Seasonal Forecasts of Category 4 and 5 Hurricanes and Landfalling Tropical Cyclones using a High-Resolution GFDL Coupled Climate Model

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Extremely intense tropical cyclones (TCs), such as categories 4 and 5 hurricanes, and TCs that make landfall have marked socio-economic impacts. Therefore, developing dynamical seasonal prediction capability for intense TCs and for landfalling TCs is central to NOAA's mission and highly relevant to society.

This study uses a global model recently developed by scientists at GFDL (know as HiFLOR; Murakami et al. 2015) to demonstrate skill in seasonal predictions of landfalling and intense TC frequency. HiFLOR leads to substantial improvements in the simulation and prediction of Atlantic TCs, by quadrupling the number of horizontal grid cells of the atmosphere and land components (from a 32-mile to a 15-mile global mesh) relative to the FLOR model (Vecchi et al. 2014) that is currently used for real-time seasonal predictions through the NMME.

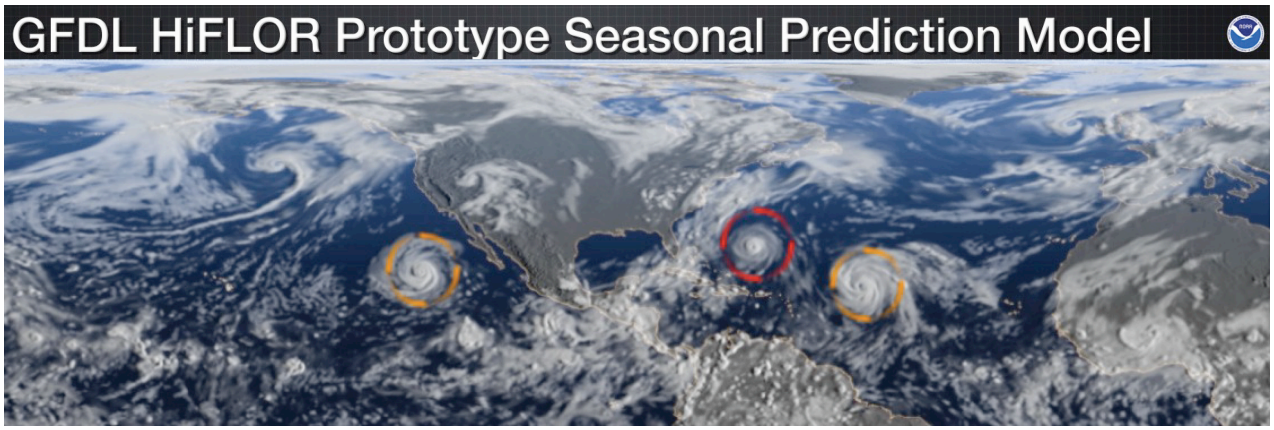

Fig. 1: Clouds from a HiFLOR simulation, showing two hurricanes in the Atlantic and one in East Pacific. (Figure Remik Ziemlinski) Animation available here: http://www.gfdl.noaa.gov/video/hiflor_flat_v7_aug-dec.mp4

This study focuses on seasonal predictions of TCs over the period 1990-2015, and it is found that:

1. HiFLOR can skillfully predict year-to-year variations in intense hurricanes in the Atlantic a few months in advance (correlation 0.7 for forecasts on 1-July, with July-November being peak hurricane season) – **Fig. 2.**
2. The high-resolution predictions exhibited significant skill in predicting landfalling hurricanes in the Caribbean (correlation=0.7) and Continental United States (correlation=0.5) – **Fig. 3.**
3. Improvements in seasonal TC prediction between FLOR and HiFLOR principally due to improved simulation of TCs and the TC response to large-scale climate drivers from increased atmospheric resolution.

This is the first time that a global general circulation model has successfully demonstrated an ability to predict the observed year-by-year variations in Saffir-Simpson Category 4 and 5 hurricanes and U.S. landfalling TC frequency. These results highlight the potential of models like HiFLOR for the subseasonal and seasonal prediction of TCs.

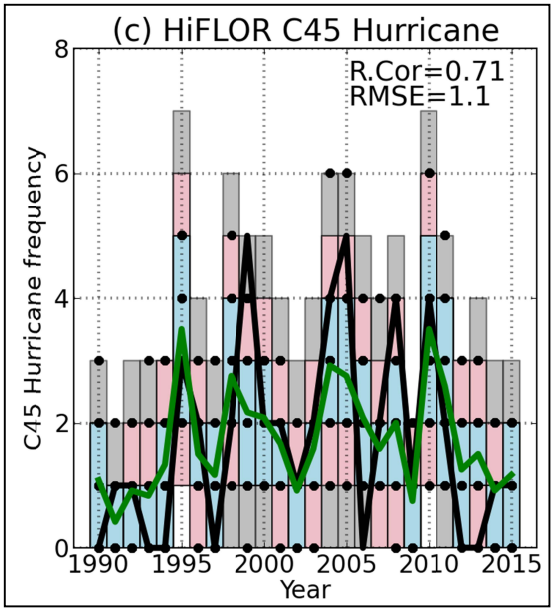

Fig. 2 HiFLOR shows skill at predicting year-to-year variations in Atlantic hurricanes and intense hurricanes. *Left panel focuses on hurricanes, right panel on intense (Saffir-Simpson Category 4-5) hurricanes in the Atlantic Murakami et al. (2016).*

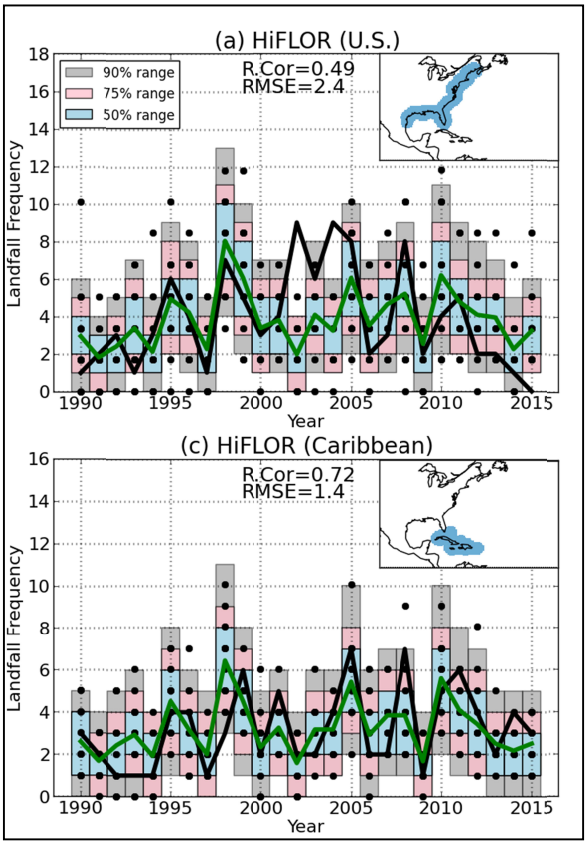

Fig. 3 HiFLOR exhibits skill in predicting year-to-year variability of U.S. and Caribbean landfalling TCs (≥34 knots). *Black line shows observed landfalling TC count, green line and dots show predictions with HiFLOR. Adapted from Murakami* et al. *(2016).*

The development of HiFLOR was enabled by years of earth systems research and model development at GFDL – including the breakthrough high-resolution modeling efforts of Delworth et al. (2012), Chen and Lin (2013), and Vecchi et al. (2014), and the seasonal to decadal prediction efforts at GFDL (*e.g.,* Yang et al. 2013; Jia et al. 2015). This work was made possible by enhancements to NOAA's research supercomputing capability including access to Gaea and Theia.

Manuscript:

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http://www.gfdl.noaa.gov/cms-filesystem-action/user_files/gav/publications/detal_2016_cat45nlf_pred.pdf

Related References:

Murakami, H. et al. (2015): Simulation and prediction of Category 4 and 5 hurricanes in the high-resolution GFDL HiFLOR coupled climate model. J. Climate doi:10.1175/JCLI-D-15-0216.1.
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