Towards Coastal (Nuisance) Flood Risk Prediction from Days to Decades

Ben Kirtman

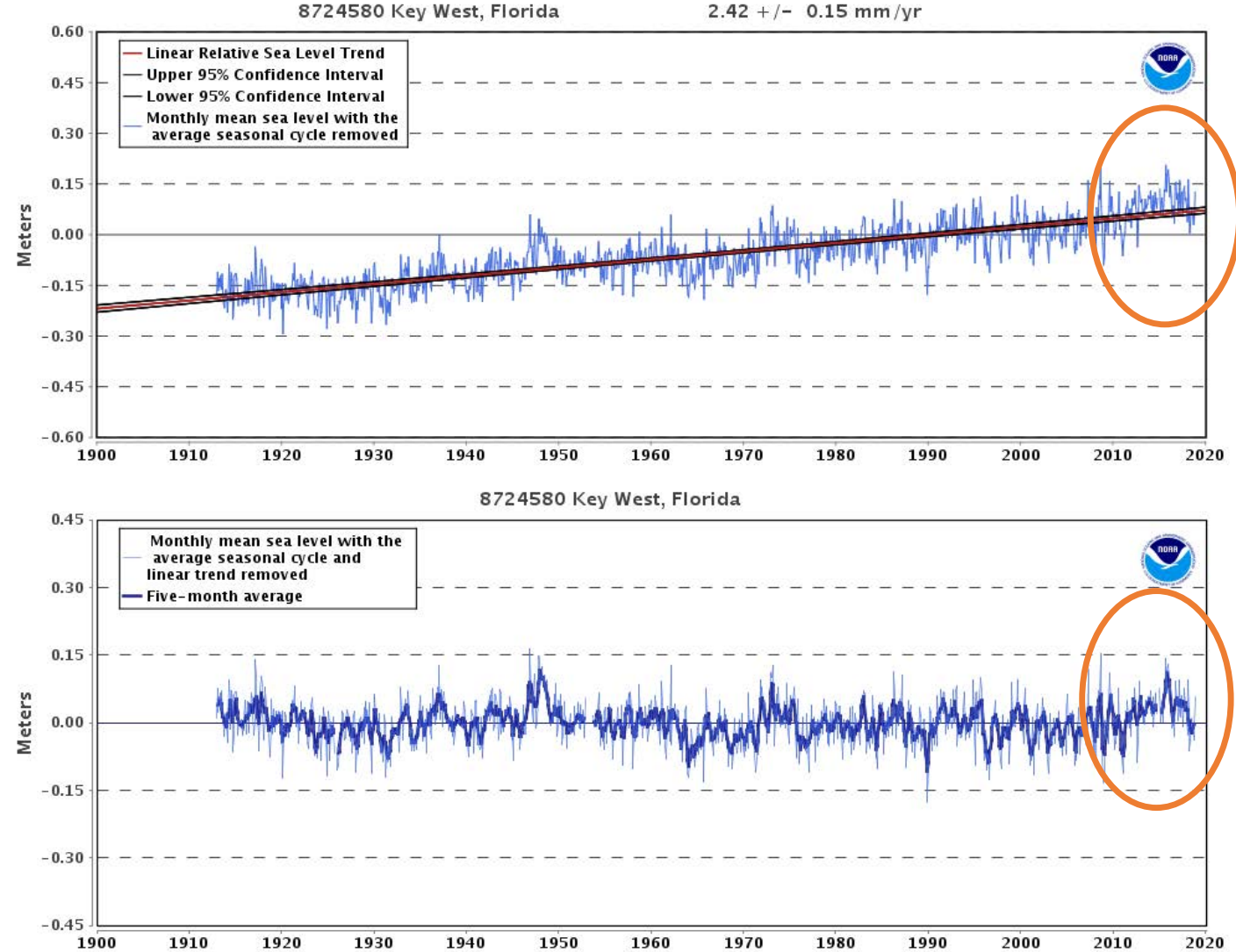**(and Gary Mitchum)**

Department of Atmospheric Sciences

Cooperative Institute for Marine and Atmospheric Science

UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL of MARINE & ATMOSPHERIC SCIENCE

UNIVERSITY OF MIAMI
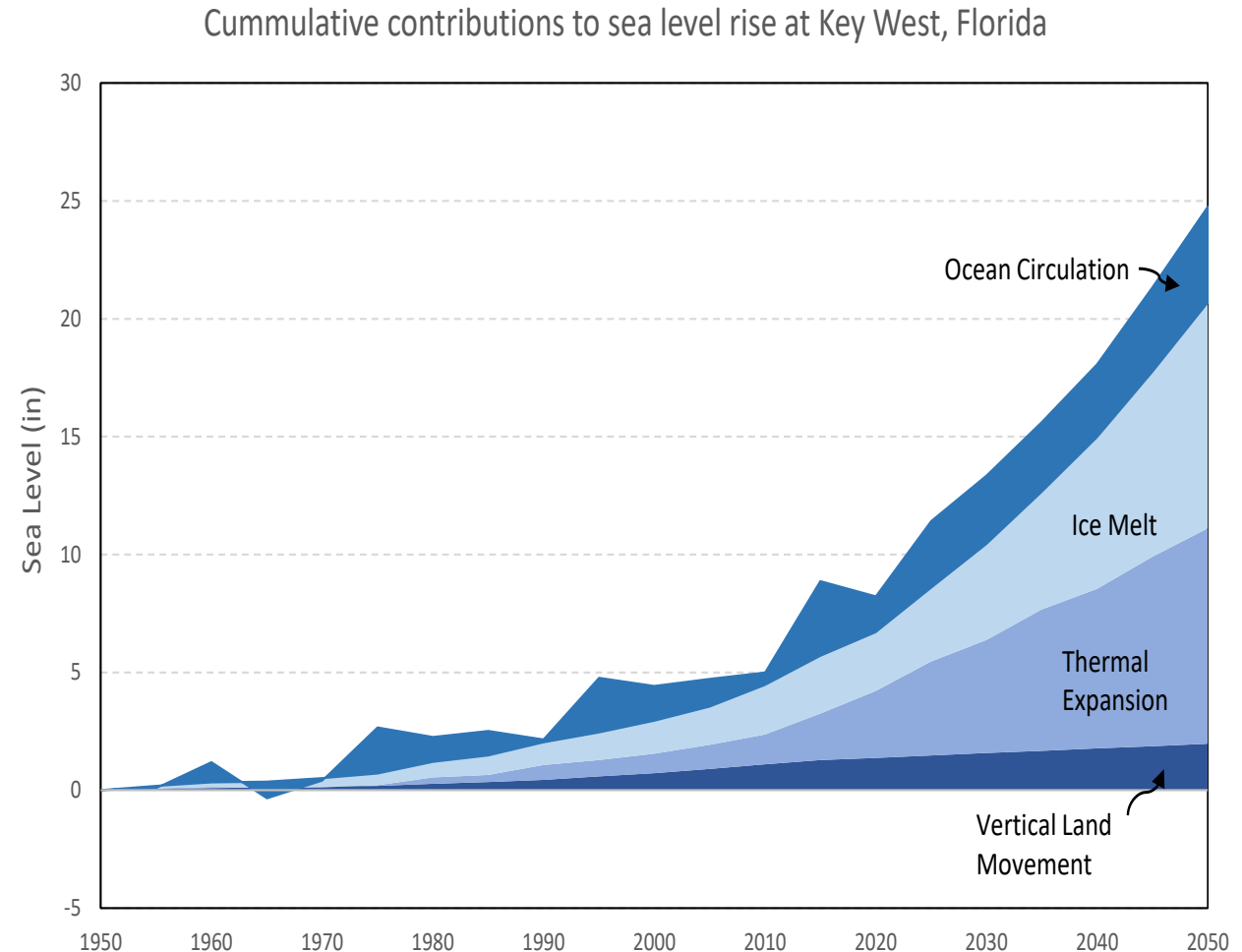COOPERATIVE INSTITUTE for MARINE & ATMOSPHERIC STUDIES

Chronic vs. Acute

- **Brief Global Context**
  - IPCC Perspective
- **What Drives Regional Sea Level Changes**
- **What Drives Regional Coastal Flood Risk**
  - Sea Level Not Always a Good Predictor of Flood Risk
  - Not Just Tides
- **Predicting Regional Flood Risk**
  - Natural Variability and Trend
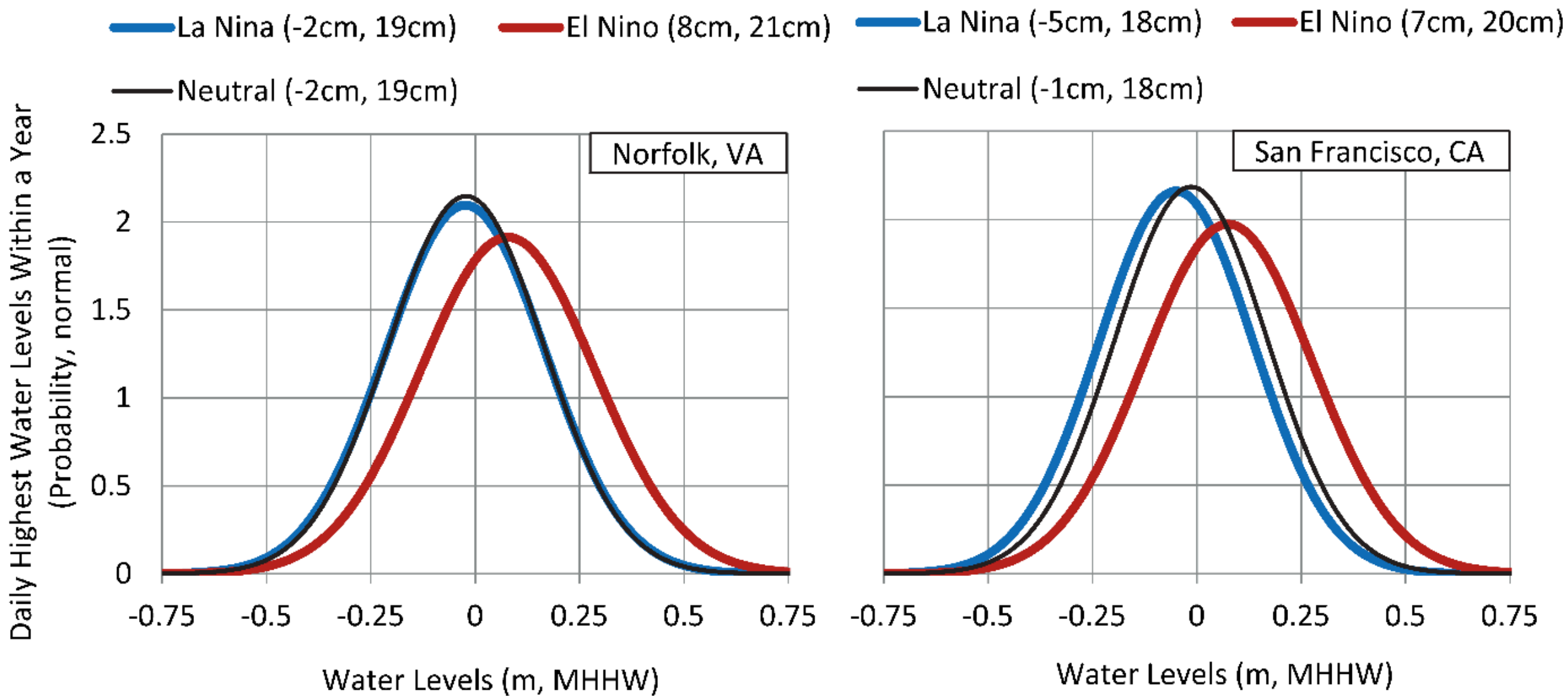- **Can we do Better?**

8724580 Key West, Florida   2.42 +/- 0.15 mm/yr

Linear Relative Sea Level Trend
Upper 95% Confidence Interval
Lower 95% Confidence Interval
Monthly mean sea level with the average seasonal cycle removed

8724580 Key West, Florida

Monthly mean sea level with the average seasonal cycle and linear trend removed
Five-month average

What Causes Regional Sea Level Change

- **Ocean, Atmospheric Circulation**
  - **Atlantic Meridional Over-Turning, Pacific Decadal Oscillation, ENSO, Gulf Stream Strength, Winds, SLP**
- **Freshwater Input**
  - **Melting of Land Ice (Glaciers)**
  - **Precipitation – Evaporation**
- **Steric Effects**
  - **Thermal Expansion – Warming Planet**
- **Land Subsidence or Rebound**

Cummulative contributions to sea level rise at Key West, Florida

Ocean Circulation

Ice Melt

Thermal Expansion

Vertical Land Movement

Sea Level (in)

Sea Surface Height Not Always a Good Indicator for Tidal (Nuisance) Flooding

- **Where (and When) is Sea Surface Height a Good Predictor?**
- **Other Possibilities: Winds? Sea Level Pressure?**
- **Do <u>Prediction Models</u> Capture These Relationships?**

Legend:
La Nina (-2cm, 19cm)   El Nino (8cm, 21cm)   La Nina (-5cm, 18cm)   El Nino (7cm, 20cm)
Neutral (-2cm, 19cm)   Neutral (-1cm, 18cm)

Norfolk, VA

San Francisco, CA

Daily Highest Water Levels Within a Year (Probability, normal)

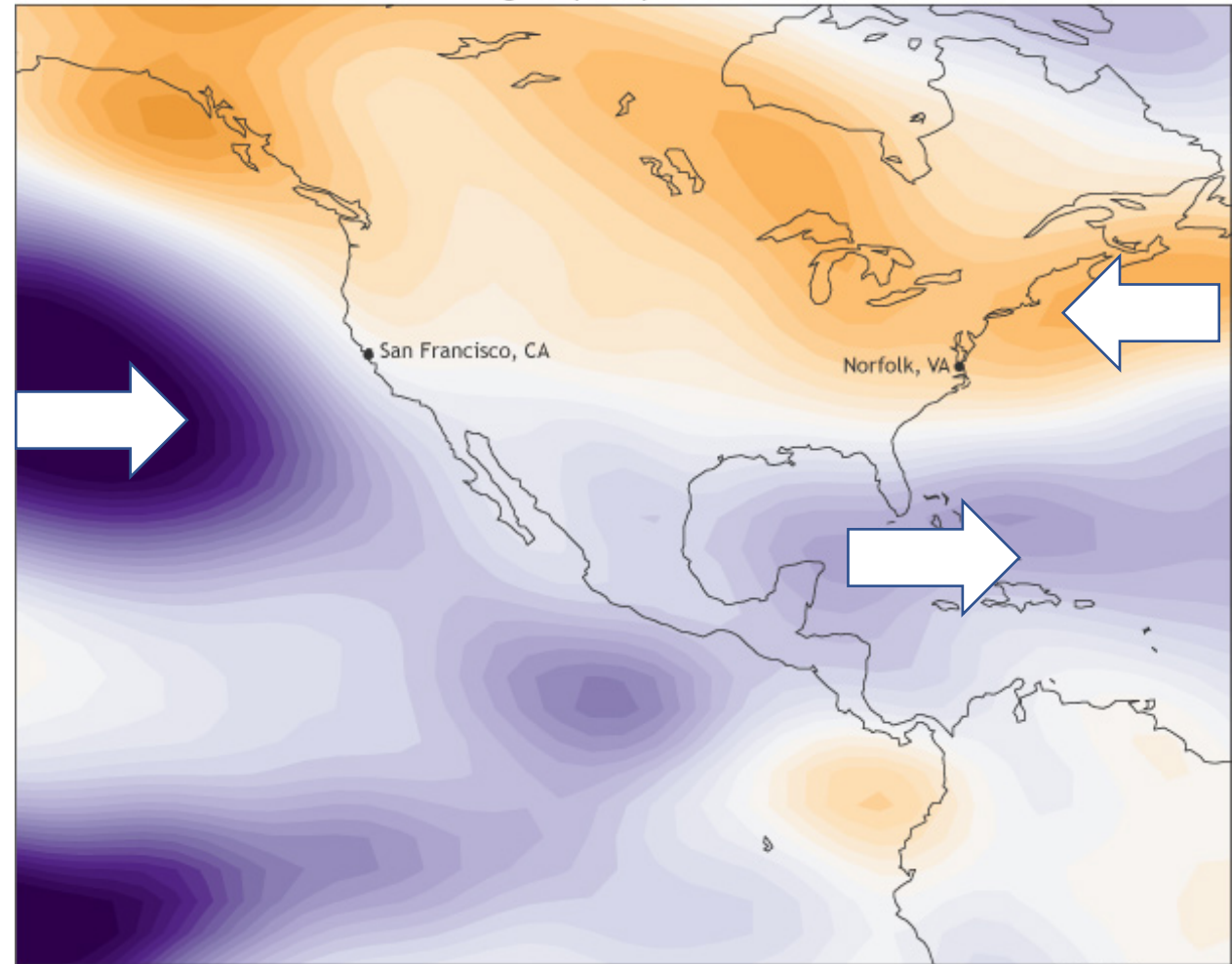Water Levels (m, MHHW)

Primarily a Wind Shift Effect   **Primarily a SSH Effect**

Predicting Coastal Flood Risk

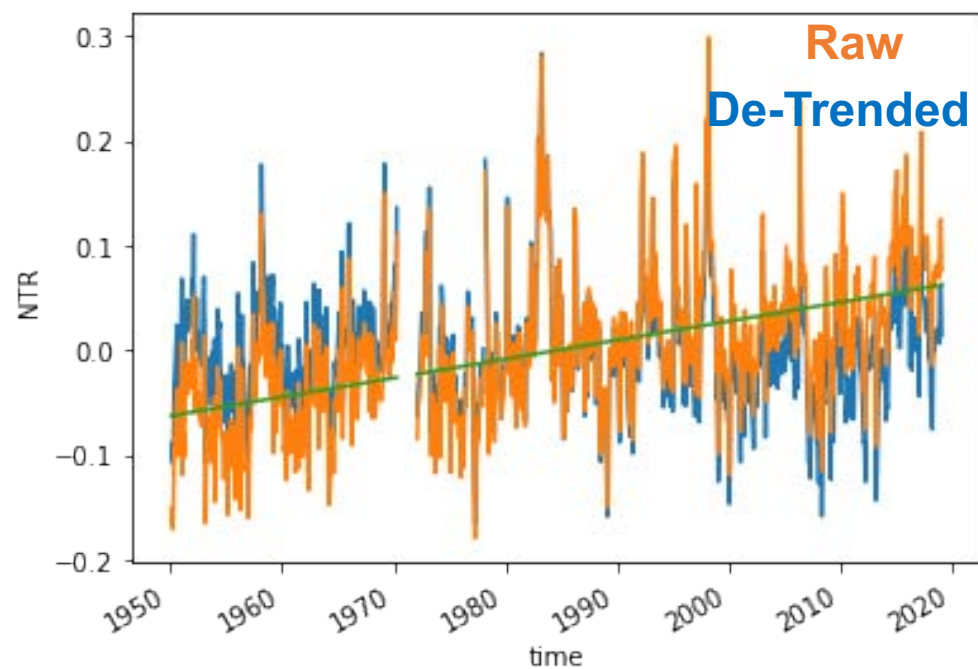Sea surface height anomalies during the peak phase of the 1997-98 El Niño
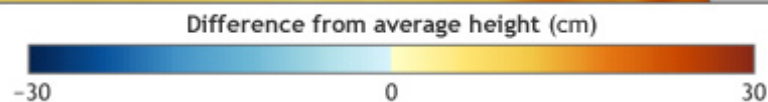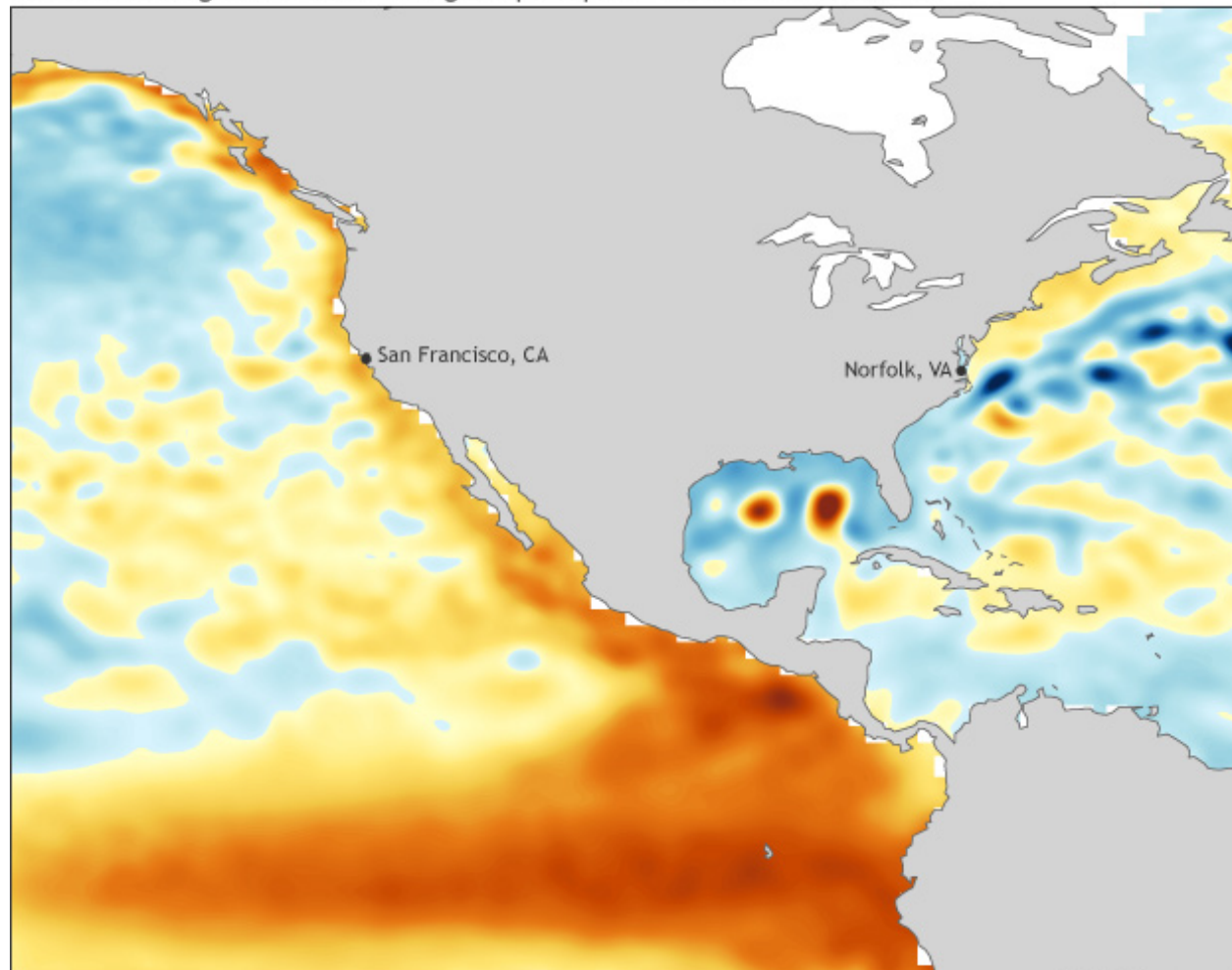
East-west surface wind anomalies during the peak phase of the 1997-98 El Niño

San Francisco, CA
Norfolk, VA

Difference from average height (cm)

NOAA Climate.gov
Data: NASA T/P

-30   0   30

Difference from average zonal winds (m/s)
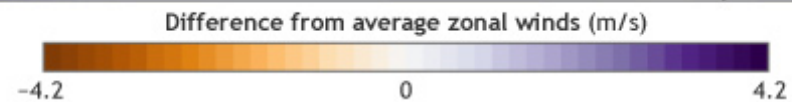
NOAA Climate.gov
Data: NCEP/NCAR

-4.2   0   4.2

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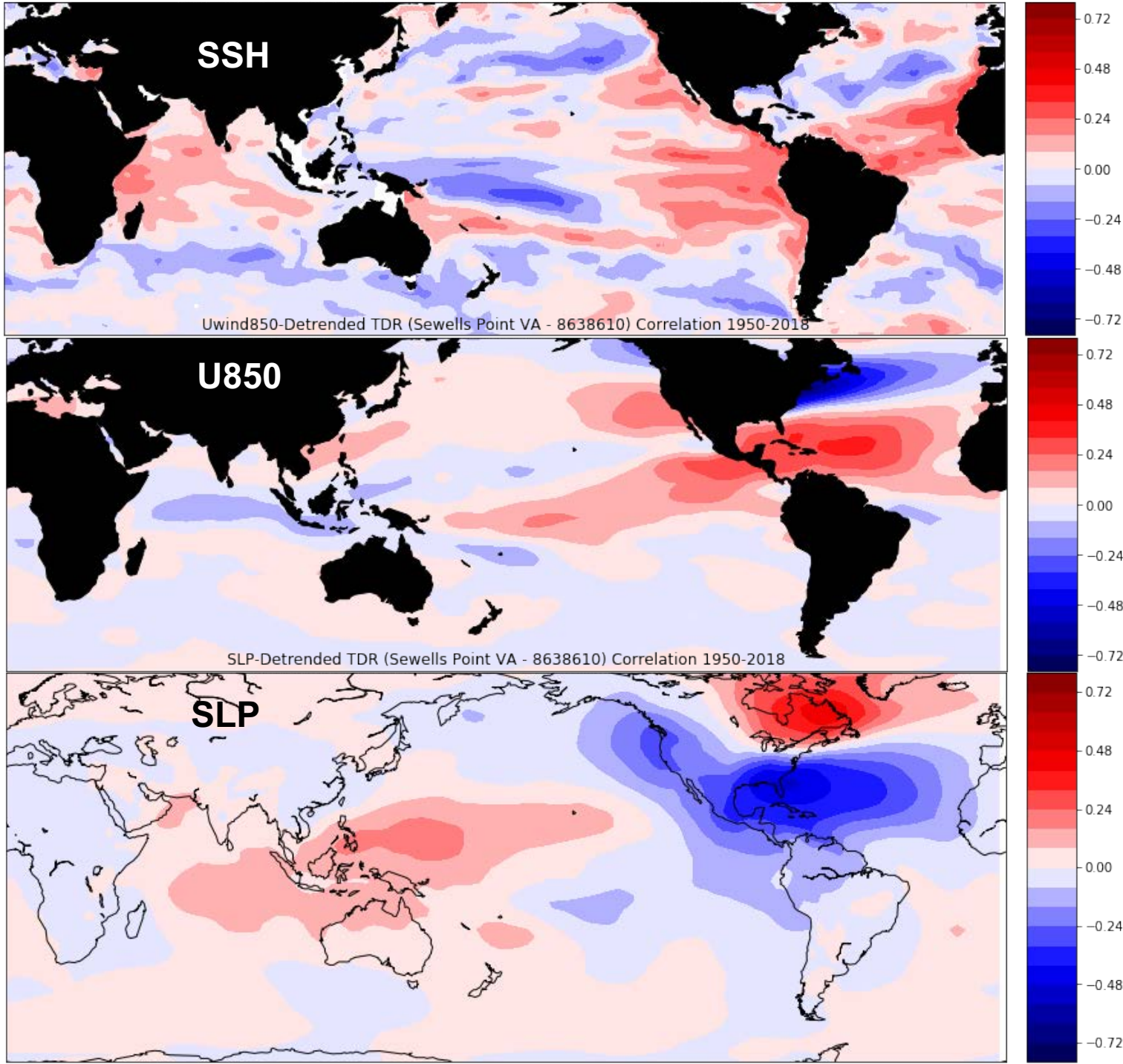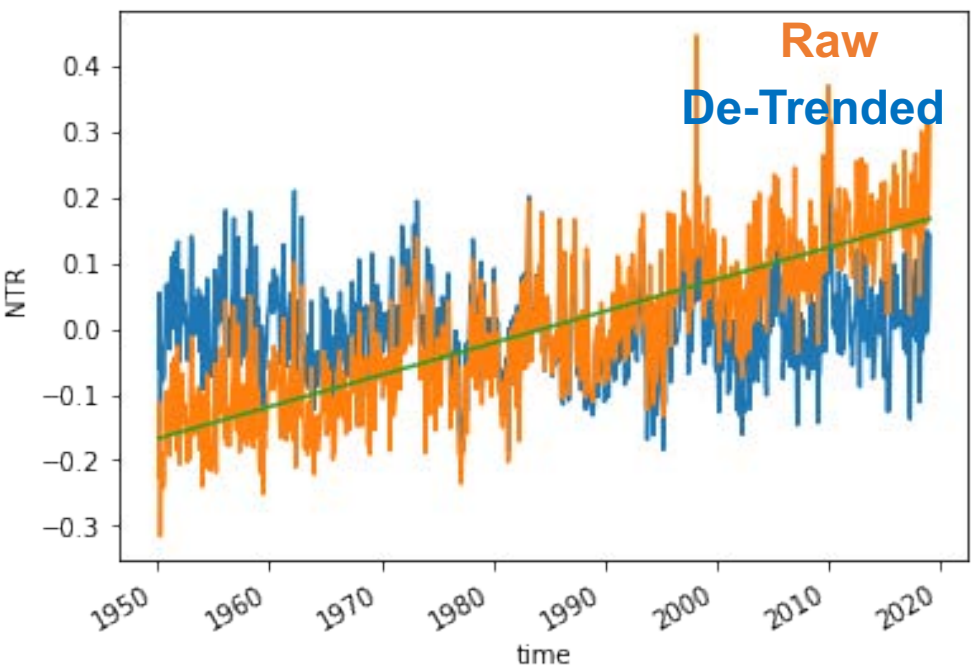## Tide Gauge Non-Tidal Residual (NTR)

SSTH (GODAS)-Detrended TDR (San Francisco, CA - 9414290) Correlation 1980-2018
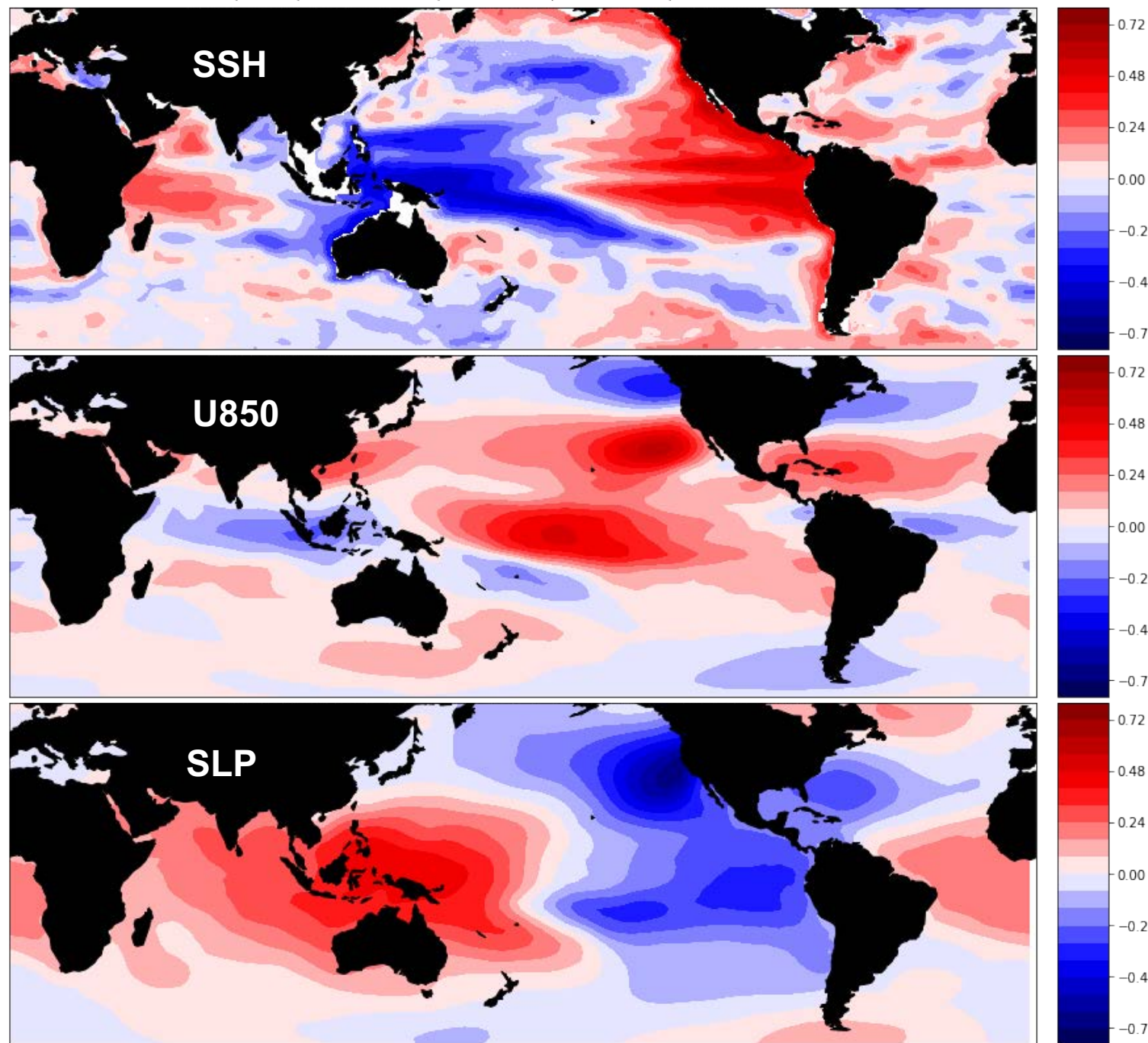
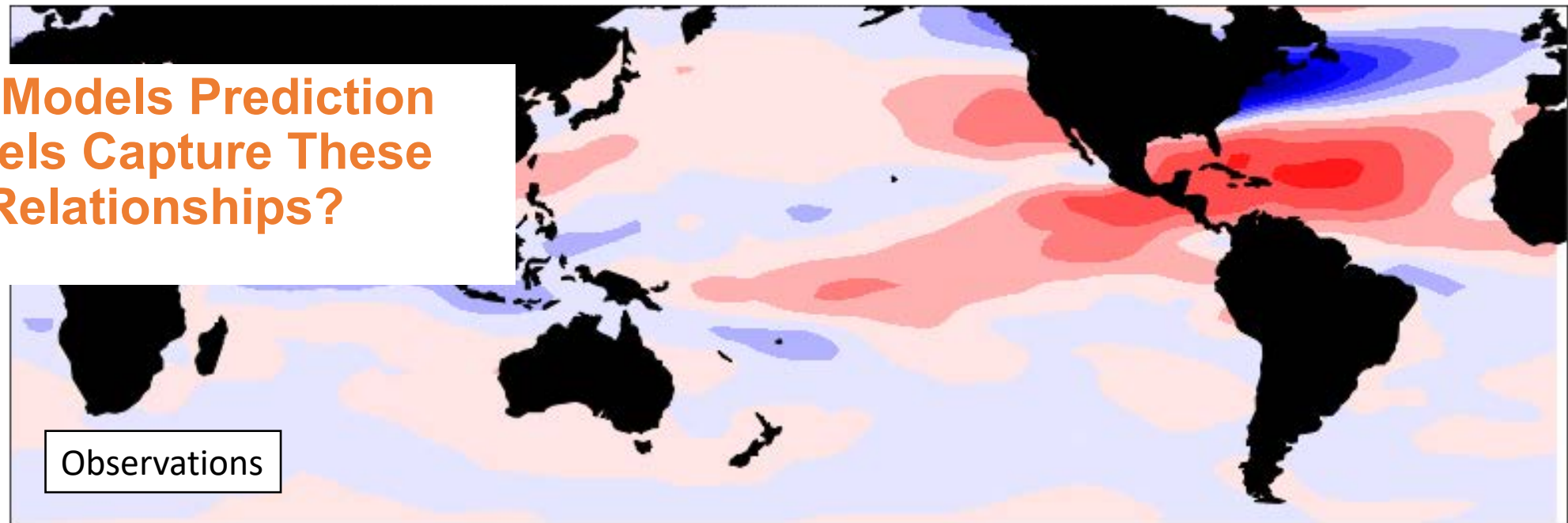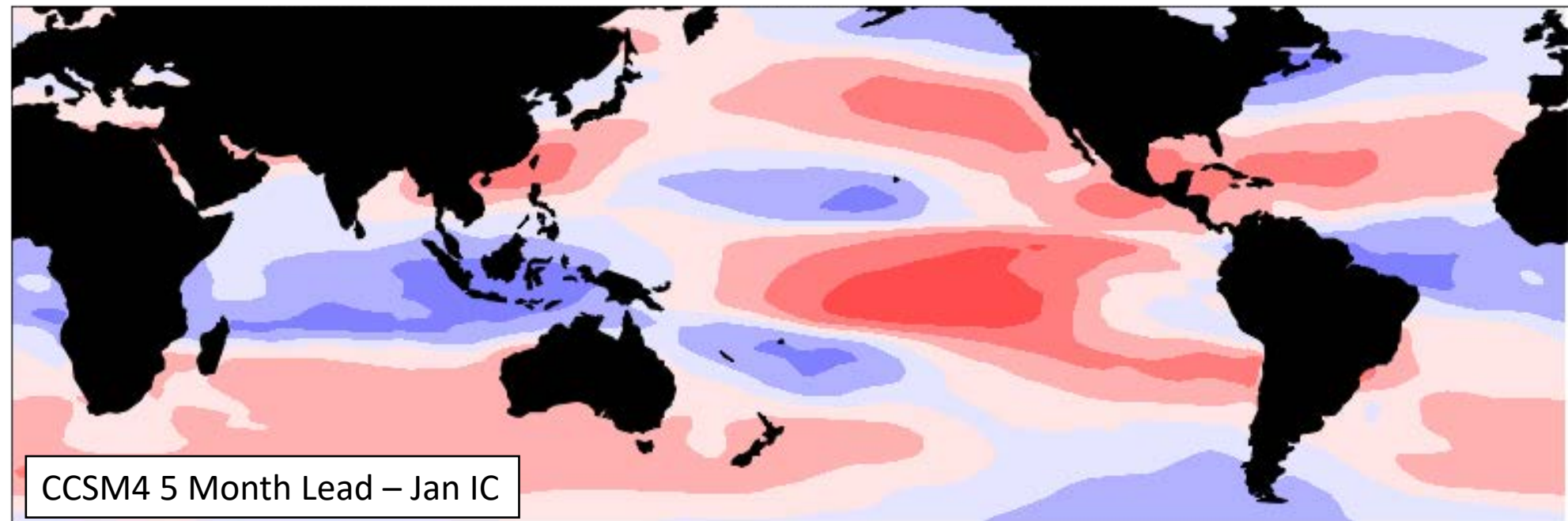# Sewells Point, VA

Tide Gauge Non-Tidal Residual (NTR)

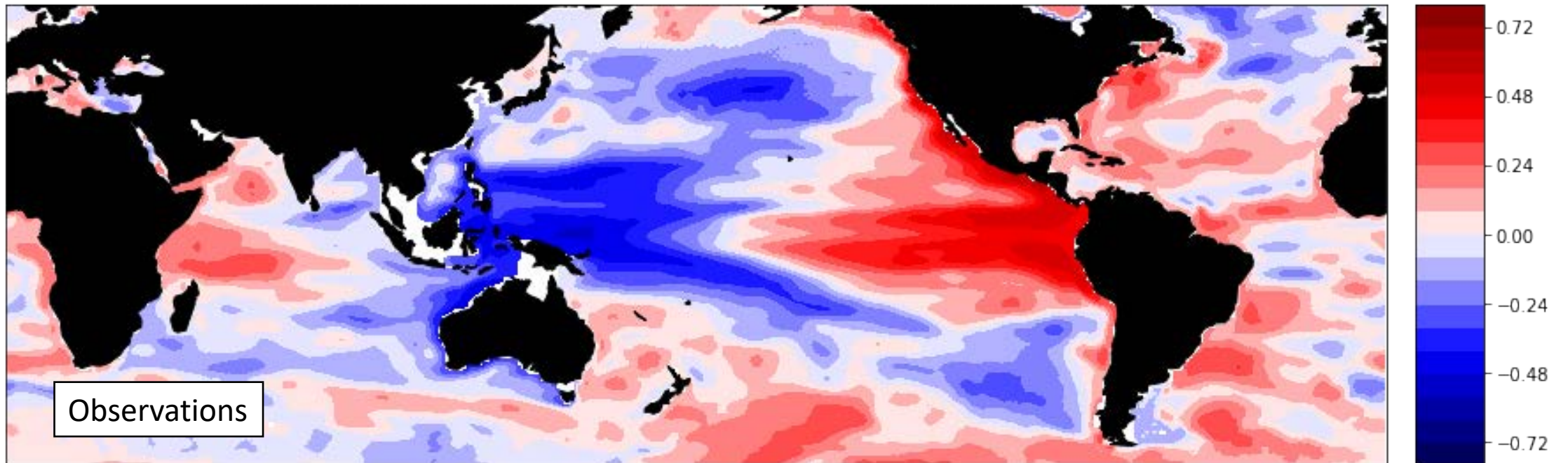Uwind850-Detrended TDR (Sewells Point VA - 8638610) Correlation 1950-2018

Can Models Prediction Models Capture These Relationships?

Observations

U850mb (CCSM4-6)-Detrended TDR (Sewells Point VA - 8638610) Correlation 1982-2018

CCSM4 5 Month Lead – Jan IC

SSTH (GODAS)-Detrended TDR (San Francisco CA - 9414290) Correlation 1980-2018

Observations

SSH (CCSM4-6)-Detrended TDR (San Francisco CA - 9414290) Correlation 1982-2018
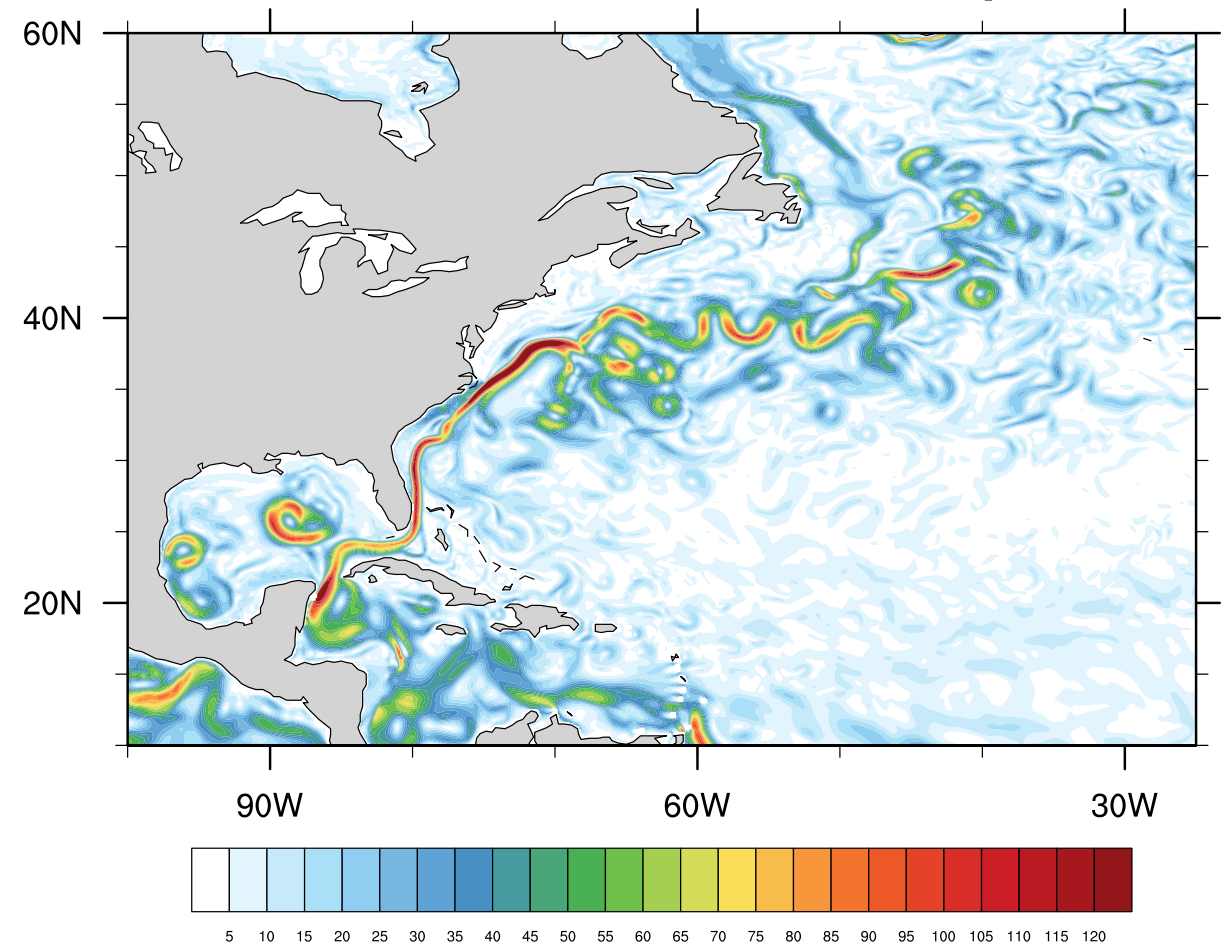
CCSM4 5 Month Lead – Jan IC
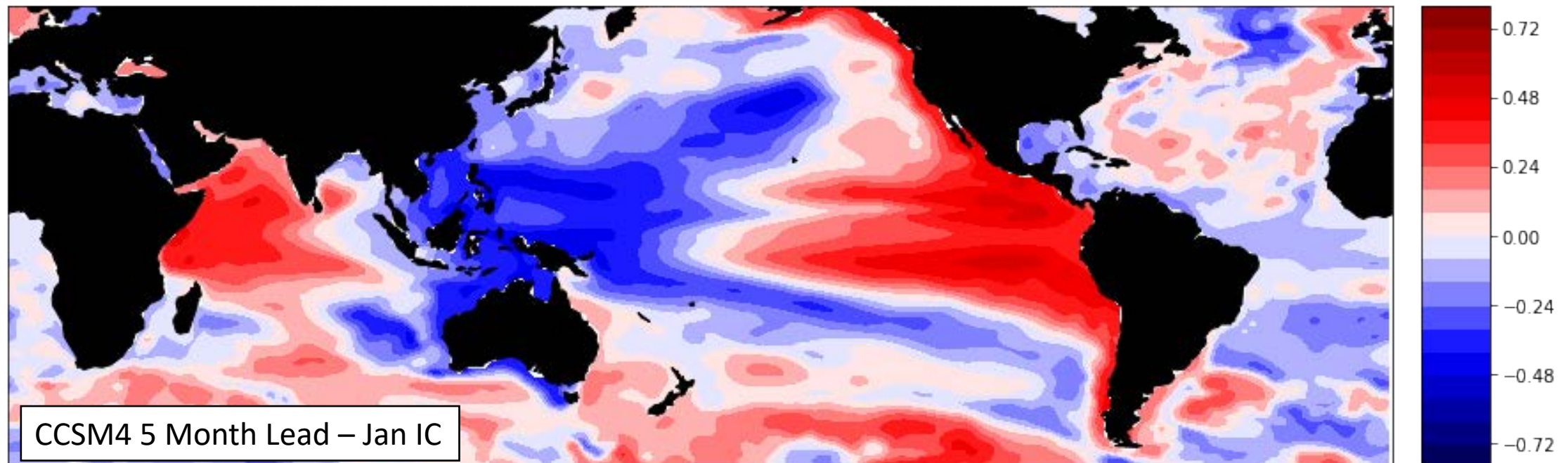
Predicting Coastal Flood Risk From Days to Decades

Ocean Model Surface Current Speeds
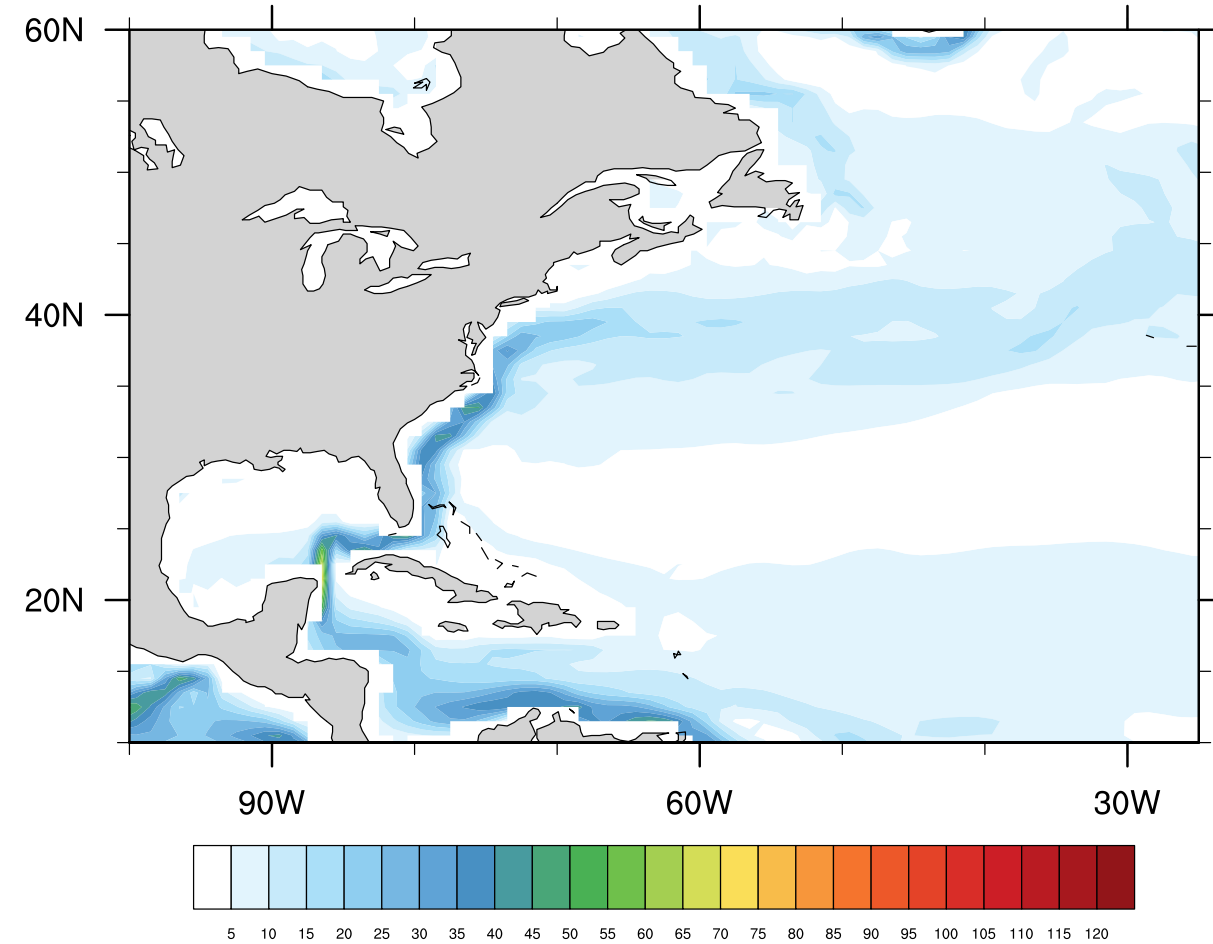
Ocean Model Surface Current Speeds

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~ -6 mm/year

~8 mm/year