Coastal Session

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University of Colorado Boulder

Extreme sea level events Induce accelerated increase in flooding time along U.S. east coast in recent decades

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Background

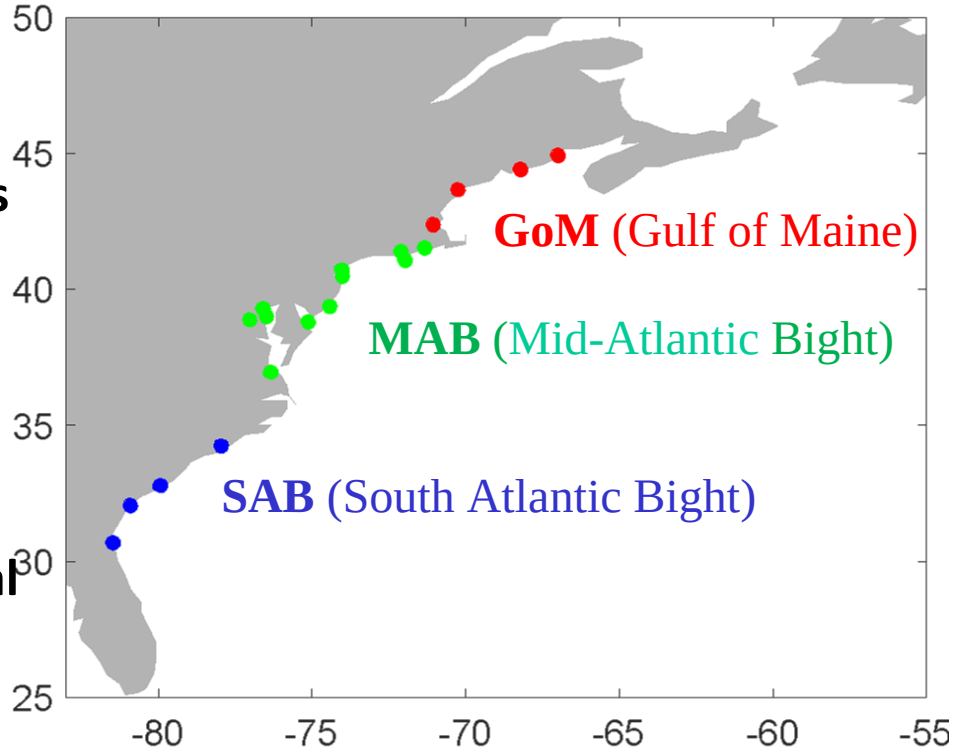
Sea level rise (SLR) at USEC

- increased frequency and severity of **nuisance flooding** (*i.e.*, *clear-sky flooding*) in recent decades;
- compounded by **modes of climate variability**, they cause **changes in location, strength and time of the extremes**.

Goal of our project:

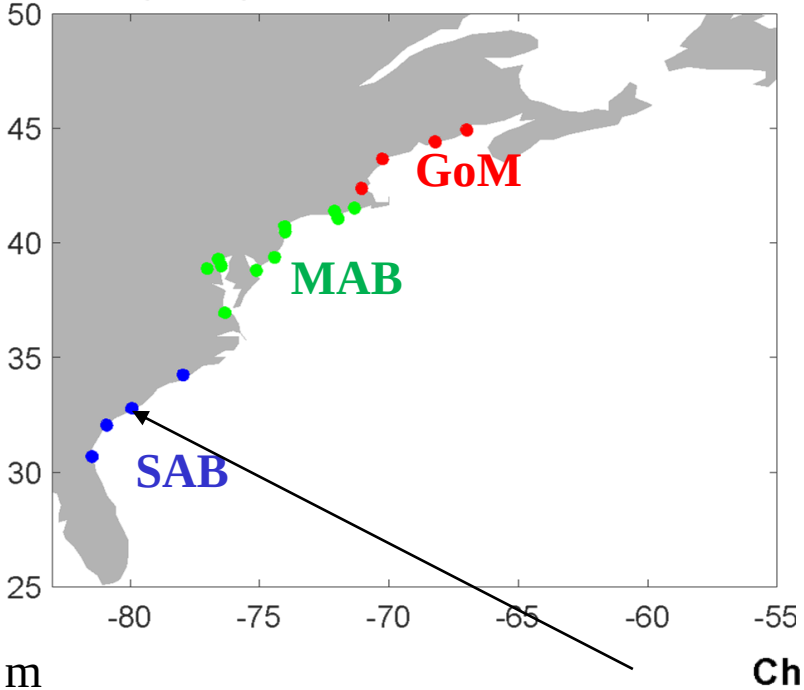
- Investigate the impacts of **climate modes and external forcing** on **spatial and temporal evolutions** of sea surface **H**eight **EX**tremes (**HEXs**) at USEC using **E3SM HR** & other CMIP6 HR models;

- **This understanding is crucial for regional prediction & near-term projection of coastal inundation.**

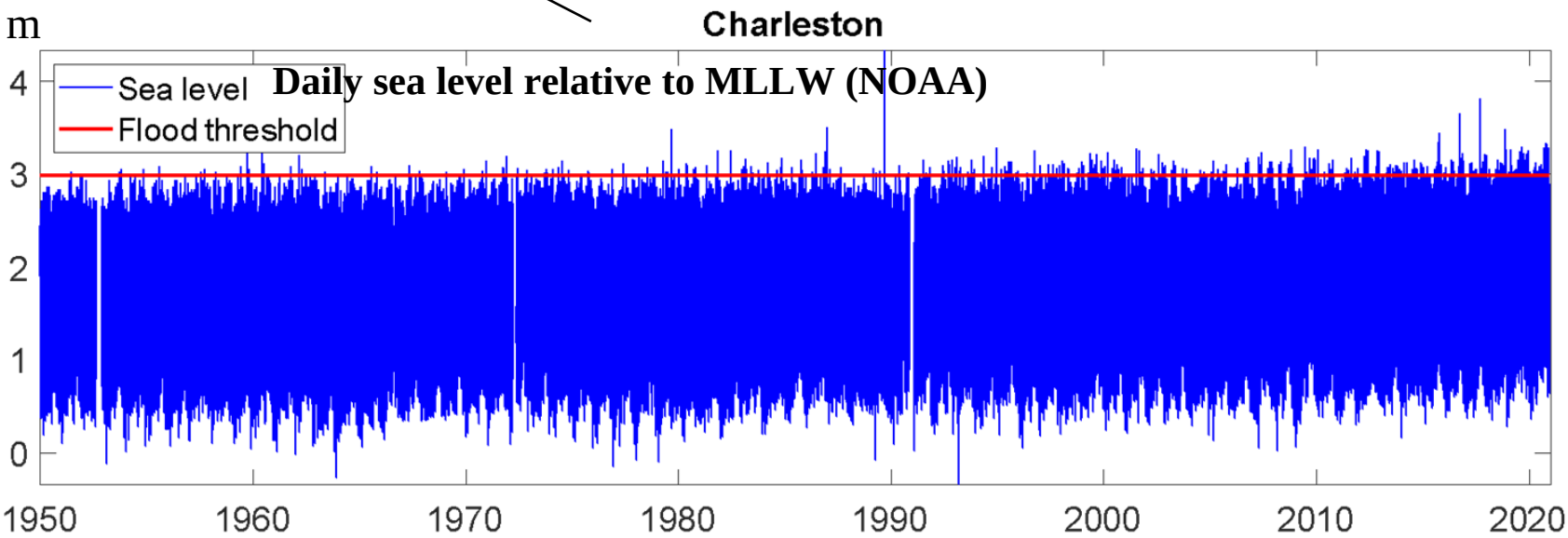


Results

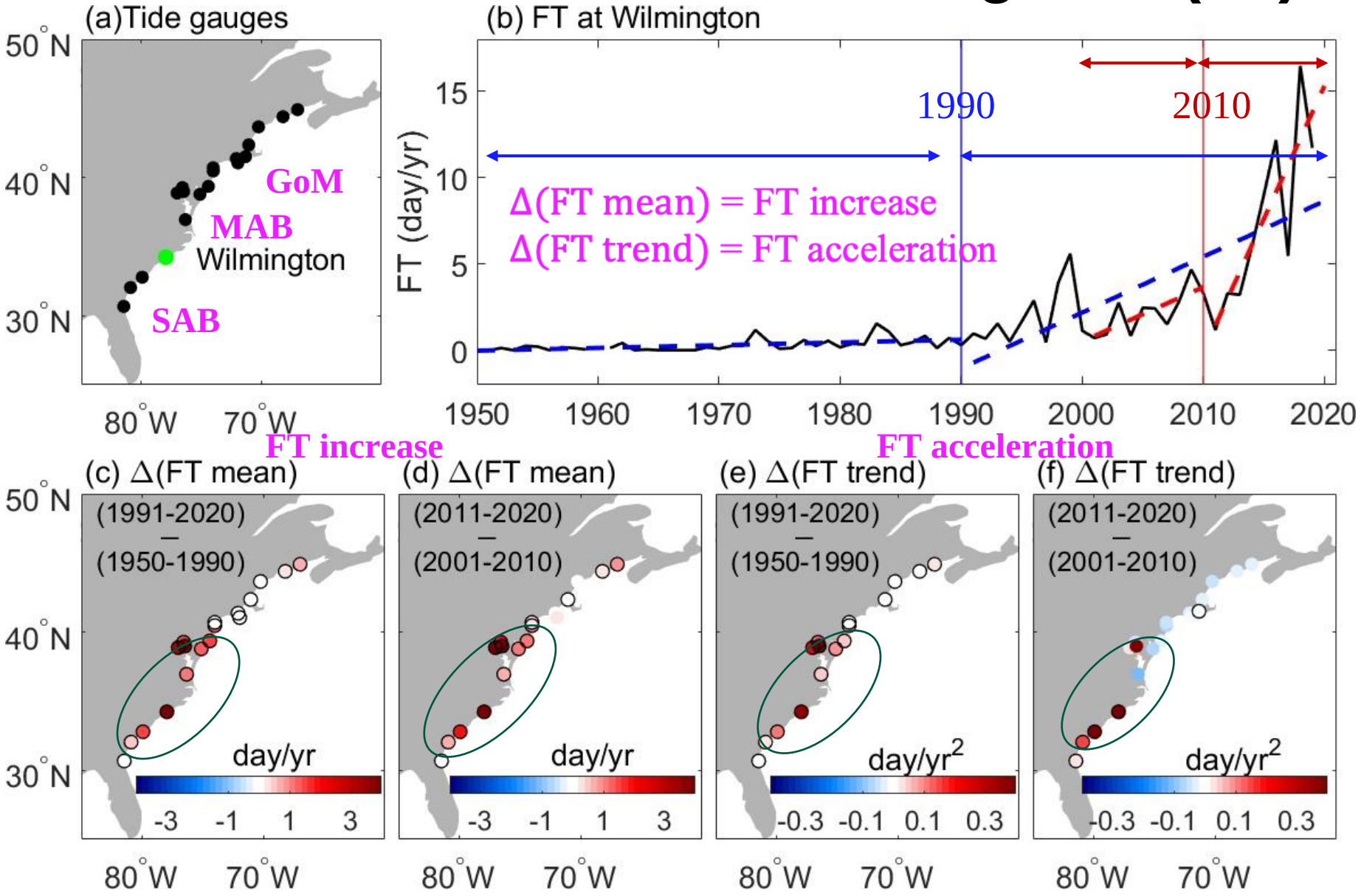
Tide gauge data 1950-2020: flooding time (FT)



- **Flooding time (FT): Total time in a year when relative sea level (RSL) exceeds the NOAA flooding threshold**
- **Flood intensity (FI): Total sea level exceedance/FT**



Accelerated increase in flooding time (FT)



Causes for accelerated increase in sea level & FT:

- **SLR trend:** Linear trend ~ global SRL (climate change)
- **Tides:** Tidal harmonics (Utide Matlab software)

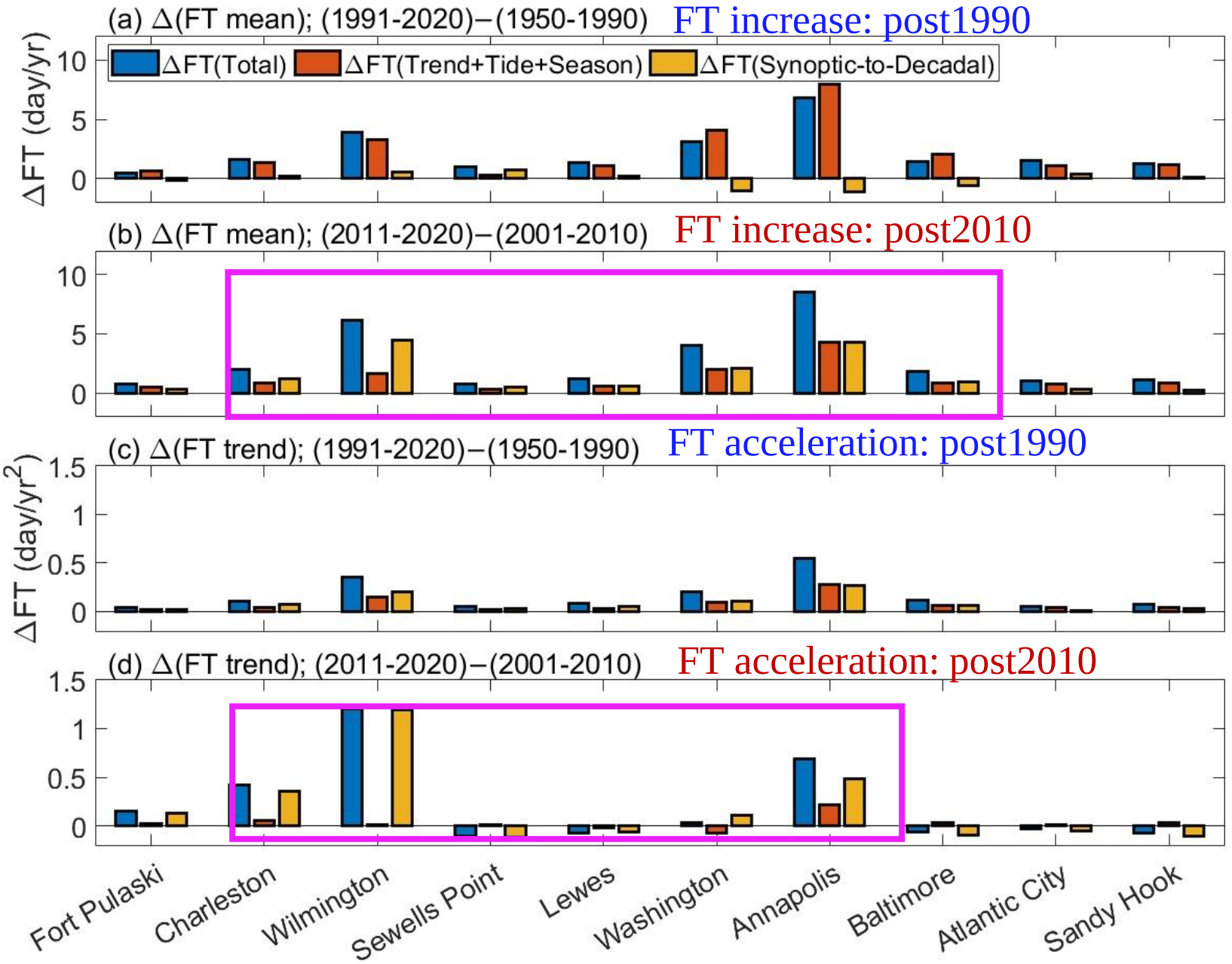
- **Decadal SLA:** >10year variability
- **Interannual SLA:** 90 days-10year variability (detrend & remove seasonal cycle)
- **Seasonal SLA:** annual+semiannual+120day
- **Intraseasonal SLA:** 10-90 days variability

Climate variability (modes)

- **Synoptic SLA:** <10 days variability (including storms)

Results

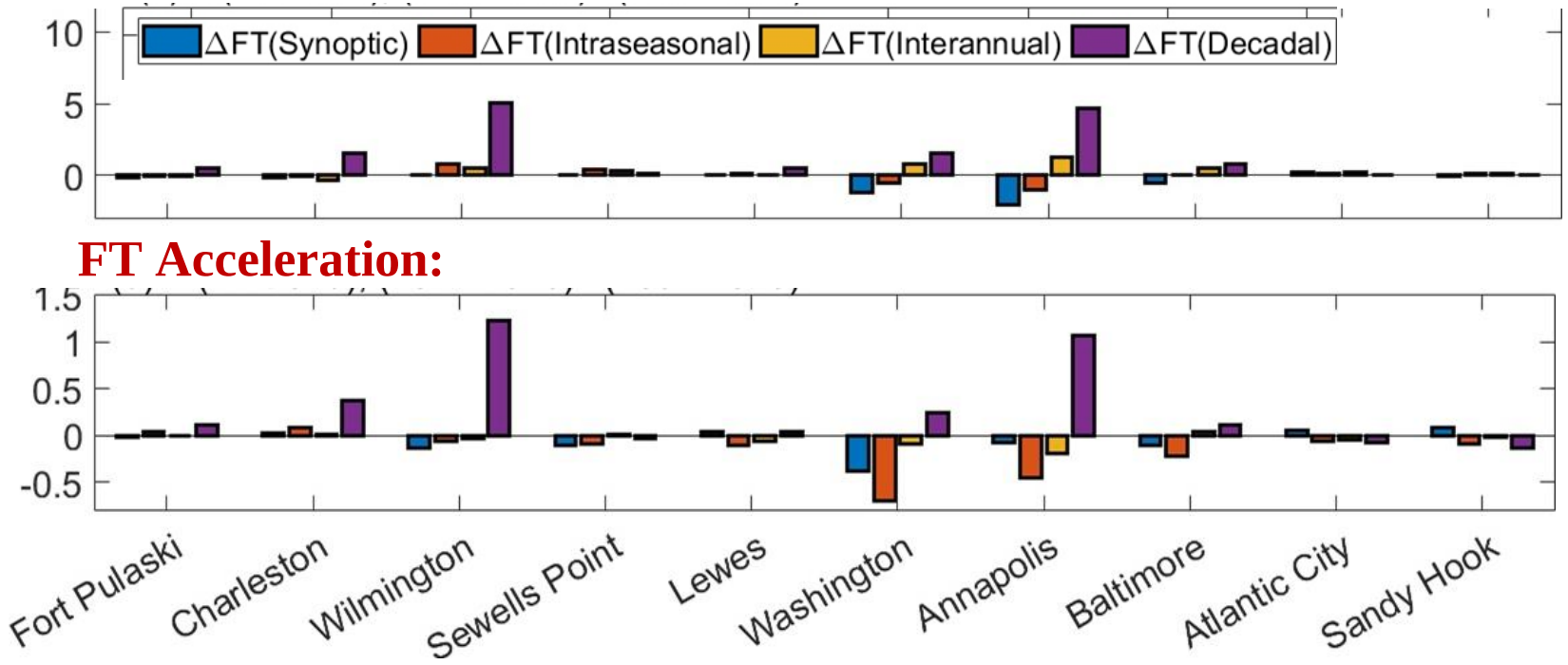
Roles of trend+tide vs synoptic-decadal sea level anomalies (SLAs)



Decadal sea level anomalies (SLAs) induces accelerated FT increase in the past decade:

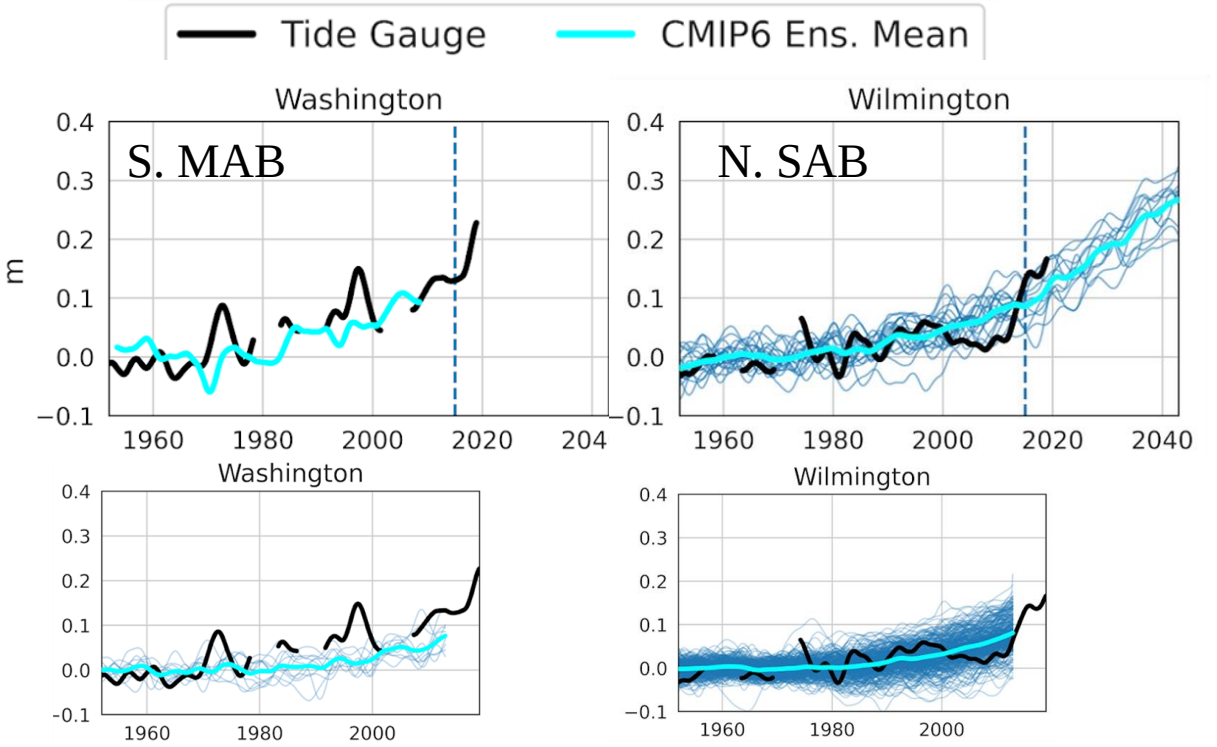
post2010=*(2011-2020) – (2001-2010)*

FT increase:

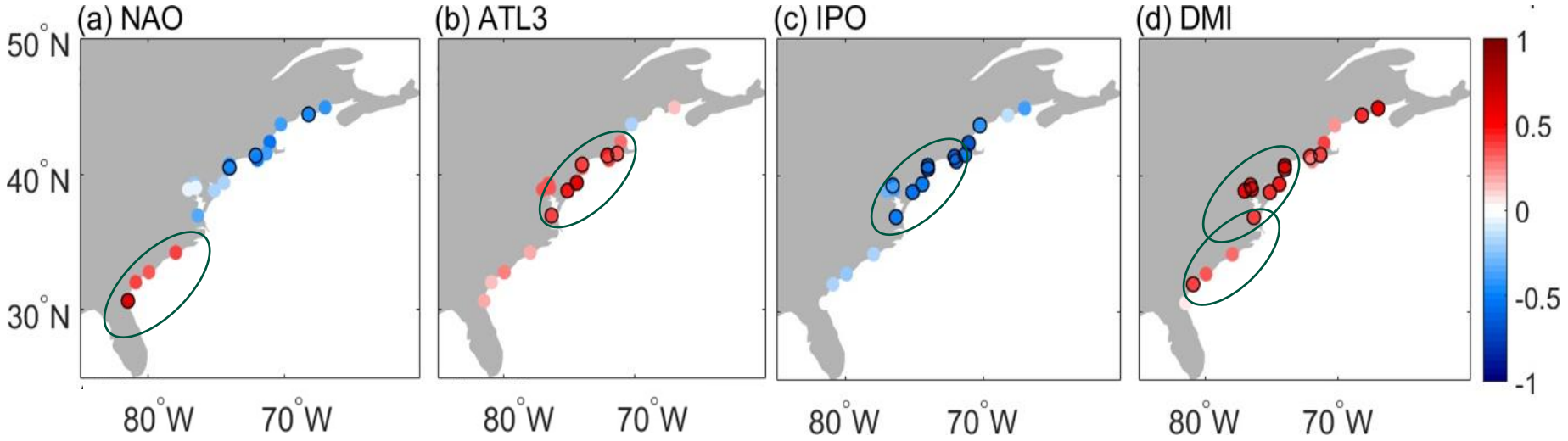


CMIP6 HR: Hist-1950
(11 models/21 members)

CMIP6 LR: Hist
(41 models/372 members)



NAO **Atlantic Niño** **IPO** **IOD** (Indian Ocean Dipole)



Summary

- Tide gauge data detected accelerated increase in flooding time (FT) since 1990, especially since ~2010, in N. SAB & S. MAB region;

- While SLR trend and tide dominate the multi-decadal FT increase since 1990, decadal sea level variability is the major cause for the the accelerated FT increase in the past decade (2011-2020) compared to the previous decade (2001-2010);

- The decadal SLAs in S. MAB are significantly correlated with decadal indices of IOD, IPO and Atlantic Niño, while in N. SAB SLAs are more linked to decadal variability of IOD & NAO.

Understand causes for decadal SLAs & impacts of climate modes: observation, HR E3SM (MPAS-O) & CESM1 Pacemaker exp

Thank you!

Acknowledgement

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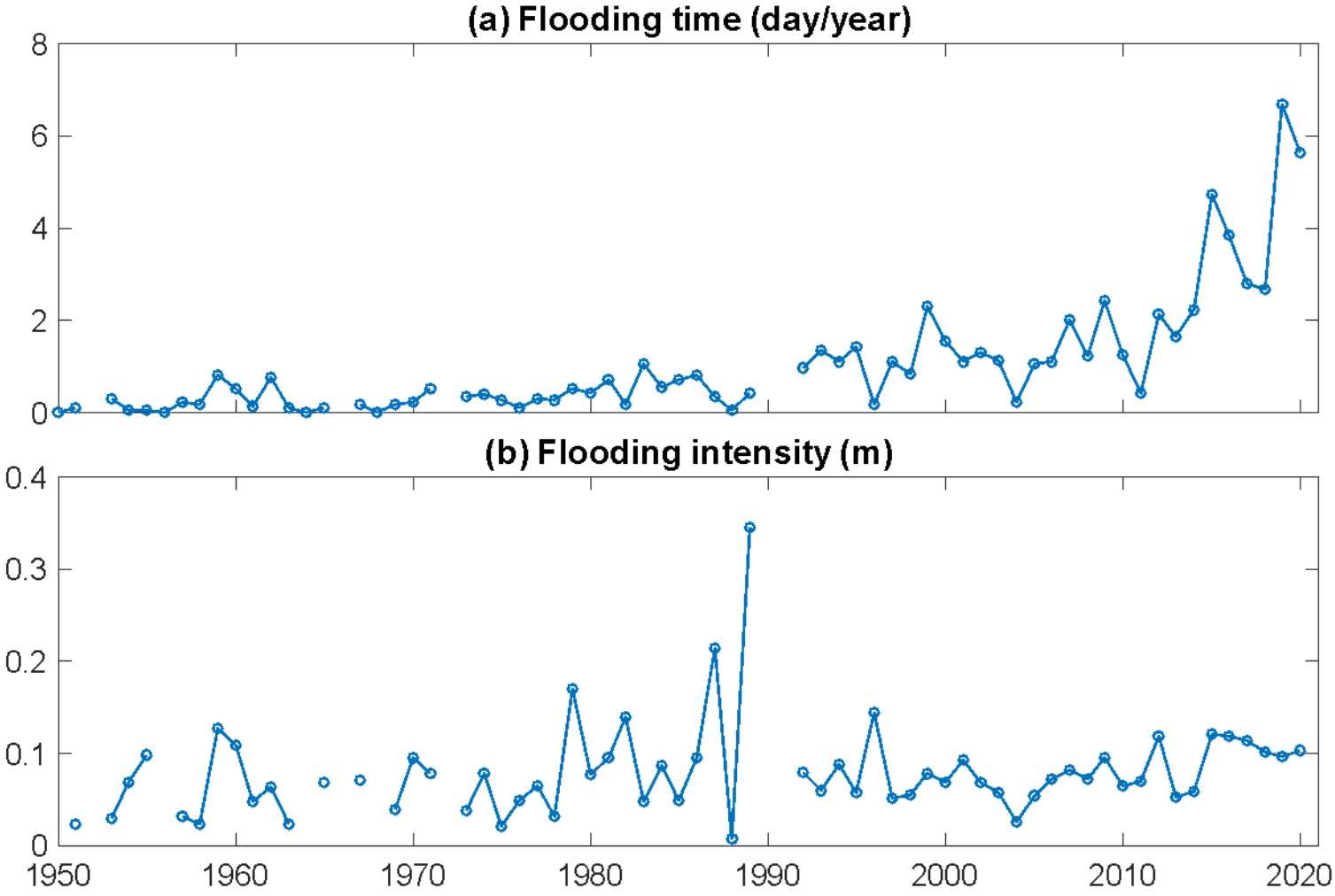
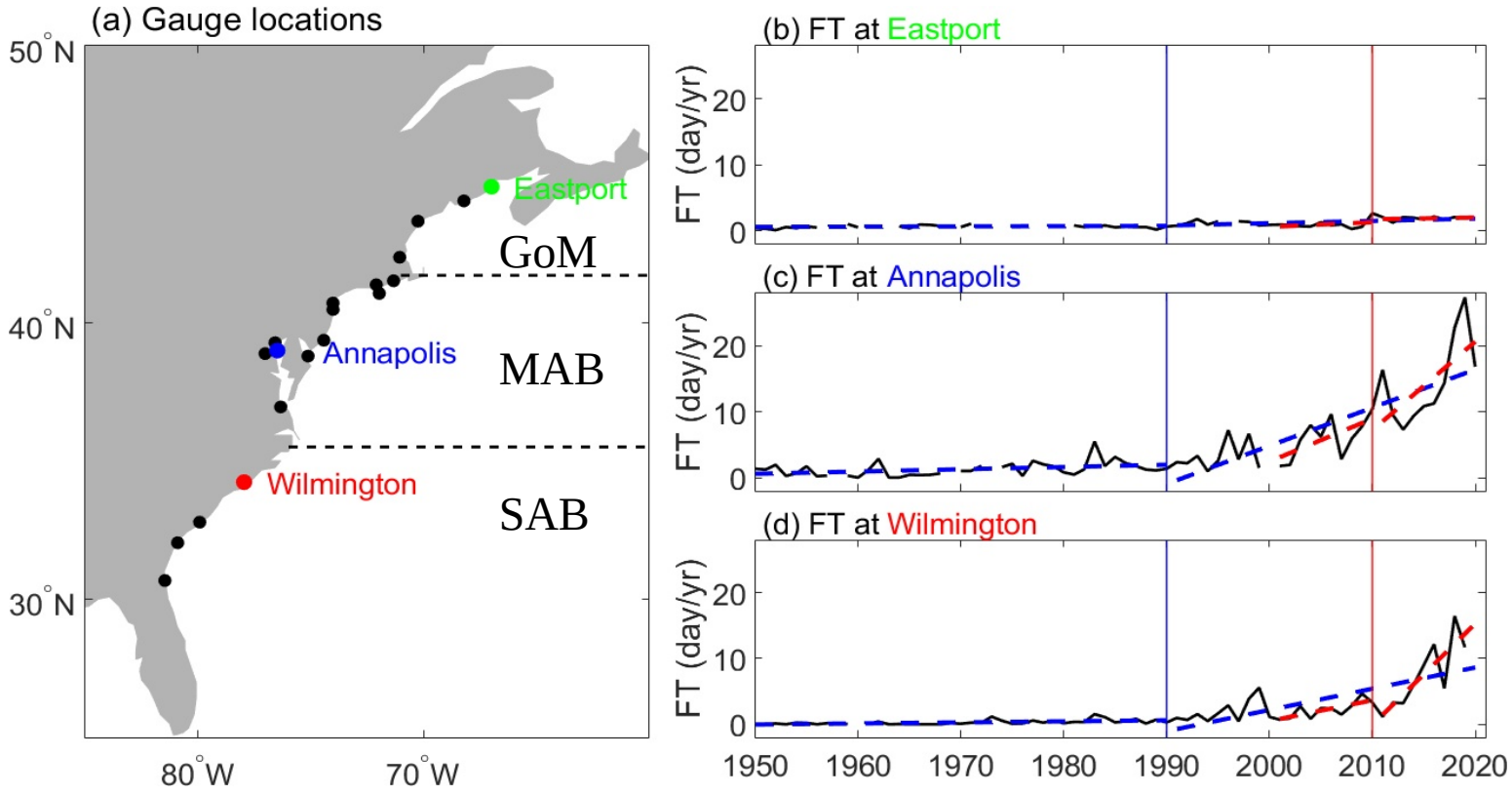
Charleston


(a) Flooding time (day/year)
8
6
4
2
0
(b) Flooding intensity (m)
0.4
0.3
0.2
0.1
0
1950
1960
1970
1980
1990
2000
2010
2020

- Tide gauge observations: dots in (a) show tide gauge locations; (b)-(d) show time series of annua
  tide gauge data (defined below).

- Flooding time (FT): Total time (days) when tide gauge sea level exceeds the NOAA flooding threshold in each year
- Rapid increase in FT is detected in the past decade compared to any previous decades in the northern part of the
  South Atlantic Bight (SAB) and Southern Part of the Mid-Atlantic Bight (MAB), but not in the Gulf of Maine (GoM)



Decadal variability

(>10 years)