Hurricane Modeling and Prediction Across Timescales at GFDL

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Hurricane Katrina Coupled Model Forecast
Aug 27 02:30 UTC

Central Pressure / Category

Sea Surface Temperature (°F)

71 75 79 83 88

GFDL
Hurricane Katrina Coupled Model Forecast
Aug 29 19:00 UTC (67h)
Atlantic Basin Tropical Cyclone Intensity Forecast Errors
Trend of 48h Forecast Errors, 2000-2014

Source: Morris Bender, GFDL/NOAA
Simulated Category 4 & 5 hurricane frequency under global warming conditions

Present-Day Simulation: 14 storms

CMIP5 Late 21st century: 19 storms

GFDL hurricane model downscaling: 27-year samples

Source: Knutson et al. (Journal of Climate, 2013).
Pioneering seasonal prediction of regional tropical storm activity

Red/Orange regions indicate where the model system has retrospective forecast skill (1981-2011), July 1 initialization times.

Rank correlation predicted vs. observed masked at $p=0.1$ >25% years with density > 0

Vecchi et al., 2014

Strategies for variable resolution on the cubed-sphere

1) Grid stretching (via analytic transformation)
   • Moderate stretching (2.5 x) maintains integrity of global circulation - use this for long term predictions
   • Aggressive stretching (20 x) – use this for short term severe weather predictions (super-cell & tornadoes)

2) 2-way nesting (Harris and Lin 2014)

3) Combination of the “stretching” and “nesting”

Example:

~ 3 km without the nest (black)
~ 1 km with a 2-way nest (red)
Simulations of tornado-like vortices within super-cell storms using GFDL’s stretched FV$^3$

Lin and Harris (2014/2015, manuscript in preparation)
A new GFDL forecast model for seasonal tropical cyclone predictions, including intense (Cat 3-5) storm activity:

HiFLOR model run at 25km grid-spacing and SSTs restored# to observations

Source: Adapted from Murakami et al., submitted to J. Climate, 2015.
HiFLOR 1-July-initialized seasonal predictions of Atlantic Cat. 3-4-5 Hurricanes
(2015 has been provided to Seasonal Hurricane Outlook Team)

Updated from Murakami et al. (2015)
Summary:

NOAA has been engaged in extensive numerical model development and research toward a predictive understanding of hurricane activity on timescales from hours to centuries.

Focus: connecting fundamental research with improvements in predictive capability.