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.
- After 2010, there has been a shift in the “hot spot” of SLR south of Cape Hatteras, NC.
- 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.

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?

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
  - IHESP SSH and surface current speed data
  - 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.

**Results**

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

**Charleston Tide Gauge SSH Correlated with Global SSH and Current Speed**

- a) b) c) d)

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

- a) b) c) d)

**IHESP Charleston SSH Correlated with Global SSH and Current Speed**

- a) b)

**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**