Seasonal Prediction of Tropical Cyclones

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Murakami, H., G. A. Vecchi, G. Villarini, T. L. Delworth, R. Gudgel, S. Underwood, X. Yang, W. Zhang, and S. Lin, 2016: Seasonal forecasts of major hurricanes and landfalling tropical cyclones using a high-resolution GFDL coupled climate model. *J. Climate*, **29**, 7977-7989.

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Motivation

- Developing a dynamical model that has skill in predicting **major hurricanes** is central to NOAA's mission and highly relevant to society.

Damage cost from U.S. Billion-dollar disaster events (1980–2013)

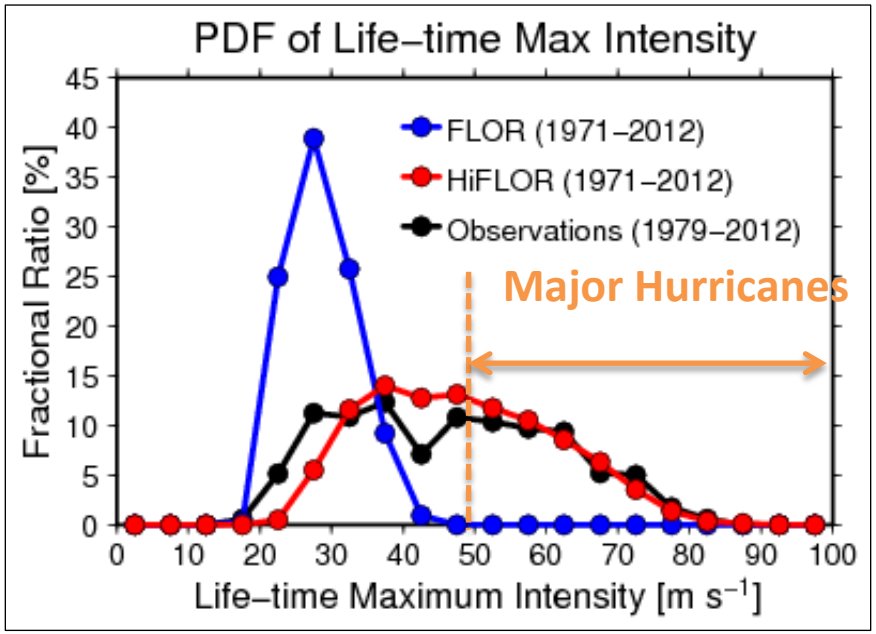
Disaster Type	Number of Events	Percent Frequency	CPI-adjusted Losses ($ billions)	Percent of Total Loss	Average Event Cost ($ billions)
Drought	21	12.4	199	19.1	9.5
Flooding	19	11.2	86	8.3	4.5
Freeze	7	4.1	25	2.4	3.6
Severe Storm	65	38.2	143	13.7	2.2
Tropical Cyclone	34	20.0	530	50.9	15.6
Wildfire	12	7.1	26	2.5	2.2
Winter Storm	12	7.1	35	3.4	2.9

Smith and Matthes (2015, Natural Hazards)

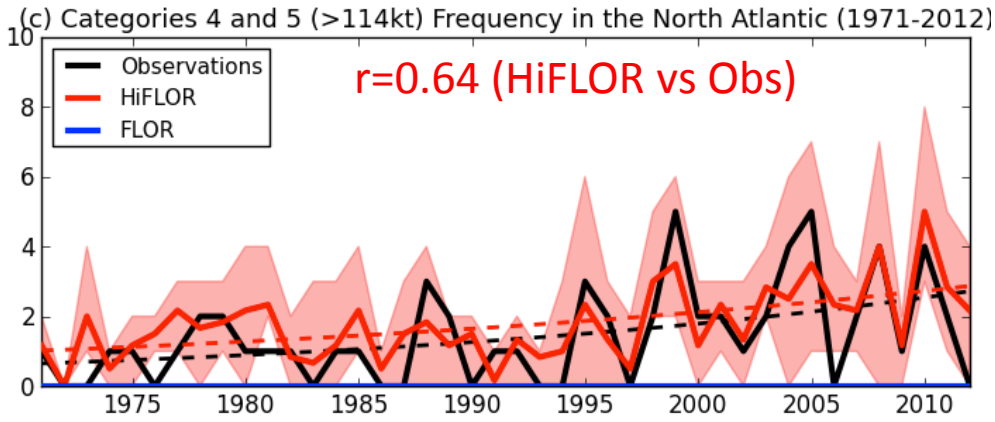
- We developed a new high-resolution coupled model, **HiFLOR** to improve prediction of major hurricanes.

Model	Resolution
FLOR	Atmosphere : **50 km**, L32 Ocean: 100 km, L50
HiFLOR	Atmosphere : **25 km**, L32 Ocean: 100 km, L50

Prescribed SST Experiment (1971–2012)



Interannual variation of C45 Hurricanes

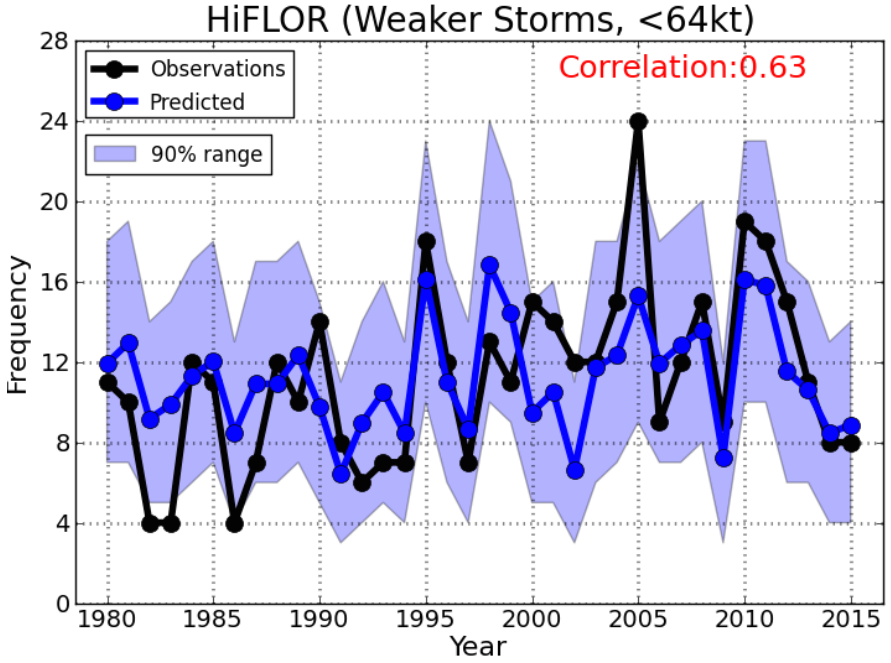


- HiFLOR can simulate intense hurricanes as observed.
- It is for the first time that a global coupled model could simulate observed interannual variation of major hurricanes given the observed SST.

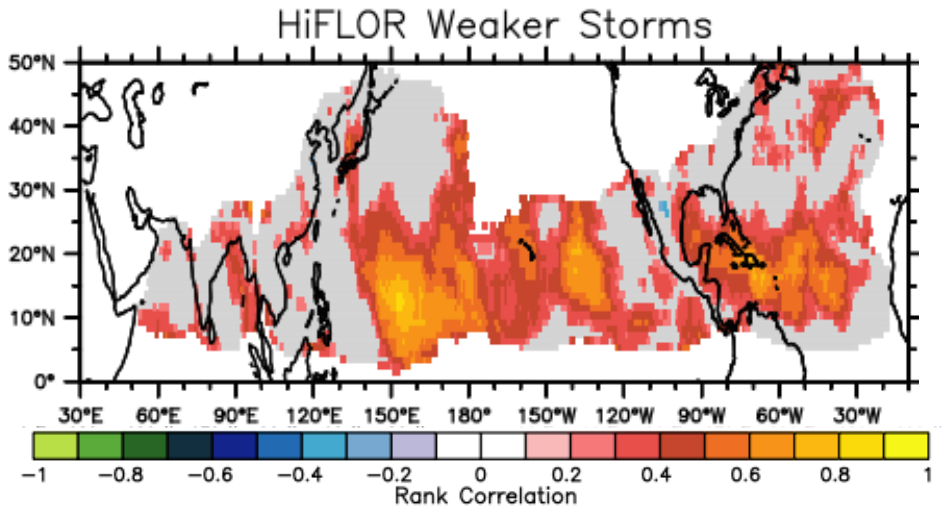
Retrospective Seasonal Forecasts (Weaker Storms)

Model	HiFLOR
Period	1980–2015, mainly focus on TC prediction for July–November
Initial	July (Leal Month=0–4), Ocean is initialized, but atmosphere is not initialized.
Ensemble	24 Ensemble Members

Weaker Storms in the North Atlantic



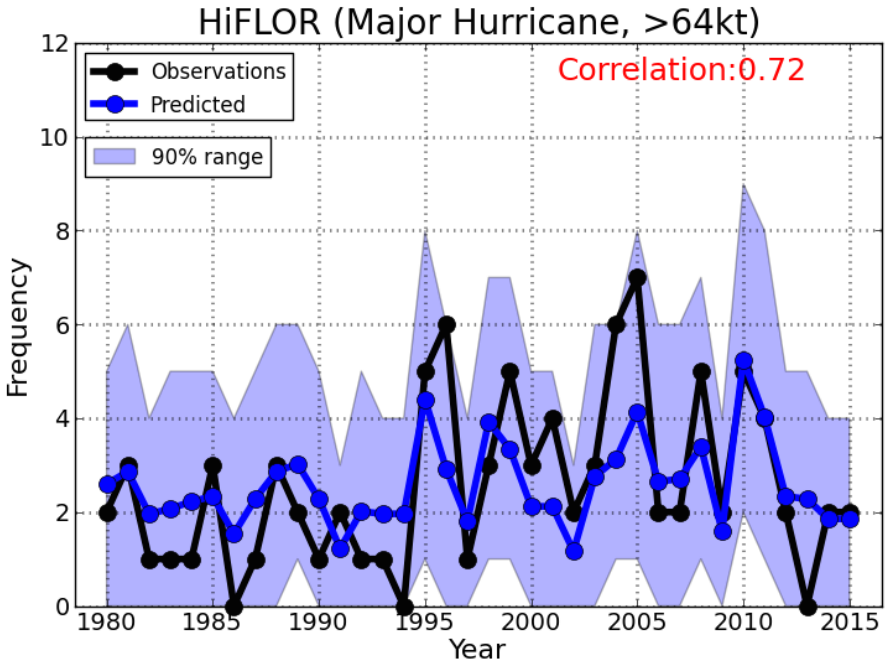
Skill in Predicting TC Density



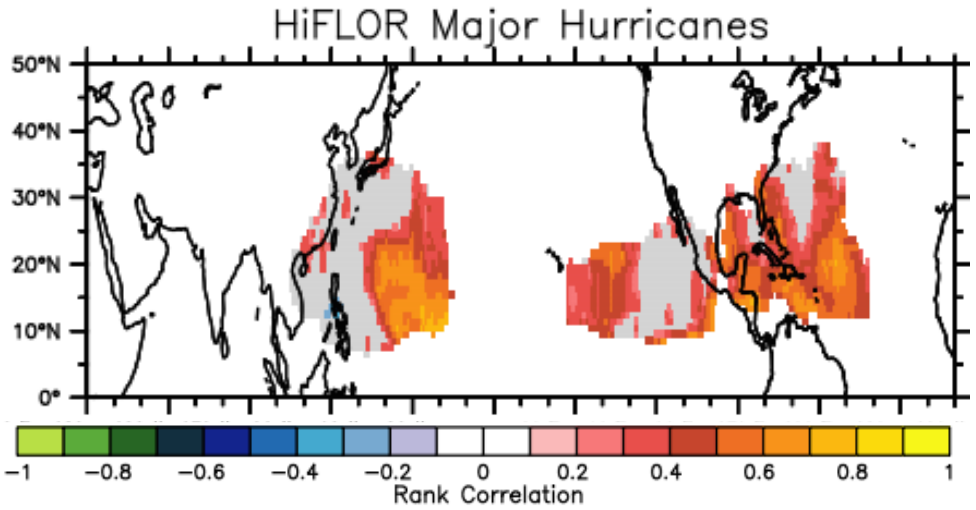
HiFLOR shows skillful prediction for weaker storms

Retrospective Seasonal Forecasts (Major Hurricane)

Major Hurricanes in the North Atlantic



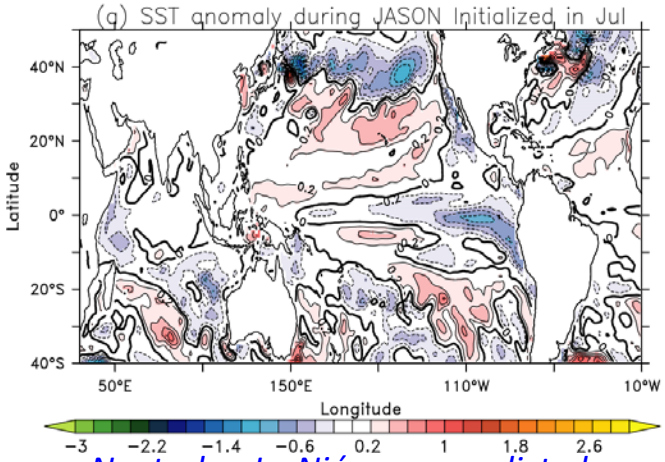
Skill in Predicting Major Hurricane Density



- HiFLOR shows skillful prediction for frequency of major hurricanes a few months in advance (r=0.72).
- HiFLOR has skill in predicting major hurricanes at regional scale.

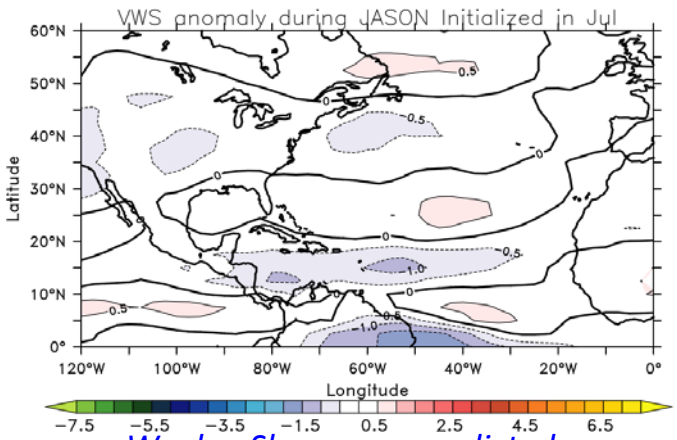
Real-Time Prediction for 2017 Summer Season
(July Initial Prediction)

Predicted SST anomaly



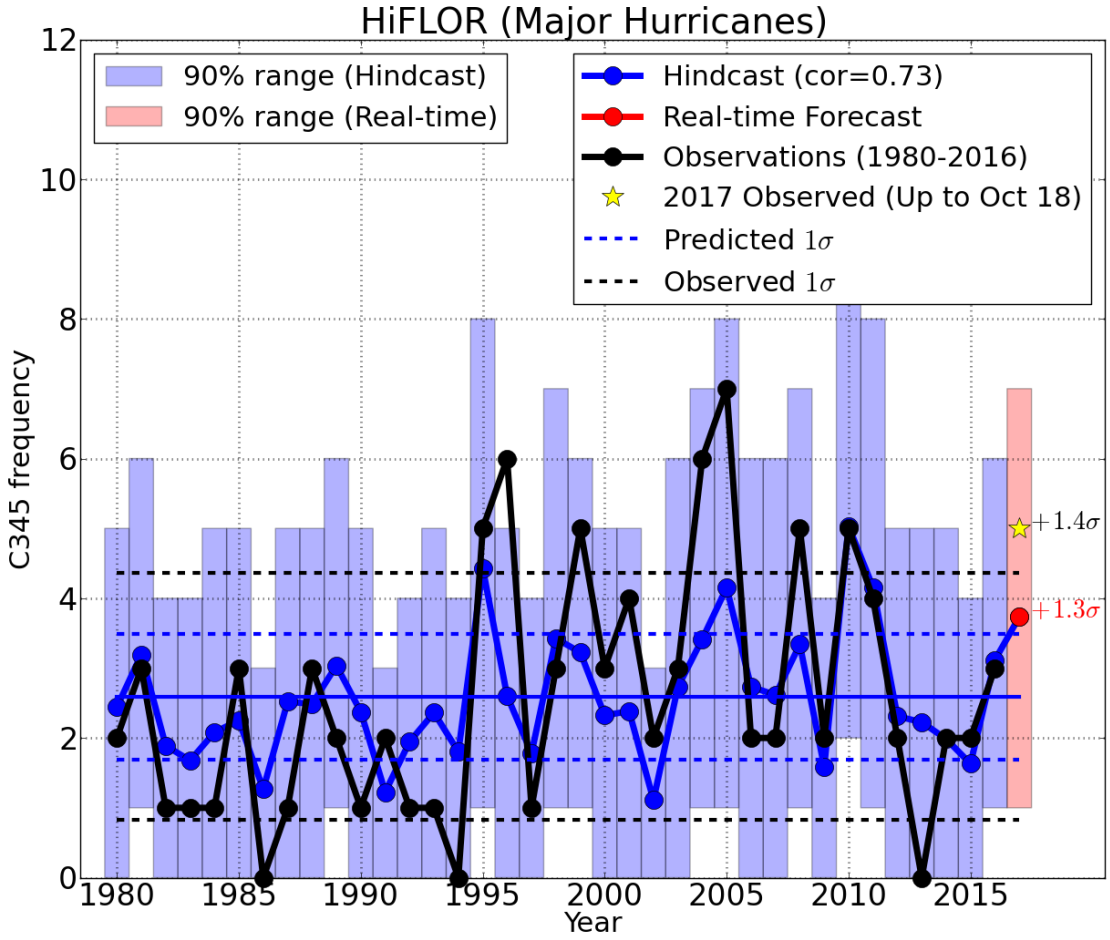
Neutral or La Nińa was predicted

Predicted Vertical Wind Shear



Weaker Shear was predicted

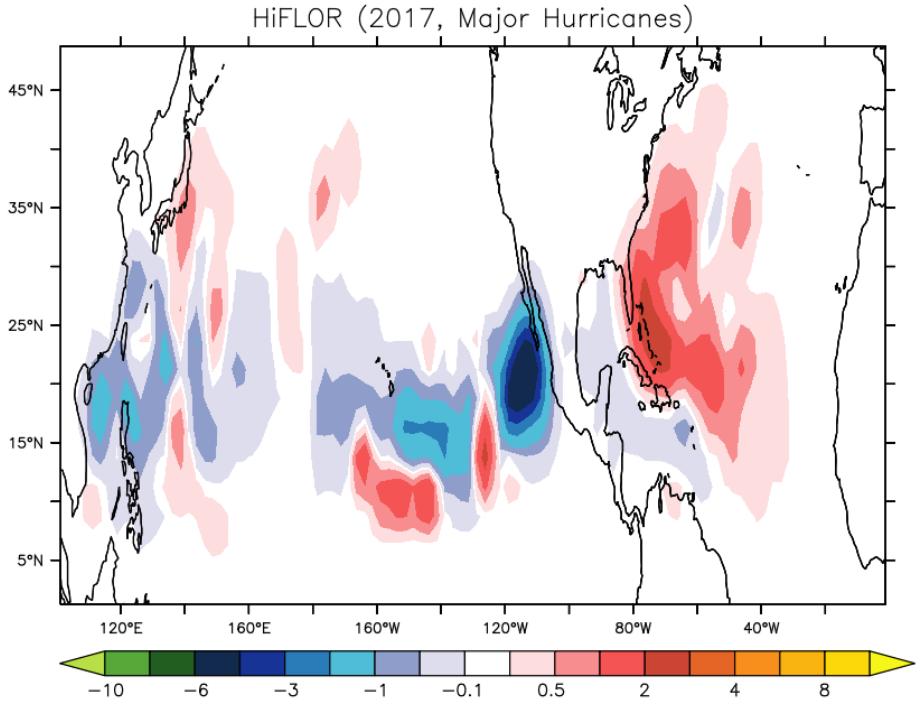
Predicted Major Hurricane Frequency



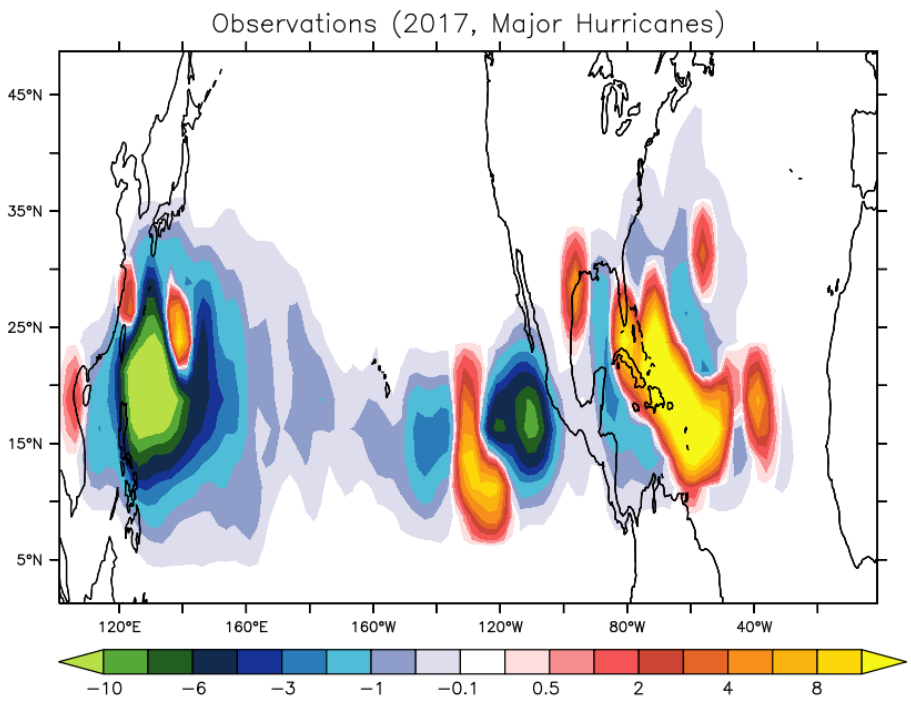
HiFLOR predicted the active major-hurricane season in this summer.

Real-Time Prediction for 2017 Summer Season

Predicted Major Hurricane Density by HiFLOR



Observed Major Hurricane Density
(up to Oct 18)



HiFLOR could predict locations of major hurricanes for the 2017 summer.

Summary

- We developed a new high-resolution coupled model, HiFLOR that can simulate/predict major hurricanes.
- HiFLOR has skill (r=0.7) in predicting frequency of major hurricanes in the North Atlantic a few month in advance.
- HiFLOR not only predicted active hurricane season in 2017, but also predicted locations of major hurricanes.
- In our continuing efforts to improve seasonal prediction skill, a new seasonal forecast model (SPEAR; AM4 and MOM6) will be tested in our future plan.