Dominant Role of Tropical Atlantic Warming on the Active 2017 Major Hurricanes over the North Atlantic

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HiFLOR (Hi-Resolution version of FLOR)

<table>
<thead>
<tr>
<th>Model</th>
<th>Resolution</th>
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</table>
| FLOR  | Atmosphere: 50 km, L32  
Ocean: 100 km, L50 |
| HiFLOR| Atmosphere: 25 km, L32  
Ocean: 100 km, L50 |

FLOR: One of the NMME models.

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

- HiFLOR can simulate MHs as observed.

Interannual variation of C45 Hurricanes

\[ r=0.64 \text{ (HiFLOR vs Obs)} \]
Retrospective Seasonal Forecasts
(July Initial to predict following Jul–Nov; Lead Month=0–4)

MH Frequency in the North Atlantic

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.

Skill in Predicting MH Density
HiFLOR could predict the locations of MHs a few months in advance for the 2017 summer.
What caused the active 2017 MH season?

A. Moderate La Niña?
B. Warmer Tropical Atlantic?
C. Warmer off the coast of North America?
Idealized SST-Prescribed Seasonal Prediction

Prescribed SST Anomaly

- Pacific SST anomaly was removed.

Predicted MH Density Anomaly

- MHs are still active.

A. Moderate La Niña?

- Pacific SST anomaly was removed.

C. Warmer off the coast of North America?

- SSTa off the coast of US was removed.

B. Warmer Tropical Atlantic?

- SSTa in the tropical Atlantic was removed.

- MHs reduced.

- MHs are still active.
More active MH season than the 2017 summer is projected in the future even with the same spatial patterns of 2017 SST anomaly, resulting in amplifying the risk of MHs.
Which of local SST anomaly or relative SST anomaly is important for frequency of MHs in the North Atlantic?

Observed number of MHs (gray bars) is correlated with both tropical SST anomaly (SSTA, $r=+0.50$) and tropical SST anomaly relative to tropical mean (RSSTA, $r=+0.61$).
Which of local SST anomaly or relative SST anomaly is important for frequency of MHs in the North Atlantic?

**# Model**

**SSTA vs MHs (r=+0.56, Slope=+5.1)**

**RSSTA vs MHs (r=+0.56, Slope=+5.8)**

**2017 Experiments only**

**SSTA vs MHs (r=+0.36, Slope=+0.7)**

**RSSTA vs MHs (r=+0.62, Slope=+6.0)**

**2017 Experiments & Future Experiments**
What will happen in the next decades?

AMO (or AMV) index is going to negative?
=> Decrease in major hurricanes in next decades?

Monitoring or predicting natural variability (AMO, AMOC) is a key to predict frequency of major hurricanes in the next decades.
Summary

- We developed a new high-resolution coupled model, HiFLOR that can simulate/predict MHs.
- HiFLOR has skill (r=0.7) in predicting frequency of MHs in the North Atlantic a few months in advance.
- HiFLOR predicted observed locations of MHs very well for the 2017 summer.
- The active 2017 major hurricanes were controlled by the tropical ocean surface warming in the North Atlantic.
- In the end of 21st century, even given the similar SST anomaly patterns like the 2017 summer, MH could be more active than the 2017 summer season.
- Relative SST anomaly associated with AMO and AMOC is a key for prediction of MHs in the near future.