Diagnostics of Eyewall Slope

using HWRF simulations of Hurricane Earl (2010) with different PBL physics

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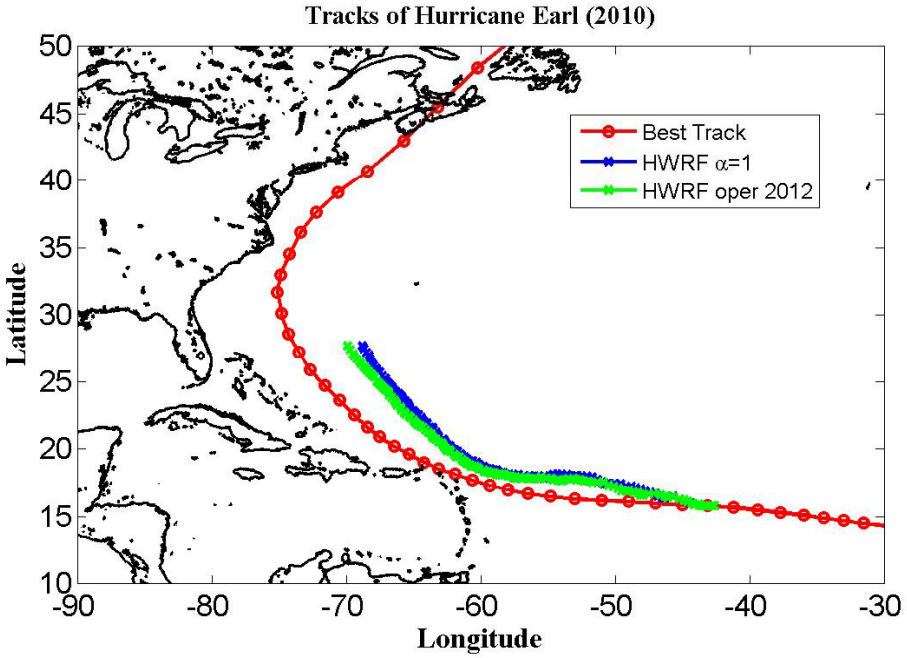
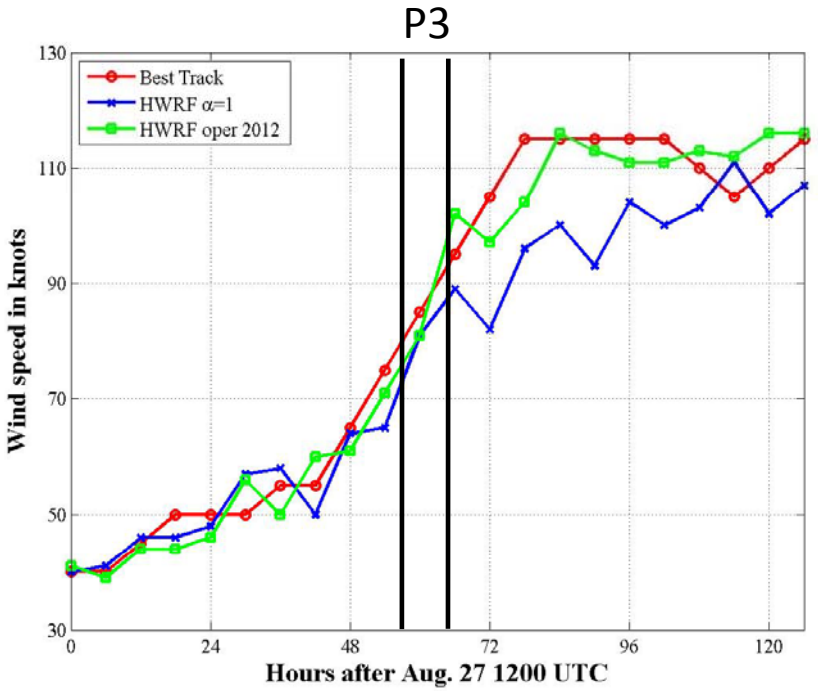
Objective

To further study the impact of vertical eddy diffusivity on simulated hurricane intensity and structure using HWRF.

- Why improving PBL physics is important for intensity forecast?

Further investigate the impact of vertical eddy diffusivity using HWRF simulations of Hurricane Earl (2010)

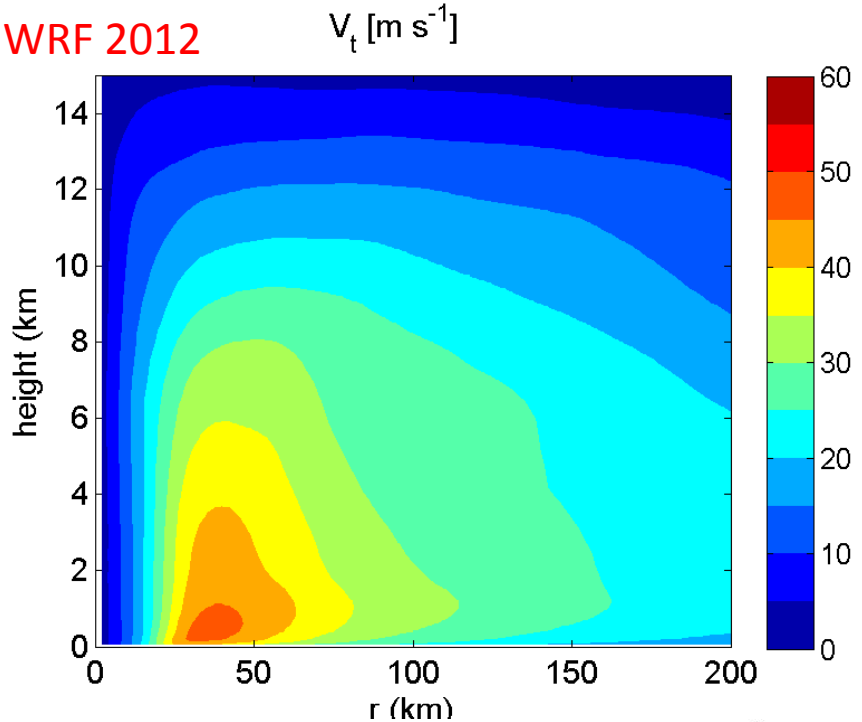




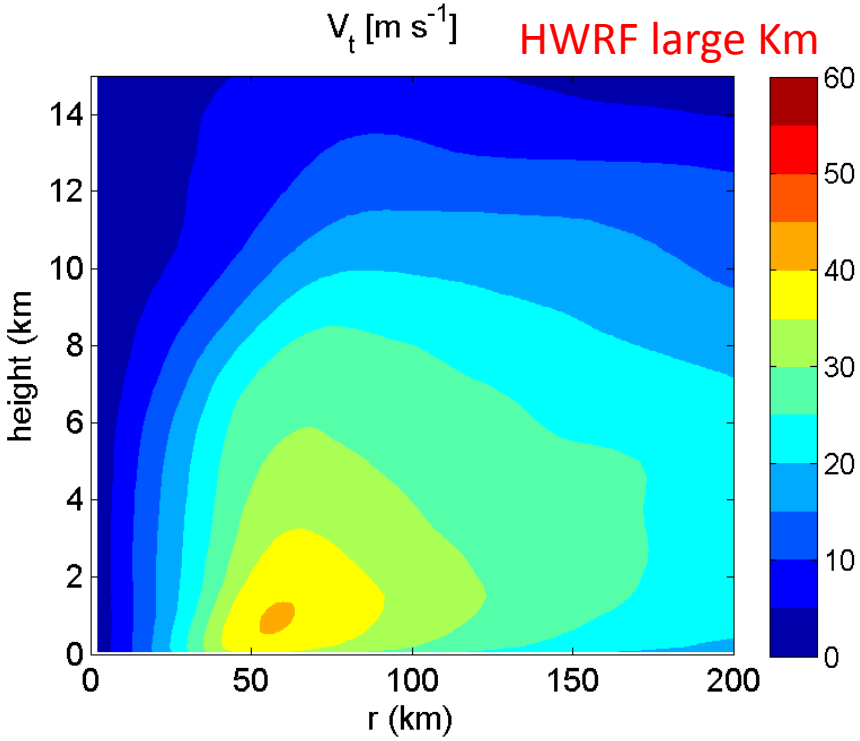
Two simulations: one with corrected K_m based on observations of J. Zhang et al. (2011) and the other with uncorrected K_m.

Vertical eddy diffusivity: $K_m = k\,(U_*/\Phi_m)\,Z\,\{\alpha(1 - Z/h)^2\}$

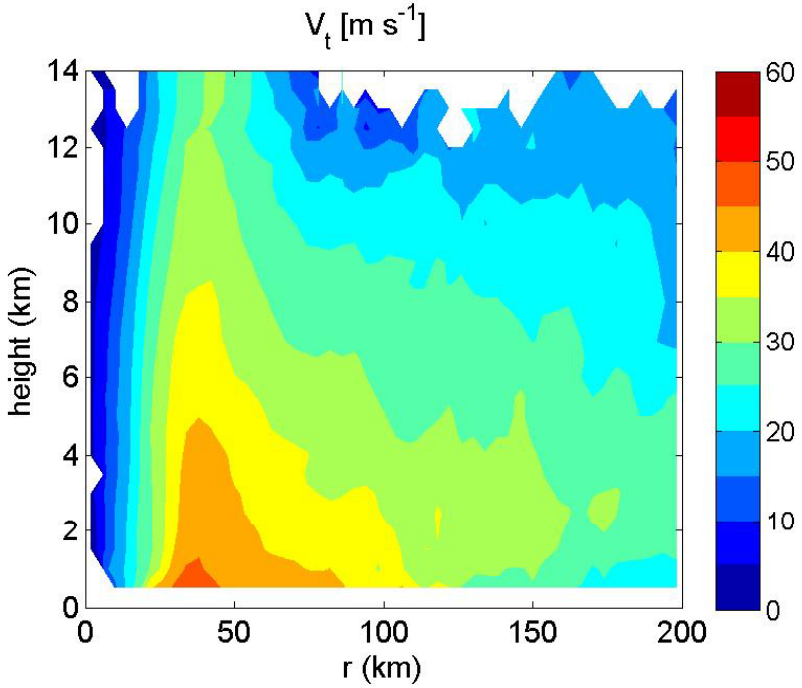
HWRF 2012



HWRF large Km

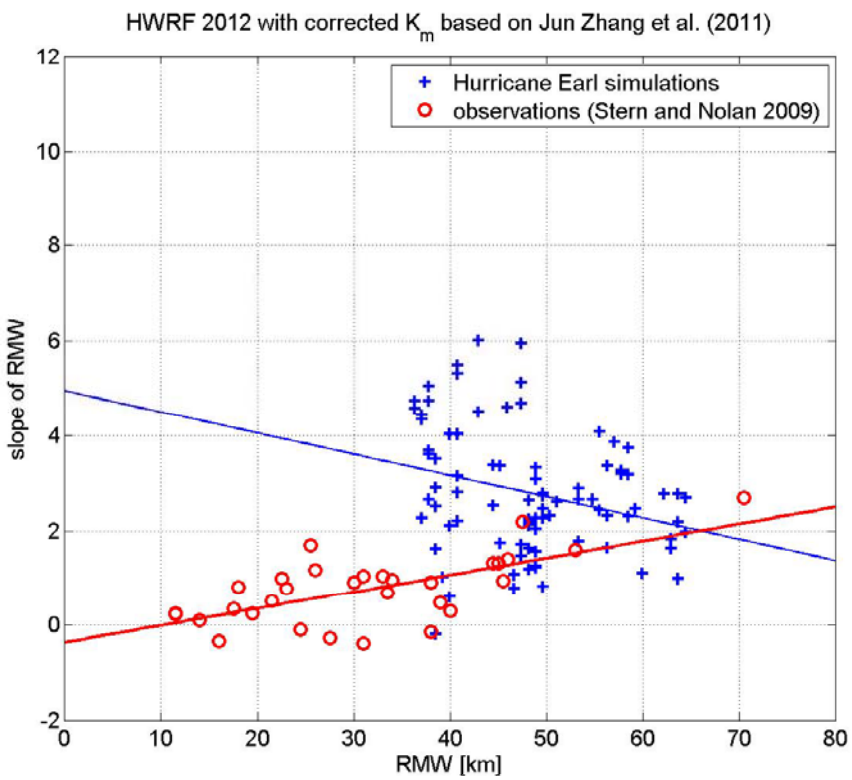


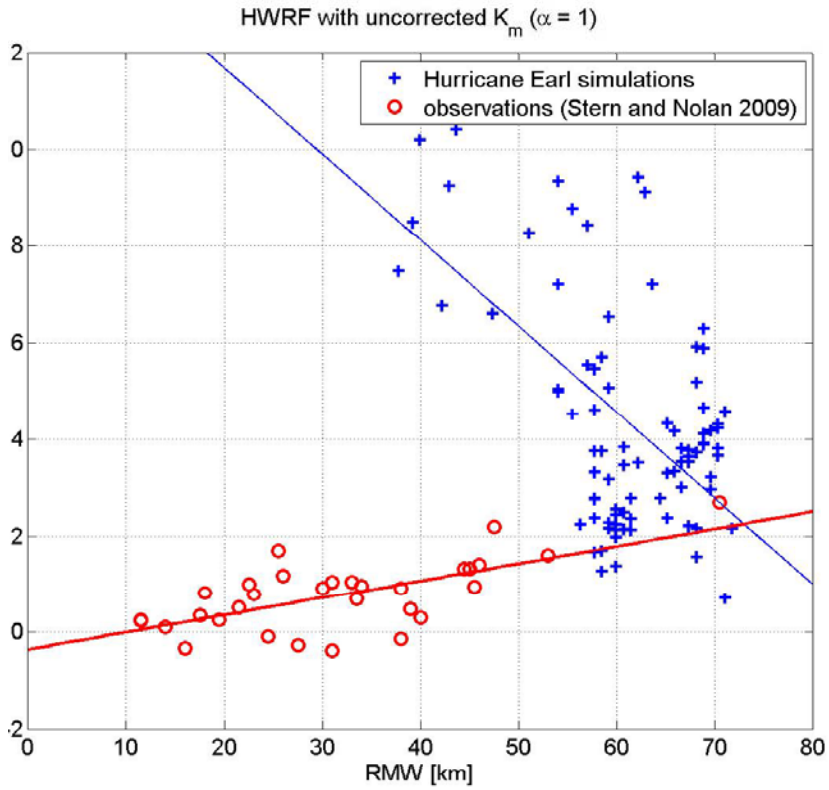
Doppler radar observation



Smaller Km leads to a stronger, deeper and smaller vortex which is more consistent with observations.

Eyewall Slope Analysis





1. On average, the sizes of simulated storms are smaller for using HWRF with corrected Km than that without correction;
2. The simulated eyewall slope is closer to observations for using HWRF with corrected Km than that without correction.

Summary

1. HRD's in-situ aircraft observation data are unique, which provide baseline for physics development and improvement (i.e., vertical diffusivity setup in HWRF), as well as model diagnostics;

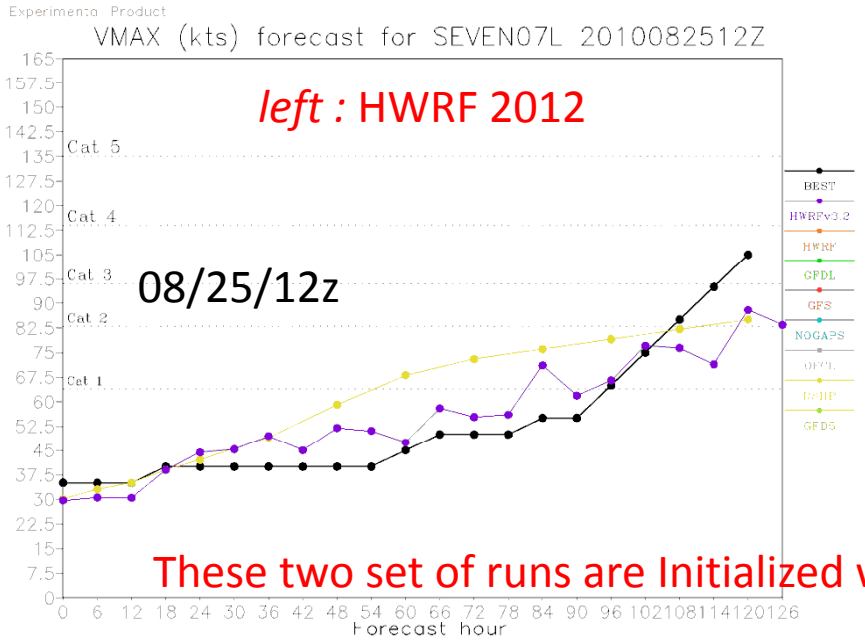
2. Is the impact of modified physics in a real-case simulation consistent with that in idealized simulations? Yes.

2. Is the intensity forecast a physics problem or initialization problem? Both.

For a single simulation, initialization may be more important than physics for intensity forecast or vice versa. But improved physics is definitely crucial for intensity forecast with cycling simulations.

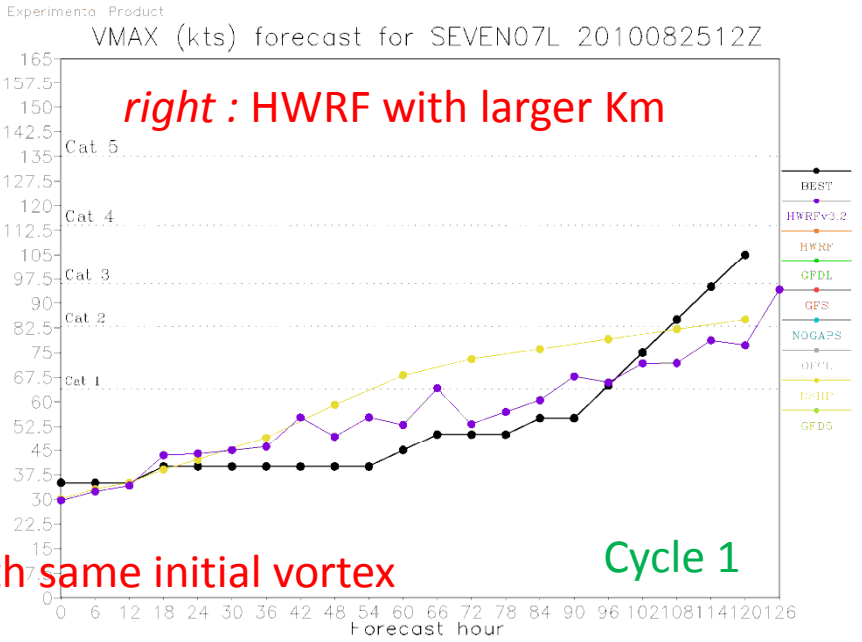
The simulated structure in terms of the size of the storm and eyewall slope distribution is improved with modified physics based on observations.

Two sets of cycling simulations of Hurricane Earl with different physics



left : HWRF 2012

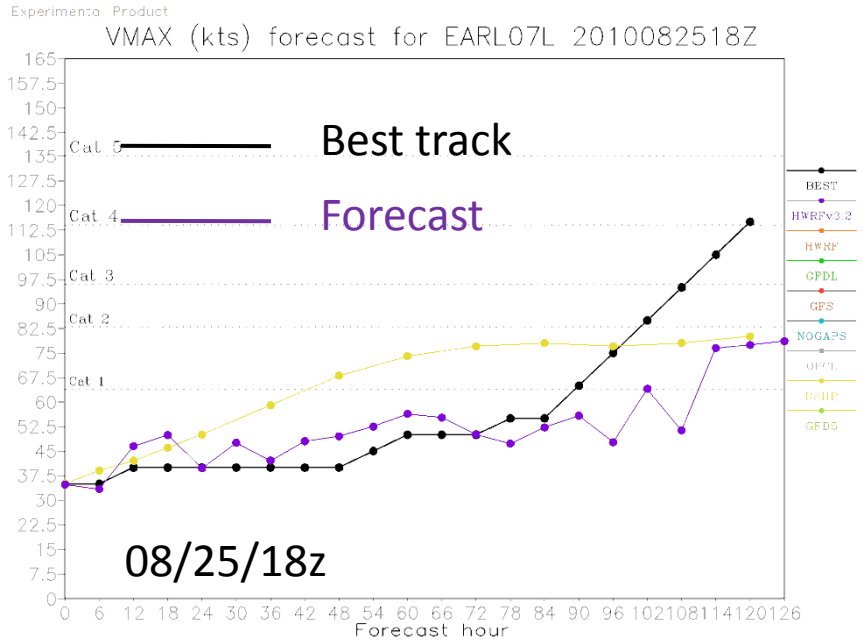
08/25/12z



right : HWRF with larger Km

Cycle 1

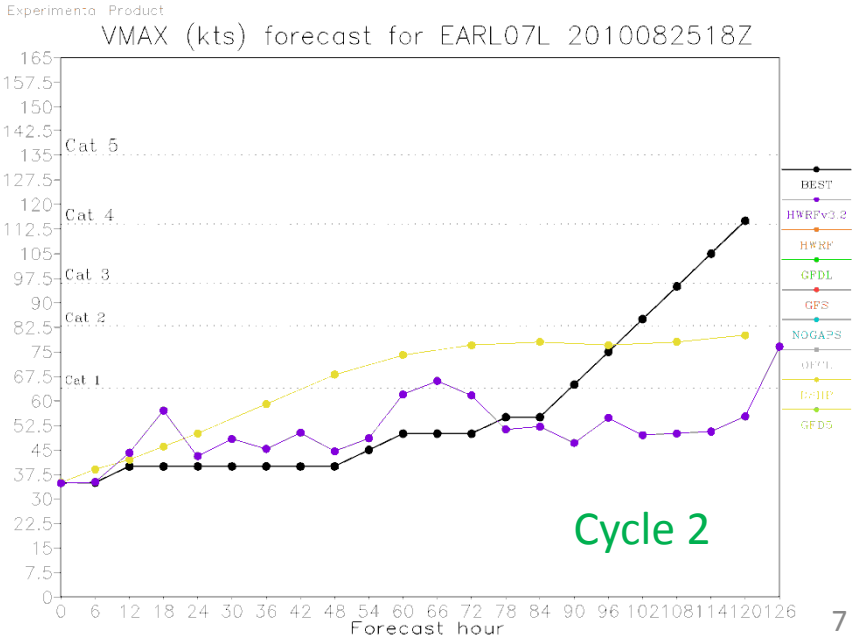
These two set of runs are Initialized with same initial vortex



Best track

Forecast

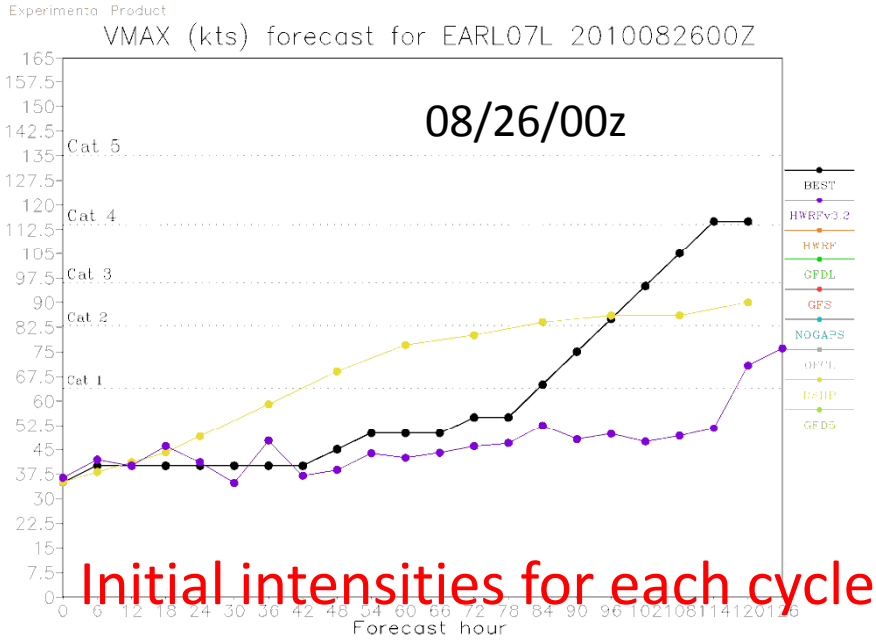
08/25/18z

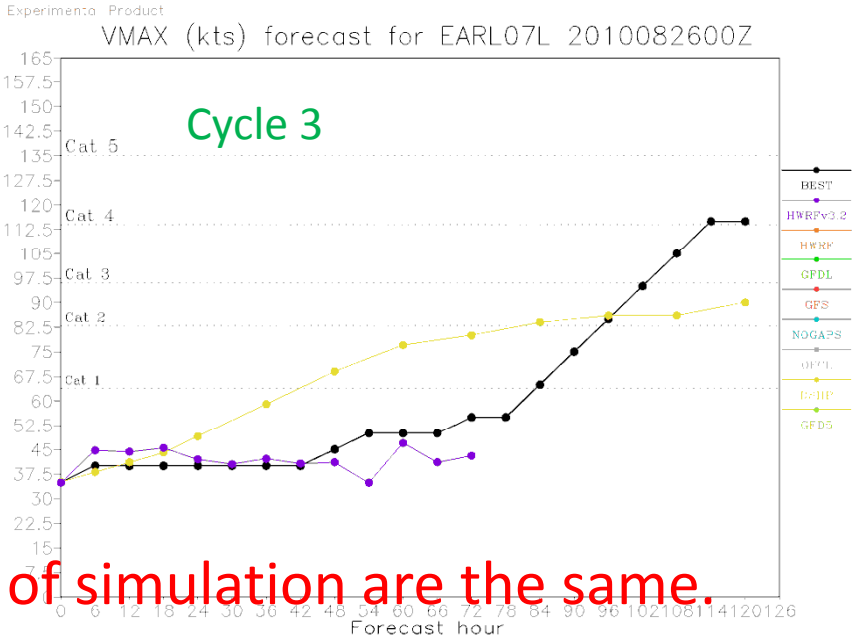


Cycle 2

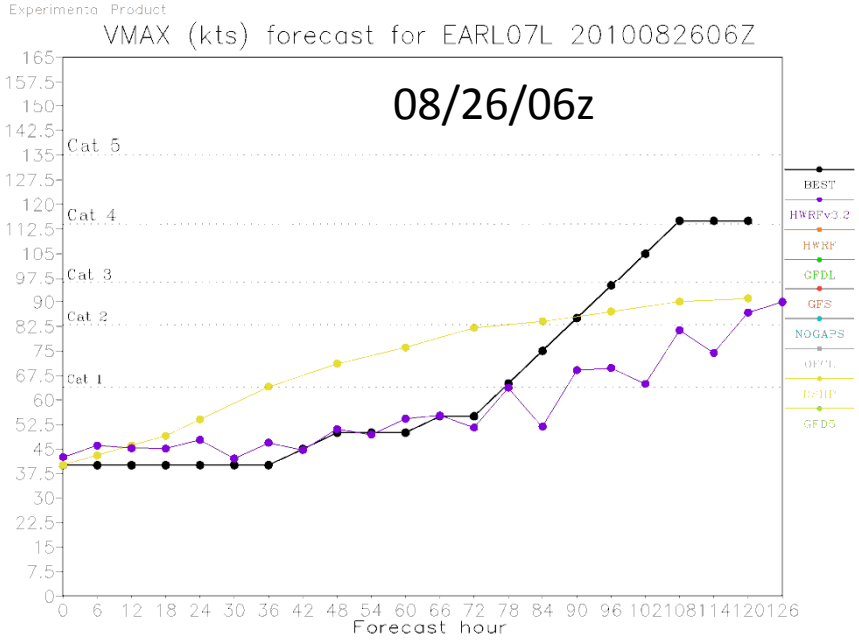
left : HWRF 2012

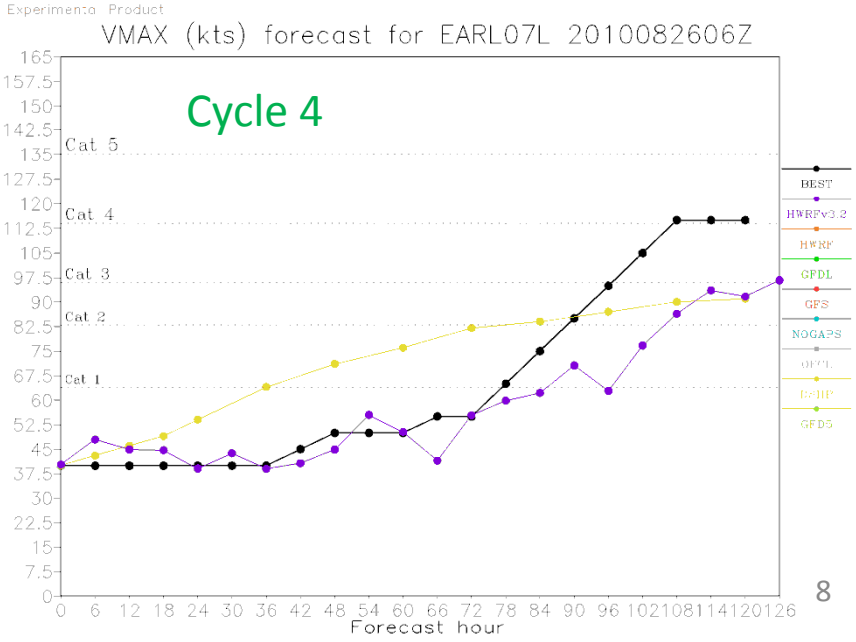
right : HWRF with larger Km





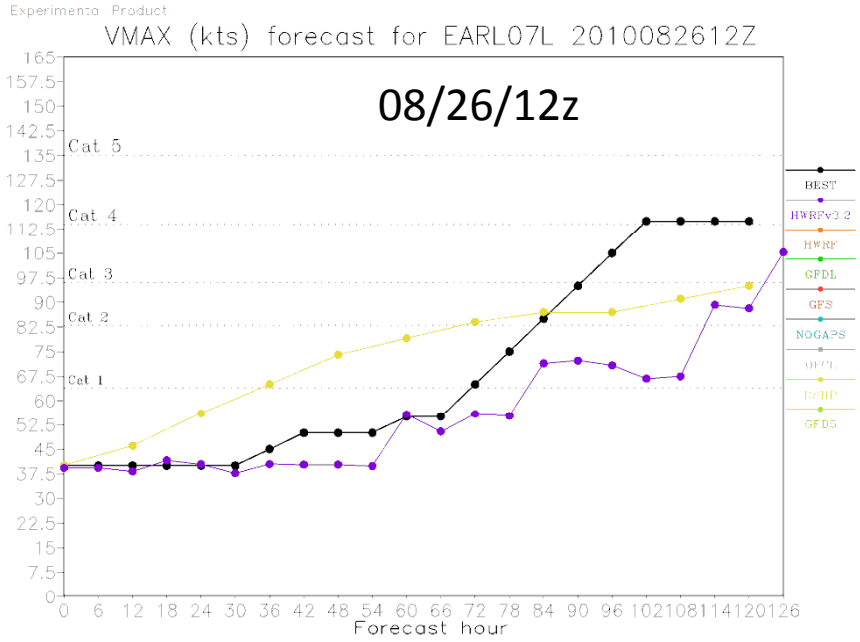
Initial intensities for each cycle of simulation are the same.

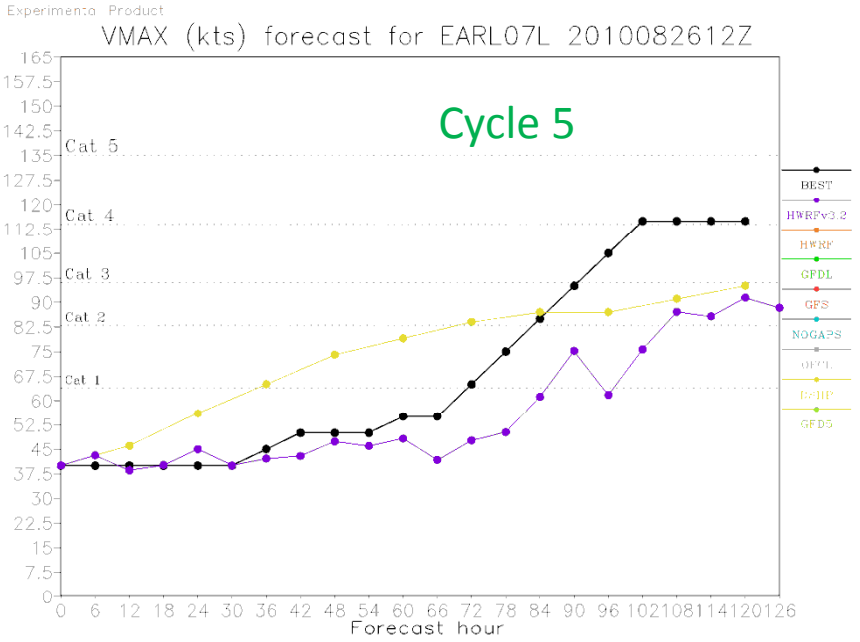


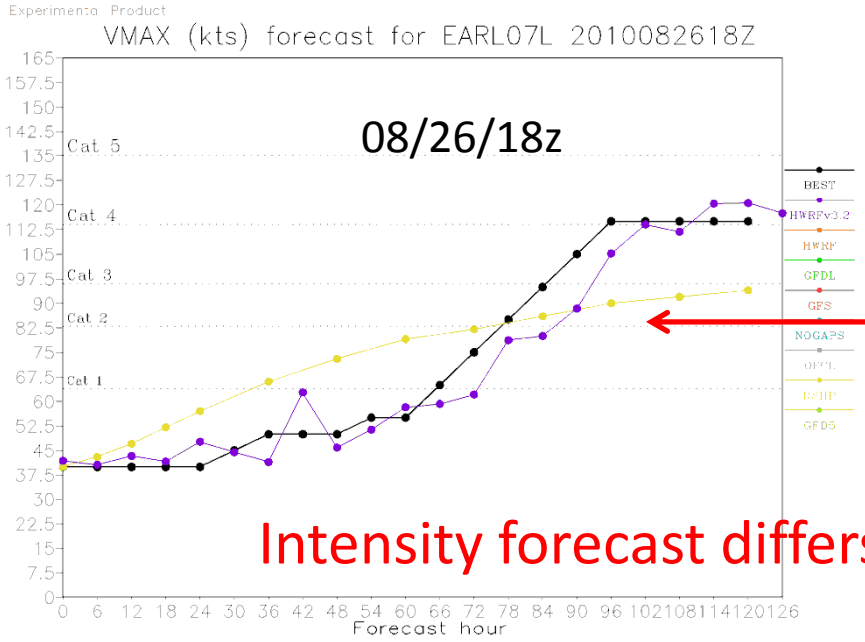


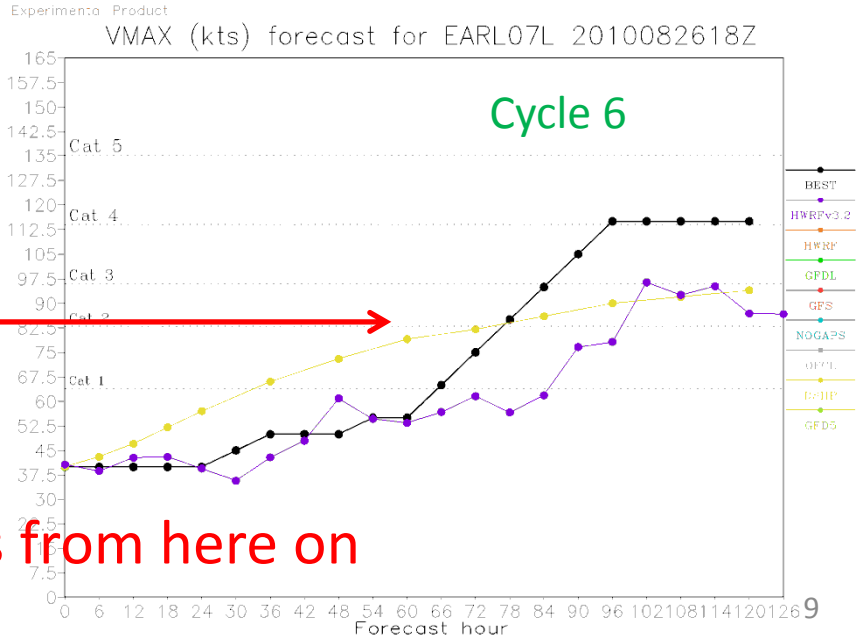
left : HWRF 2012

right : HWRF with larger Km





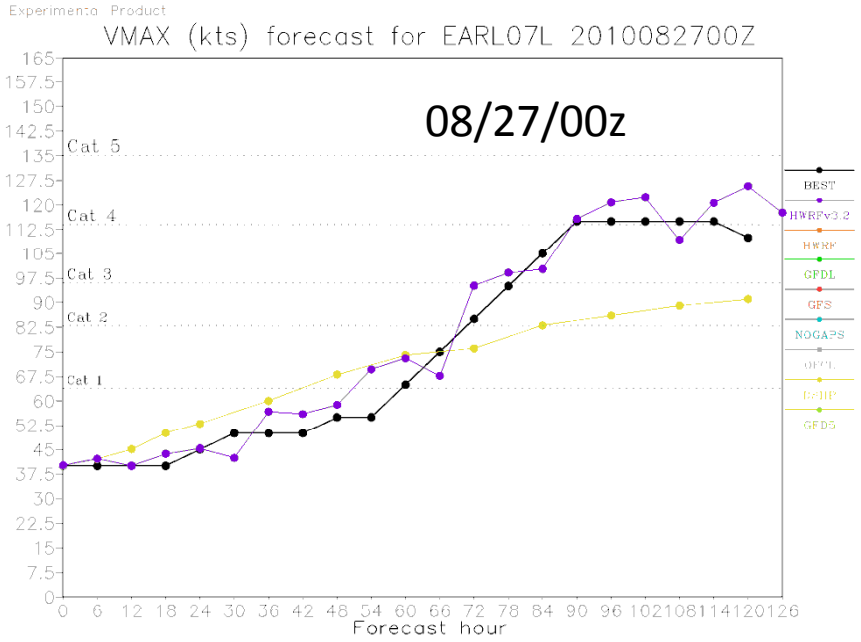


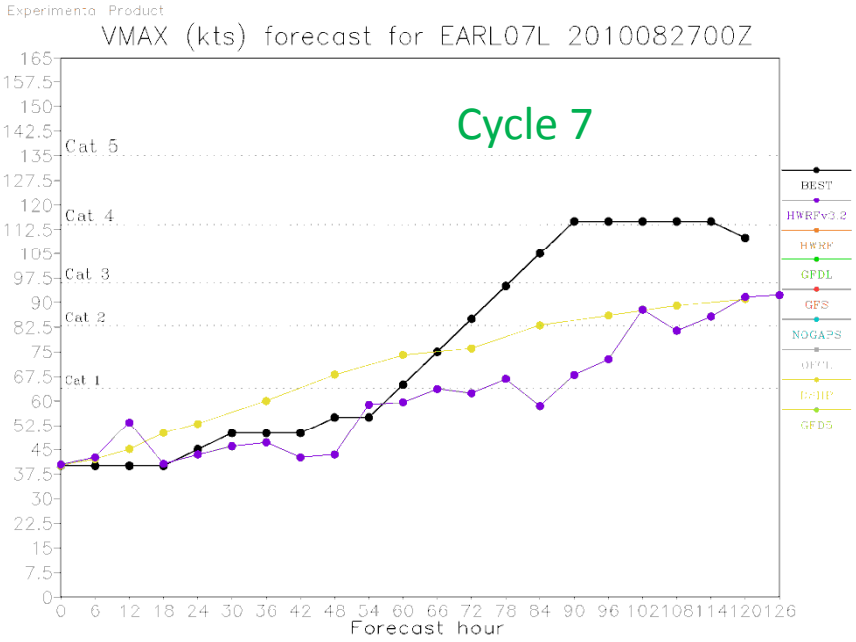


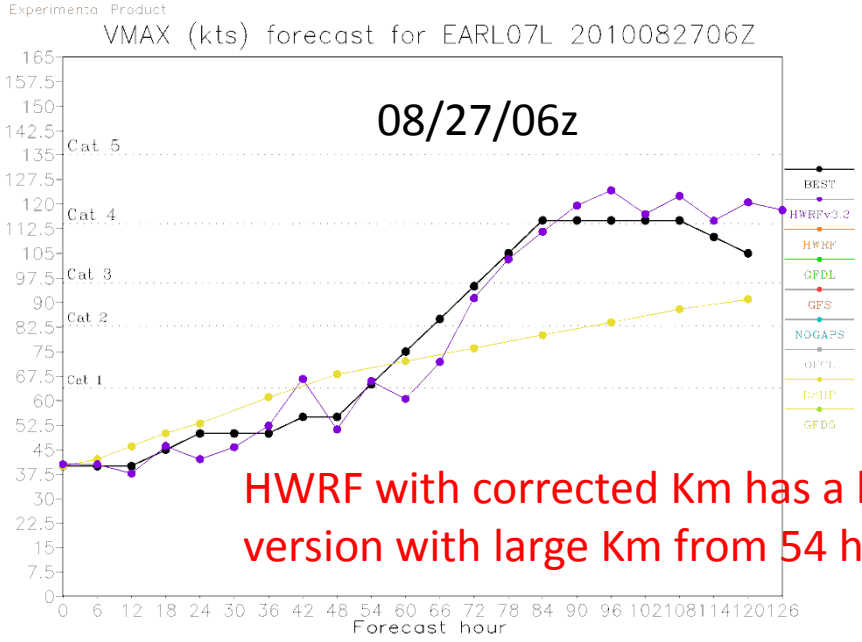
Intensity forecast differs from here on

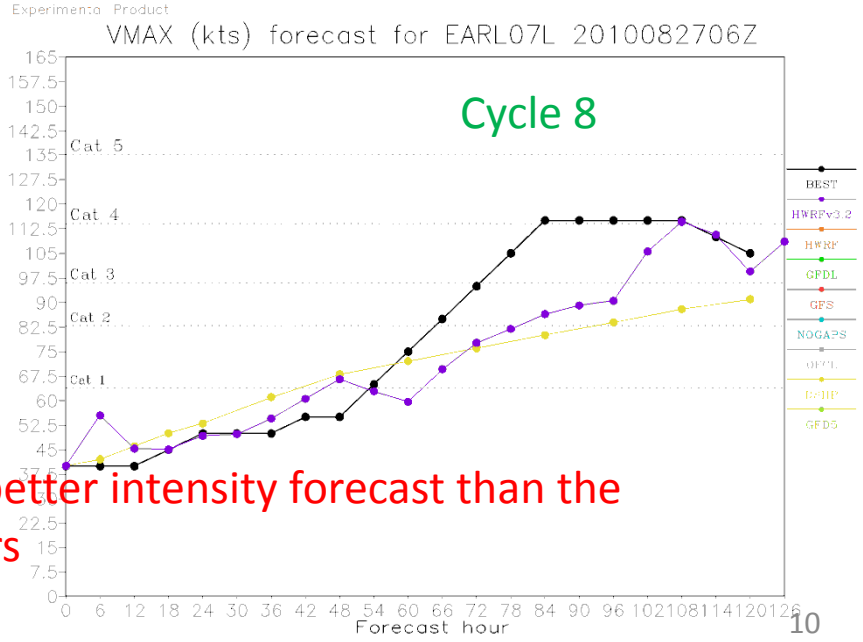
left : HWRF 2012

right : HWRF with larger Km









HWRF with corrected Km has a better intensity forecast than the version with large Km from 54 hrs