2012 Upgrades to the Operational GFDL/GFDN Hurricane Model

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Proposed GFDL 2012 UPGRADE

Benchmarked GFDL model (currently operational in GFDN)
1.) Detrained Microphysics passed from SAS to micro-physics
2.) Bug Fixed in current PBL scheme (from 2003 implementation)
3.) Bug Fixed in current SAS convective scheme (from 2010 implementation)
4.) Retuning of momentum mixing

Additional Physics
1. Improved formulation of Surface exchange coefficients (ch, cd)
2. Implementation of GFS Shallow Convection
3. New GFS PBL scheme evaluated and rejected for implementation
4. Improved PBL structure (.25 Critical Richardson number; reduced vertical mixing coefficient by 40% in storm region)
5. Advection of individual micro-physics species gave improved response to shear but not ready for 2012 implementation (Likely to be run in parallel for 2013 implementation

Initialization
1. Reduction in storm size for larger storms
2. Removal of asymmetries (impact was neutral)

- Proposed 2012 Upgraded model tested extensively on 2010 and 2011 Atlantic and East Pacific storms.

- Results to be summarized in presentation

- Upgraded GFDL model rerun using new GFS hybrid system to be implemented before start of hurricane season.

Cases run during August 21st -October 15th test period :

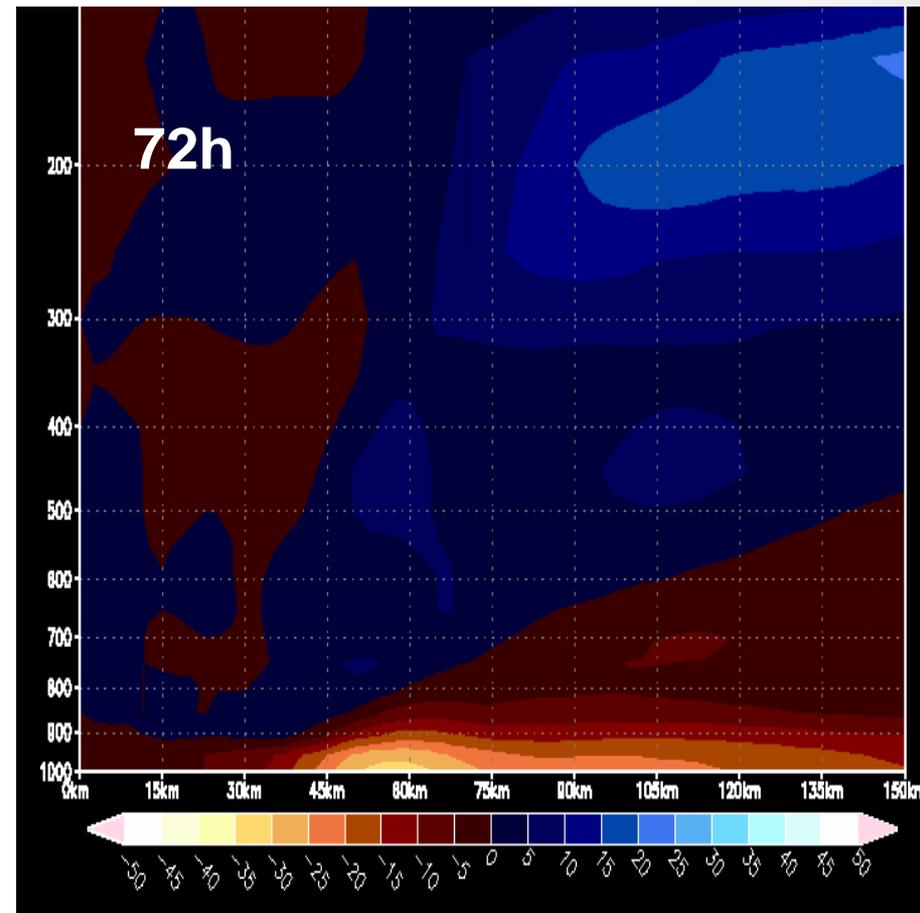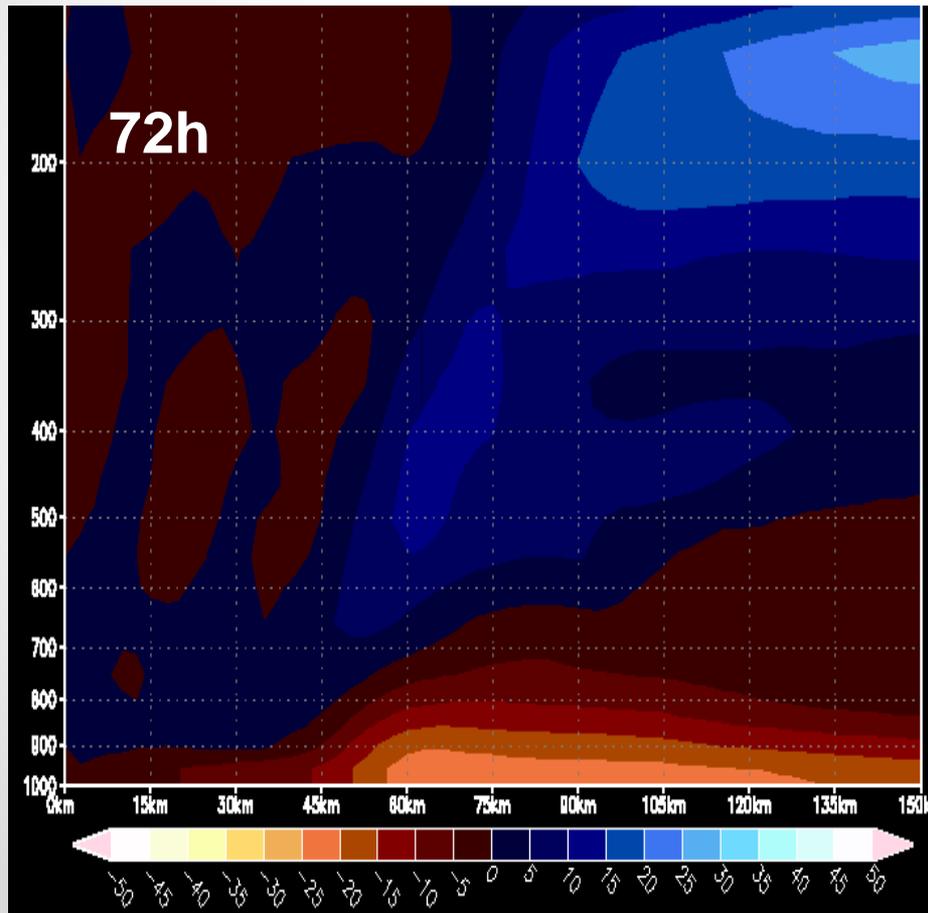**Irene, Katia, Maria, Ophelia, Philippe: Atlantic Basin**

Hillary, Irwin, and Jova : Eastern Pacific Basin

Example of Improved Boundary Layer Structure

Hurricane Katia (*0000 UTC 3 September, 2010*)

CURRENT MODEL

UPGRADED MODEL

CIRCULARLY AVERAGED RADIAL WIND

IMPACT ON TRACK PREDICTION

Atlantic Average Track Error

2010 SEASON

2011 SEASON

2010 ATLANTIC HURRICANE SEASON
NUMBER OF CASES: (233, 233, 229, 215, 177, 138, 109)

2011 ATLANTIC HURRICANE SEASON
NUMBER OF CASES: (216, 213, 208, 201 177, 153, 129)
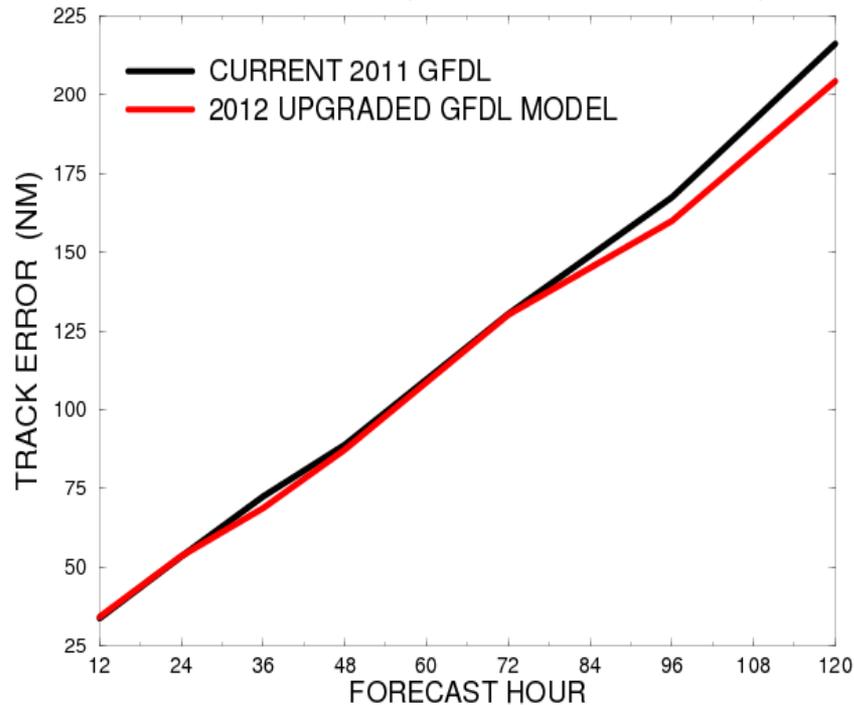
5% Reduced track error days 4-5
West bias reduced from 80 to 20 nm
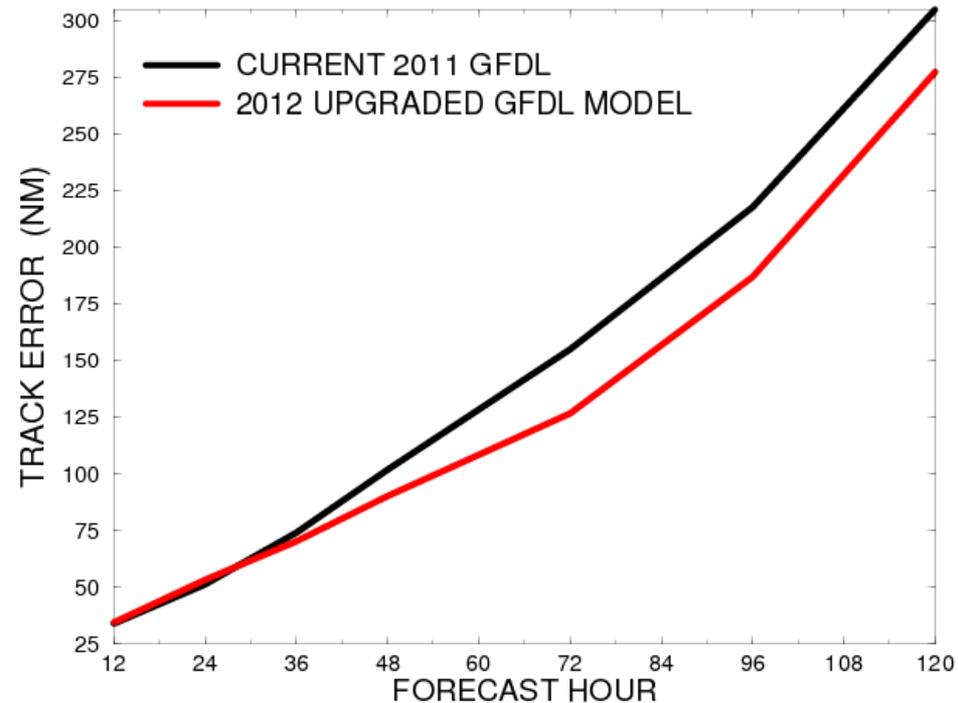
15% Reduced track error days 3-5
West bias reduced from 90 to 30 nm

Eastern Pacific Average Track Error

2010 SEASON

2011 SEASON

Neutral Impact on track for both seasons

2010 and 2011 Combined Track Error

Atlantic Basin

Eastern Pacific Basin

2010 AND 2011 ATLANTIC HURRICANE SEASON

NUMBER OF CASES: (449, 446, 437, 416, 354, 291, 238)

CURRENT 2011 GFDL
2012 UPGRADED GFDL MODEL

2010 AND 2011 EASTERN PACIFIC HURRICANE SEASON

NUMBER OF CASES: (257, 253, 243, 226, 188, 134, 82)

CURRENT 2011 GFDL
2012 UPGRADED GFDL MODEL
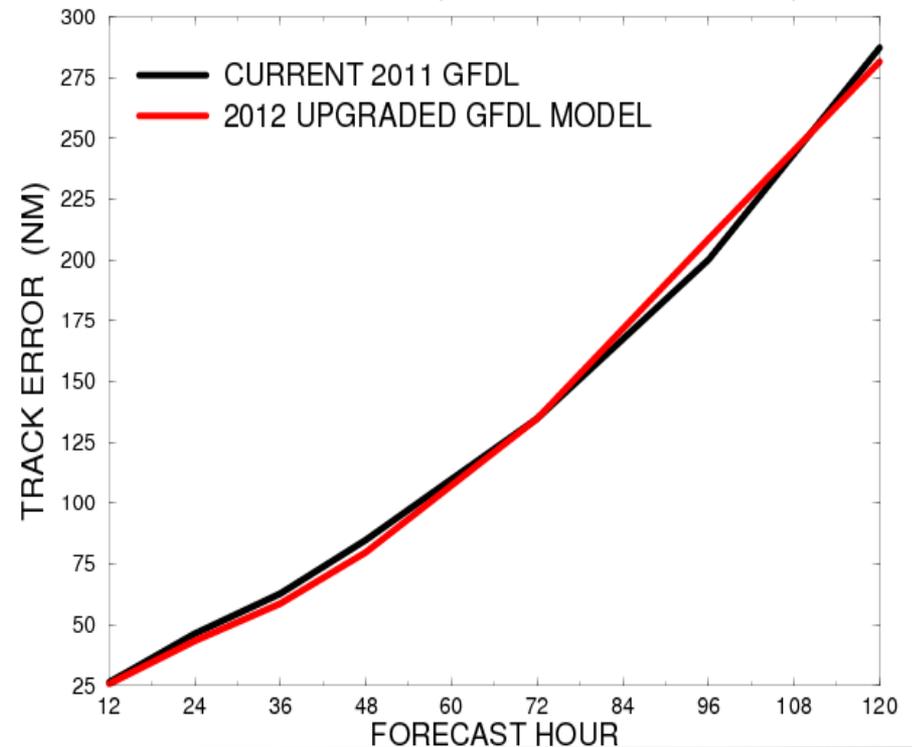
- 10% Reduced Error 3-5 days

Completely neutral impact

IMPACT ON INTENSITY PREDICTION

Atlantic Average Intensity Error

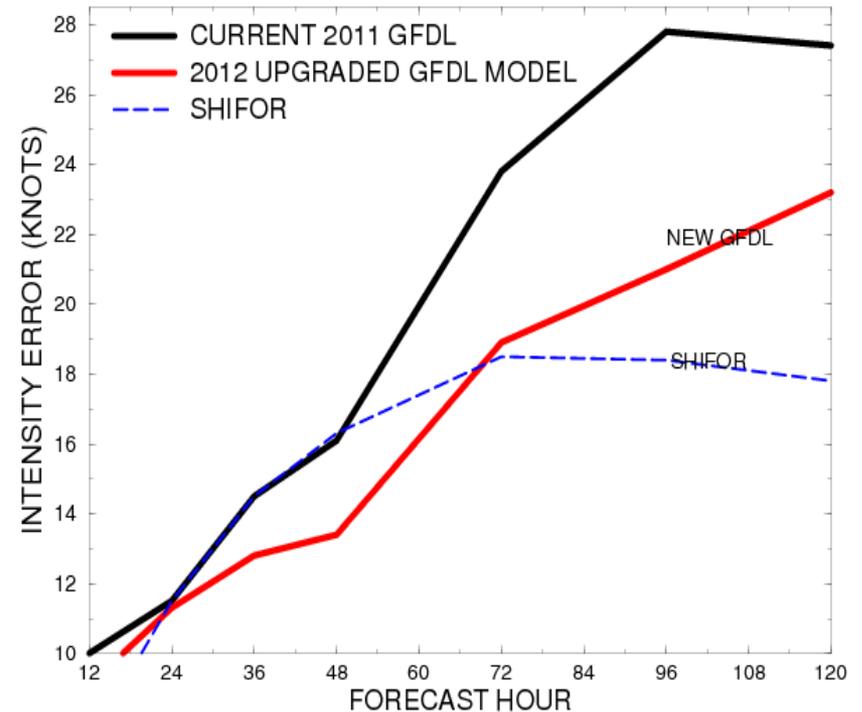## 2010 SEASON

2010 ATLANTIC HURRICANE SEASON

NUMBER OF CASES: (231, 231, 227, 214, 176, 137, 108)
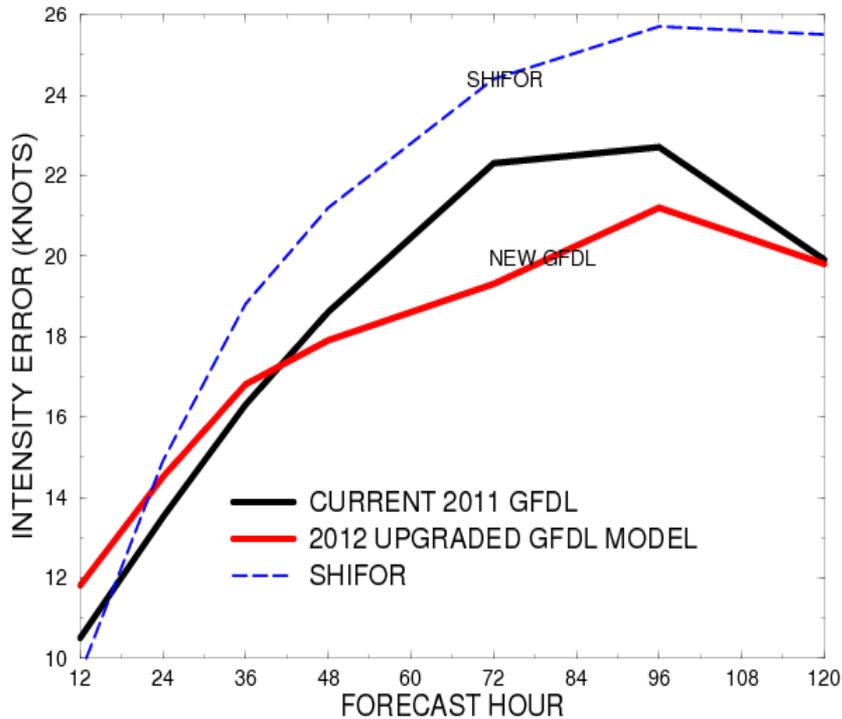
2011 SEASON

2011 ATLANTIC HURRICANE SEASON
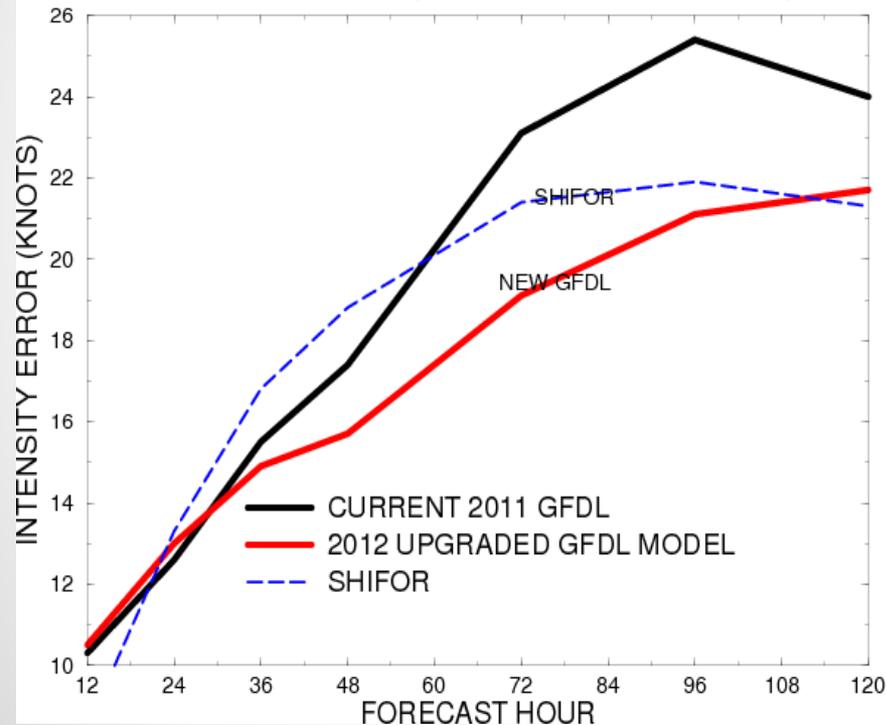
NUMBER OF CASES: (215, 212, 207, 200, 177, 153, 129)

15-25% Reduction in error for days 2-5

2010 and 2011 Combined Intensity Error

Atlantic Basin

Eastern Pacific Basin

10-20% reduction in error for days 2 through 5

Some degradation at early time periods, improved 3-5 days

2010 and 2011 Combined Intensity Bias
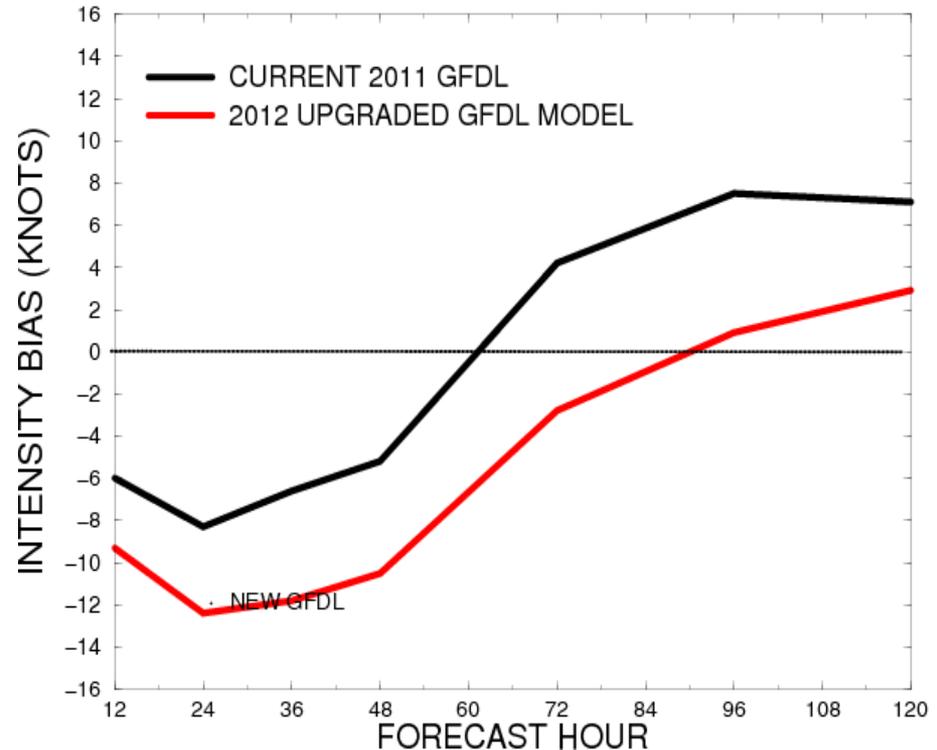
Atlantic Basin

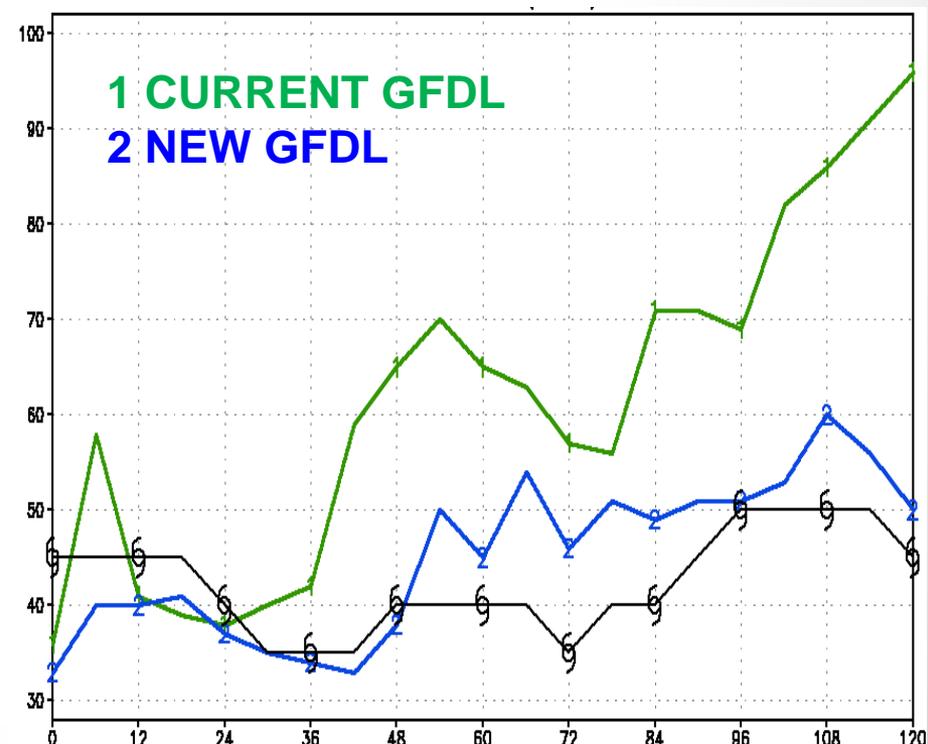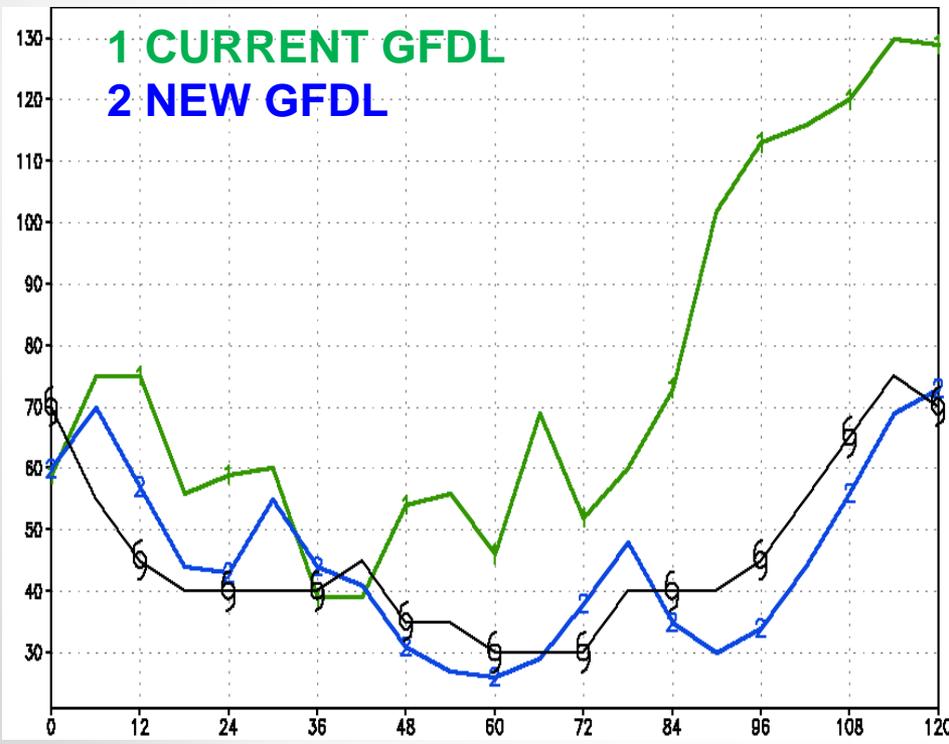**Eastern Basin**

Some <u>increased</u> negative bias days 1-2- <u>much reduced</u> positive bias days 3-5 •

Much Improved Intensity Prediction for sheared and non-developing systems

HURRICANE TOMAS
(October 31st, 18z)

HURRICANE MARIA
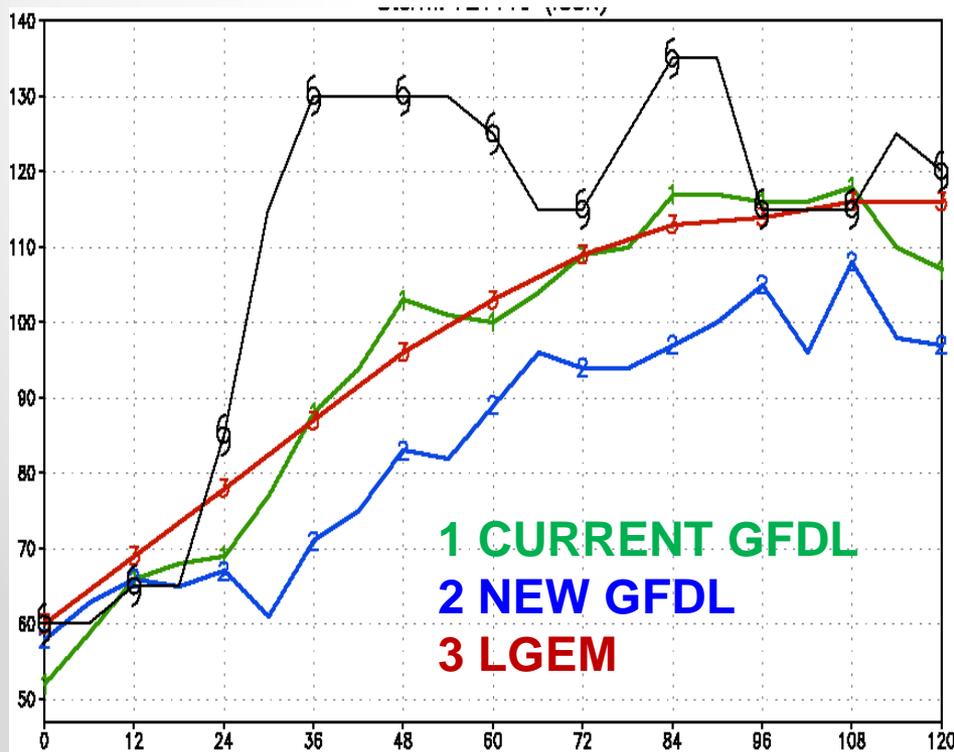**(September 7th, 12z)**

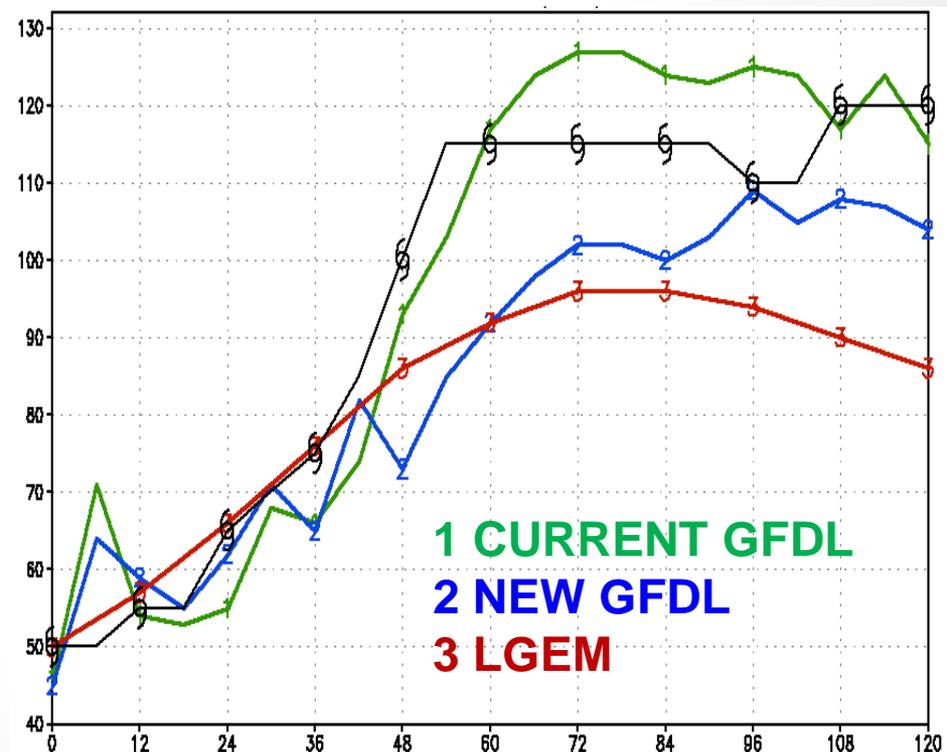# Larger negative bias in early forecast times suggests tendency for slowed Intensification in Rapidly Developing Storms

(higher resolution may be needed to address this ??)

Hurricane Igor (September 11th, 12z, 2010)

Hurricane Earl (August , 28th, 12z, 2010)
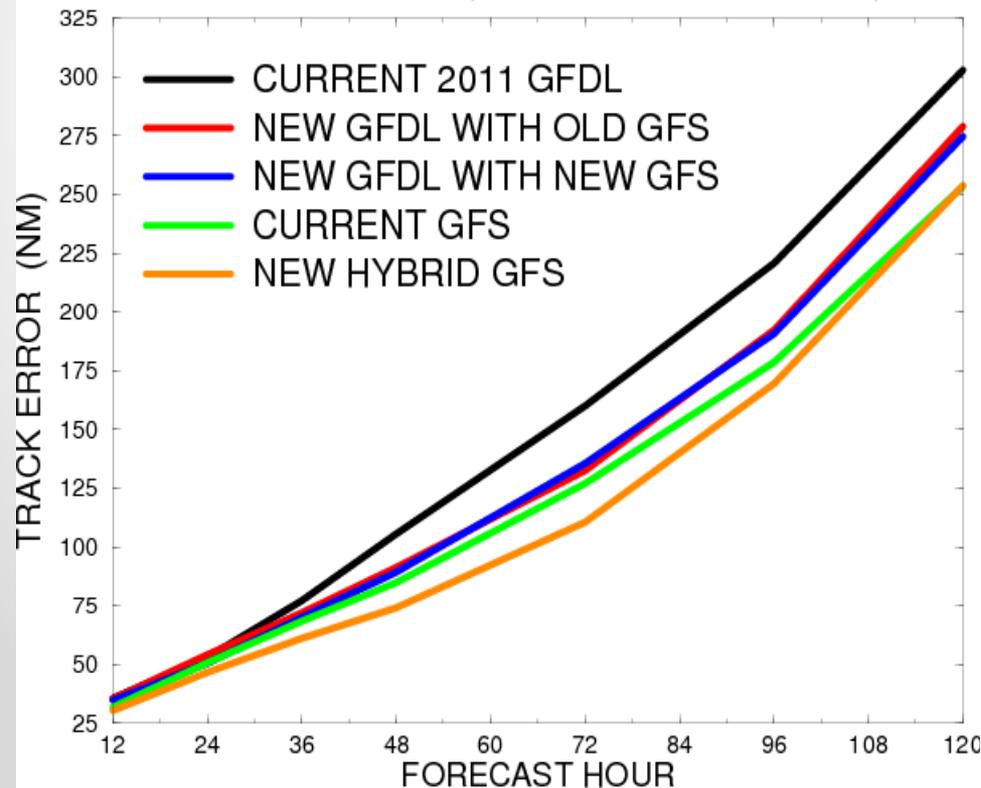
IMPACT OF NEW NCEP HYBRID GFS

Track Error using Current and New GFS

Evaluation Period: August 21st through October 15th
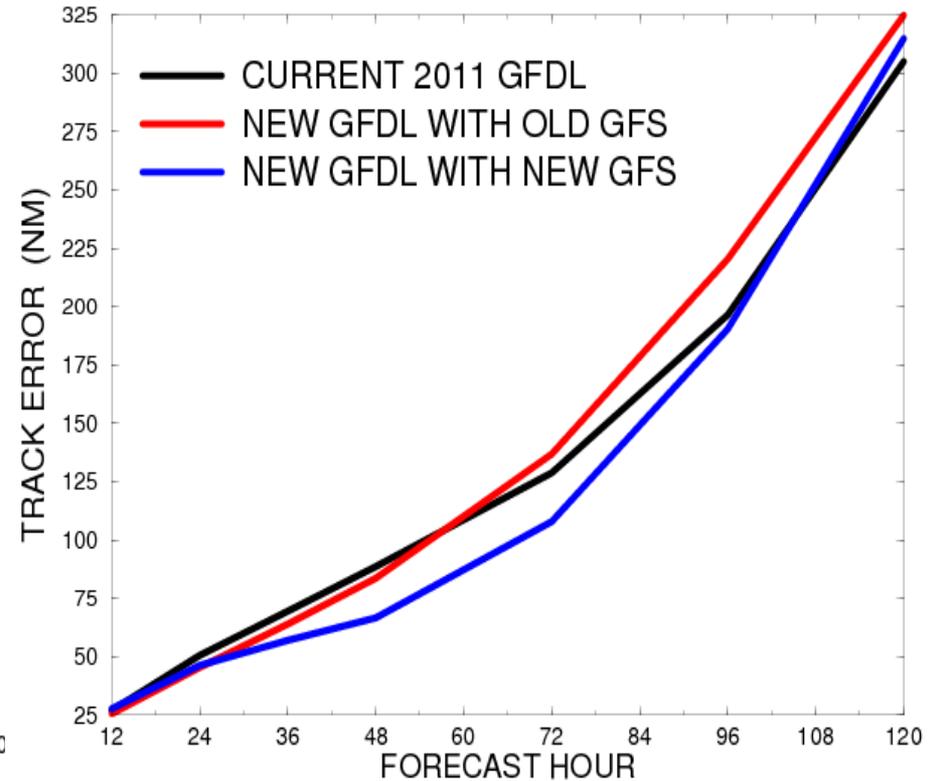

ATLANTIC

IRENE, KATIA, MARIA, OPHELIA, PHILIPPE

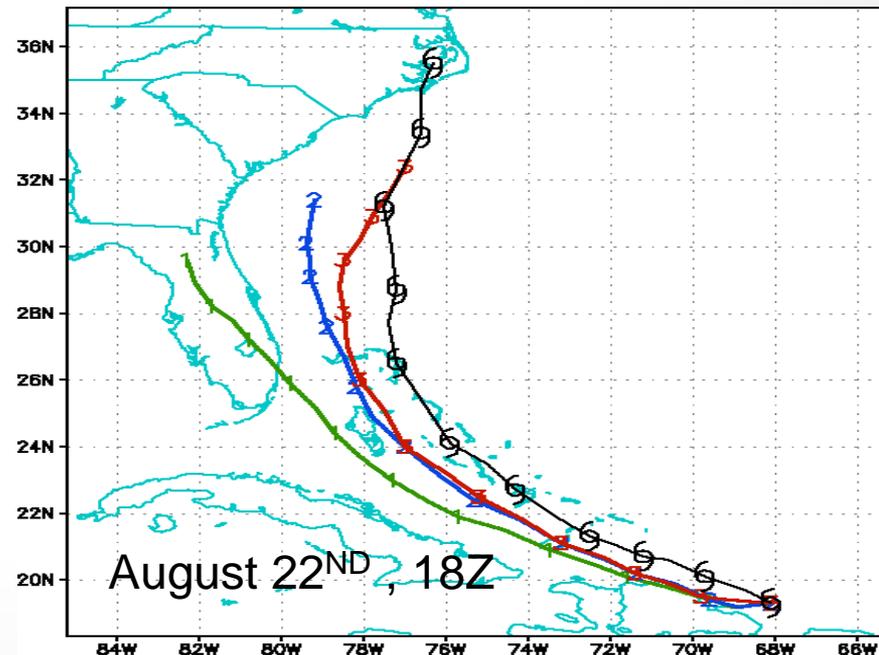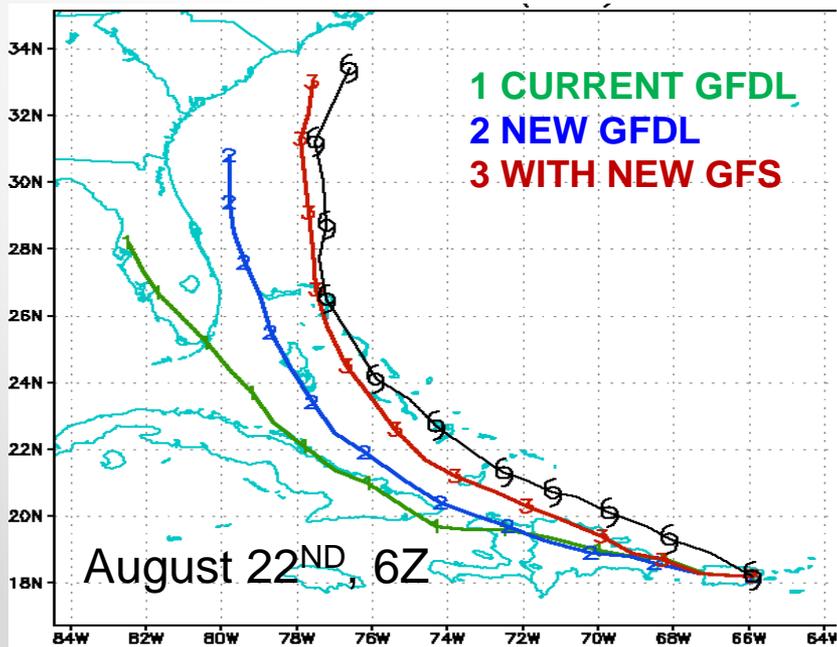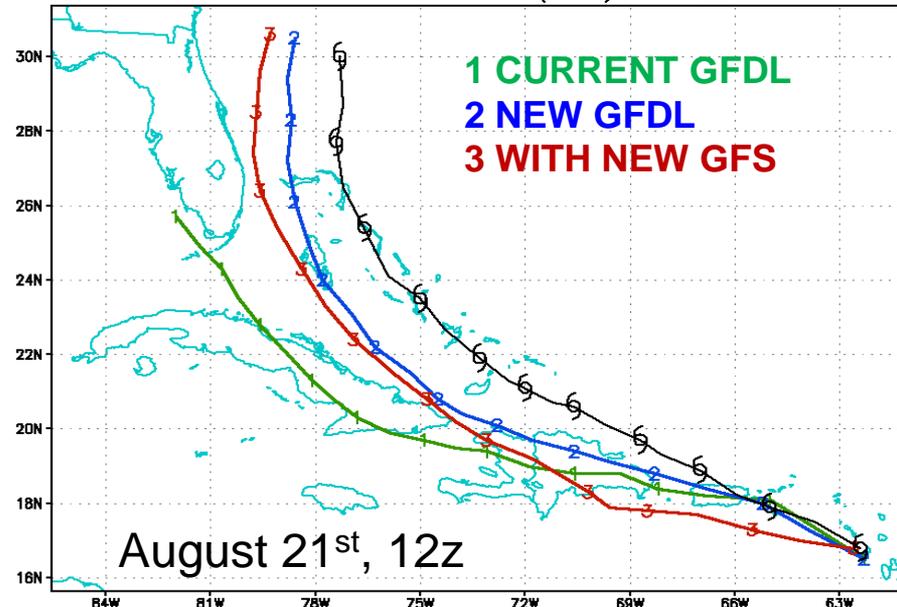NUMBER OF CASES: (161, 161, 161, 161, 152, 139, 120)

- CURRENT 2011 GFDL
- NEW GFDL WITH OLD GFS
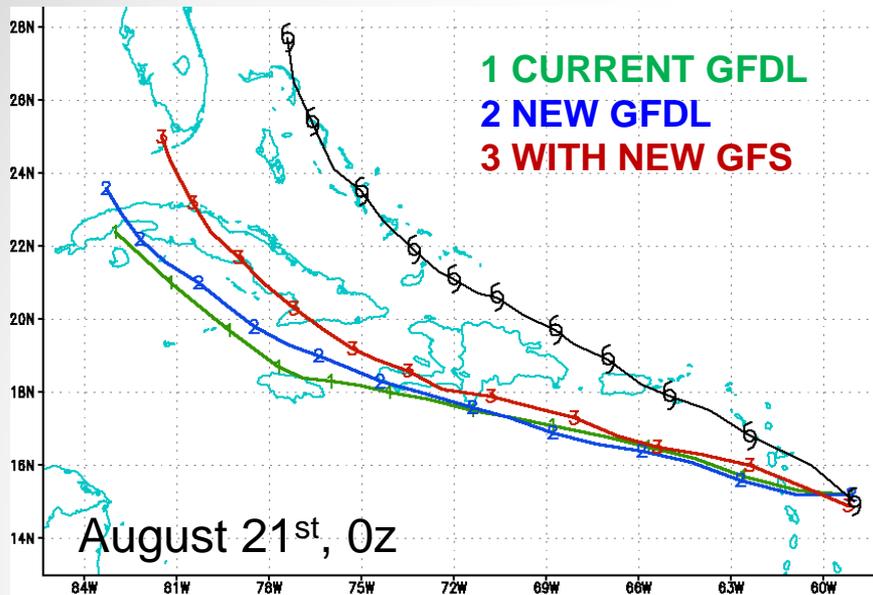- NEW GFDL WITH NEW GFS
- CURRENT GFS
- NEW HYBRID GFS

EASTERN PACIFIC

HURRICANES HILARY, JOVA, IRWIN

NUMBER OF CASES: (79, 79, 76, 74, 69, 56, 37)

- CURRENT 2011 GFDL
- NEW GFDL WITH OLD GFS
- NEW GFDL WITH NEW GFS
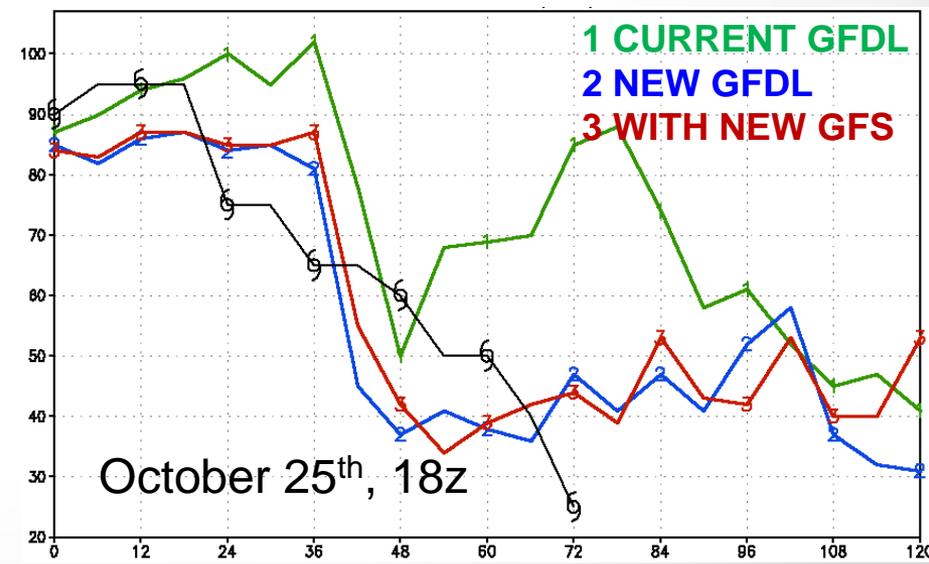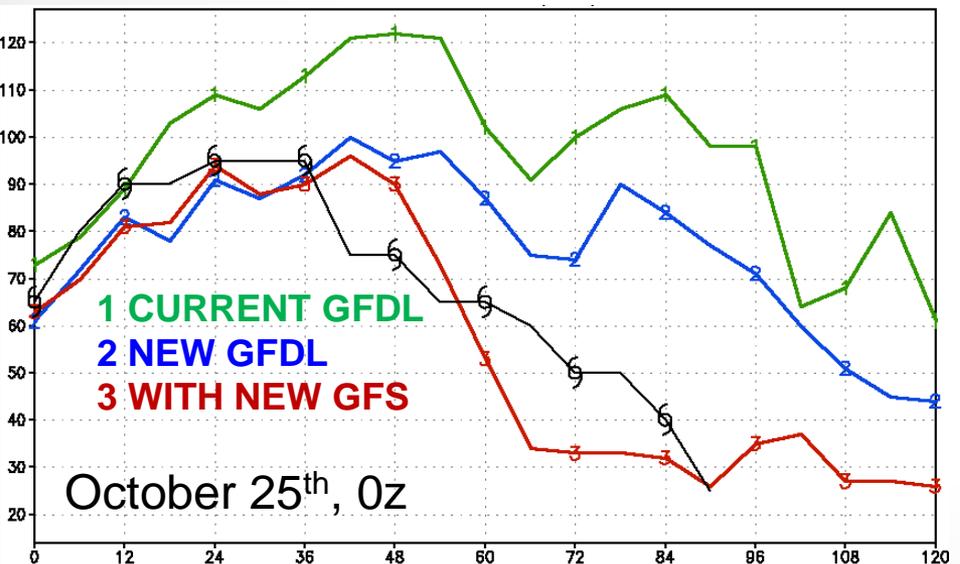
Hurricane Irene

Hurricane Rina Improved Performance
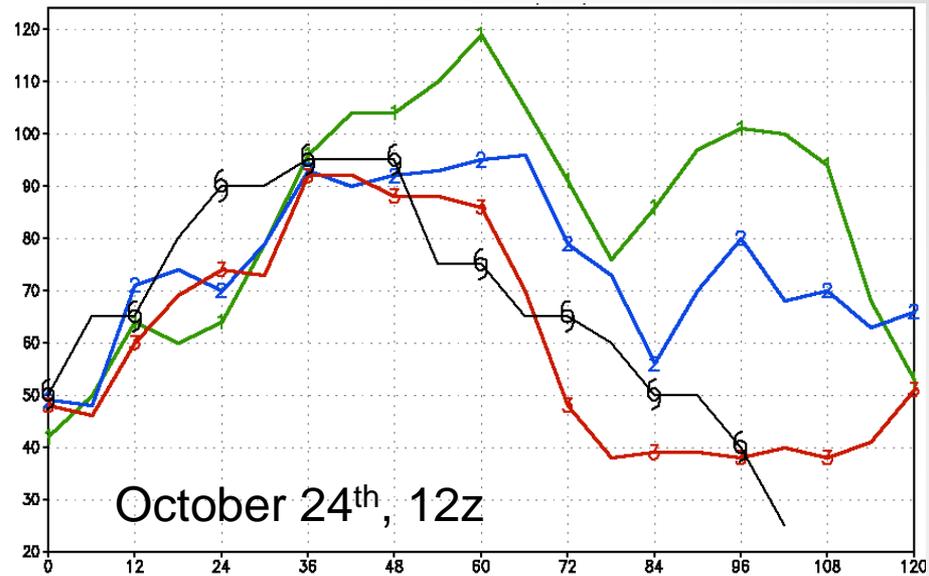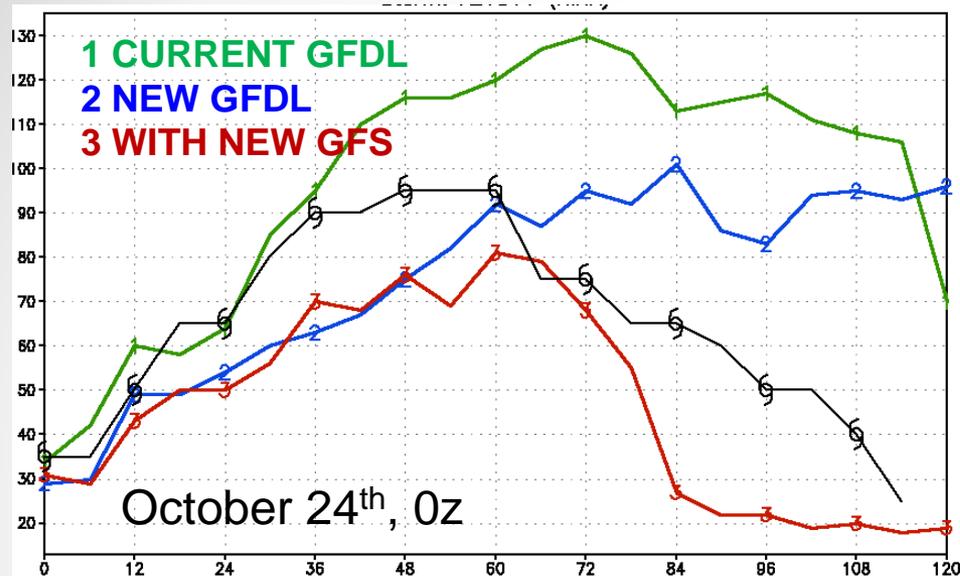
Maximum Surface Winds (knots)

POSSIBLE FUTURE GFDL UPGRADES

- **Increase inner-nest resolution (1/12th to 1/18th degree).** Address possible negative bias introduced with more realistic physics

- **Full Coupling with Wave Model and incorporation of sea-spray effects.**

- **Improved Radiation Package**

SUMMARY

- **TESTS OF PROPOSED GFDL UPGRADE SHOWS REDUCTION OF TRACK ERROR FOR DAYS 3-5 OF 10% FOR COMBINED 2010-2011 ATLANTIC HURRICANE SEASON WITH NEUTRAL IMPACT IN THE EASTERN PACIFIC**

- **REDUCTION OF INTENSITY ERROR IN DAYS 2-5 AVERAGED 10-20% IN COMBINED ATLANTIC SEASONS (15-25% IN 2011 !)**

- **EXCESSIVE POSITIVE INTENSITY BIAS (15-20 KNOTS) INTRODUCED BY 2011 UPGRADE GREATLY REDUCED. SOME INCREASED NEGATIVE BIAS IN RAPIDLY INTENSIFYING STORMS DUE TO SLOWER INTENSIFICATION.**