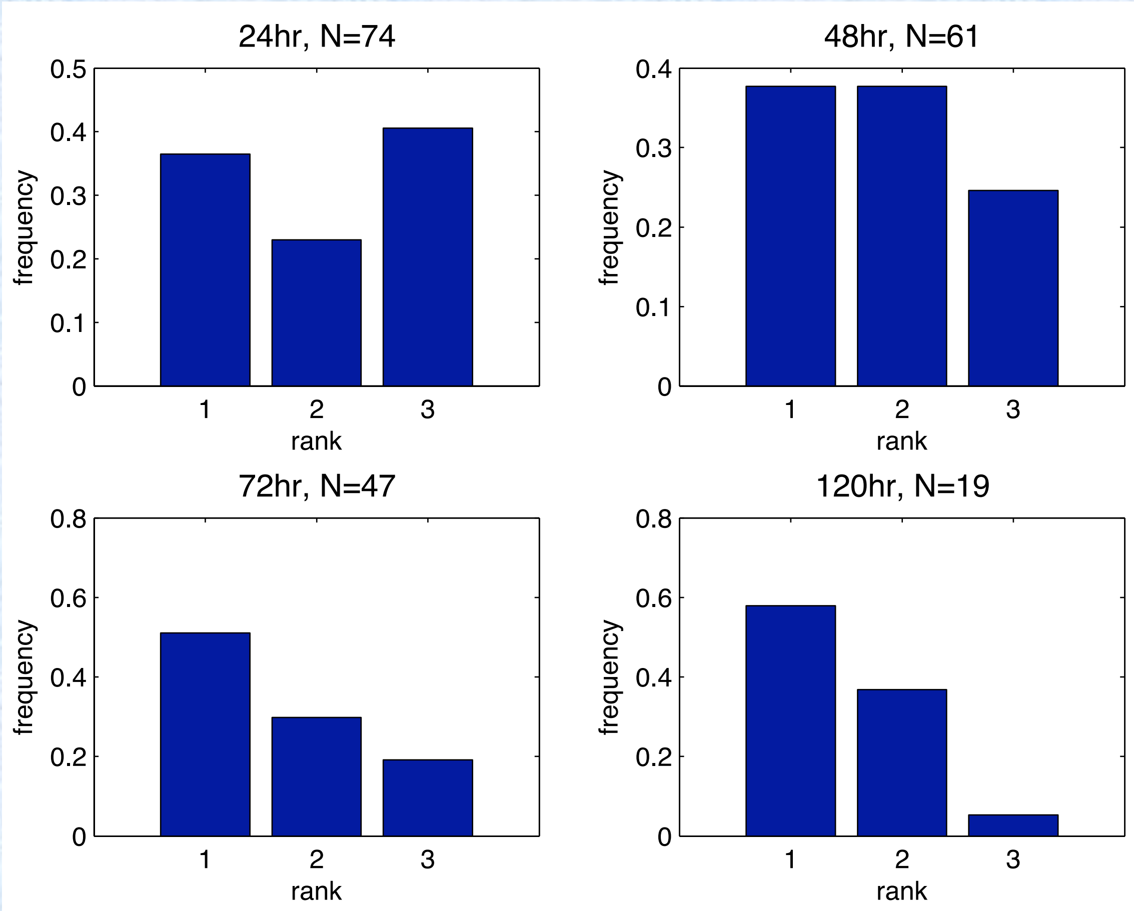
UWN8 Intensity Forecast Rank Histograms 2011 YTD – All Forecasts



UWN8 Intensity Forecast Rank Histograms 2011 YTD – i.e. < 64kt



UWN8 Intensity Forecast Rank Histograms 2011 YTD – i.e. >= 64kt



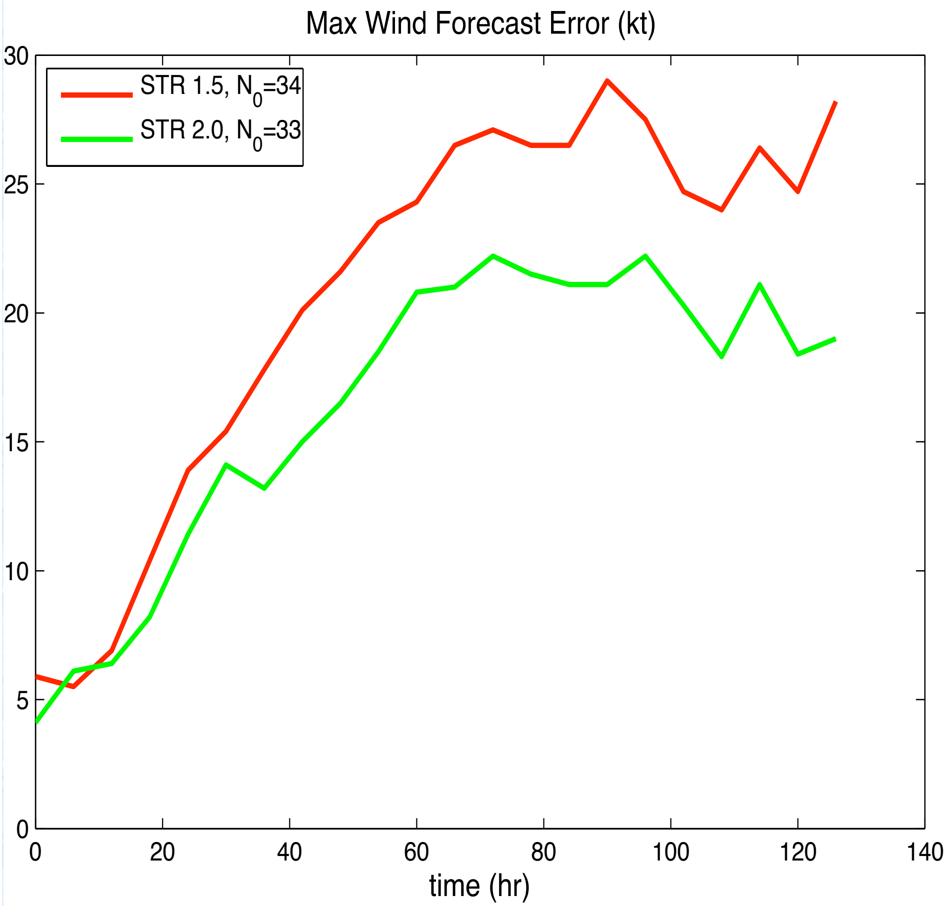
2011 Performance Summary

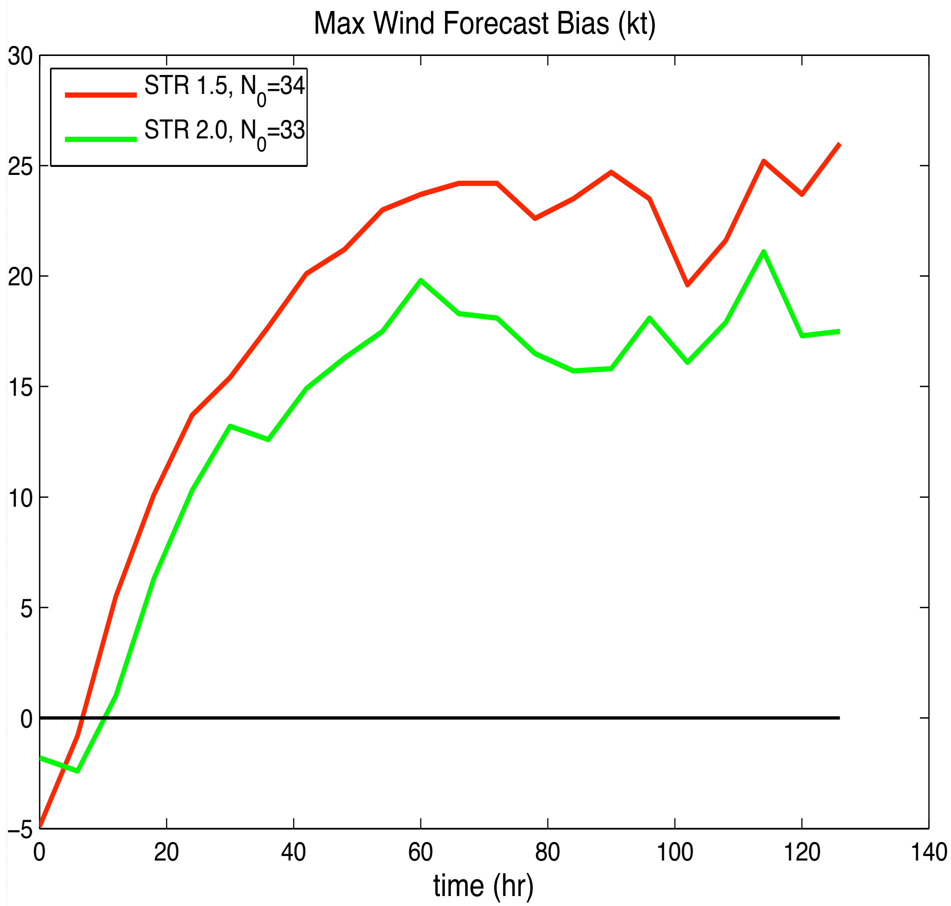
- Intensity forecast behavior quite different than either HWRF or GFDL.
- Error evolution for initially weak TCs markedly different than more well-developed TCs.
- Why? IC for weaker TCs has larger (magnitude) bias than for stronger TCs (-> Bogus) Resultant error growth continues throughout the forecast, while for stronger TCs the error growth is strongly damped after 6-12 hr.
- Role of the surface fluxes (sea-spray)?

Stream 2.0 Modifications

- After Retro runs were completed, several problems with the bogus initialization were discovered and corrected for Stream 2:
  - constraints were implemented for RMW (40km < rmw < 100km, per KC)
  - KC humidity modification turned off (default to GFS moisture analysis).
- Began running S2 rather late in season, so comparisons are rather limited at this point.

Hurricane Maria (14L)





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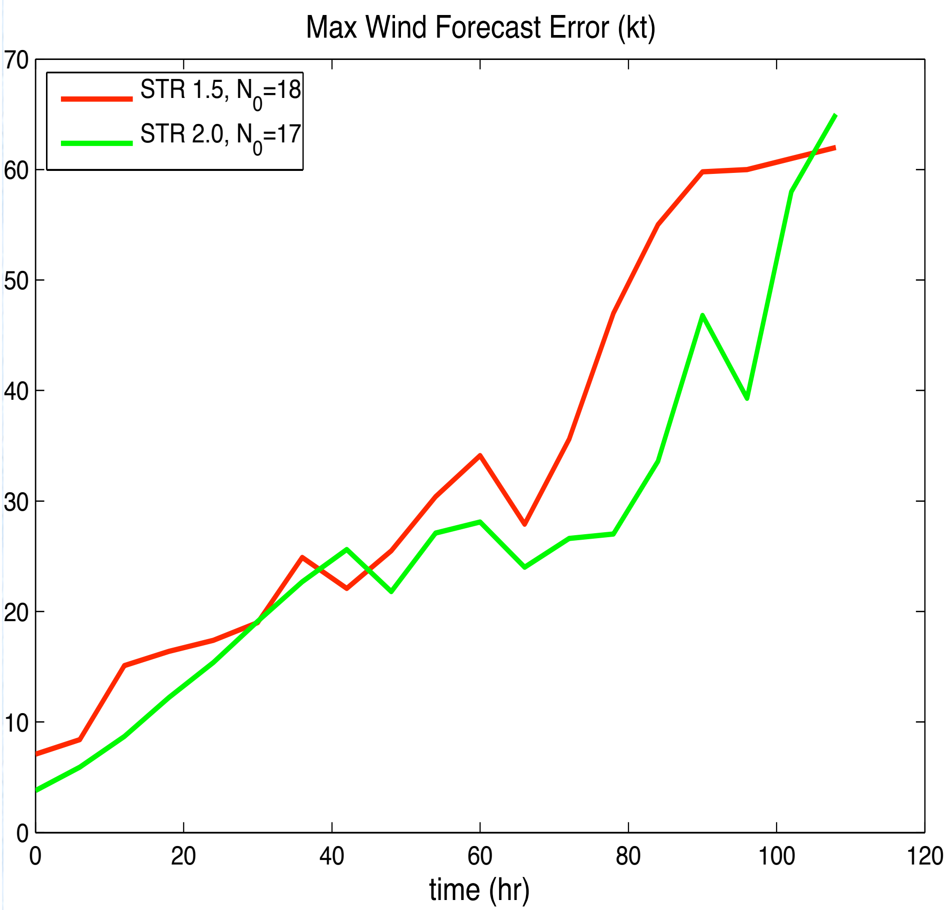

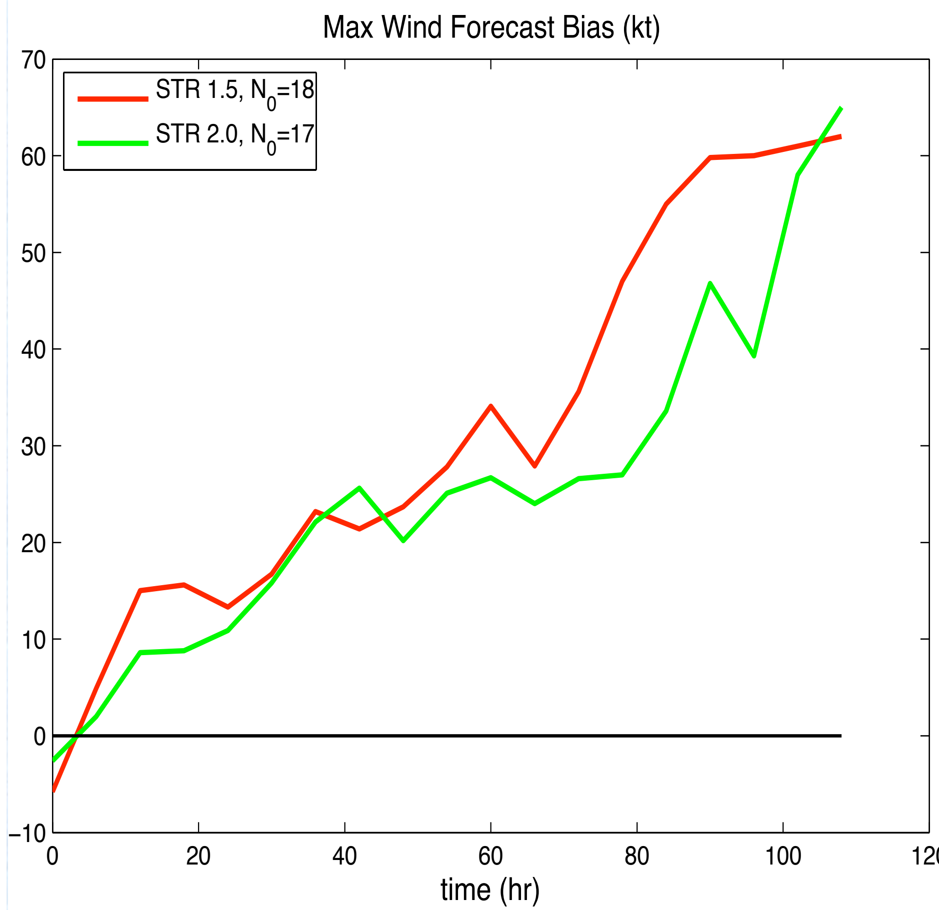

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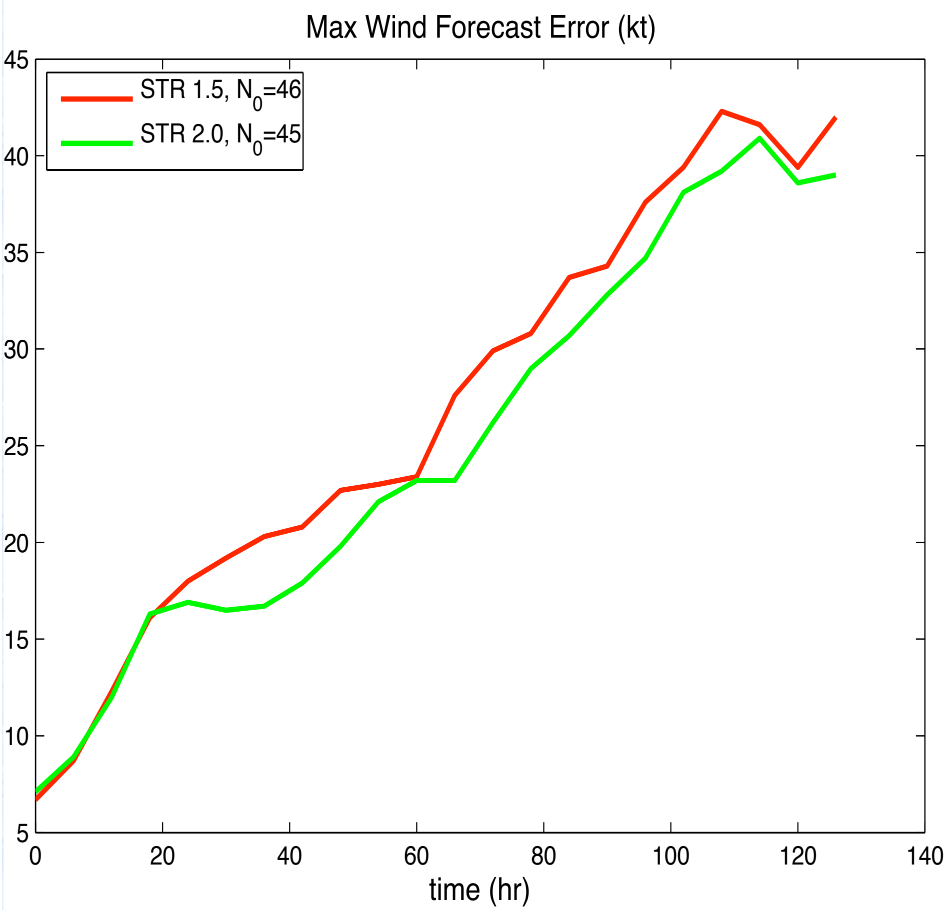
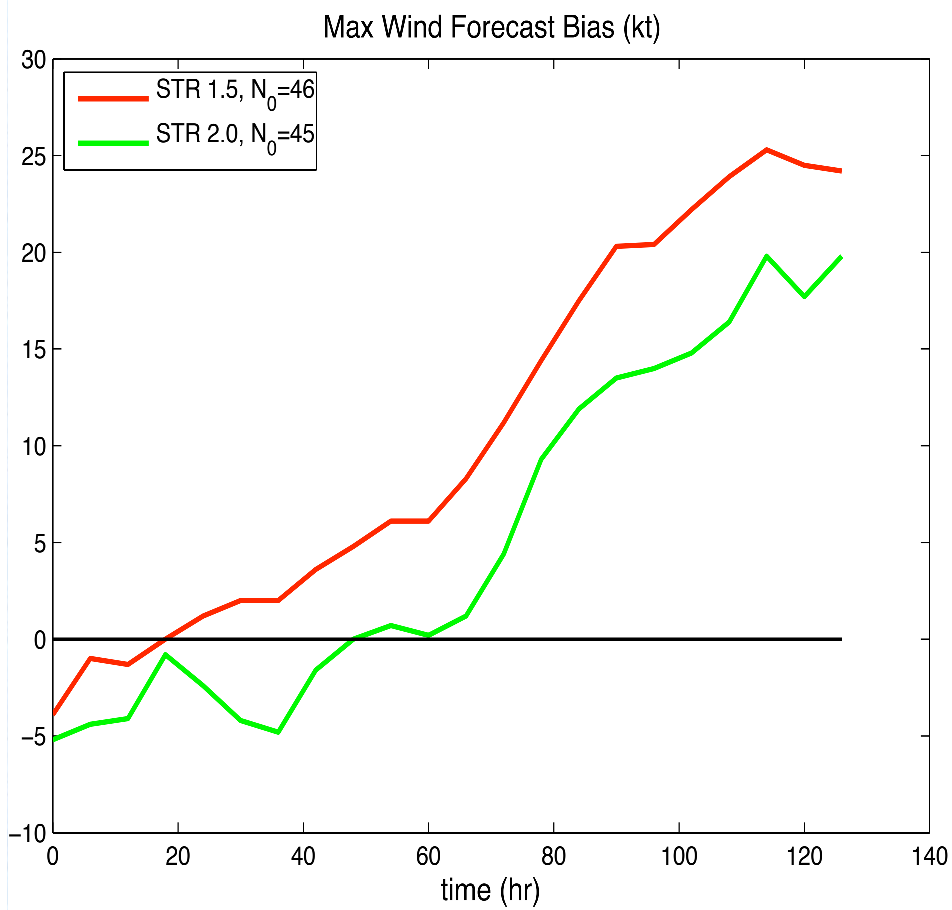
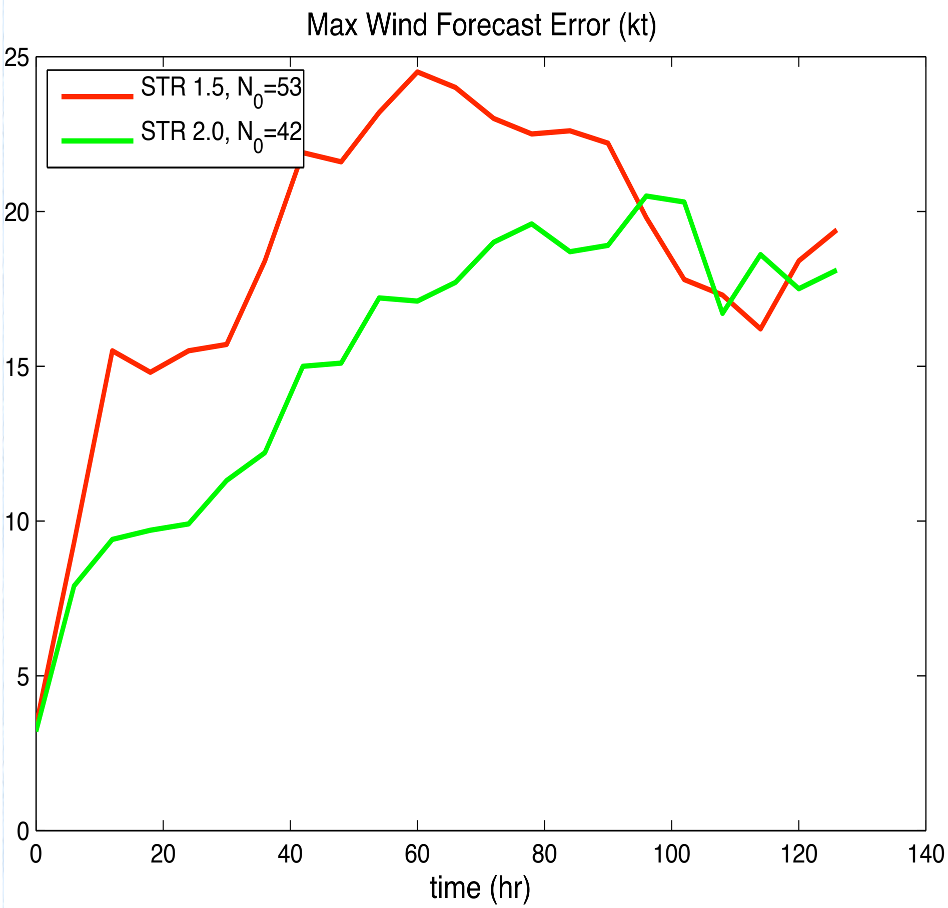
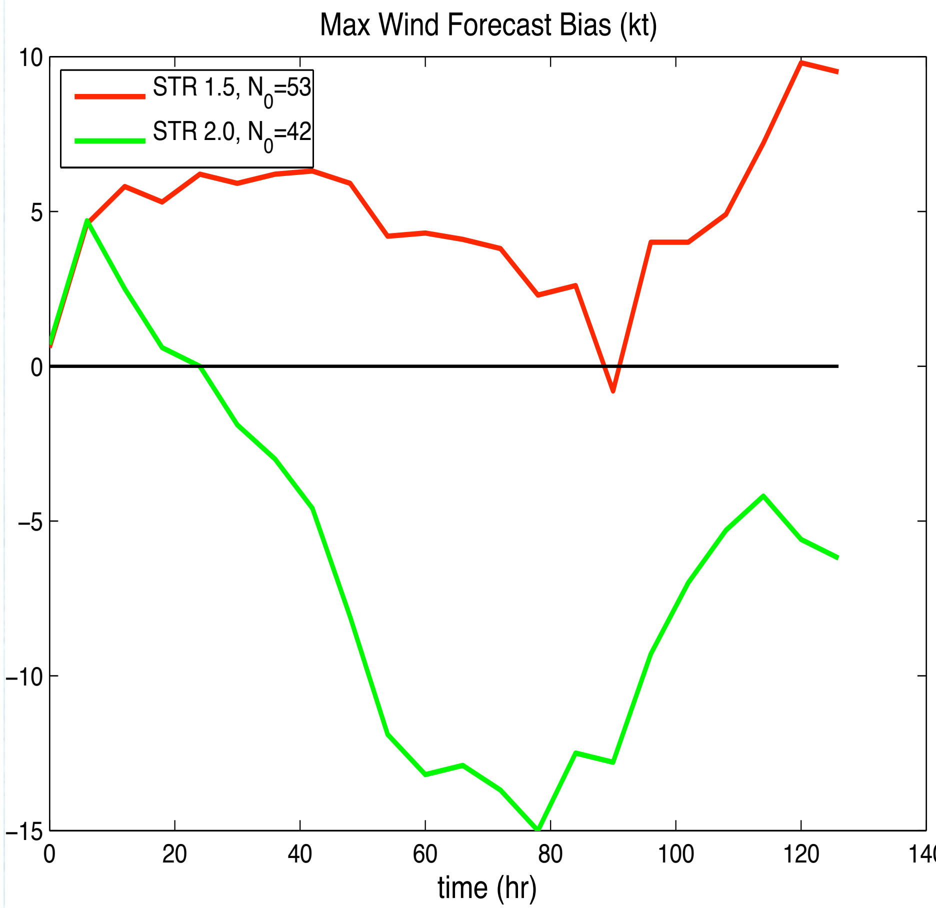




Hurricane Philippe (17L)





Future Work

- Bogus vortex changes (rmw constraint, core moisture) reduce intensity bias and improve forecast performance – carry over to next Retro test.
- Increase threshold intensity for using bogus?
- ***Cycling (warm start) initialization to be tested.***
- Issues properly simulating decay over land (NOAH LSM?) Different (larger) CZIL values will be tested.
- Improve vortex following code to eliminate erratic performance / jumps with weaker TCs.
- Andreas sea-spray? Explore different weighting possibilities for interfacial and spray-modulated fluxes?
- Larger g1 (spanning entire basin?) to eliminate occasional problems with g2 interacting w/ the boundary.