Testing of Grell-Freitas scheme with HWRF model

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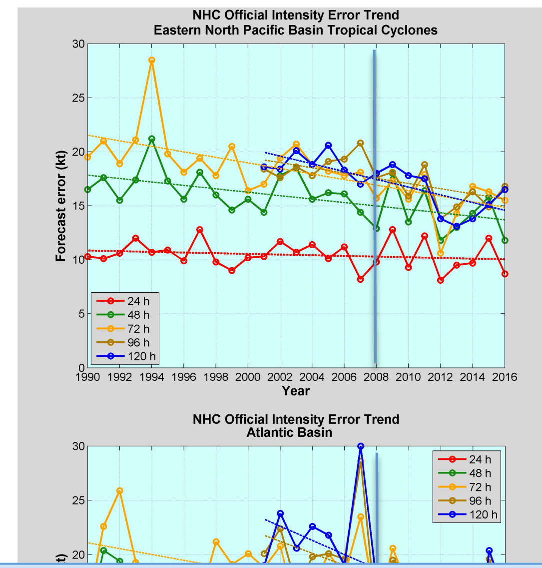
Motivation

- Can we improve intensity forecasts
  - NHC's official intensity error trend shows some improvement in intensity prediction
  - RI prediction still an issue
- Avenues currently persued
  - Improvement in data assimilation
  - Ocean response
  - **Physics advancements**



Posters:

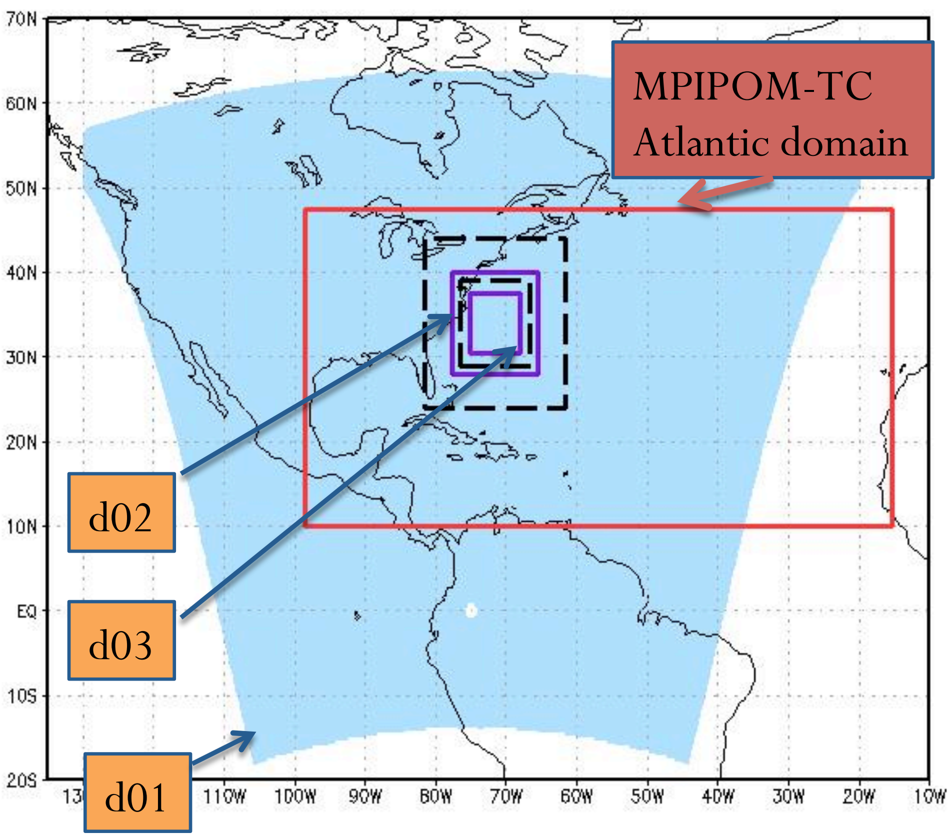
P31 Kathryn Newman et al. ***An evaluation of cloud-radiation enhancements within the 2016 Hurricane WRF system.***

P32 John Henderson et al. ***Revisions to RRTMG cloud radiative transfer in HWRF.***

DTC's Testing Configurations

	Control – HWRF with SASAS (H6CL)	HWRF with GF (H6GF)
Cumulus	Scale Aware SAS	**GF**
Microphysics	Ferrier-Aligo	Ferrier-Aligo
Surface layer	HWRF	HWRF
Land surface	Noah LSM	Noah LSM
PBL	GFS Hybrid EDMF	GFS Hybrid EDMF
Radiation	RRTMG	RRTMG

HWRF grid configuration



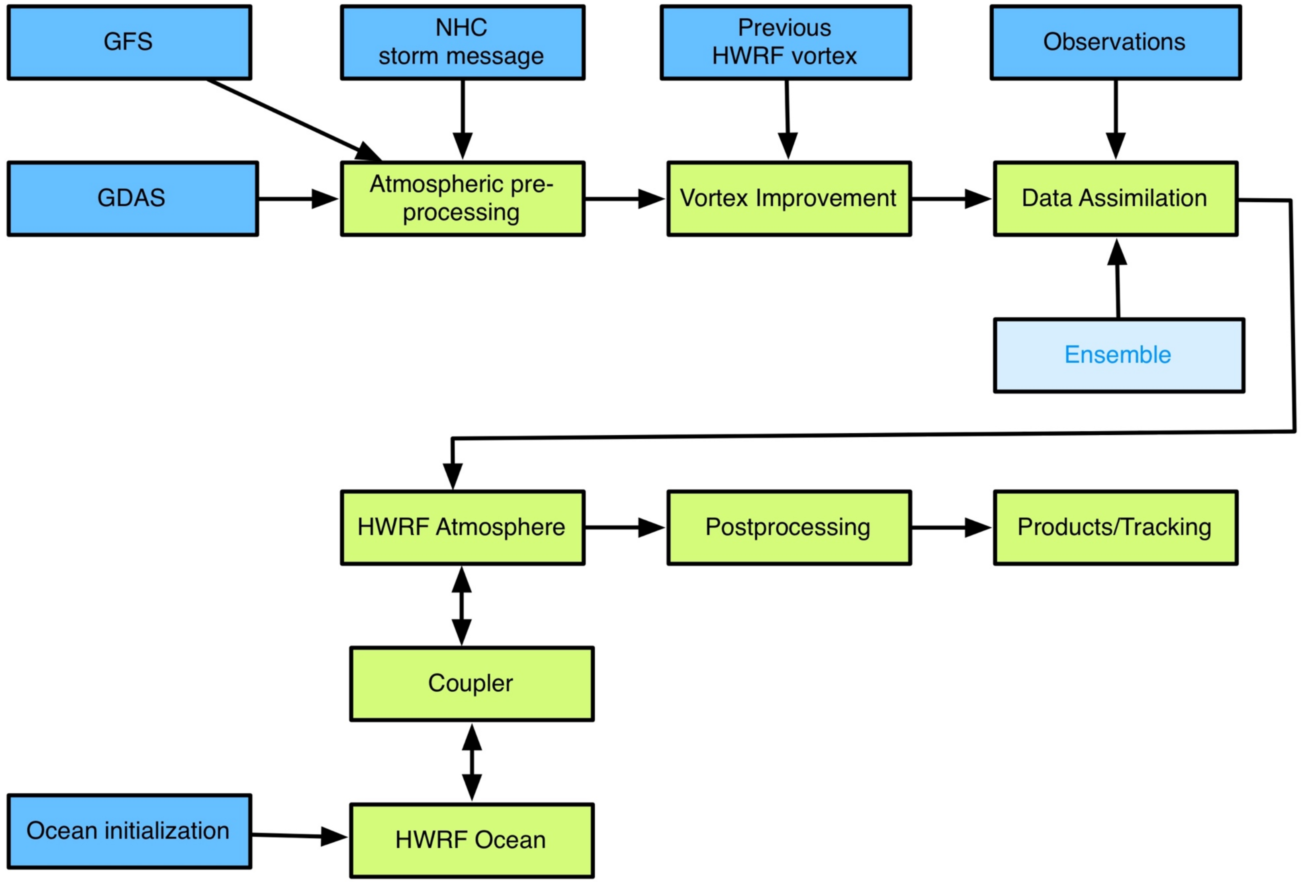
Atmospheric configuration

- Horizontal grid spacing: 18, 6, 2 km
- Inner nests move to follow storm
- Domain location vary from run to run depending on storm location
- 61 vertical levels; top at 2 hPa

Oceanic configuration – MPIPOM-TC

- Horizontal grid spacing: 1/12 deg (~9km)
- Location of grid depends of location of storm
- Atlantic and N. Eastern Pacific
    - 3-D model
    - 23 vertical levels

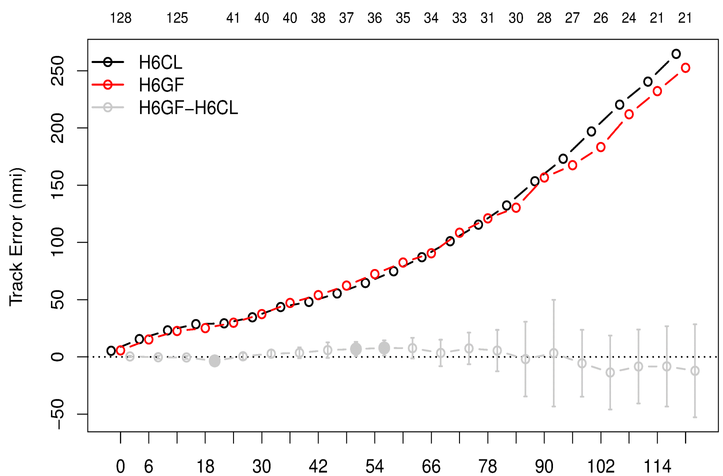
Components of HWRF system

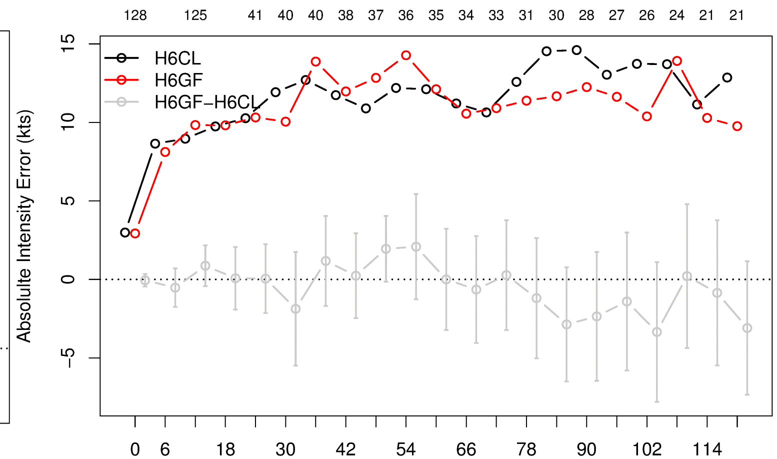


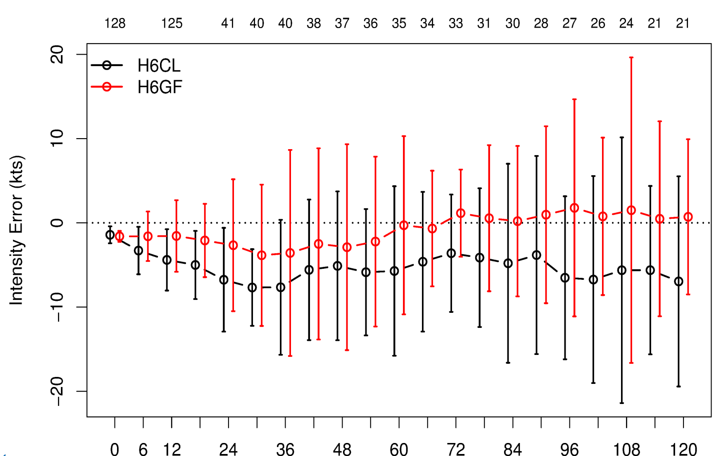
Results

Track and Intensity errors

Storms included: Gonzalo (2014), Edouard (2014), Matthew (2016)







Neutral to positive track forecasts improvements for GF scheme

Negative intensity bias was alleviated for the GF scheme especially at longer lead times

Intensification

Control

		Observation	
		RI	*No RI*
Model Forecast	***RI***	**28**	13
	No RI	52	472

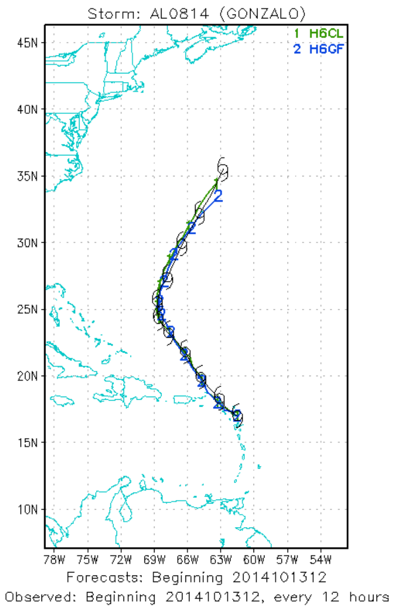
GF

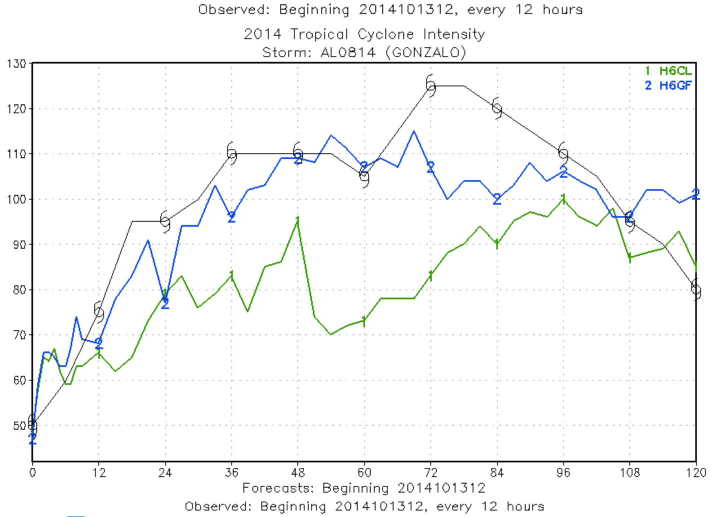
		Observation	
		RI	*No RI*
Model Forecast	***RI***	**38**	26
	No RI	42	459

"RI" is defined as 20 kt intensity increase in 24 hr

Case study

Case study – Gonzalo

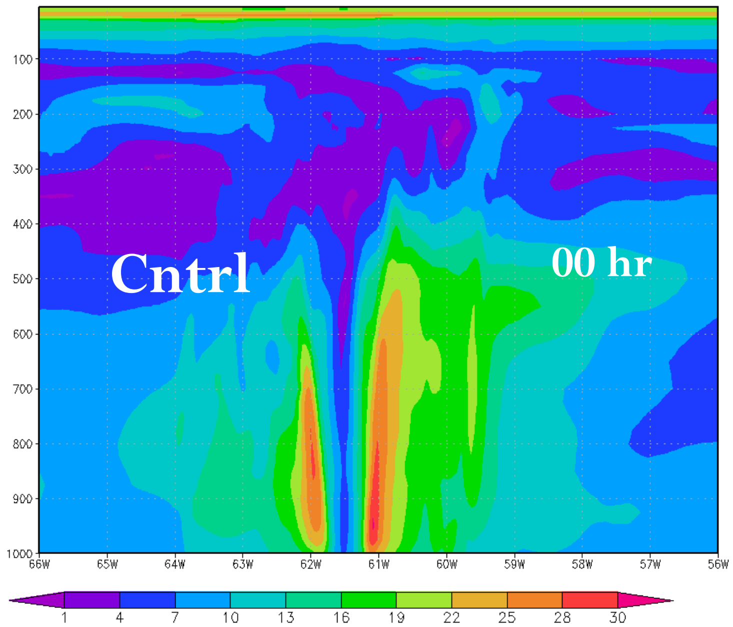


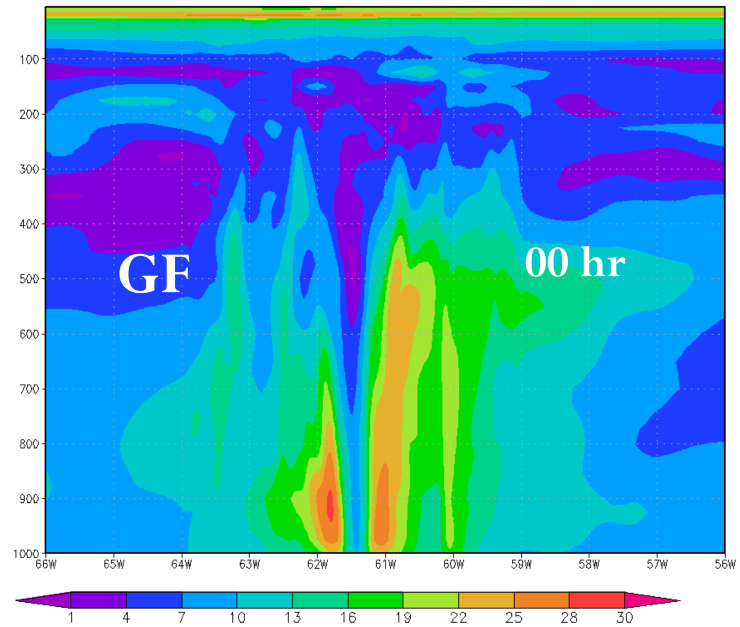


Differences in the intensity forecast can come from

1. **Initial conditions**
2. **Physics differences**
3. **Large scale environment**
4. **Storm scale environment**

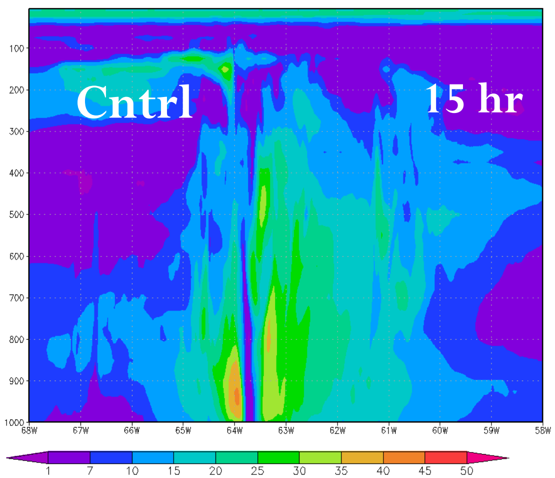
Wind analysis @ t=0

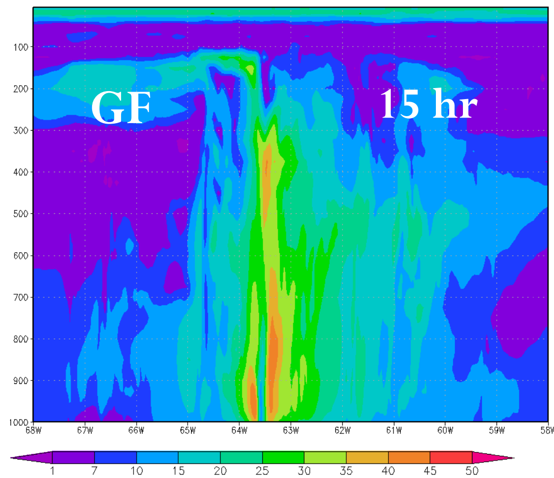




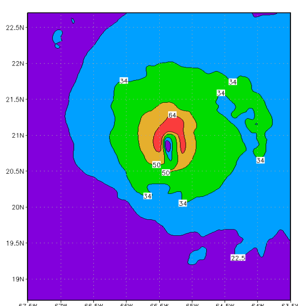
Wind structure is different at t=0, due to cycling

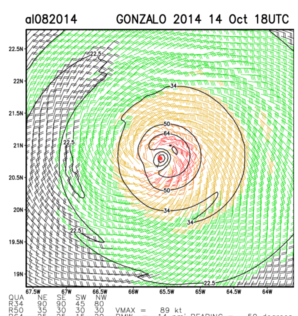
Wind forecast

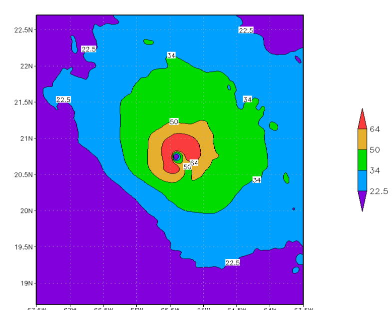




GF wind reach upper levels at t=15 h, when the intensities starts to diverge

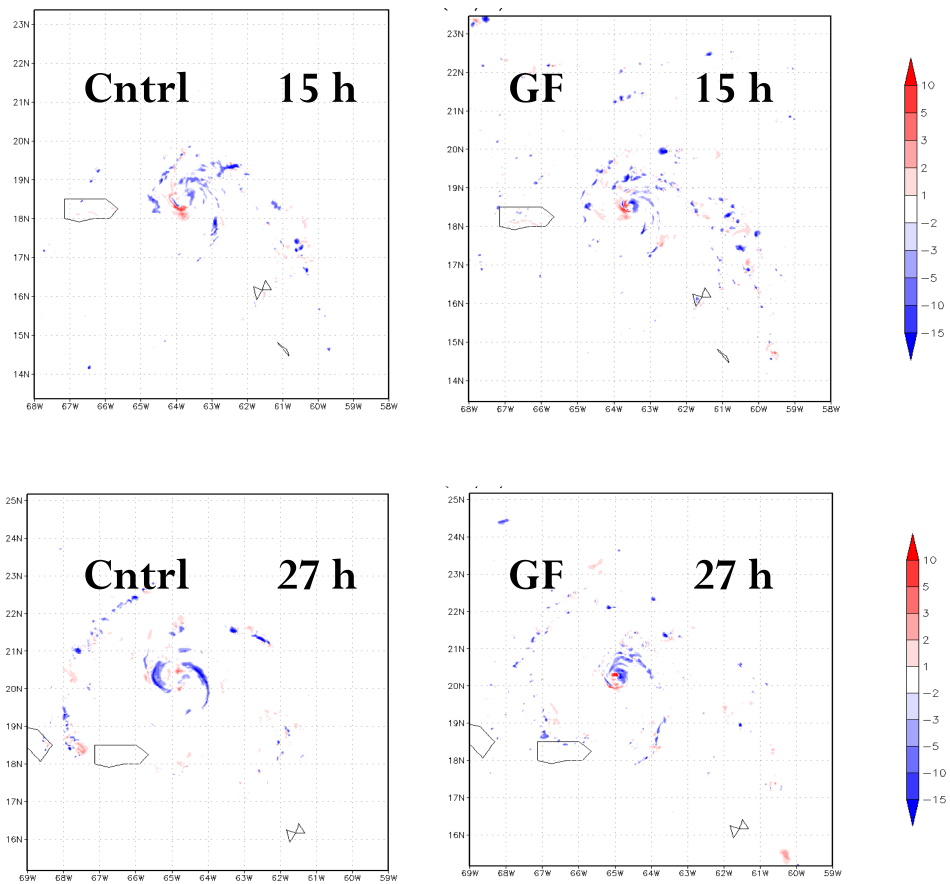






GF 10m wind pattern is axisymetric at the center and is favorable for intensification

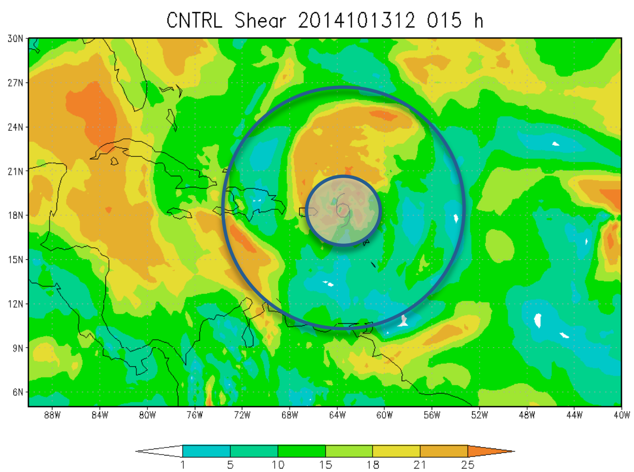
Vertical velocity

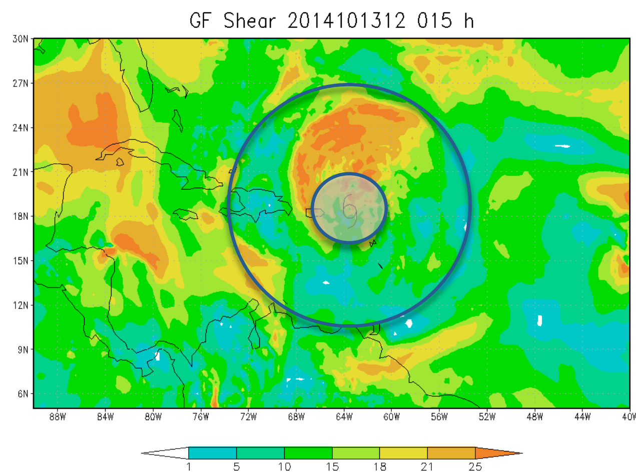


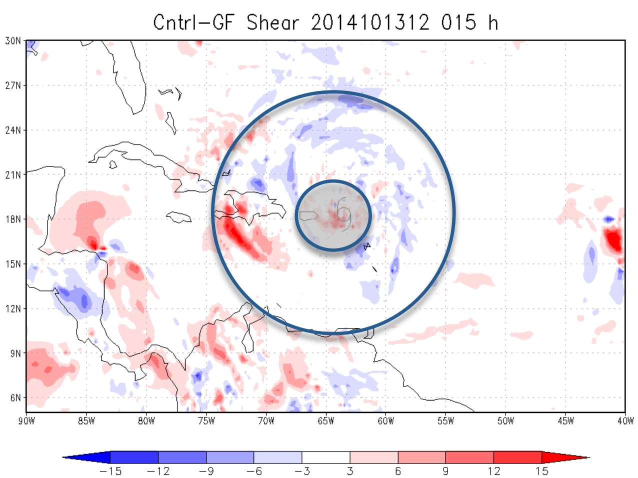
Vertically averaged vertical velocity for GF shows strong updrafts near the eye-wall region.

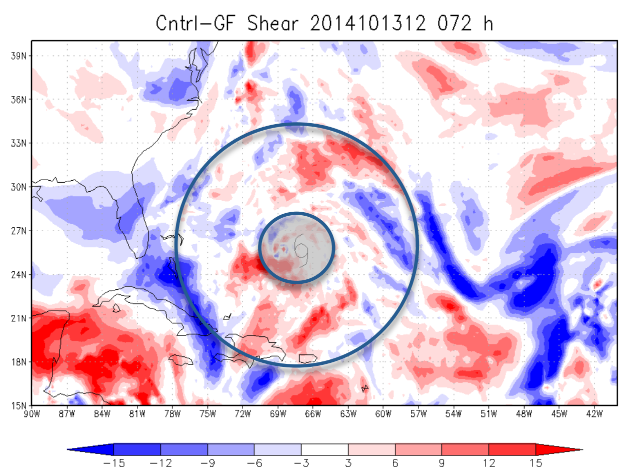
These vertical velocity contours show the location of the roots of the updraughts.

Wind shear





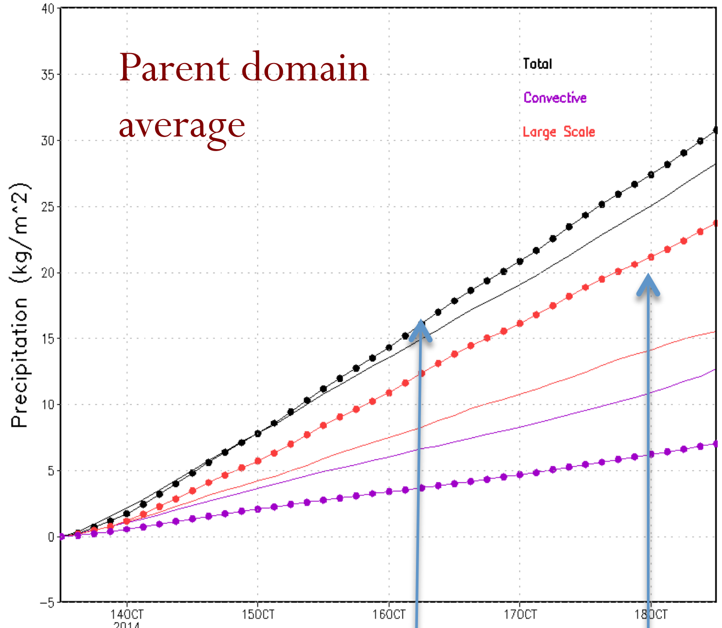




Shear differences shows increase in environmental shear for control at longer lead times

Precipitation

Time series of area averaged accumulated precipitation



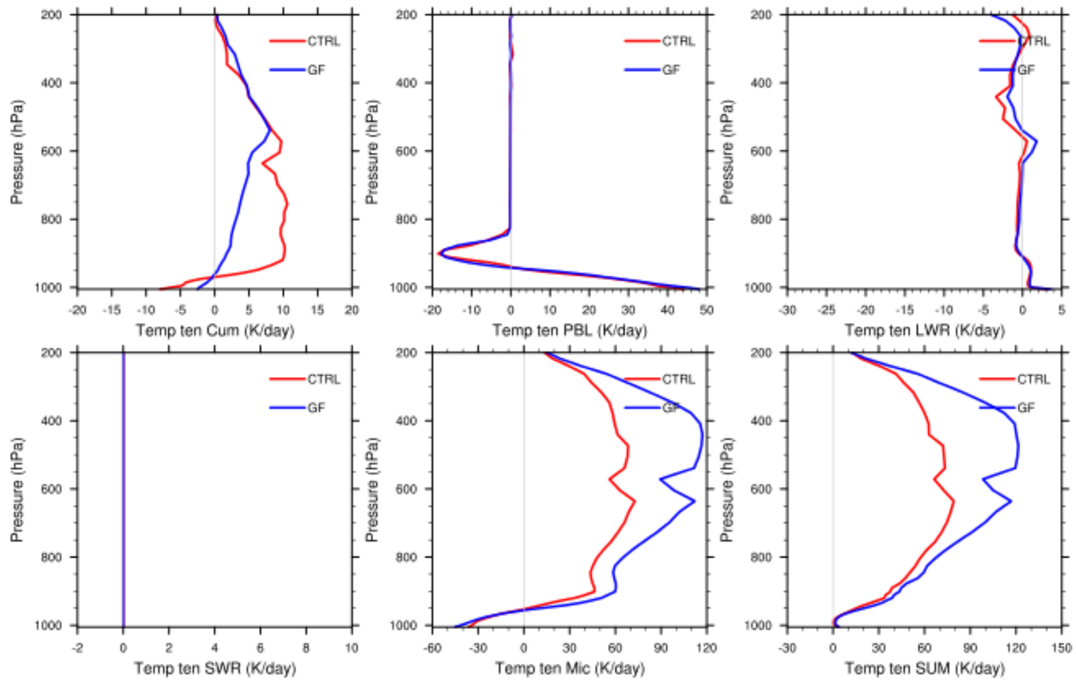
Closed circle - GF

Total precipitation
Grid scale precipitation
Convective precipitation

GF produces higher total precipitation than control

Large-scale precipitation higher than convective-scale in GF

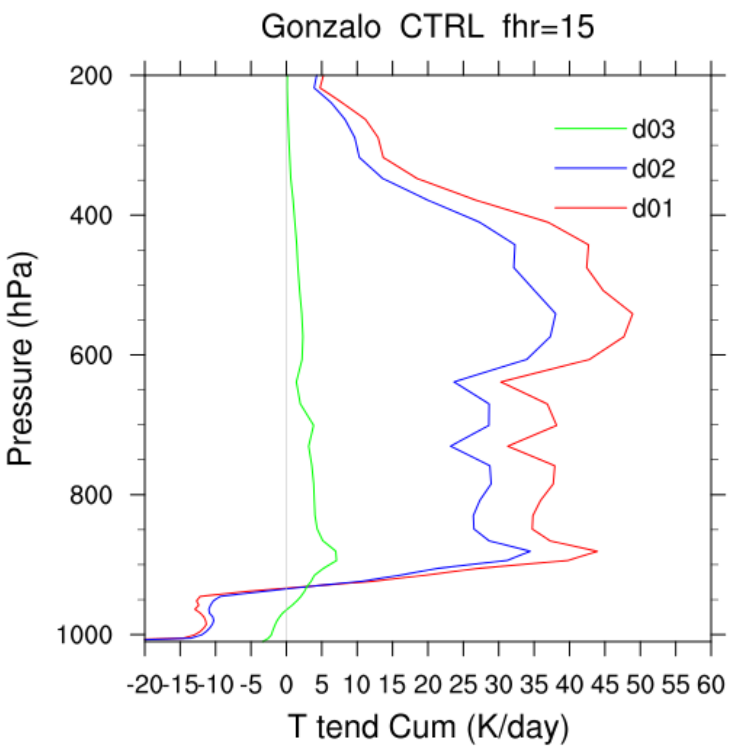
Temperature tendencies

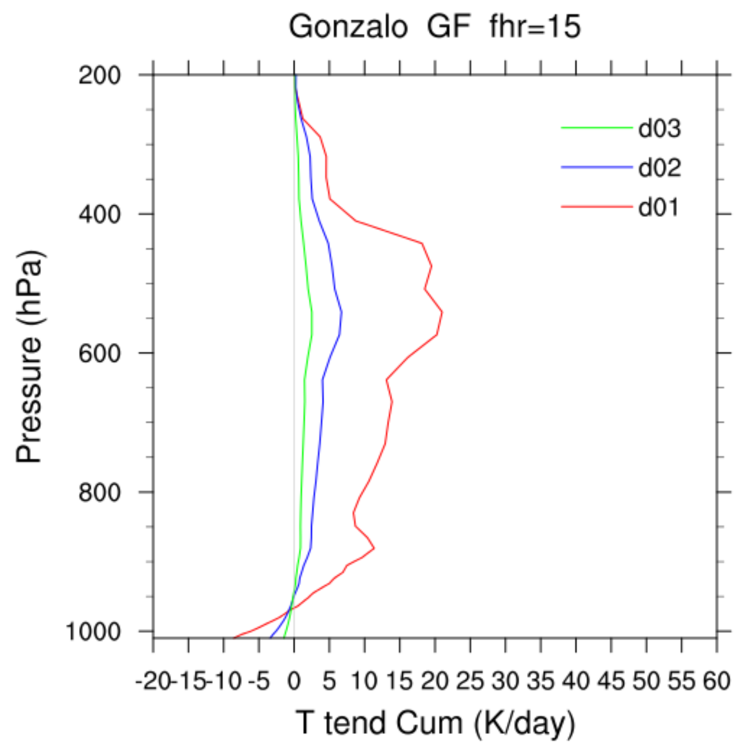


Temperature tendency from the convective scheme is higher for control

Temperature tendency from microphysics is higher for GF

Scale Awareness





Summary

- HWRF-GF reduced track errors at longer lead times
- HWRF-GF alleviates the negative intensity bias compared to control
- Lower wind shear in the HWRF-GF favored intensification
- Updrafts were absent in the eye-wall region for the HWRF-SASAS
- The grid-scale precipitation was higher than convective precipitation in the HWRF-GF run
  - Microphysics is more active in HWRF-GF scheme

DTC visitor program

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http://www.dtcenter.org/visitors/opportunity/