

HWRF testing at the DTC: quantification of  
environmental biases and impact of cumulus  
parameterizations on storm structure and intensity

**Ligia R Bernardet<sup>1,2</sup>**

**J. Vigh<sup>3</sup> and M. Biswas<sup>3</sup>**

In collaboration with

**Vijay Tallapragada<sup>4</sup> and Chanh Kieu<sup>4</sup>**

<sup>1</sup>NOAA/ESRL/GSD, <sup>2</sup>CIRES-CU

<sup>3</sup>National Center for Atmospheric Research

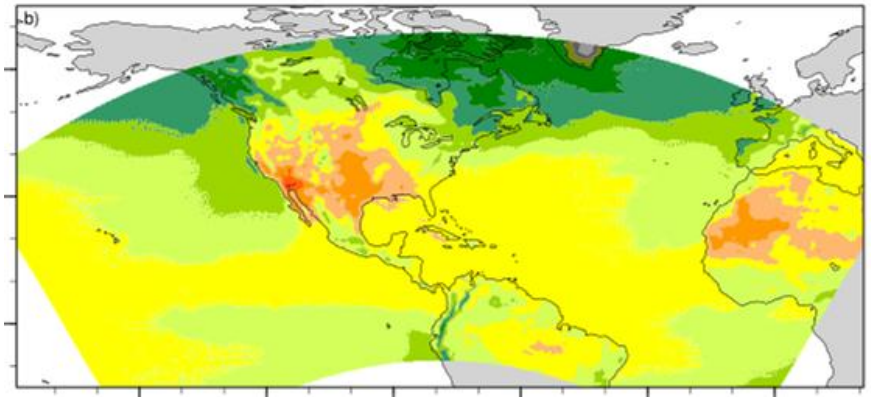
<sup>4</sup>NOAA/NCEP/EMC



# Topic 1: Analysis of HWRF Large Scale

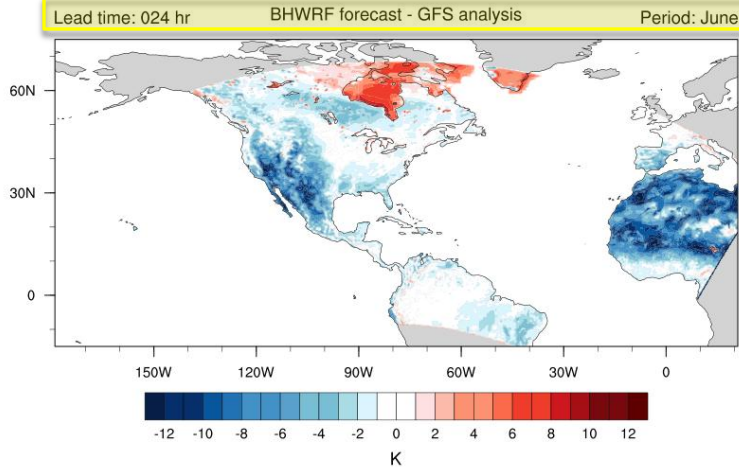
- NCEP, with HFIP/ESRL/HRD/DTC, is planning to implement a basinscale HWRF at  $\sim$  2015. Lots of development going on.
- DTC conducted analysis of the large scale fields from the baseline cold-started basin-scale HWRF to document systematic errors
- Results shown here are recent and further interpretation needed
- Would like your input in determining what is relevant investigating further, and what has strongest tie to TC behavior

489 retrospective cold-start HWRF runs for 2011 conducted by EMC were compared against GFS analysis (interpolated to HWRF grid)

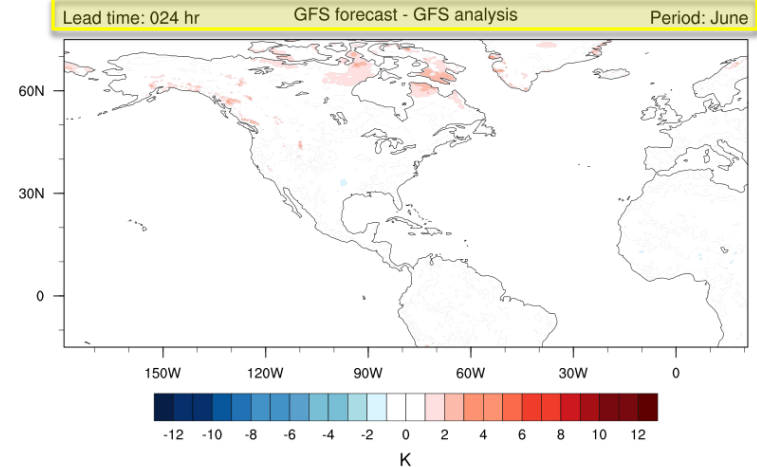


# Surface temperature – June 24h

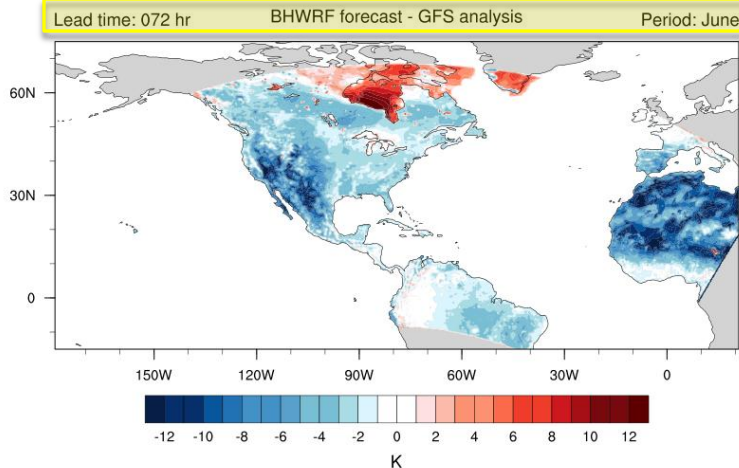
**BIAS Surface Temperature**



**BIAS Surface Temperature**



**BIAS Surface Temperature**



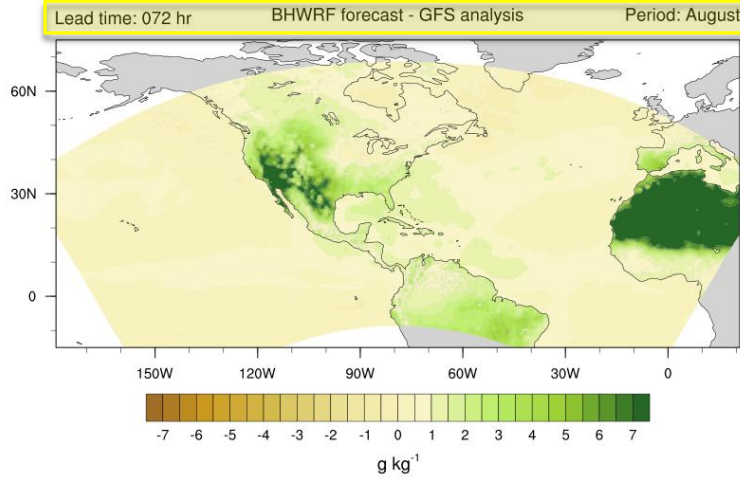
HWRf too warm over frozen ocean/lakes

HWRf has trouble representing inland ice, which creates warm bias over frozen areas (only in June)

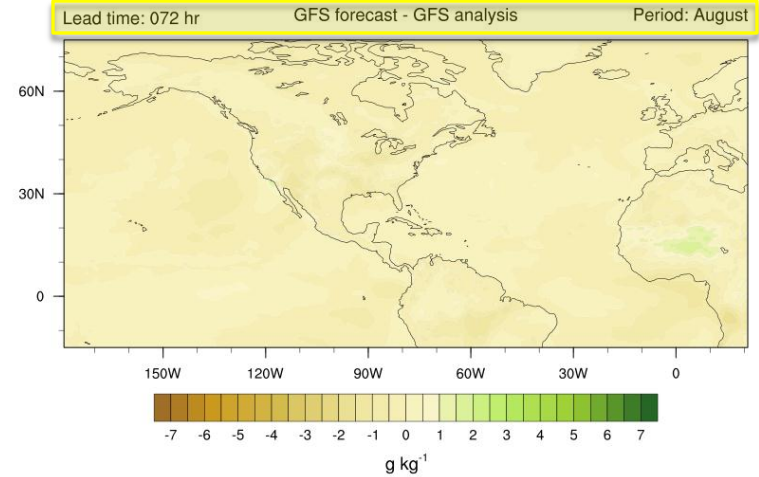
HWRf too cold over dry continental areas

# 2-m specific humidity – Aug 72h

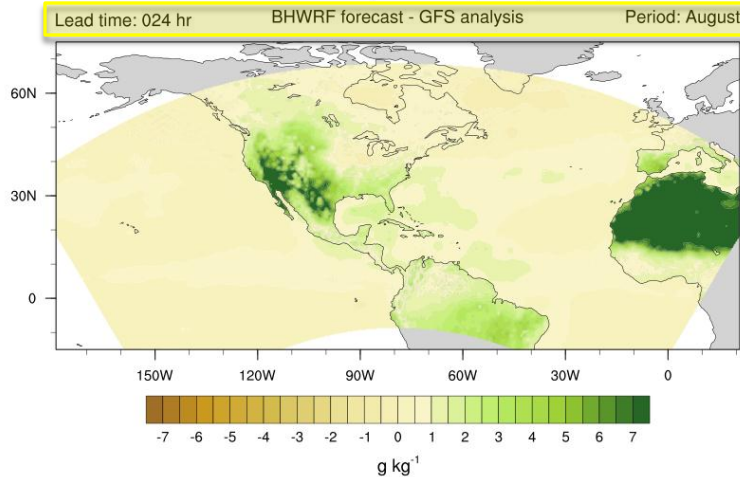
**BIAS 2-m Specific Humidity**



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**BIAS 2-m Specific Humidity**



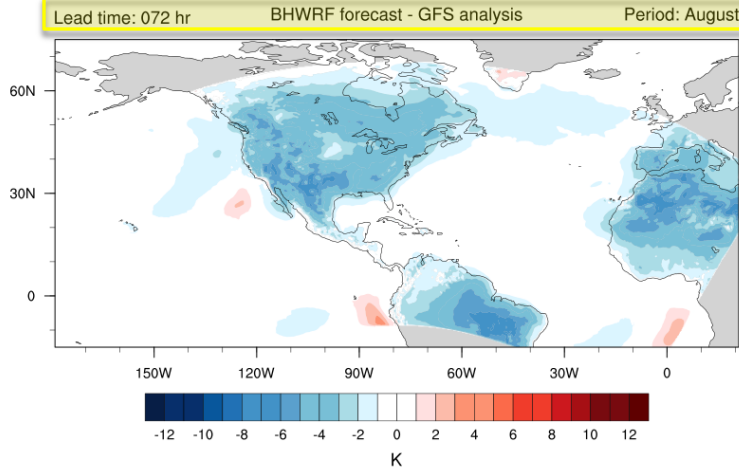
HWRf has wet biases at 2-m over dry areas

GFS does not have this bias

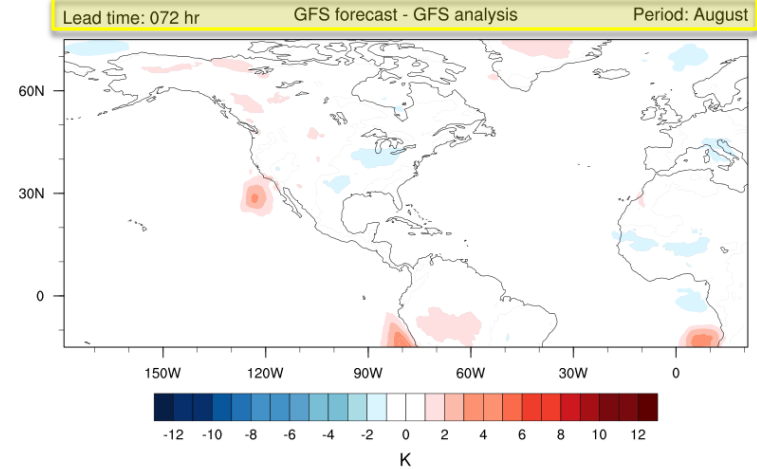
Bias already present at 24-h forecast  
remains in time

# 925/700 hPa temp - Aug 72h

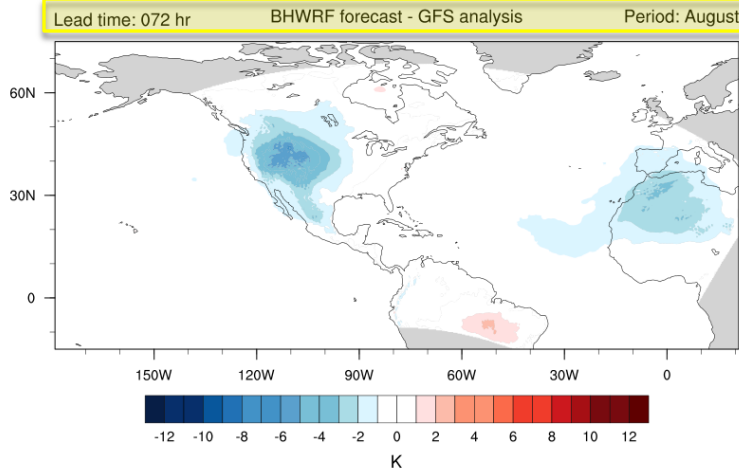
**BIAS 925-hPa Temperature**



**BIAS 925-hPa Temperature**



**BIAS 700-hPa Temperature**



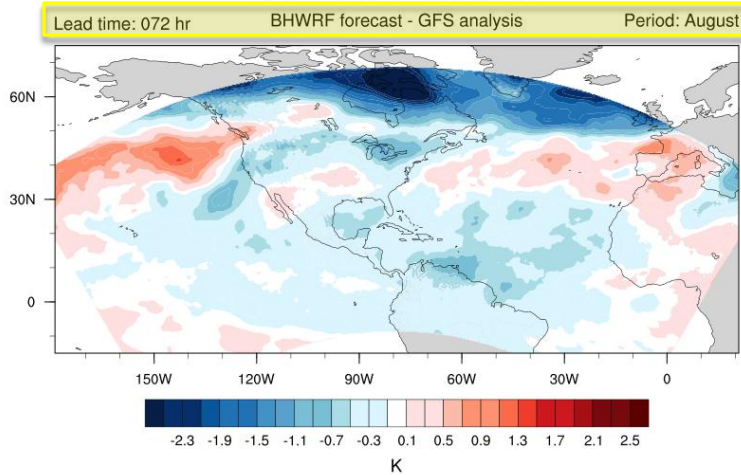
HWRF has low level cold biases not present in GFS

Over Brazil, low level cold bias translates onto warm bias at 700 hPa.  
Could radiation or moist physics be placing heat at incorrect level?

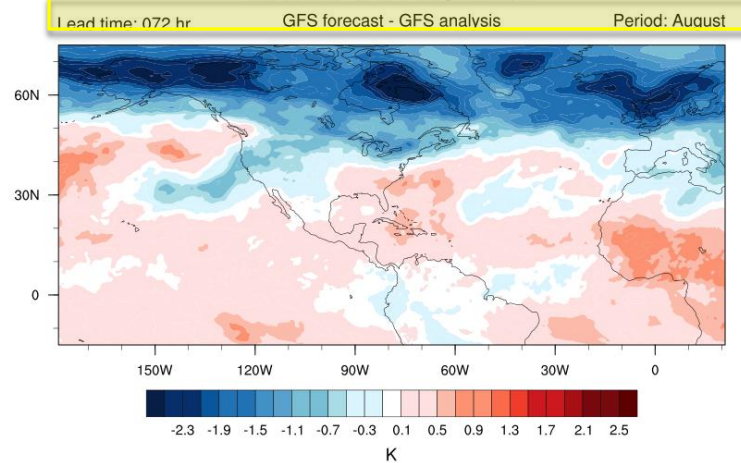
Lack of stratocumulus over CA & Peru? In GFS too

# 200/250 hPa temp - Aug 72h

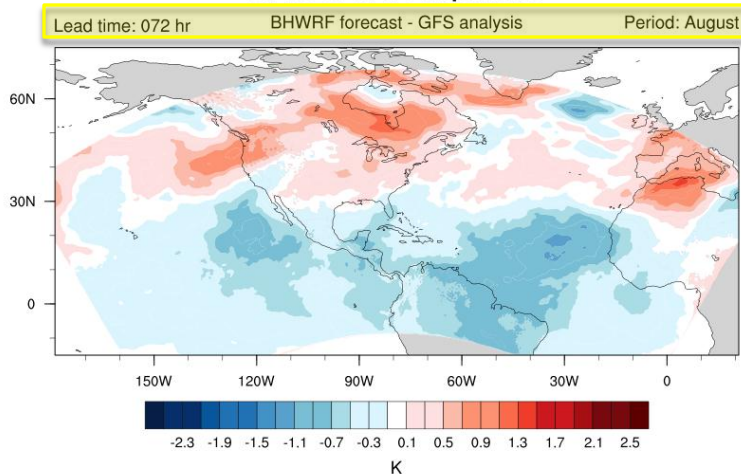
### BIAS 200-hPa Temperature



### BIAS 200-hPa Temperature



### BIAS 250-hPa Temperature



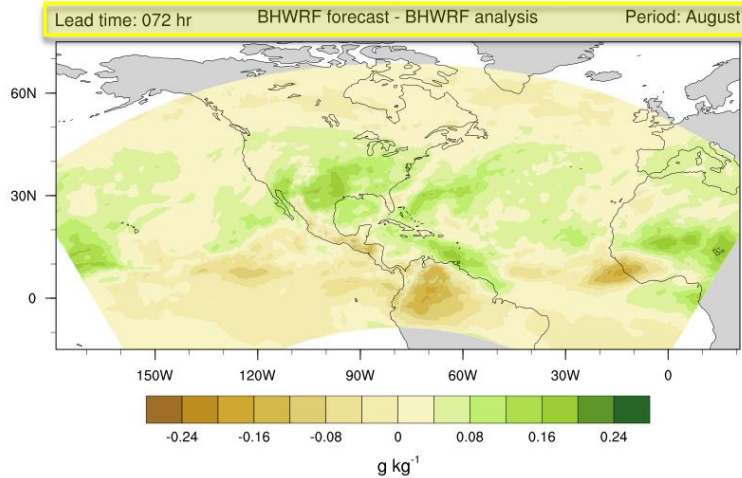
HWRF has warm biases at high latitudes in N Hem at 250 hPa, which change to cold bias at 200 hPa

Similar bias present in GFS

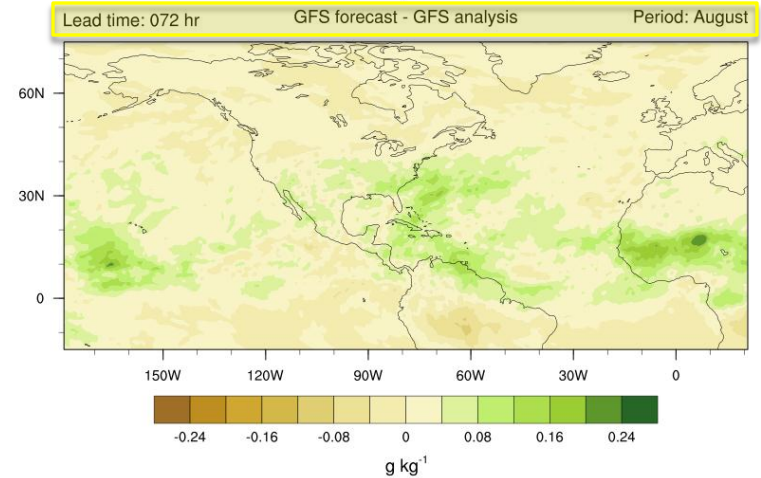
Bias grows with forecast lead time

# 300 hPa spec humidity – Aug 72h

**BIAS 300-hPa Specific Humidity**



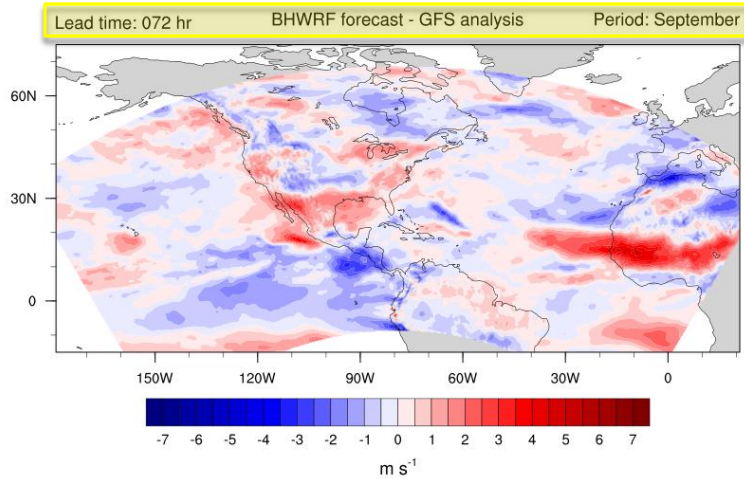
**BIAS 300-hPa Specific Humidity**



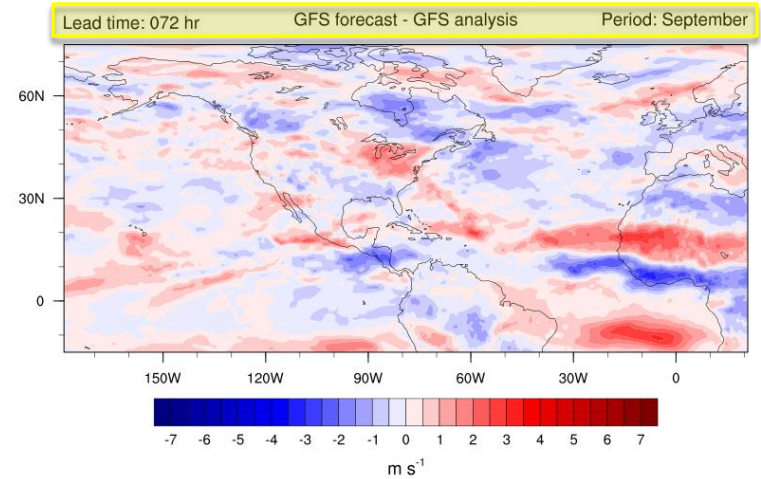
HWRf is dry at upper levels on the equator

# 600 hPa zonal wind – Sep 72 h

**BIAS 600-hPa Zonal Wind Speed**



**BIAS 600-hPa Zonal Wind Speed**

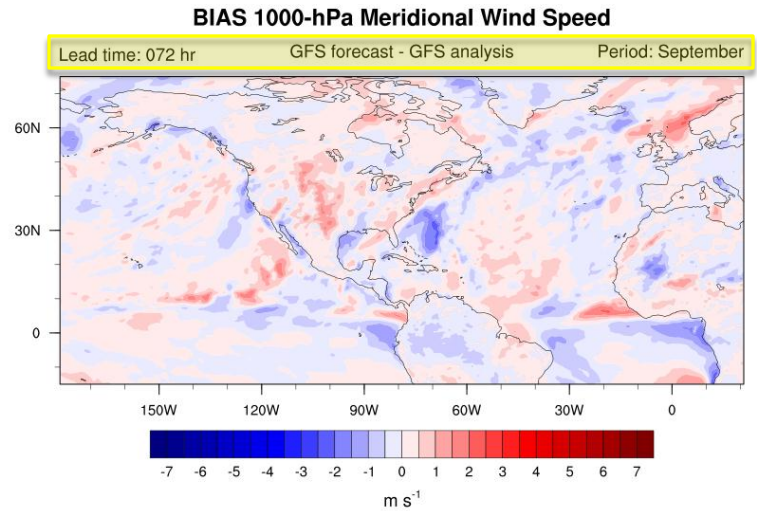
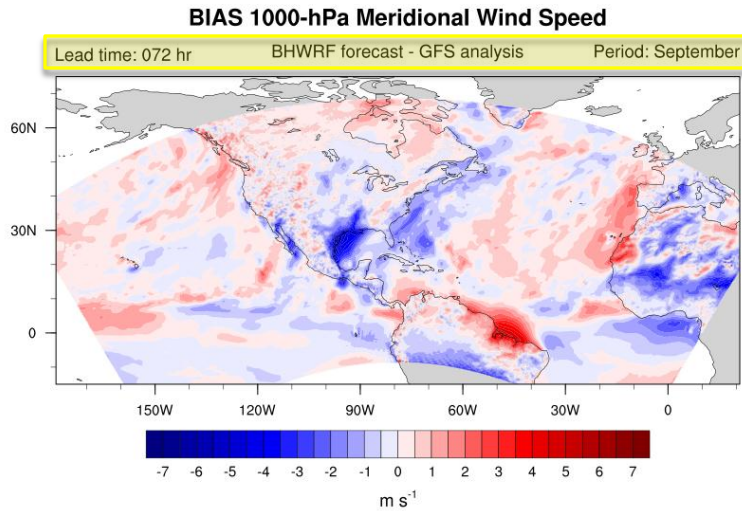


African jet too strong in HWRF

In GFS jet displaced to south



# 1000 hPa winds – Sep 72 h



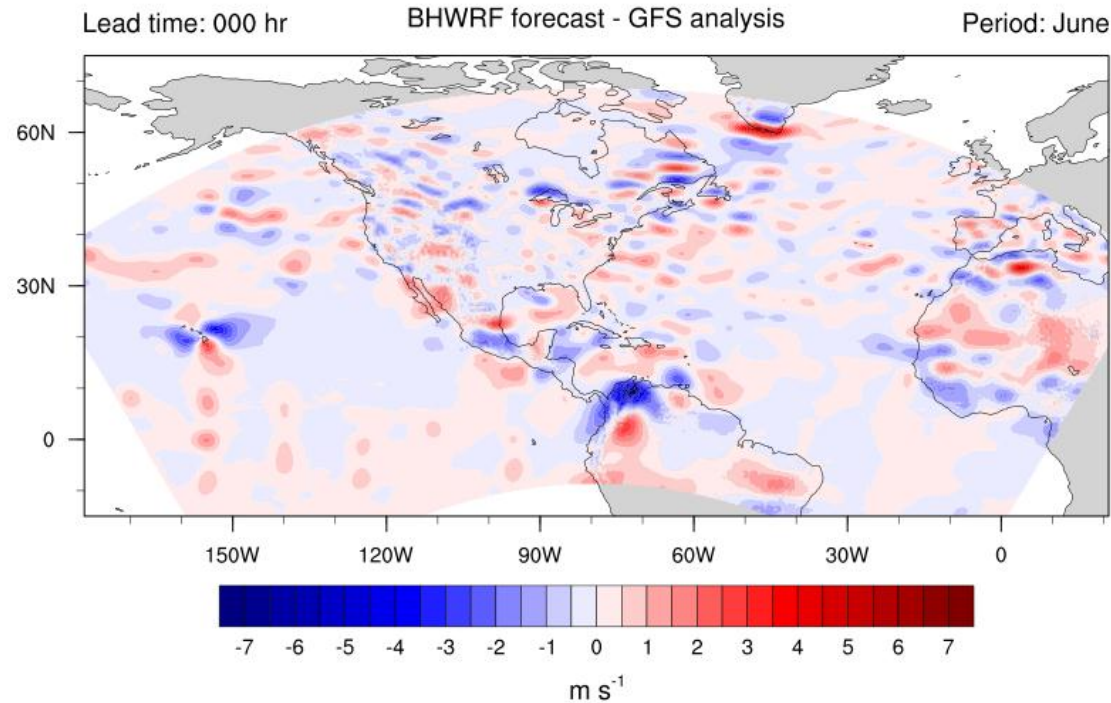
Large northerly bias in western Gulf of Mexico – onshore flow too weak

Substantial positive wind speed bias near Amazon River outlet– trade easterlies too weak?

Bias not present in GFS

# 850-hPa zonal wind – June 00h

## BIAS 850-hPa Zonal Wind Speed



Initial wind fields have noise near high topography

# Topic 2: Cu parameterization testing

follow-up from the 2011 HFIP Regional Team meeting and subsequent telecons

- Increase HWRF's ability to use alternate physics
- Evaluate sensitivity of HWRF to cumulus parameterization

Acronym	Scheme
HPHY	HWRF SAS (no shallow convection)
HNSA	SAS implemented by YSU (with shallow convection)
HTDK	Tiedtke
HKF1	Kain Fritsh

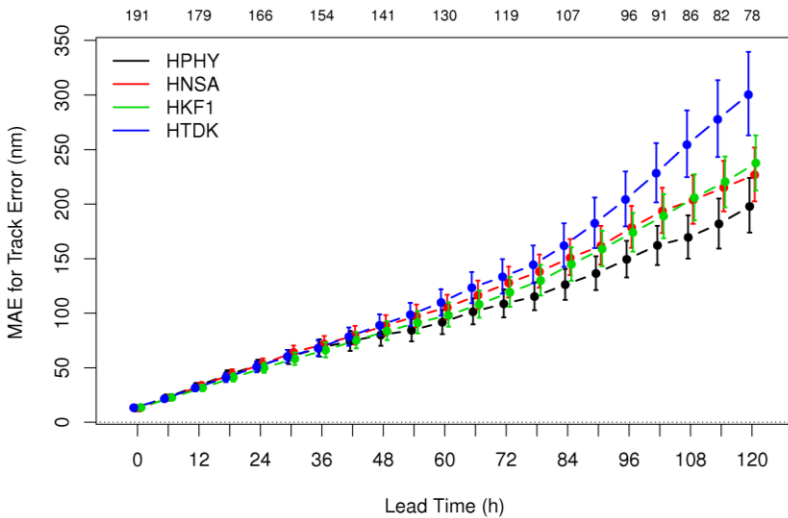
Runs used HWRF 2012 pre-implementation code as of Feb 2012 (27/9/3 km)



# Track and Intensity Errors Atlantic Basin

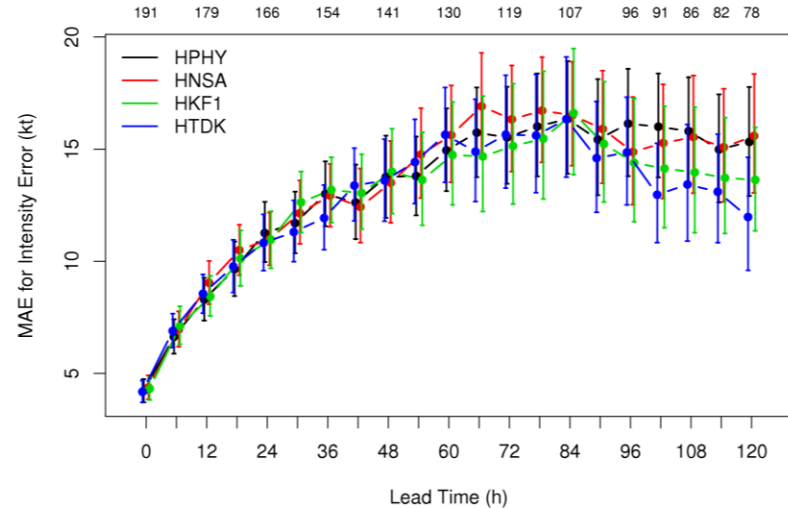
MAE for Track Error

2011: 08L(14),09L(32),12L(47),14L(36),16L(42),18L(20)



MAE for Intensity Error

2011: 08L(14),09L(32),12L(47),14L(36),16L(42),18L(20)



## Track

	12	24	36	48	60	72	84	96	108	120
HNSA										
HKF1										
HTDK										

## Intensity

	12	24	36	48	60	72	84	96	108	120
HNSA										
HKF1										
HTDK										

Statistical  
Significance

95%

Green = HPHY

better

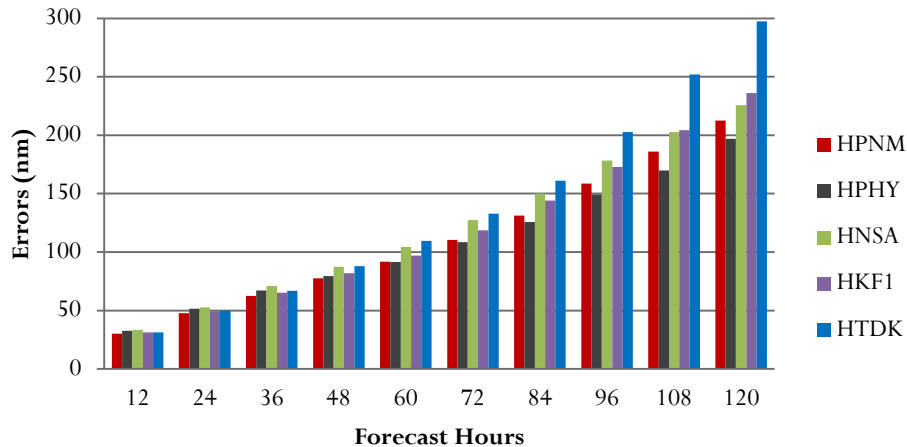
Red = HPHY

worse



# HWRF Mini-Ensemble (HPMN)

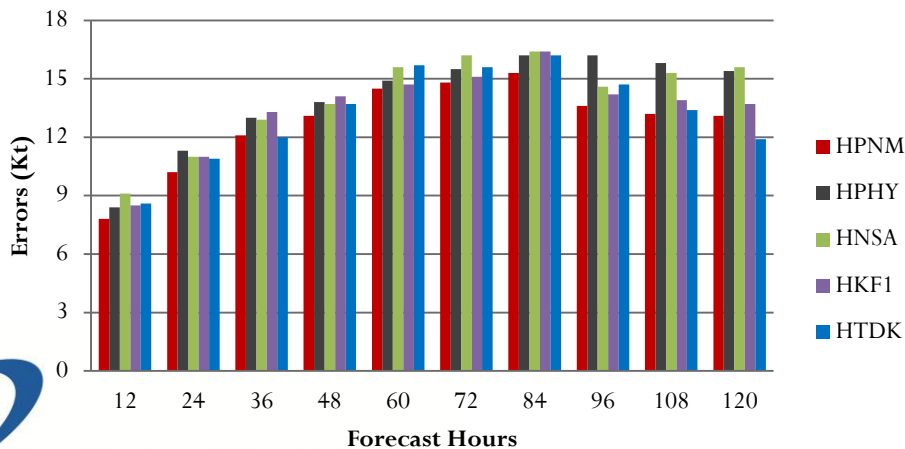
## Track Errors Atlantic



HPHY performs best for track.

HPMN suffers from high Tiedtke errors.

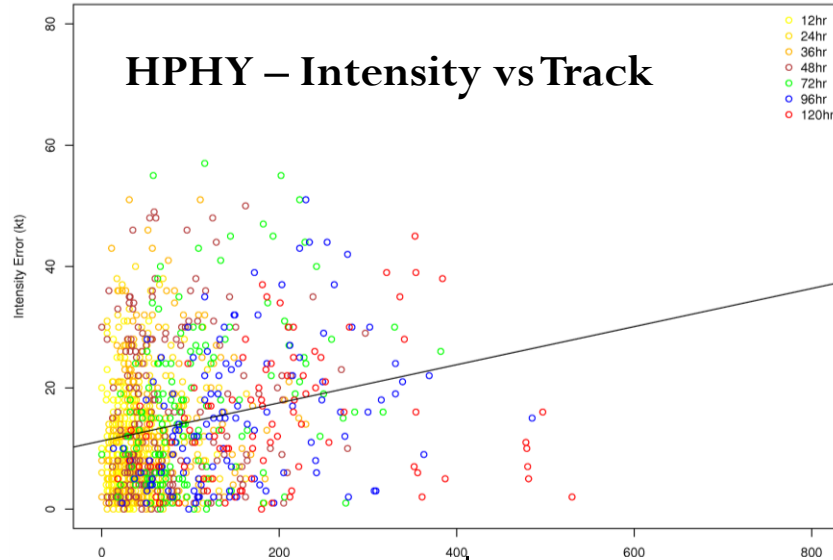
## Intensity Errors Atlantic



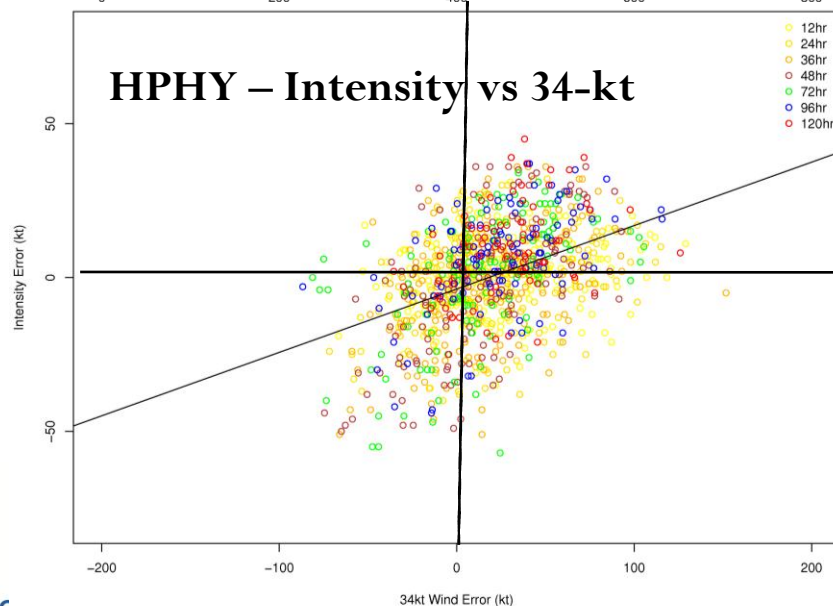
HPMN outperforms HPHY at all lead times — not tested for SS



# Error Correlation (by lead time)



No definite relationship, except good correlation between track error and forecast lead time

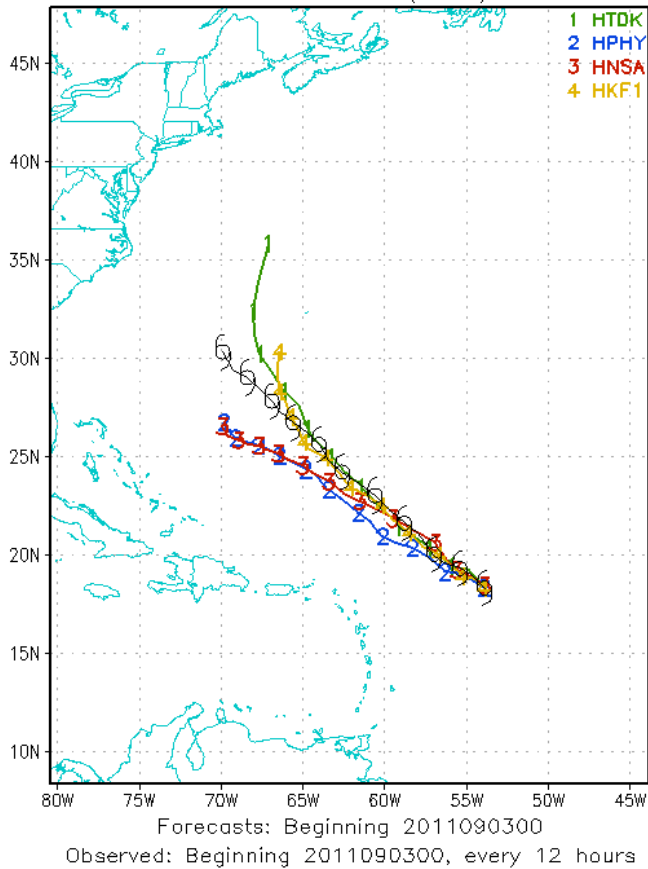


- Weak relationship between structure and intensity error
- In general, larger storms too intense, smaller storms too weak

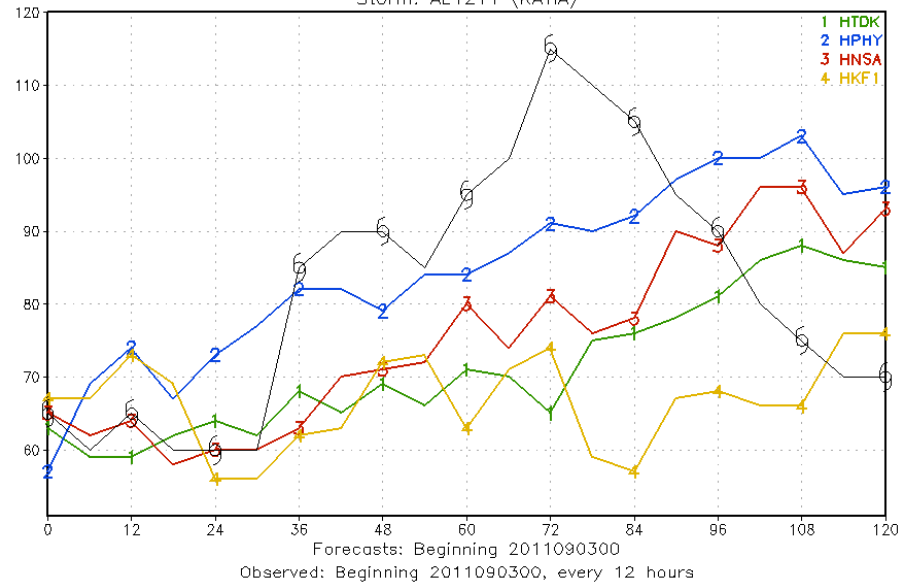
Similar for other schemes

# Case study for Katia 2011090300

2011 Tropical Cyclone Tracks  
Storm: AL1211 (KATIA)

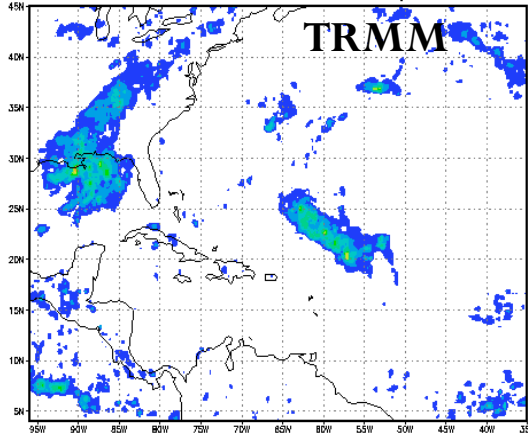


2011 Tropical Cyclone Intensity  
Storm: AL1211 (KATIA)

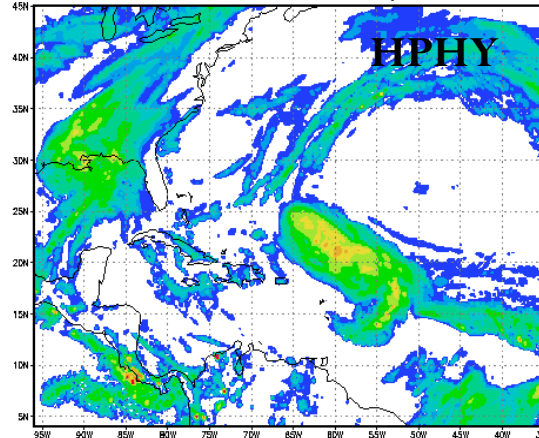


# Large scale precipitation 72 h forec

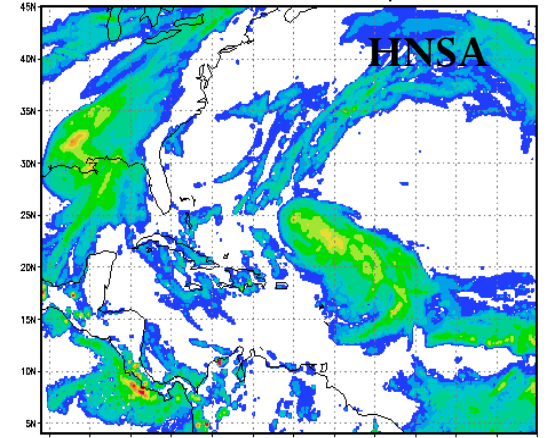
TRMM Katia 072hr INIT 00Z03Sep2011



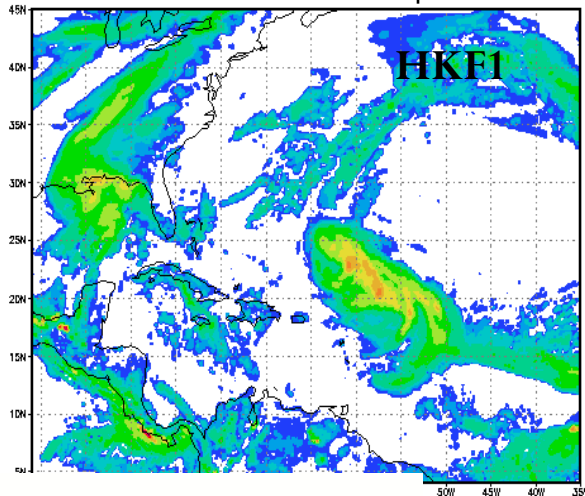
HPHY Katia 072hr 00Z03Sep2011



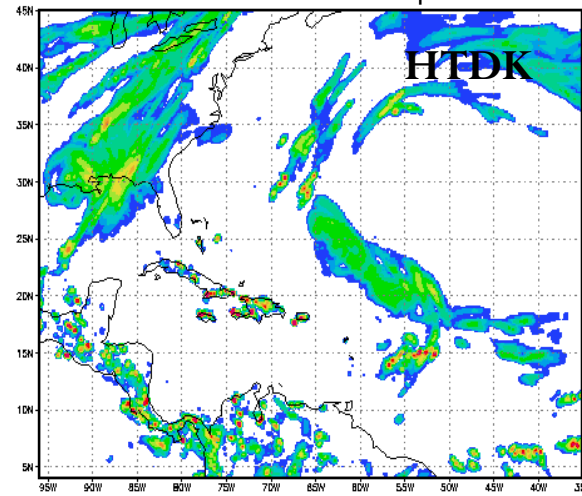
HNSA Katia 072hr 00Z03Sep2011



HKF1 Katia 072hr 00Z03Sep2011



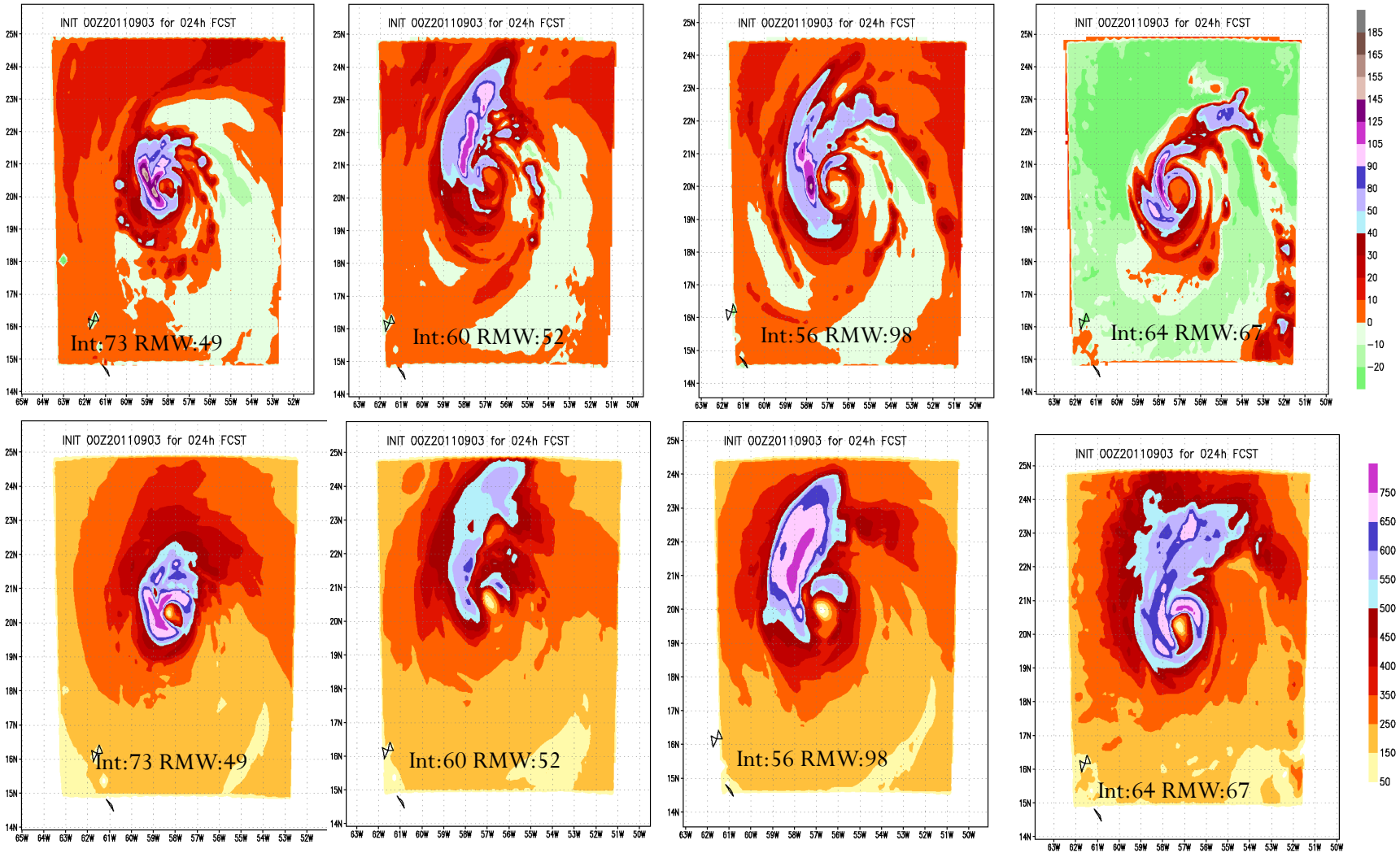
HTDK Katia 072hr 00Z03Sep2011



All schemes overdo precip



# Fluxes at 24h (W/m<sup>2</sup>): SENS (top), LAT (bottom)



Large variability in spatial distribution depending on cumulus schemes

# Last comments

- Need to do further work to interpret large scale biases
- Large scale evaluation should be repeated with cycled-DA basinscale HWRF to see if environment is improved
- Possible that some of these bias are also present in op HWRF
- Follow up work we will consider conducting
  - Investigation of interpolation of fields from GFS to HWRF
  - Look at representation of inland ice
  - Consider alternate Land Surface Model
- Large sensitivity to cumulus deserves continued exploration
- DTC will continue to facilitate access to the code and avenue for developers to contribute code – feedback appreciated!

