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# Understanding the Role of the Gulf Stream in Shifting Hot Spots of Sea Level Rise Along the East Coast of North America

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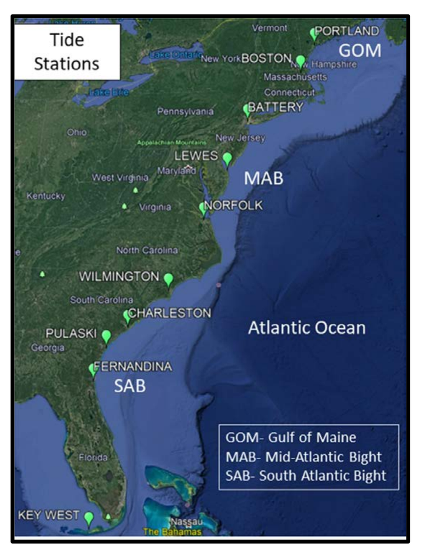
## Background

- Recent acceleration of sea level rise (SLR) along the East Coast of the U.S. has prompted many studies due to the severity of coastal flooding[1-4].
- After 2010, there has been a shift in a "hot spot" of SLR south of Cape Hatteras, NC [3].
- Previous studies have suggested that AMOC and the slowdown of Gulf Stream (GS) flow were to blame for SLR acceleration in south-Atlantic Bight, suggesting a role of GS variability in regional SLR[2,4].

**Here, we expand the analysis of Ezer 2019 with a focus on Charleston, SC.**

**The three primarily objectives of this study are as follows:**

1. Compare four datasets commonly used in SLR analysis to determine if coastal locations are being represented well.
2. Determine the frequency at which the GS variability affects "hot spots" in SLR acceleration at Charleston, SC.
3. Is tide gauge station data reflecting connections between coastal flooding and ocean circulation? Are they accurate in predicting flooding?



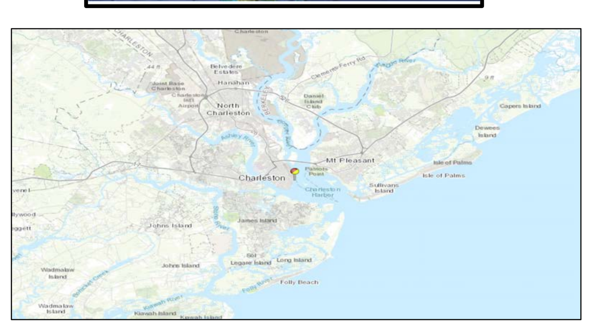



Fig 1. Tide Gauge station located in Charleston, SC.

## Data and Methods

**Time Period: Monthly Means from 1993-2022**

- Empirical mode decomposition (EMD) analysis with an ensemble of simulations was applied to non-tidal residual data from NOAA tide gauge station at Charleston, SC
- Low frequency signals (>5 years) were correlated with global sea surface height (SSH) and surface ocean current speed anomalies from reanalysis and satellite data products
  - NCEP GODAS Reanalysis SSH, UVEL, VVEL
  - Altimeter SSH and geostrophic velocity data from AVISO program 1/4°
- The same method was used with the grid point closest to Charleston in the reanalysis and altimetry SSH data as well as IHESP model data to compare datasets
  - CESM IHESP historical + rcp85 SSH, UVEL, VVEL

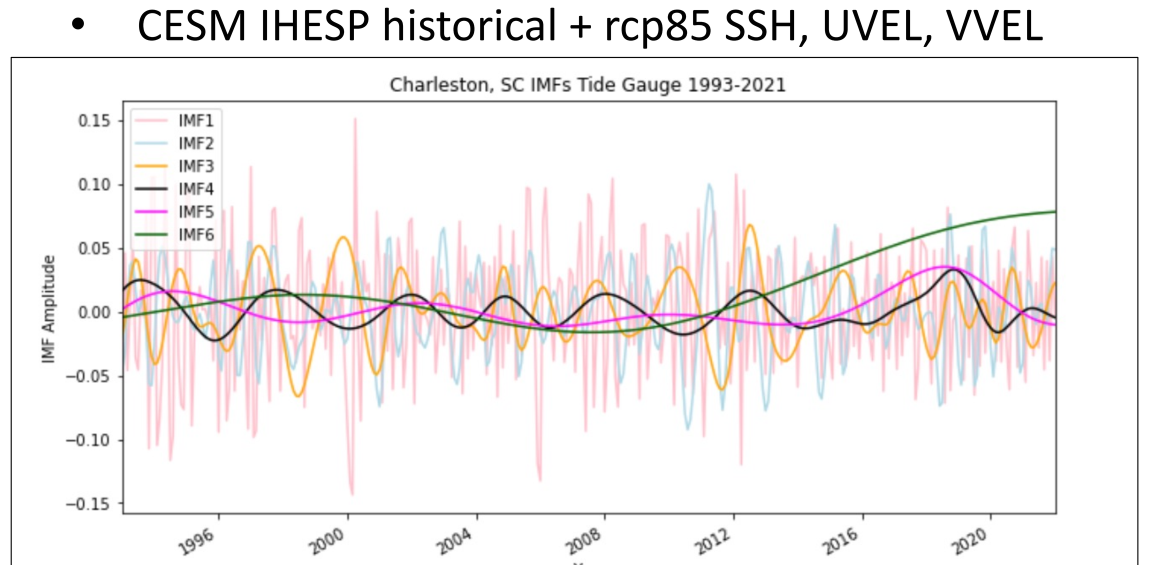



Fig. 2. Example of individual IMF signals from EMD analysis of Charleston Tide Gauge Data from 1993-2021.

## Results

### Low Frequency Empirical Mode Decomposition Analysis 1993-2022

Charleston Tide Gauge SSH Correlated with Global SSH and Current Speed

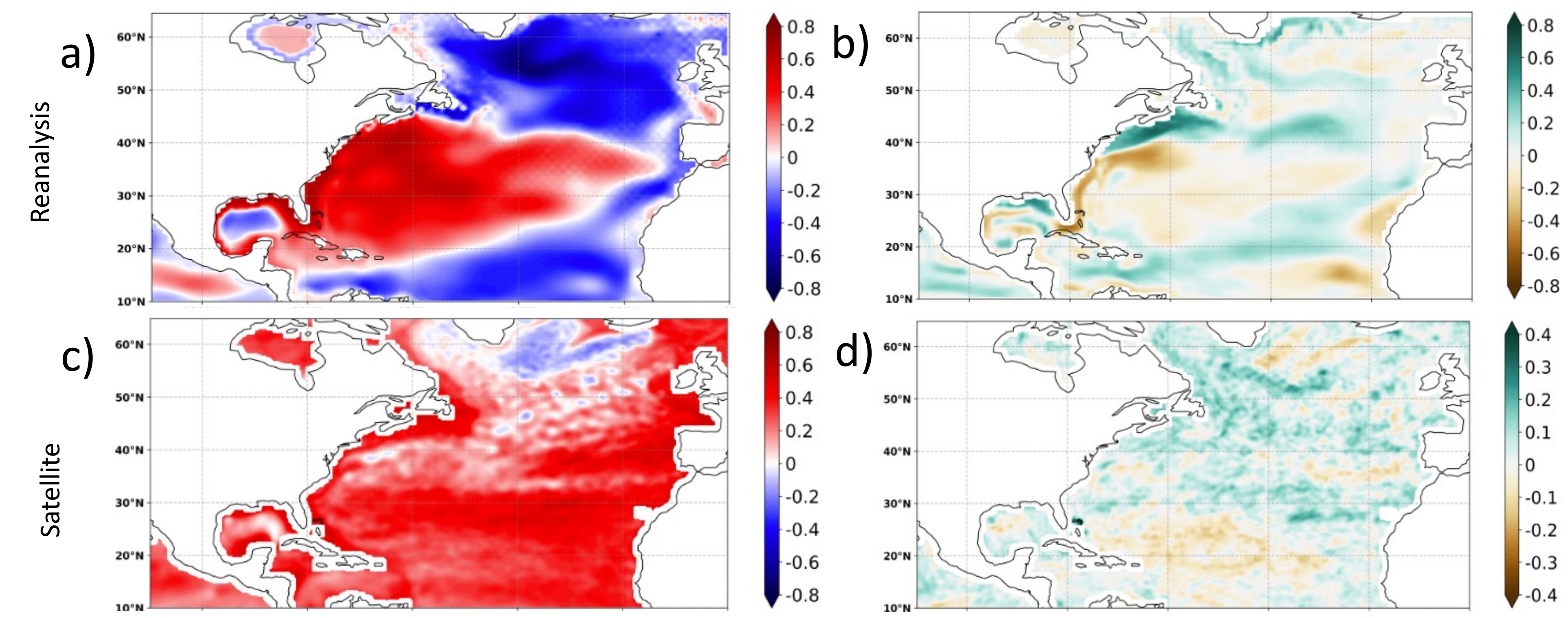



Fig 3. Composites of combined low frequency IMFs from tide gauge data correlated with a) global SSH from reanalysis b) global surface ocean current speeds from reanalysis c) global SSH from altimetry d) global geostrophic surface velocities from altimetry.

Charleston Reanalysis and Satellite SSH Correlated with Global SSH and Current Speed

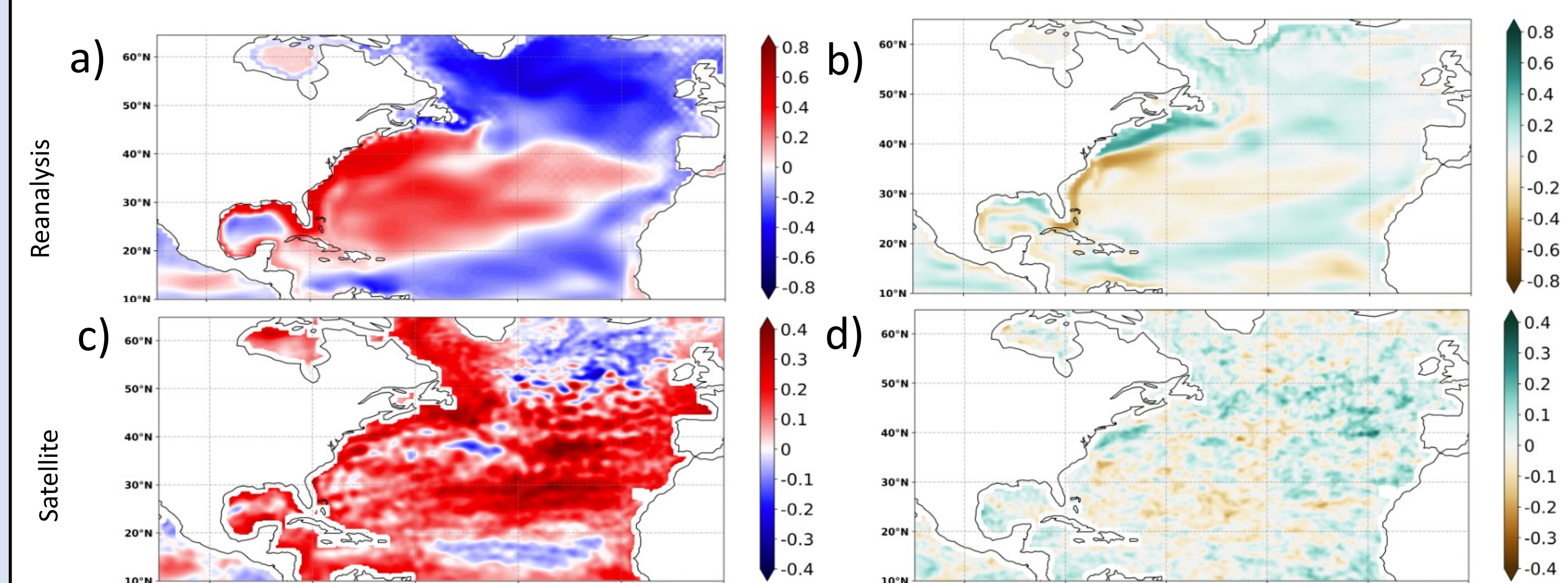



Fig 4 Composites of combined low frequency IMFs from grid point closest to Charleston, SC in reanalysis (top row) and altimetry (bottom row) SSH correlated with a) global SSH from reanalysis b) global surface ocean current speeds from reanalysis c) global SSH from altimetry d) global geostrophic surface velocities from altimetry.

IHESP Charleston SSH Correlated with Global SSH and Current Speed

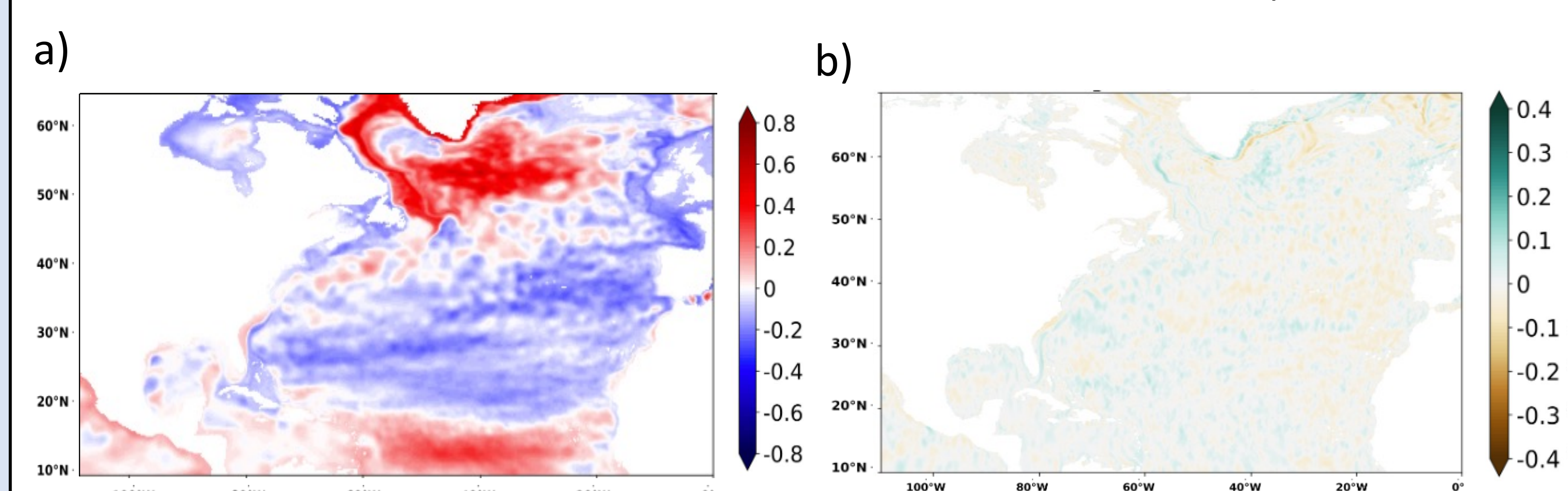



Fig 5 Composites of combined low frequency IMFs from grid point closest to Charleston, SC in IHESP model data correlated with a) IHESP SSH b) IHESP surface current speed.

## Results

### IMF Time Series

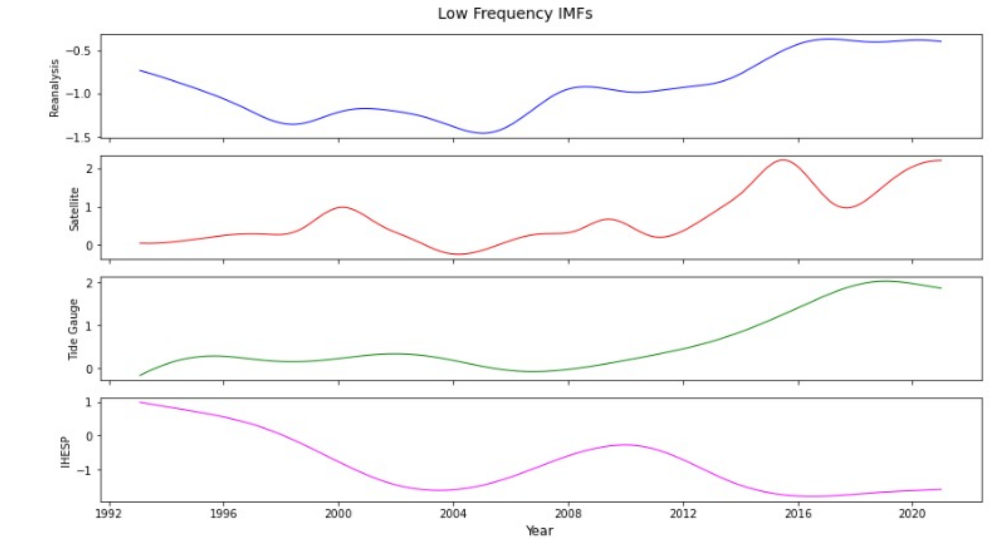



Fig 6. Standard deviation of low frequency IMFs from reanalysis, altimetry, tide gauge, and IHESP SSH data (top to bottom).

### Where is acceleration of SLR in IHESP data?

- IHESP has opposite signal at the end of the 1993-2022 record
- Acceleration of SLR trend does not appear until the end of the rcp85 2100-year run

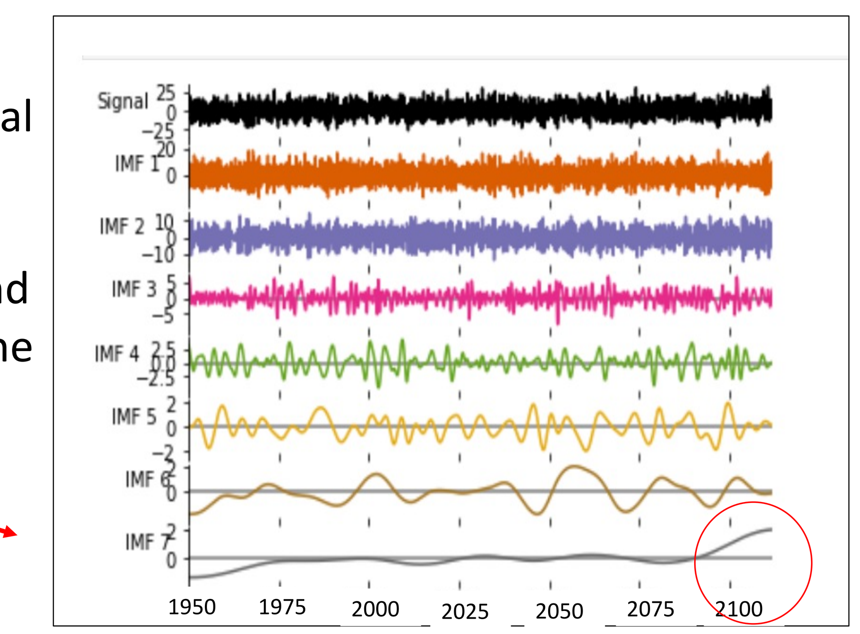



Fig 7. EMD analysis of total record of IHESP historical and rcp85 run.

## Conclusions

- Across time scales, current speeds in reanalysis do appear to relate to low frequency changes in tide gauge data
- The character of lower frequency IHESP data does not match up with observational data, in fact it appears to show opposite signal
- The reanalysis data at the grid point closest to Charleston, SC is fairly representative of the tide gauge data at Charleston at similar time scales
- Current speeds showing signal of gulf stream separation from the coast with observational datasets but not with IHESP data
- SLR acceleration is not being captured in IHESP data

**Future Work**

- How can we use gulf stream variability to aid with coastal flooding prediction?
- Dive into problems with the IHESP model: Why is the trend only showing up after 2100 years

## References and Acknowledgments

**References**

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