Seasonal Predictions for 2017 Hurricane Season

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- Developing a dynamical model that has skill in predicting **hurricanes** is highly relevant to society.

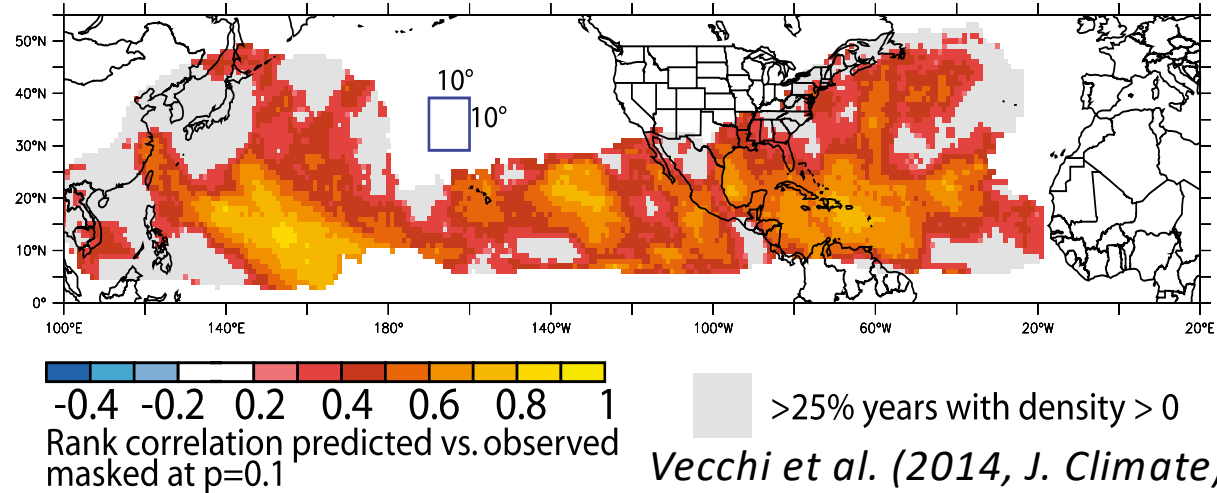Damage cost from U.S. Billion-dollar disaster events (1980–2013)

| 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)

GFDL FLOR: Forecast-oriented Low Ocean Resolution version of CM2.5

- FLOR : Fully dynamical model with **50km**-mesh atmosphere and **1°** ocean/sea ice models
- FLOR is a hurricane-permitting model
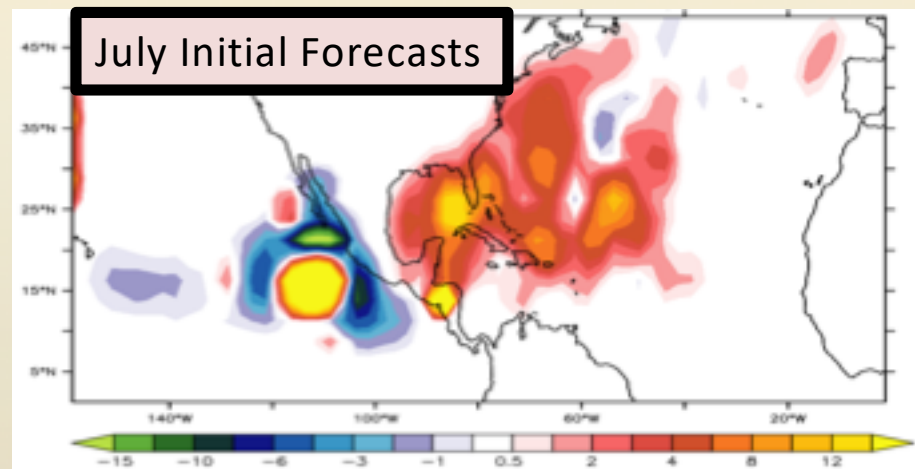- We use FLOR for real-time seasonal predictions for experimental purpose.

Rank correlation predicted vs. observed masked at p=0.1

>25% years with density > 0

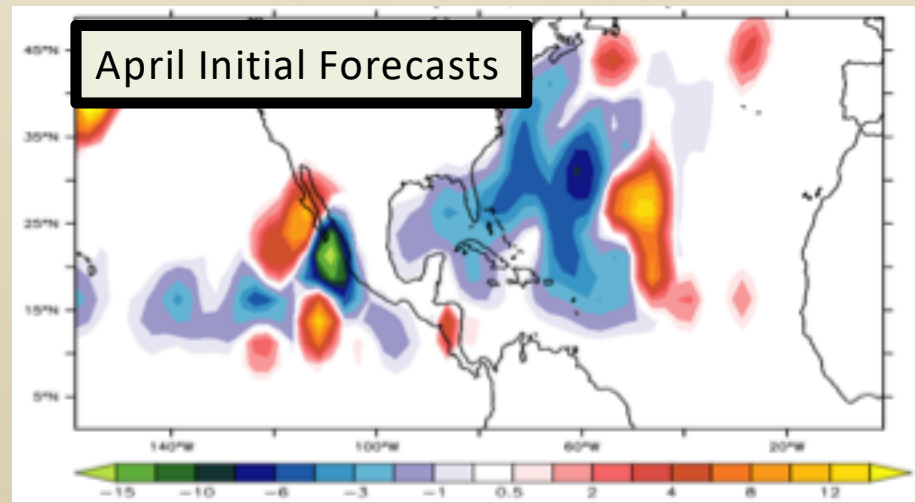*Vecchi et al. (2014, J. Climate)*

Real-Time Prediction for the 2017 Summer Season

Observed Hurricane Density Anomaly in 2017
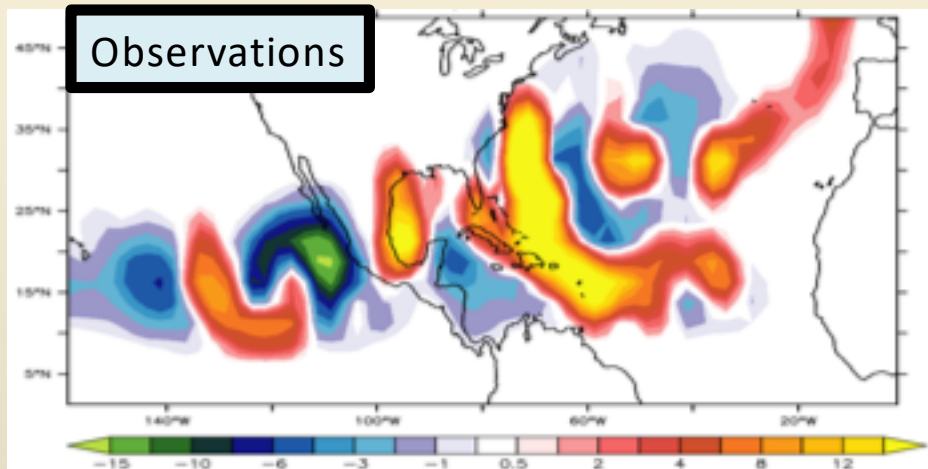
Predicted Hurricane Density Anomaly in 2017

Observations
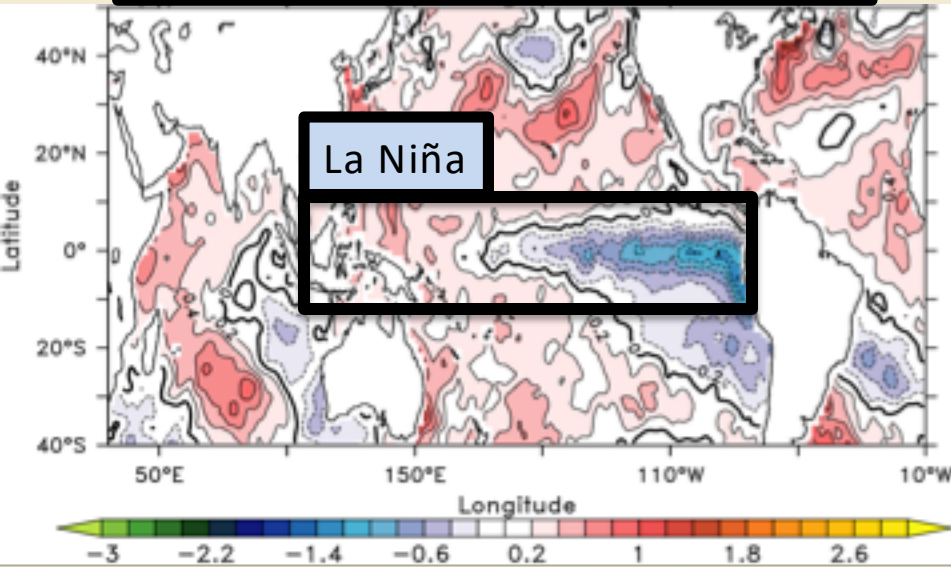
July Initial Forecasts

Observed Storm Tracks in 2017
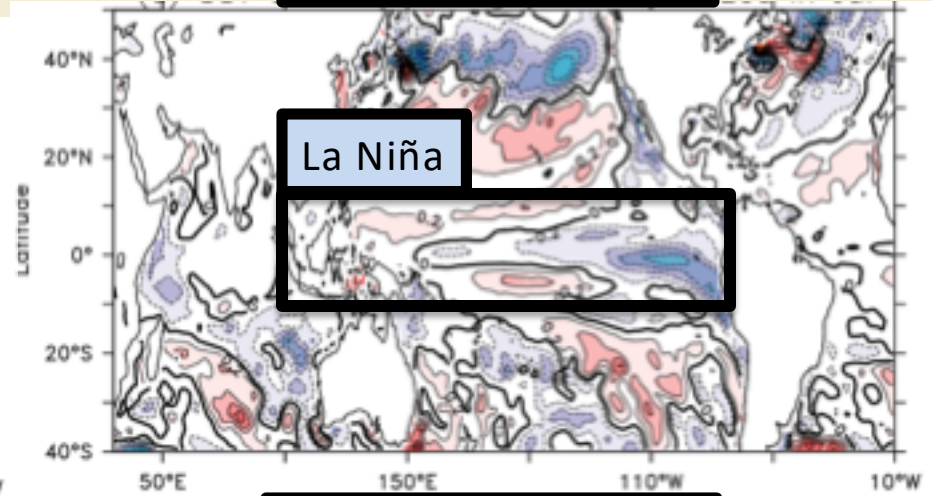

April Initial Forecasts
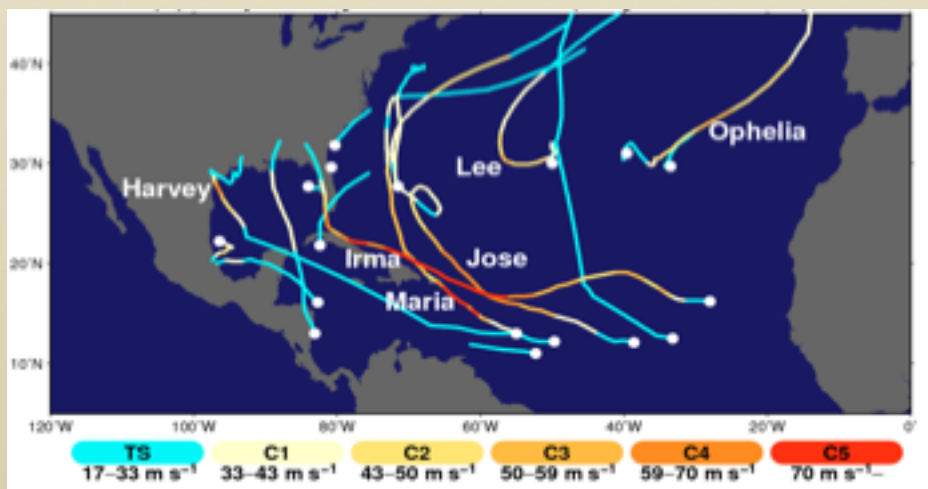
FLOR could predicted active 2017 hurricane season from 2017 July, but not from 2017 April.
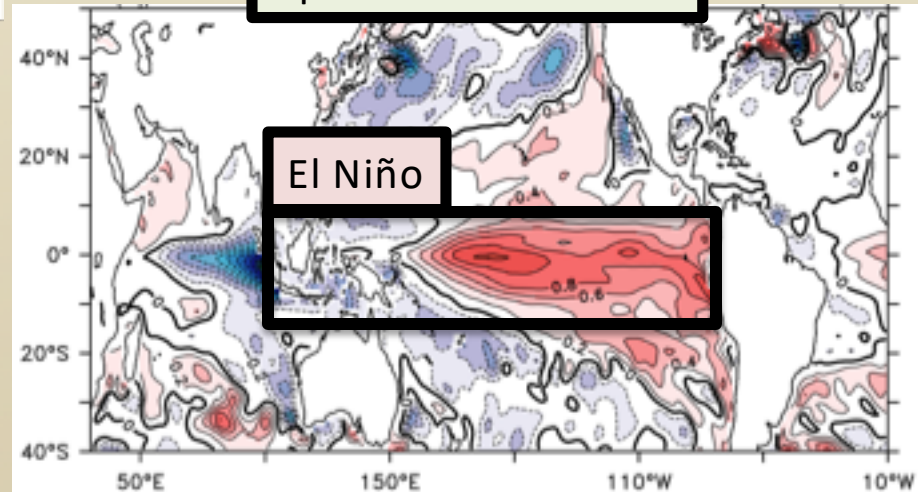
Observed and Predicted Sea Surface Temperature Anomaly

Observations (2017 July-November)

July Initial Forecasts

La Niña

La Niña

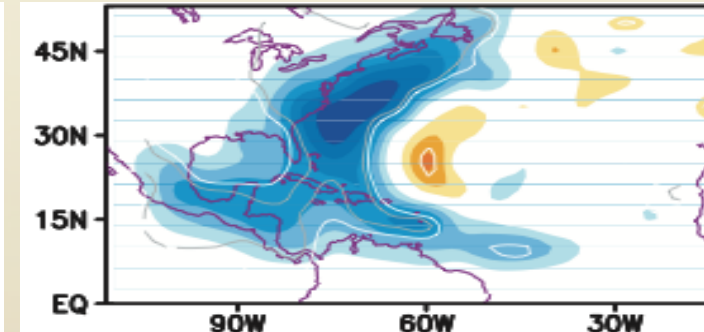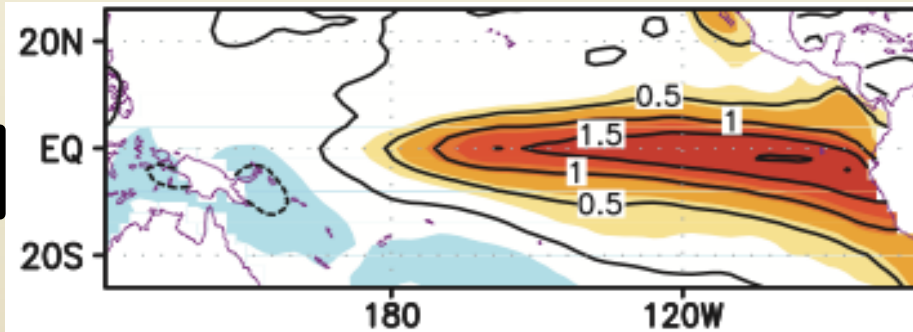April Initial Forecasts

El Niño

Impact of ENSO on North Atlantic Hurricanes

Based on observations (1956–2006) by *Kim et al. (2009, Science)*
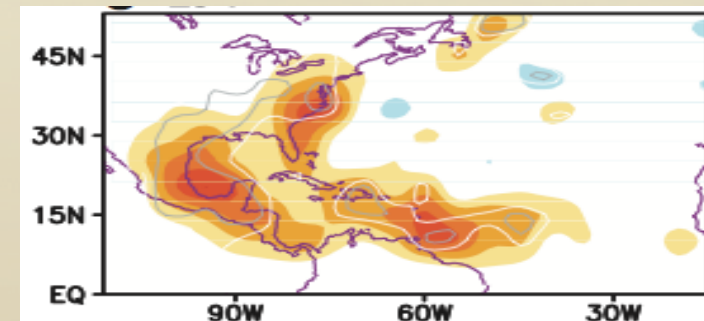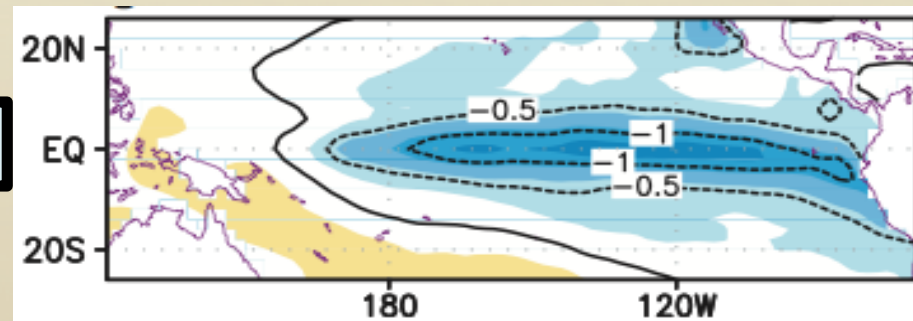
Sea Surface Temperature Anomaly
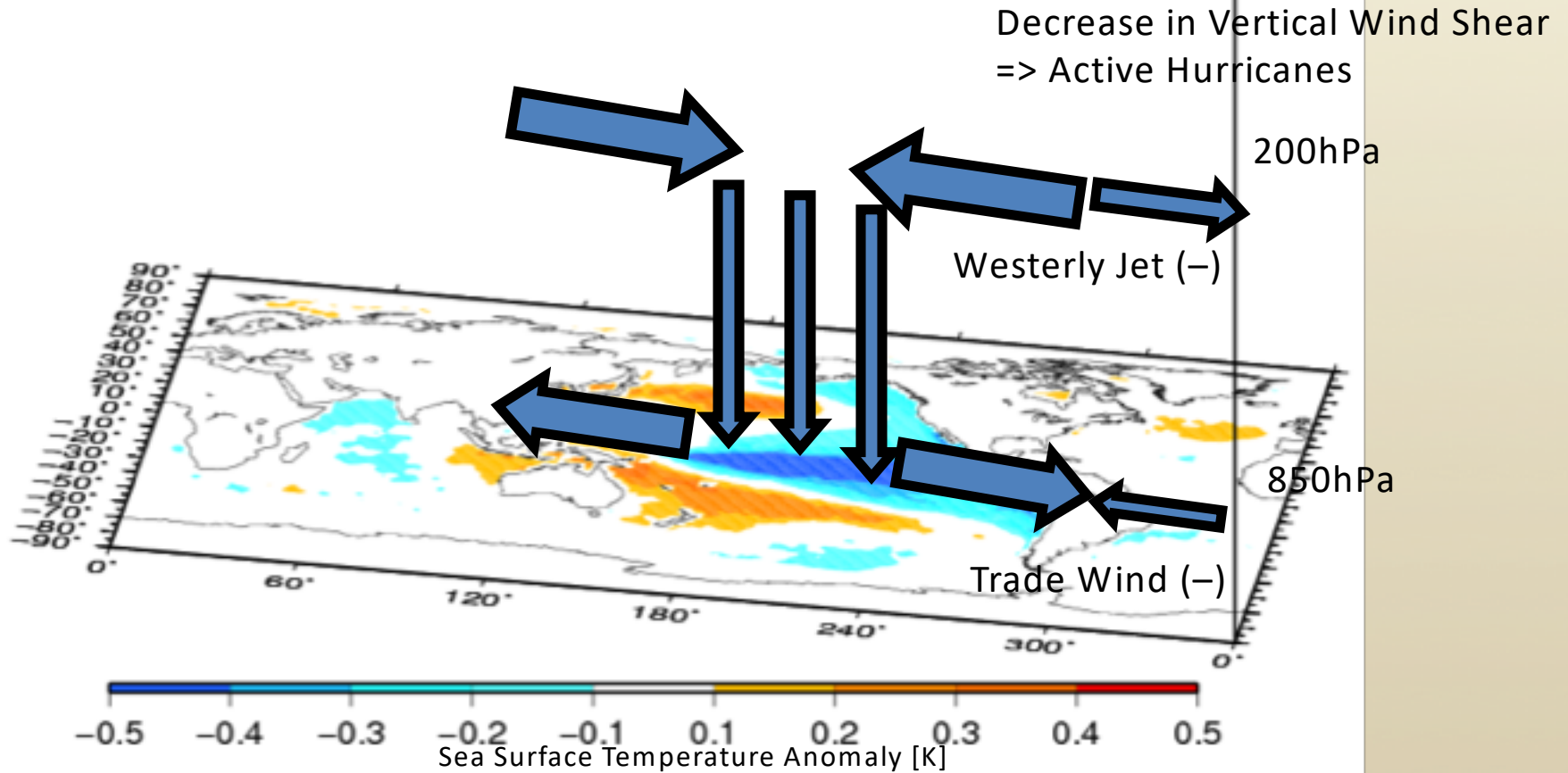
Storm Density Anomaly

El Niño

La Niña

Empirical Relationship: **El Niño -> Inactive Hurricane Season**
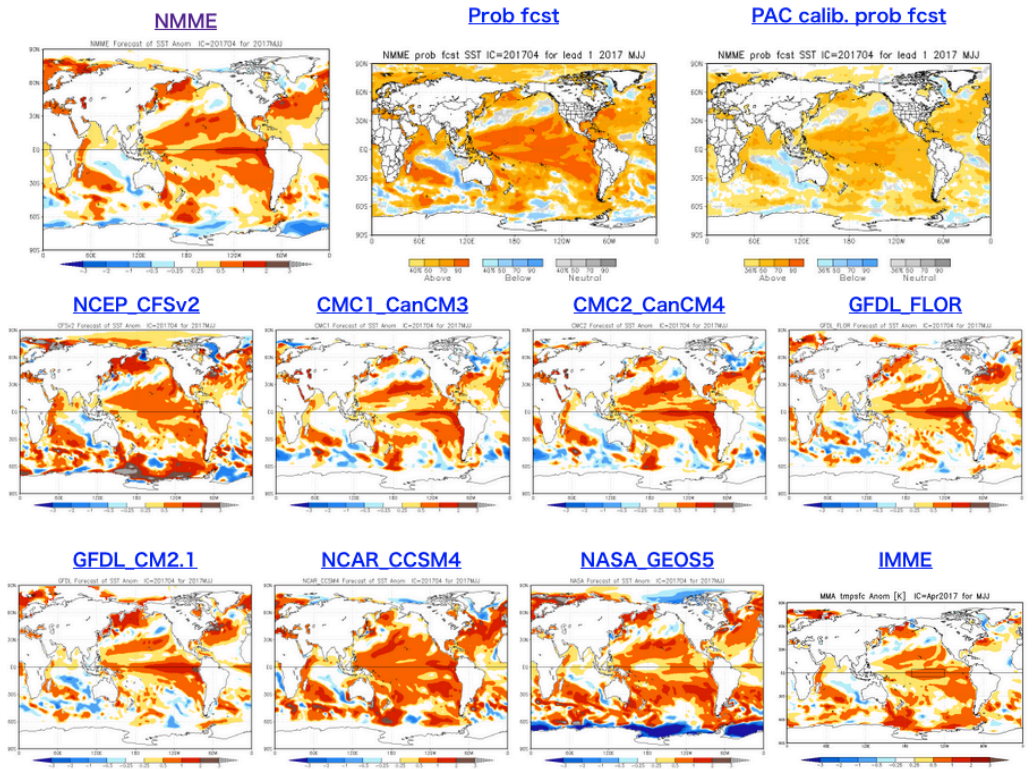**La Niña -> Active Hurricane Season**

La Niña Years

Decrease in Vertical Wind Shear => Active Hurricanes

200hPa

Westerly Jet (−)

850hPa

Trade Wind (−)

Sea Surface Temperature Anomaly [K]

2017 Summer Prediction from April by Multiple Models

Prediction Skill for Niño-3.4 SST

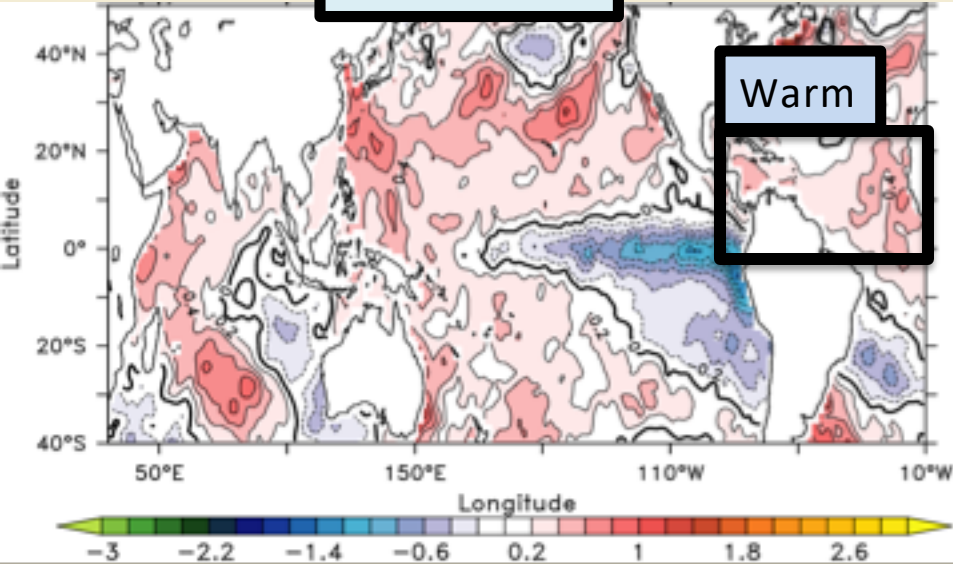worse than climo.   better than climo.

Jia et al. (2015)
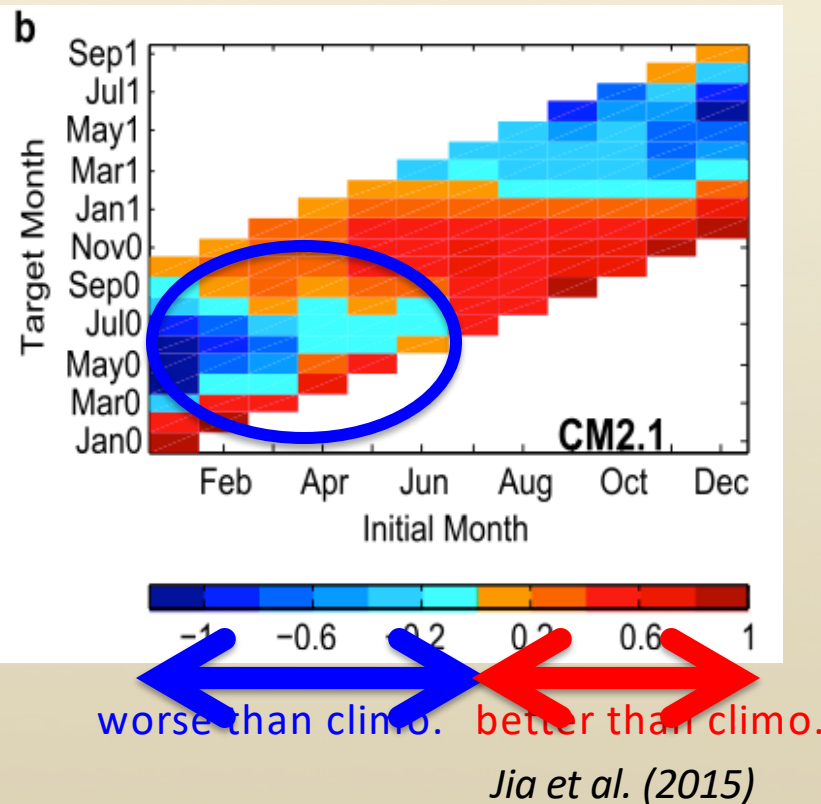
- The models from the prediction centers commonly miss-predicted El Niño conditions for the 2017 summer from the April initial predictions.
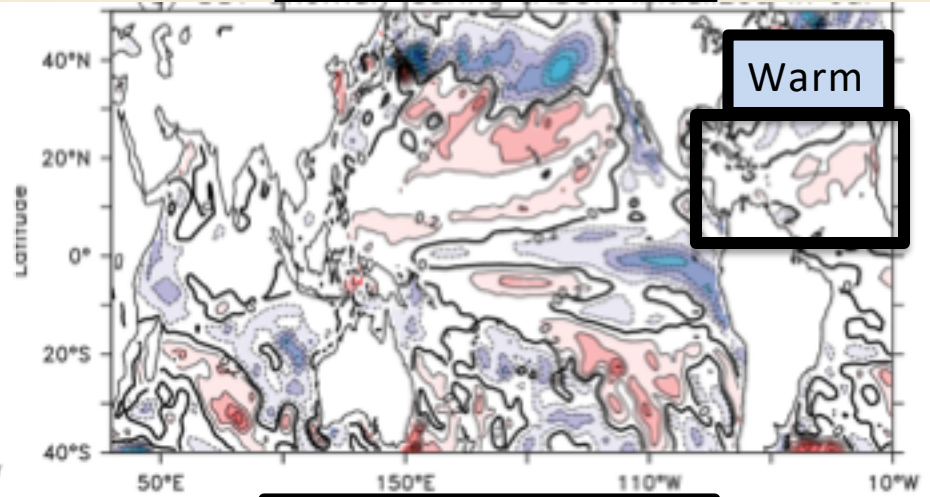- There is a "spring barrier" for prediction of ENSO.

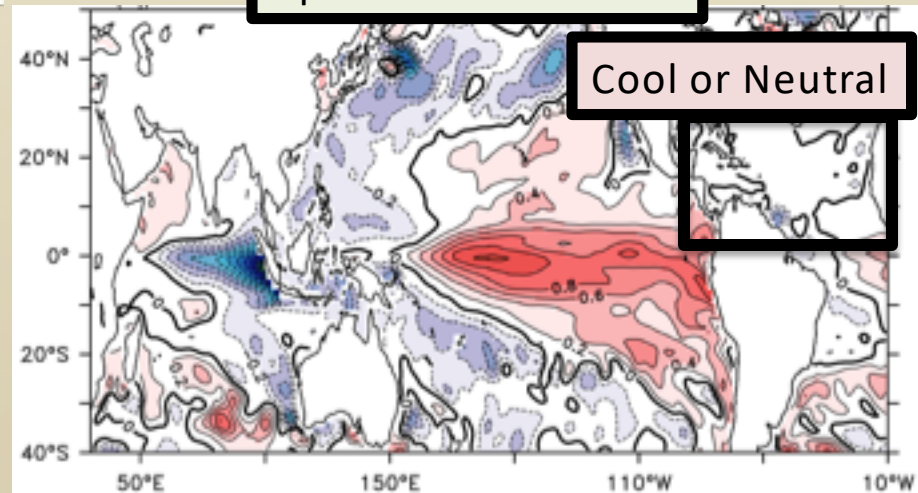# Observed and Predicted Sea Surface Temperature Anomaly

Observations

Warm

July Initial Forecasts

Warm

April Initial Forecasts

Cool or Neutral

Based on observations (1979–2017)

Major Hurricane Frequency and MDR SSTA (July-November)

r (MH freq. vs SSTA)=+0.50
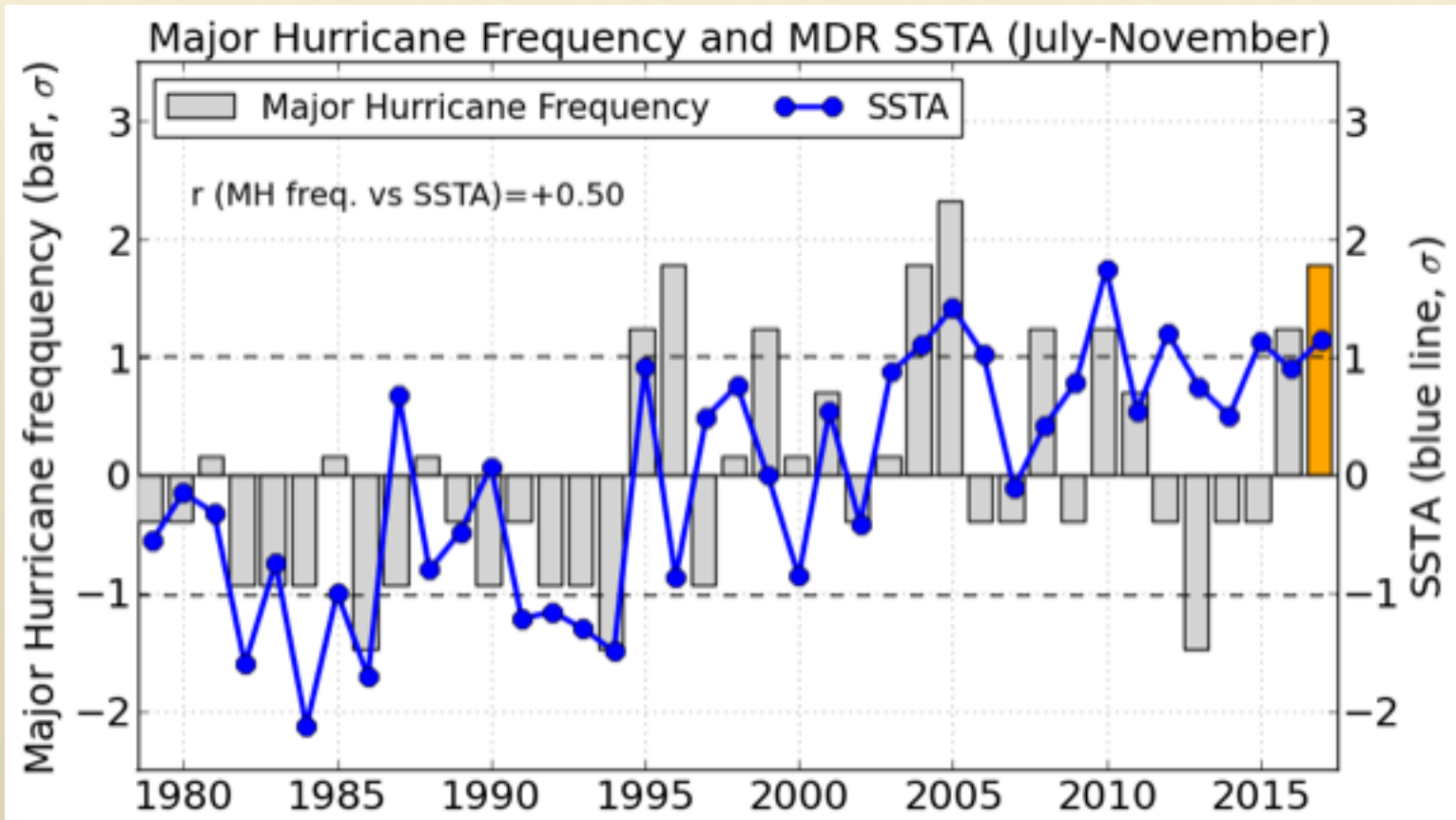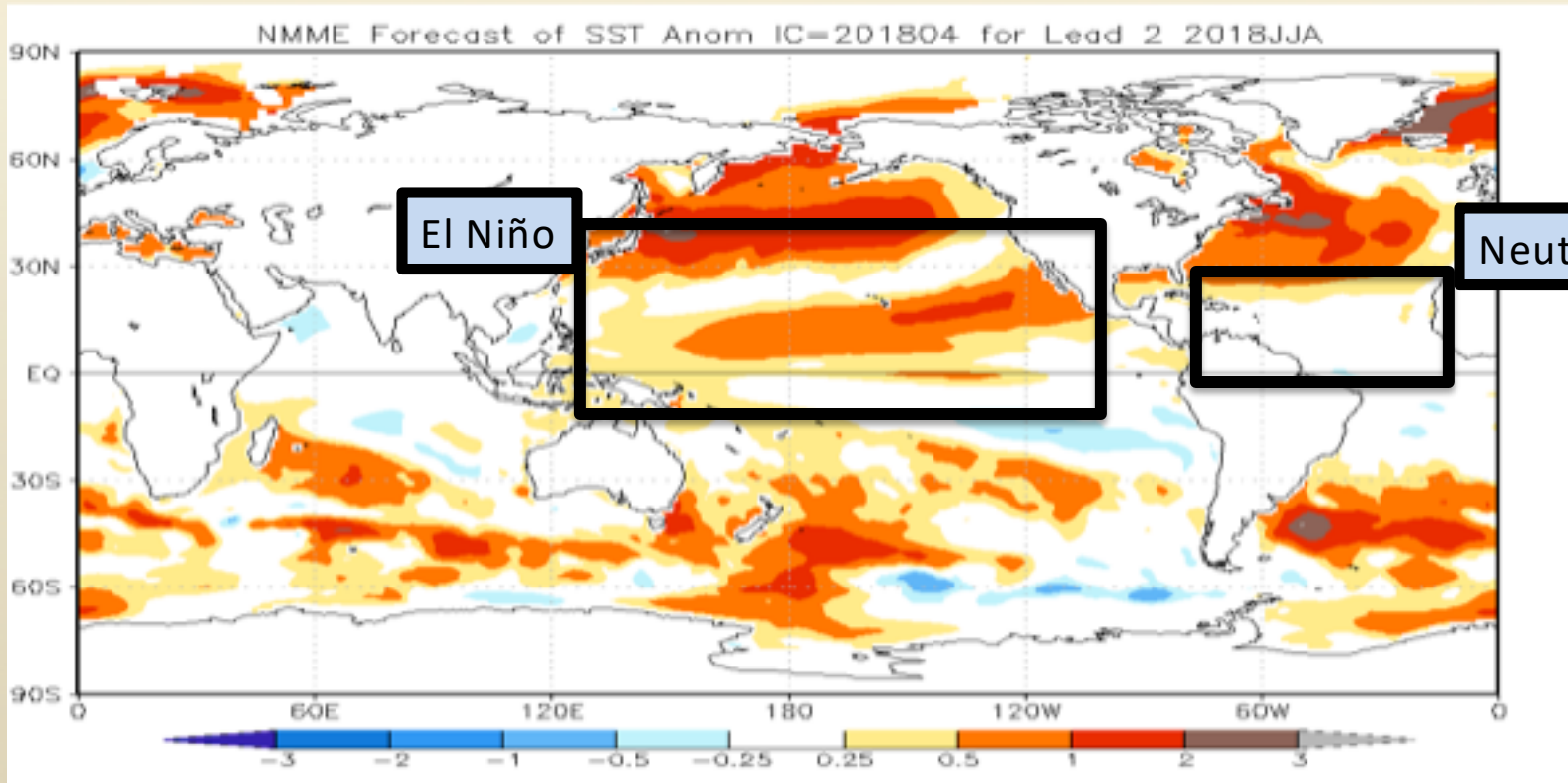
- Frequency of major hurricanes is highly correlated with SST in the tropical Atlantic
- Monitoring and predicting tropical Atlantic SST is a key for successful prediction of hurricanes

2018 Summer SST Prediction from April 2018.

NMME Forecast of SST Anom IC=201804 for Lead 2 2018JJA

El Niño

Neutral

Based on 7-models from the North American Multi-Model Ensemble (NMME) Project
http://www.cpc.ncep.noaa.gov/products/NMME/current/tmpsfc_Seas2.html

- Inactive or neutral hurricane season is expected for the 2018 summer over the North Atlantic.

Summary

- Dynamical seasonal prediction model succeeded in predicting active 2017 hurricane season from July initial predictions, but not from April initial predictions.

- April predictions falsely predicted El Niño and cooler tropical Atlantic, resulting in failure of seasonal hurricane predictions.

- Predictions of ENSO and tropical Atlantic SST are key factors for hurricane activity in the North Atlantic.

- Dynamical models are suffering from "spring barrier" for ENSO predictions from spring time.

- Inactive or neutral 2018 summer season is predicted by the state-of-the-art models from the April initial predictions associated with predicted El Niño development. However, we should keep in mind the low skill in predicting ENSO by the dynamical models.