HFIP Physics in AHW Part 2

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Analysis physics

- Track error may be due to analysis biases in data void Atlantic
- Made effort prior to 2011 changes to reduce large-scale biases
- The main result of this effort was changing to the Tiedtke cumulus scheme from Kain-Fritsch
- Tiedtke scheme has more shallow convection reducing warm dry bias in lower troposphere

Changes for 2011

- Remove the 1.33 km domain for operational timeliness
- Physics same (YSU, Garratt, Donelan, Ocean Mixed Layer, Noah LSM, RRTM LW, Goddard SW) except
  - Upgrade to V3.3
  - Change from Thompson to WSM6 for consistency with DA system
    - DA 36 km domain has time step too long for V3.3 Thompson
    - WSM6 is also a graupel scheme (like Thompson)
  - Change from KF to Tiedtke cumulus on 36/12 domains
    - Shallow convection needed

Changes for 2011

- DA system in 2011
  - 96 members at 36 km with 6 hr cycle
  - Deterministic 12/4 km 5-day run for each active storm every 6 hrs for semi-operational delivery
  - 15 ensemble 12/4 and deterministic 12/4/1.33 for storm of interest every 6 hrs
  - Change from KF to Tiedtke cumulus parameterization for 36/12 km domains
    - Shallow convection helps with Atlantic low-level larger-scale analysis biases

Tiedtke Cumulus Scheme

U. Hawaii version (Yuqing Wang)

- Mass-flux scheme
- CAPE-removal time scale closure
- Includes cloud and ice detrainment
- Includes mass-flux shallow convection
- Includes momentum transport
- New in V3.3

WSM6 microphysics

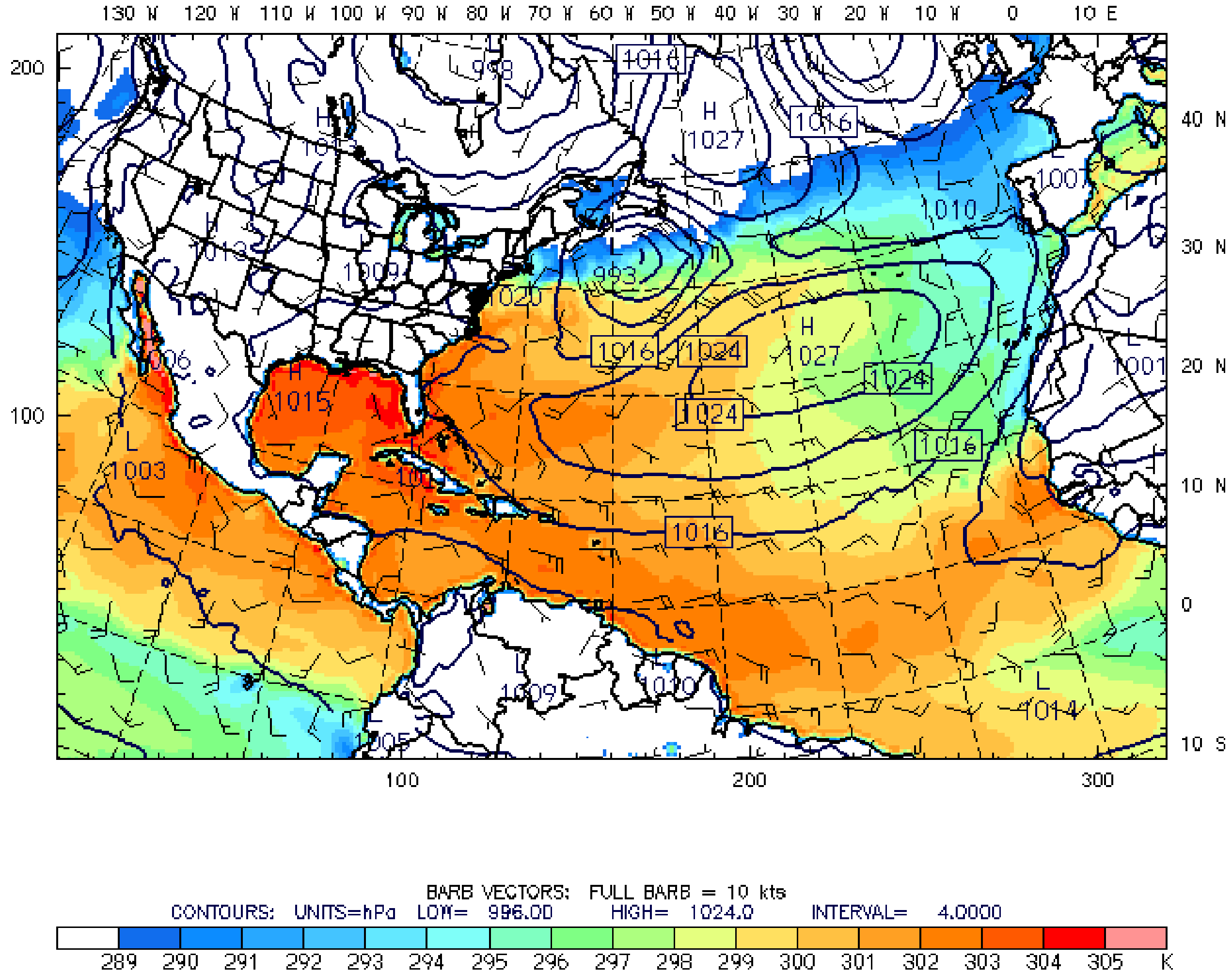
- Hong and Lim (2006)
- Ice crystal number concentration parameterized in terms of ice mass (Hong, Dudhia and Lim 2004)
- Adds graupel to WSM5 scheme
- Lagrangian fallspeeds (not time-split)
- Combined snow/graupel fallspeed to represent gradual riming (Dudhia , Hong and Lim 2008)

36km EM-WRF -- NCAR/MMM for TC
Fcst: 42 h

Init: 00 UTC Thu 04 Aug 11
Valid: 18 UTC Fri 05 Aug 11 (12 MDT Fri 05 Aug 11)

Ground/sea-surface temperature sm= 4
Sea-level pressure sm= 2
<U10,V10> Vectors

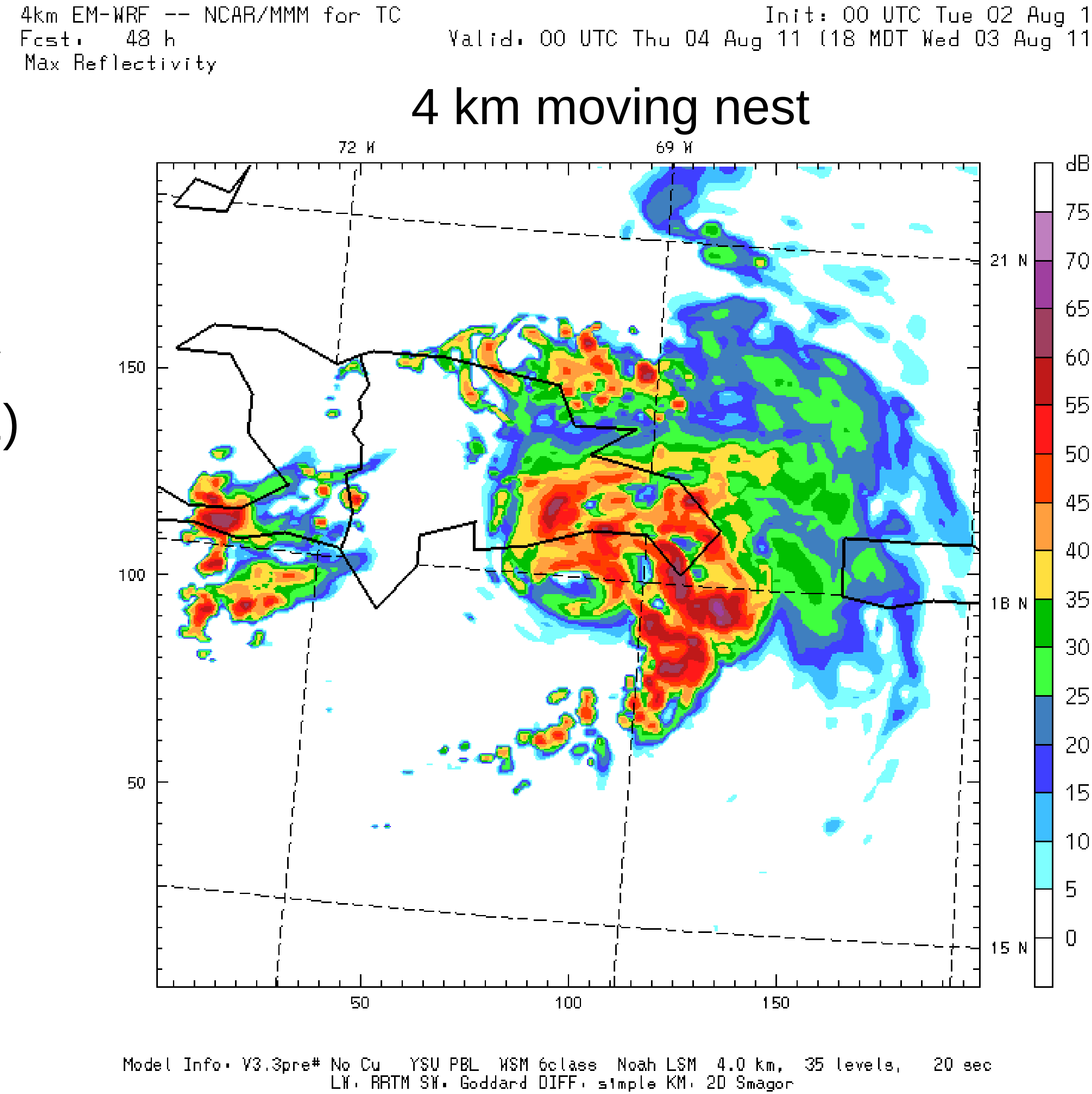
36 km fixed domain



Model Info: V3.3pre#1 M YSU PBL WSM 6class Noah LSM 36 km, 35 levels, 180 sec
LW: RRTM SW: Goddard DIFF: simple KM: 2D Smagor

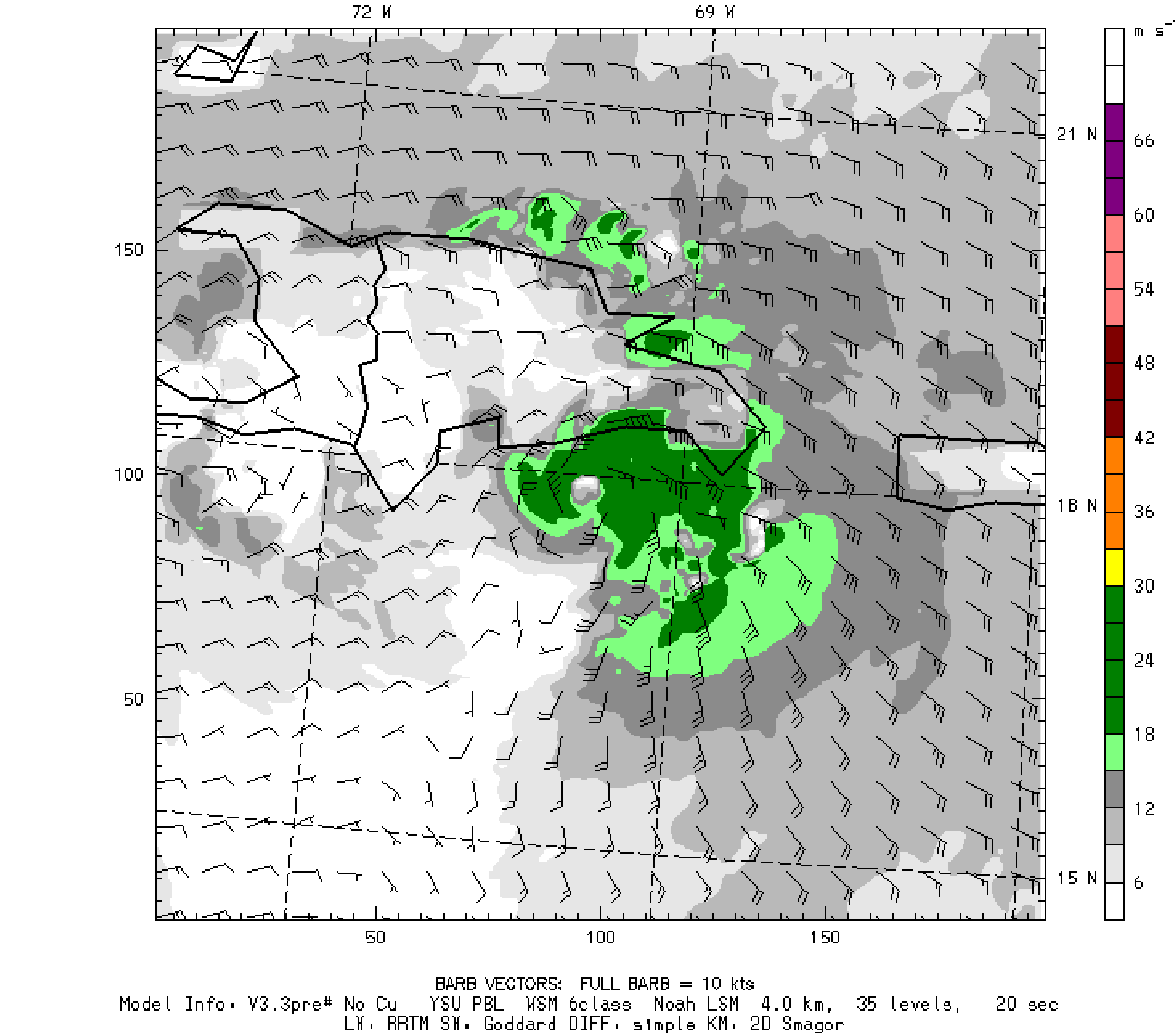
4 km moving nest

Emily (2011)



4 km moving nest

Emily (2011)

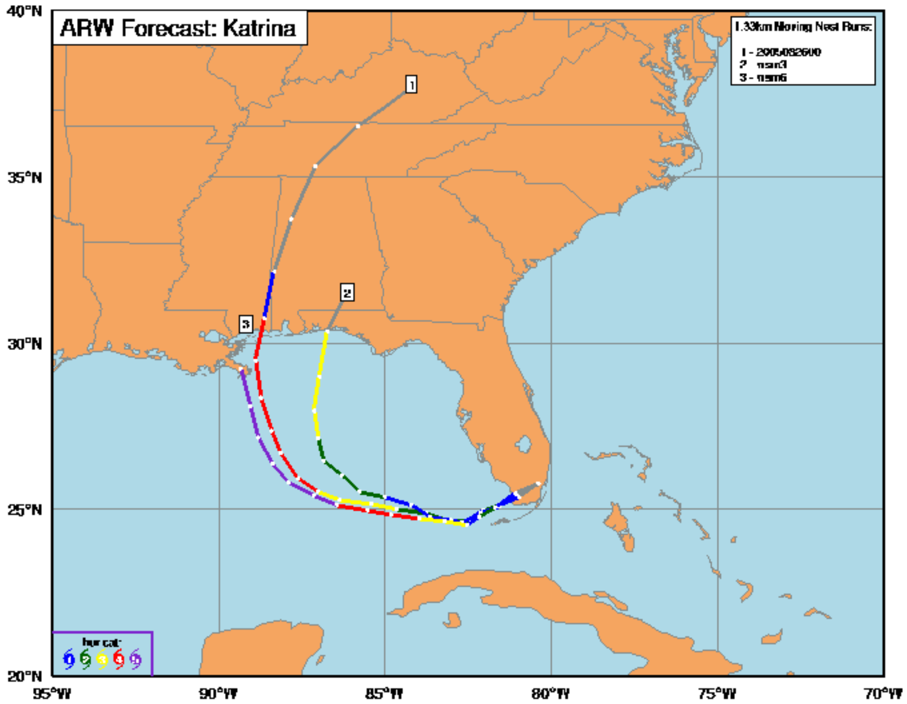


Microphysics Sensitivity

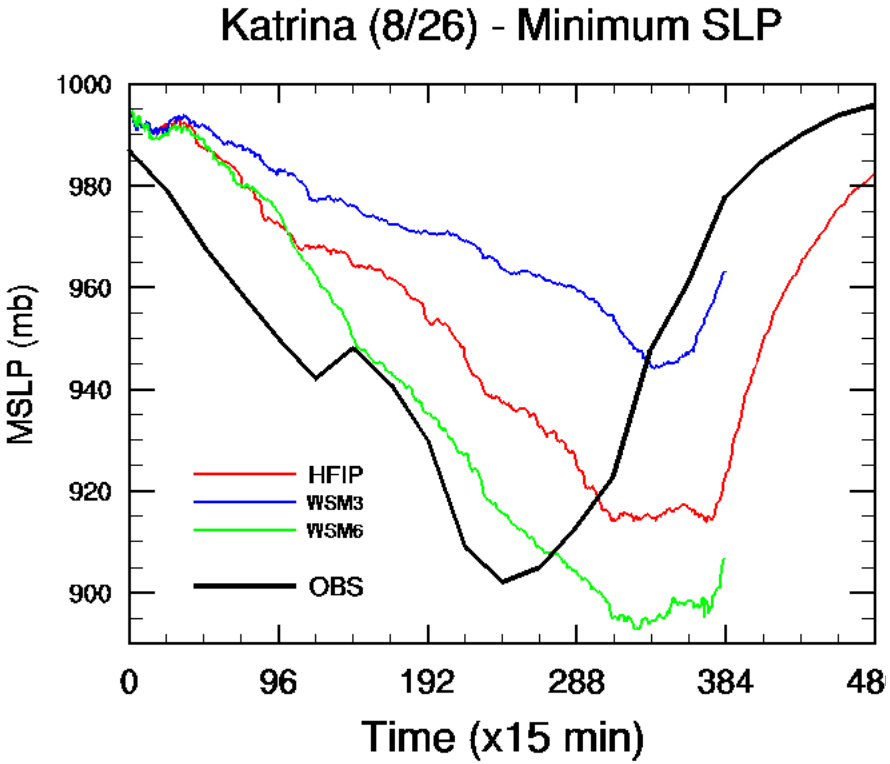
- WSM3
  - simple ice scheme, no supecooled water, instant snowmelt at freezing level
- WSM5
  - Allows supercooled water and gradual snowmelt
- WSM6
  - Adds graupel

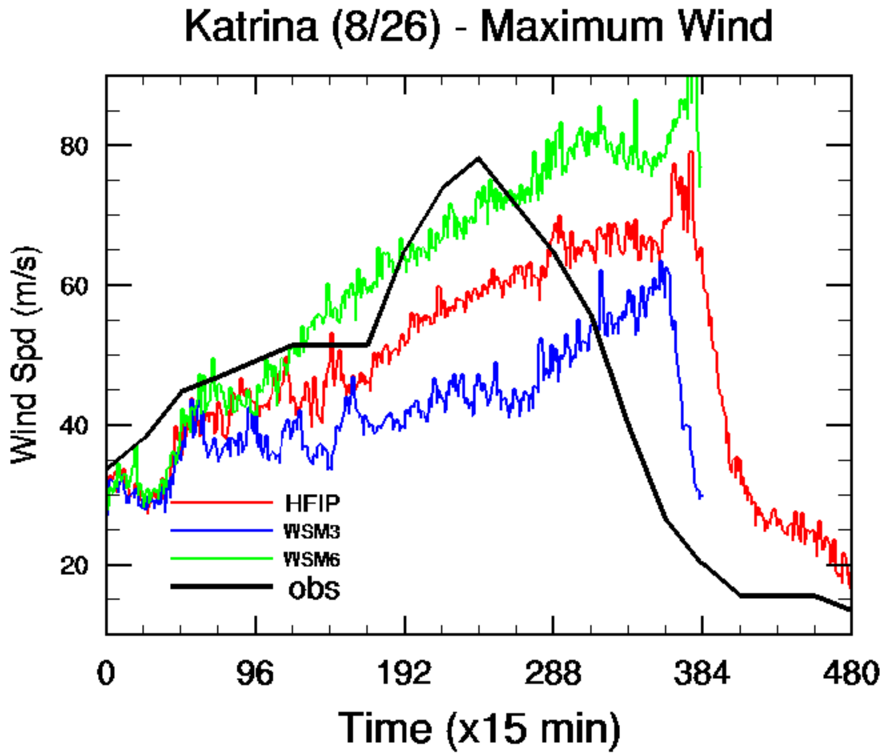
Katrina (2005) Microphysics Comparison

- Initialized August 26th (EnKF)
- GFS forecast boundaries
- 12/4/1.33 km moving nests
- 96 hours
- WSM5 default versus WSM3 and WSM6



Microphysics Comparison





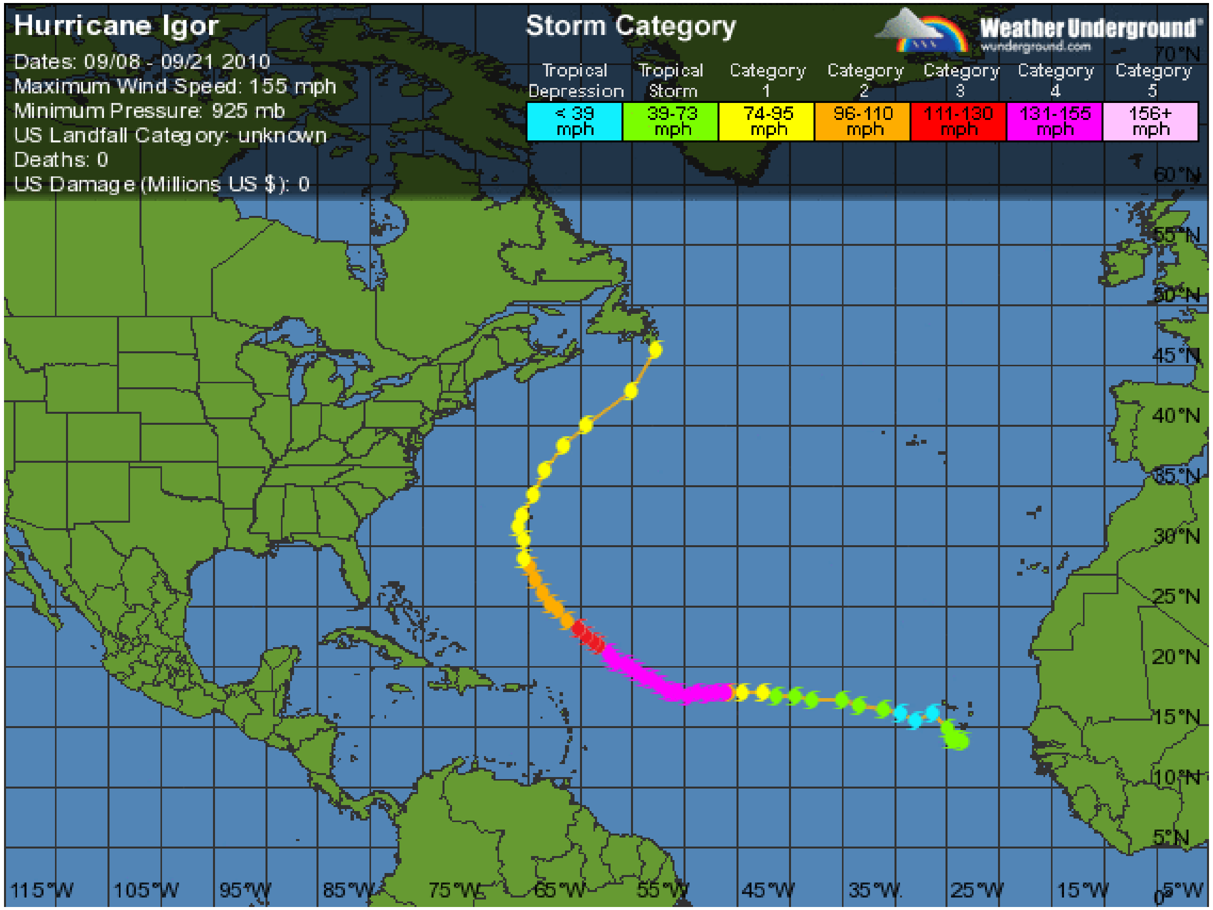
Microphysics Sensitivity

- Supports Bryan and Rotunno idea that higher fall speed leads to less loading, lower hydrostatic pressure and more intensity
- Implies that graupel-type microphysics schemes will intensify storms more

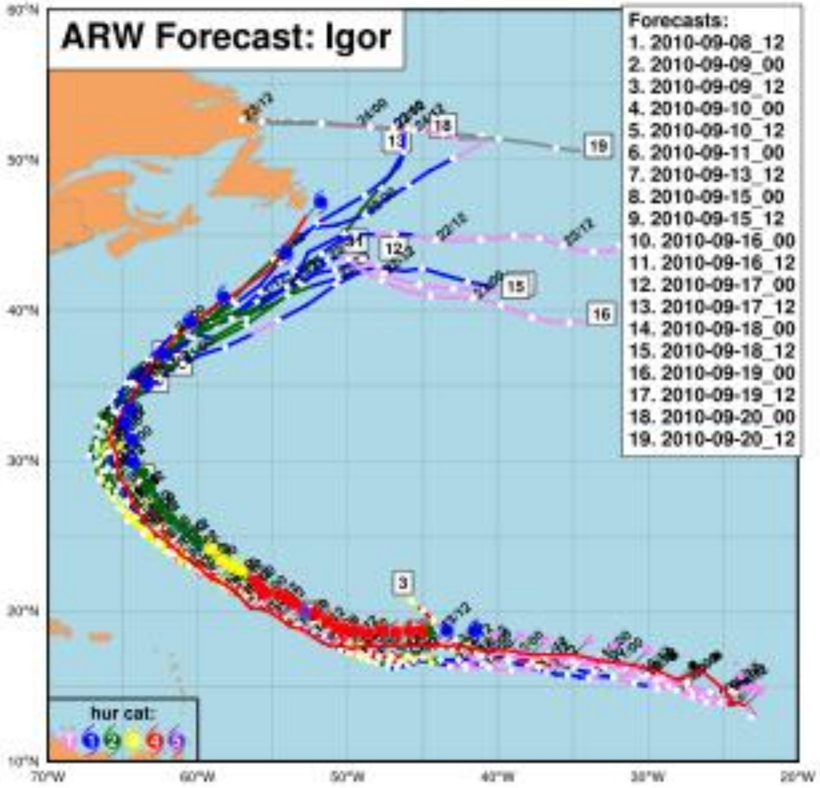
Hurricane Igor (2010)

- Example of AHW showing rapid intensification and storm details including an eyewall replacement cycle

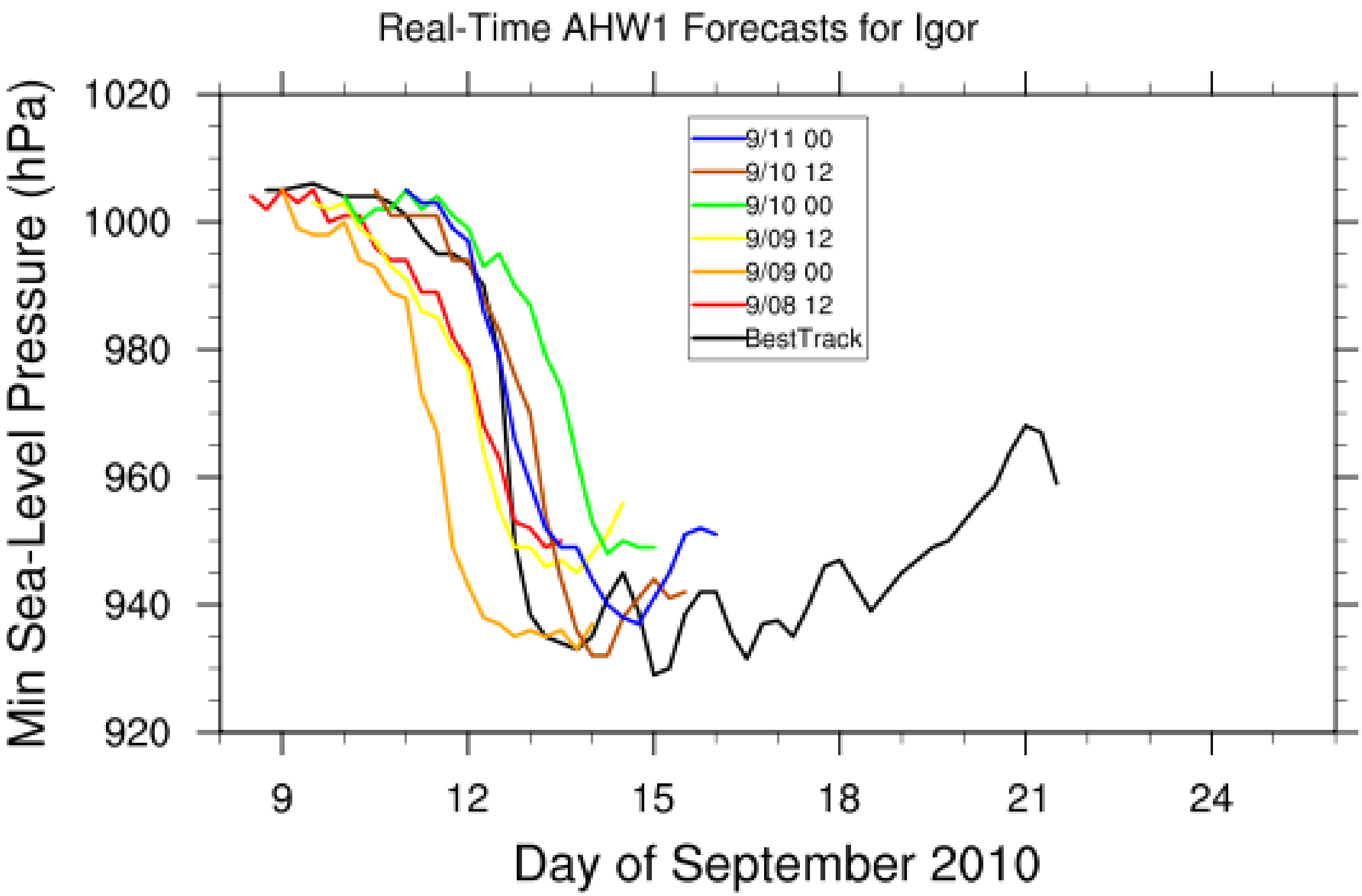
Hurricane Igor



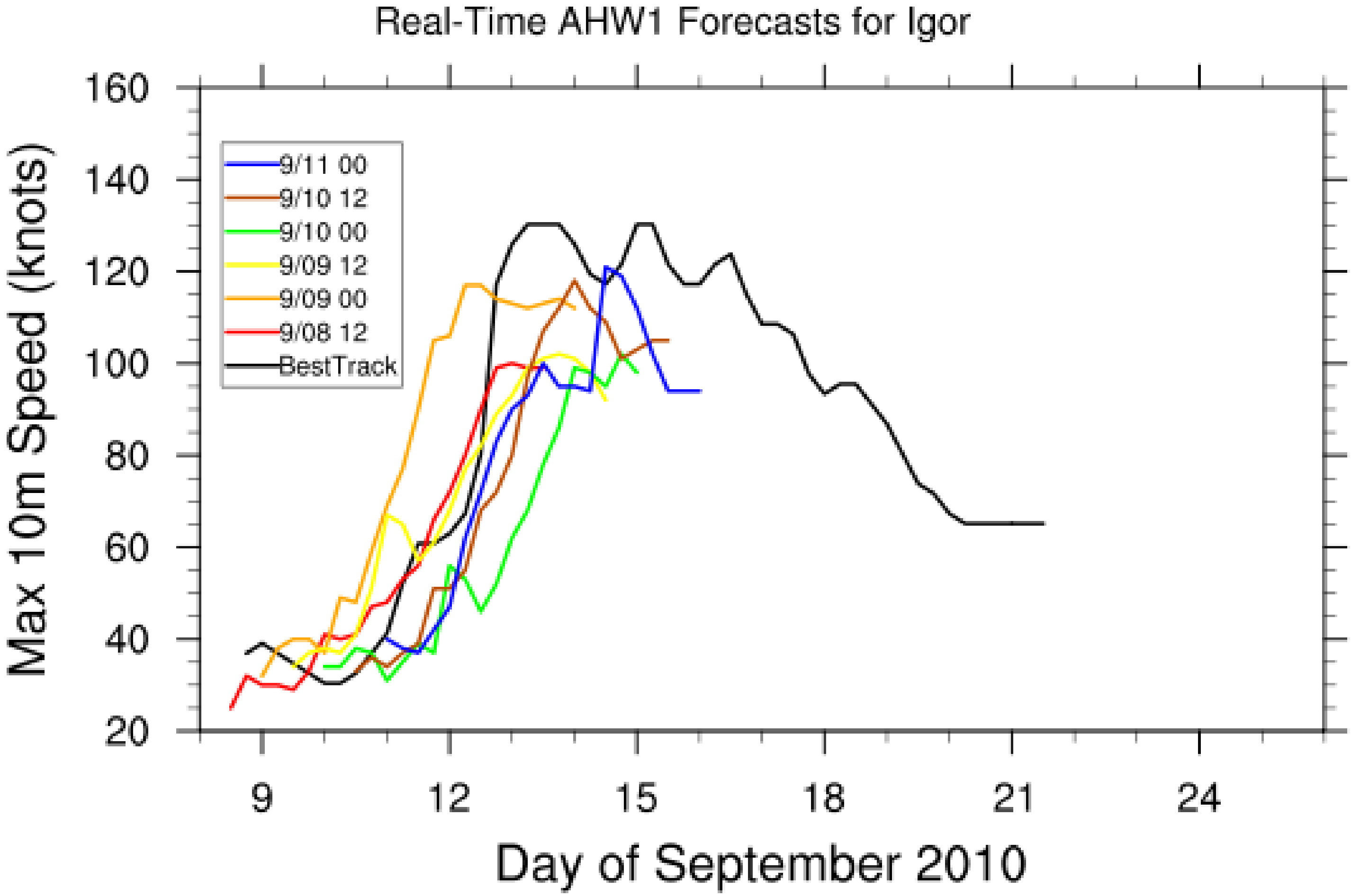
Hurricane Igor



Hurricane Igor



Hurricane Igor



Concluding Remarks

- Cumulus parameterization is important in analysis phase
  - Biases can lead to track errors
- Microphysics sensitivity points to need to better characterize fall speeds of particles in hurricanes (riming rates, densities, size distributions)

Future Directions

- Other biases may relate to radiation and Saharan dust
  - Need a method to represent this
- Sea spray parameterization should be tested