A Multidecade Reanalysis of Coastal Water Levels and Waves

20th Annual Climate Prediction Applications Science Workshop (CPASW)
Asheville, NC

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**Beta release of the data:
https://renci.github.io/edsreanalysisdoc/**

Motivation

Past
- 1979:
  - 23 gages
  - ~6000 km of coast
  - ~1 gage every
    - 260 km
    - or 2.5 deg lat/lon

Present
- 154 gages
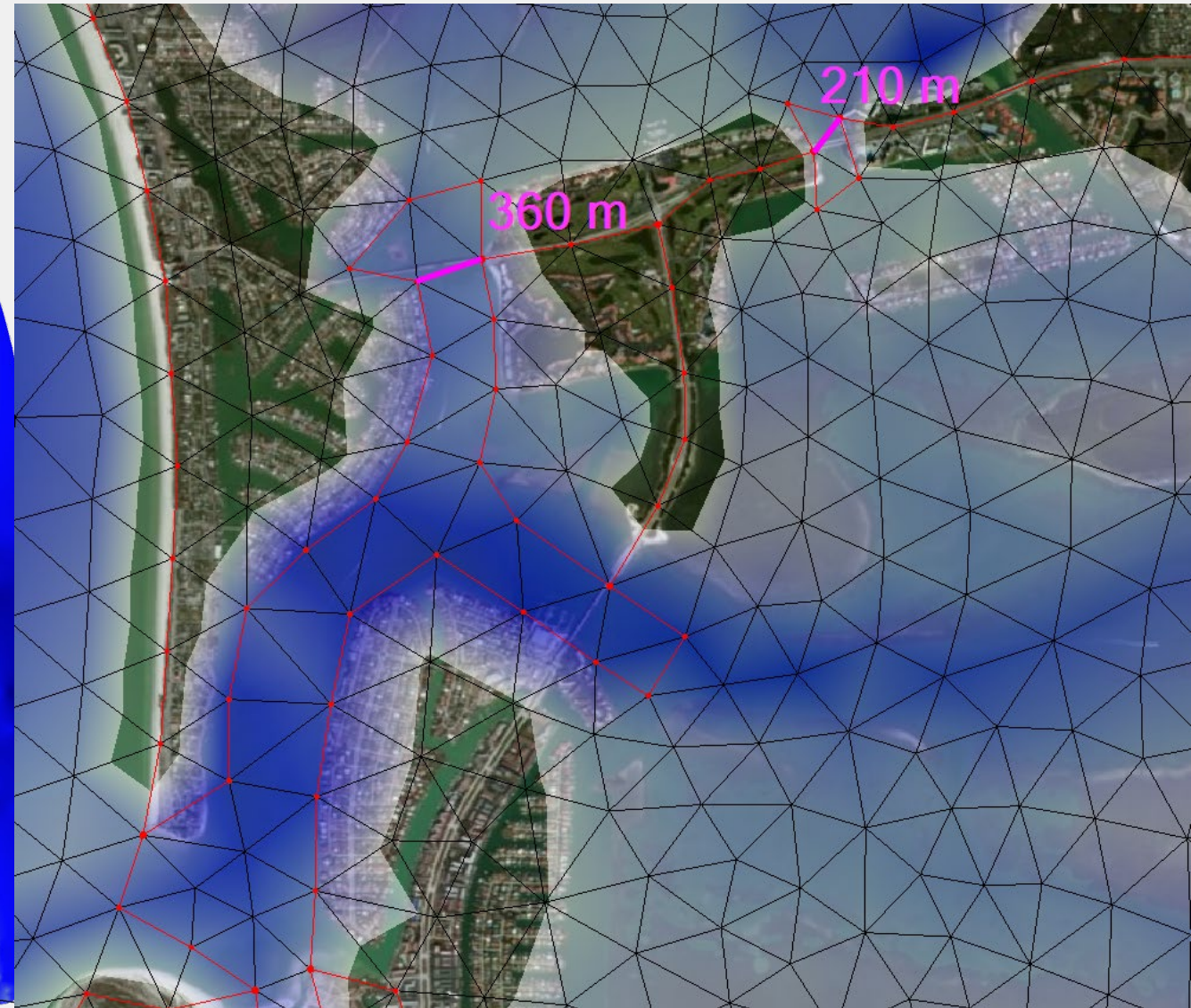- Some gaps >200 km
- Sheltered coastal coverage still sparse
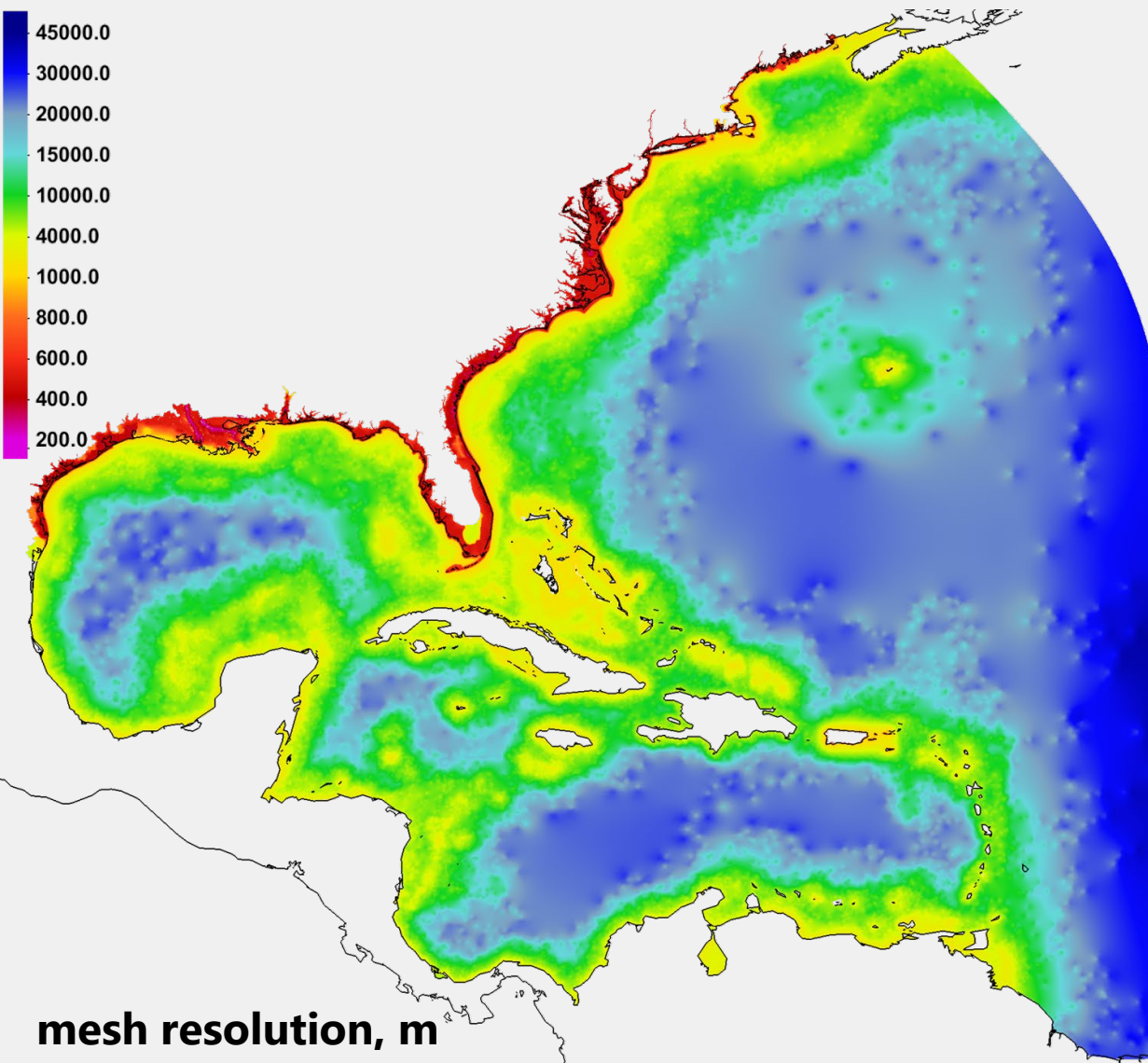
- Short gage records lack historical data
- Climate & other conditions changing
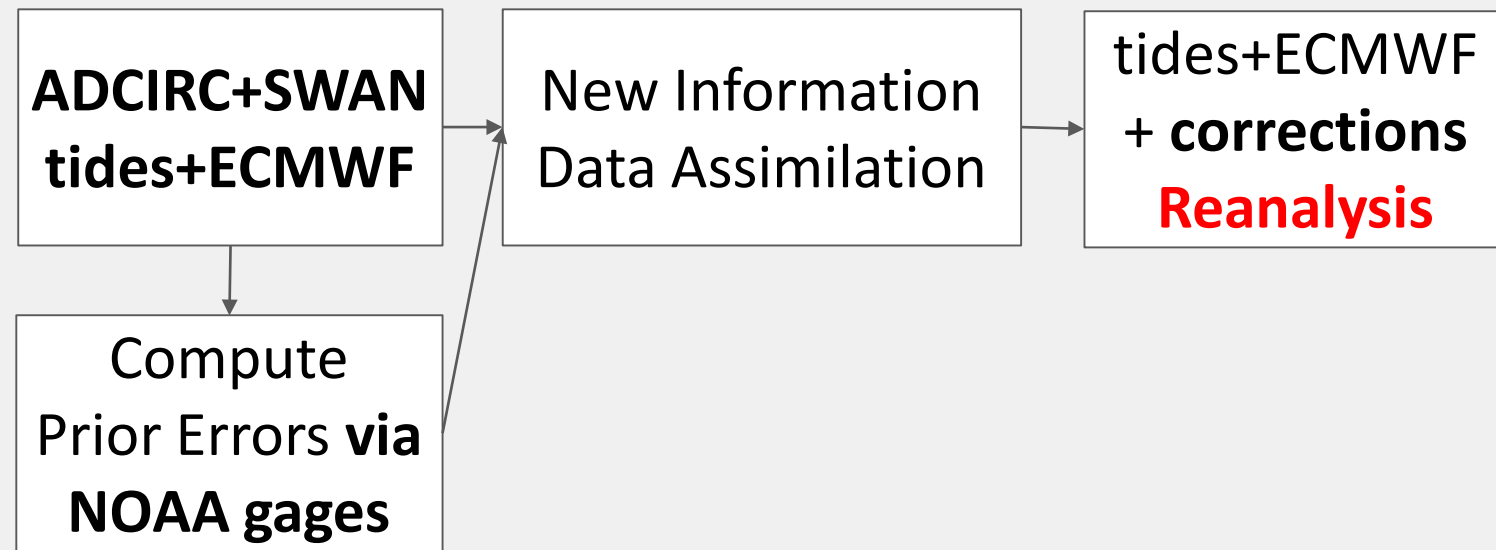- Need tools for prediction

Future

Goals

- Simulated high-resolution, hourly water level and wave records across all U.S. coasts & overland

- 1979-present

- Leverage these data
  - Nuisance flooding
  - Historical storms
  - Flood frequency estimation
  - Sub-seasonal to annual water level prediction
  - Freely available data, convenient and accessible interface

2015 HSOFS/ESTOFS Mesh

mesh resolution, m

Our reanalysis

```
┌─────────────────┐      ┌─────────────────┐      ┌─────────────────┐
│  ADCIRC+SWAN    │  →   │ New Information │  →   │  tides+ECMWF    │
│  tides+ECMWF    │      │ Data Assimilation│     │  + corrections  │
│                 │      │                 │      │  Reanalysis     │
└─────────────────┘      └─────────────────┘      └─────────────────┘
        │                        ↗
        ↓                       /
┌─────────────────┐            /
│    Compute      │───────────
│ Prior Errors via│
│   NOAA gages    │
└─────────────────┘
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e.g.,

NCEP Climate Forecast System Reanalysis

NOAA WAVEWATCH III® Hindcast and Reanalysis

ECMWF ERA5

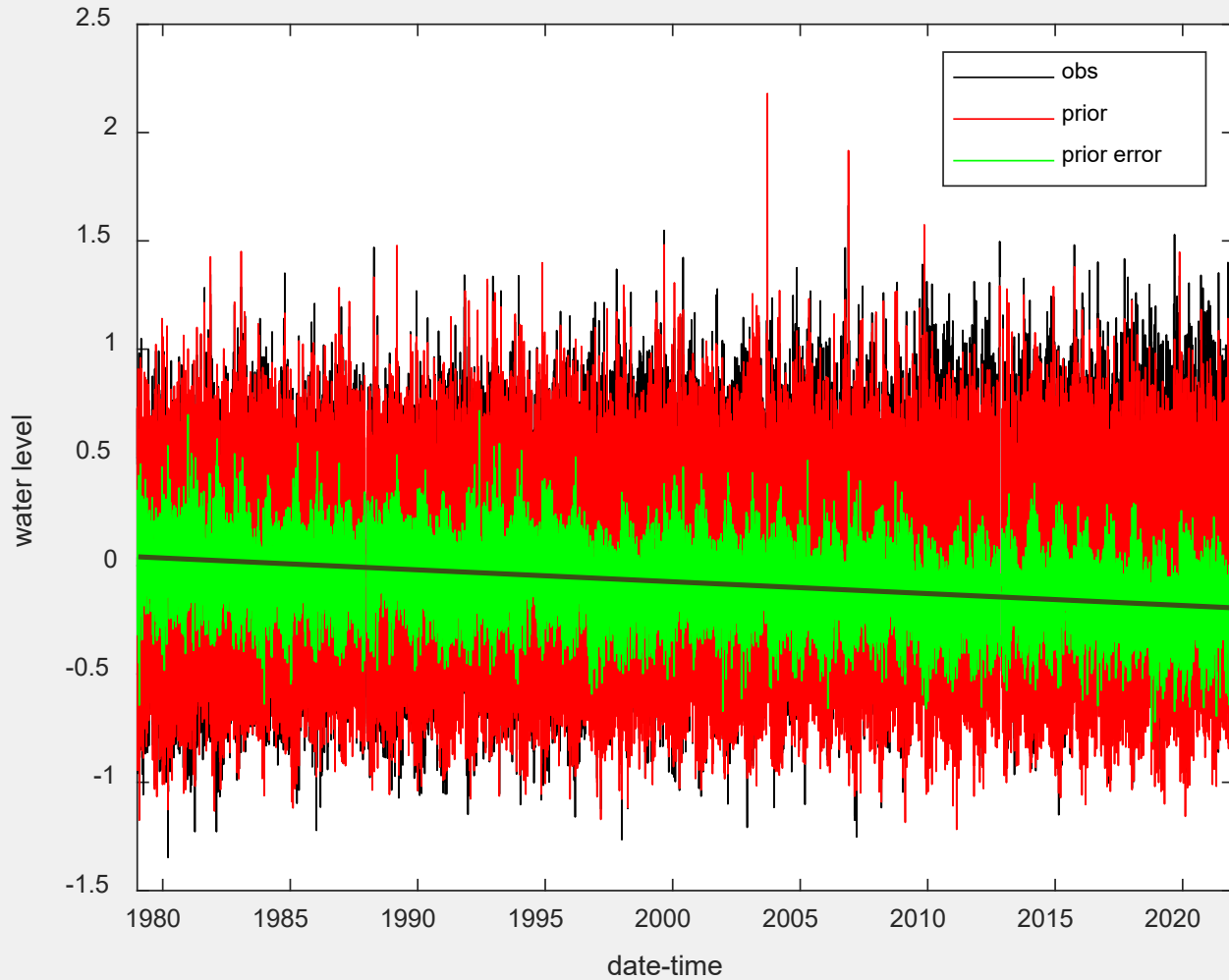**All the cool kids are doing it!**

Reanalysis Results

Duck, NC

Errors cm	mean	std
Prior	-8	14
Posterior	0	7

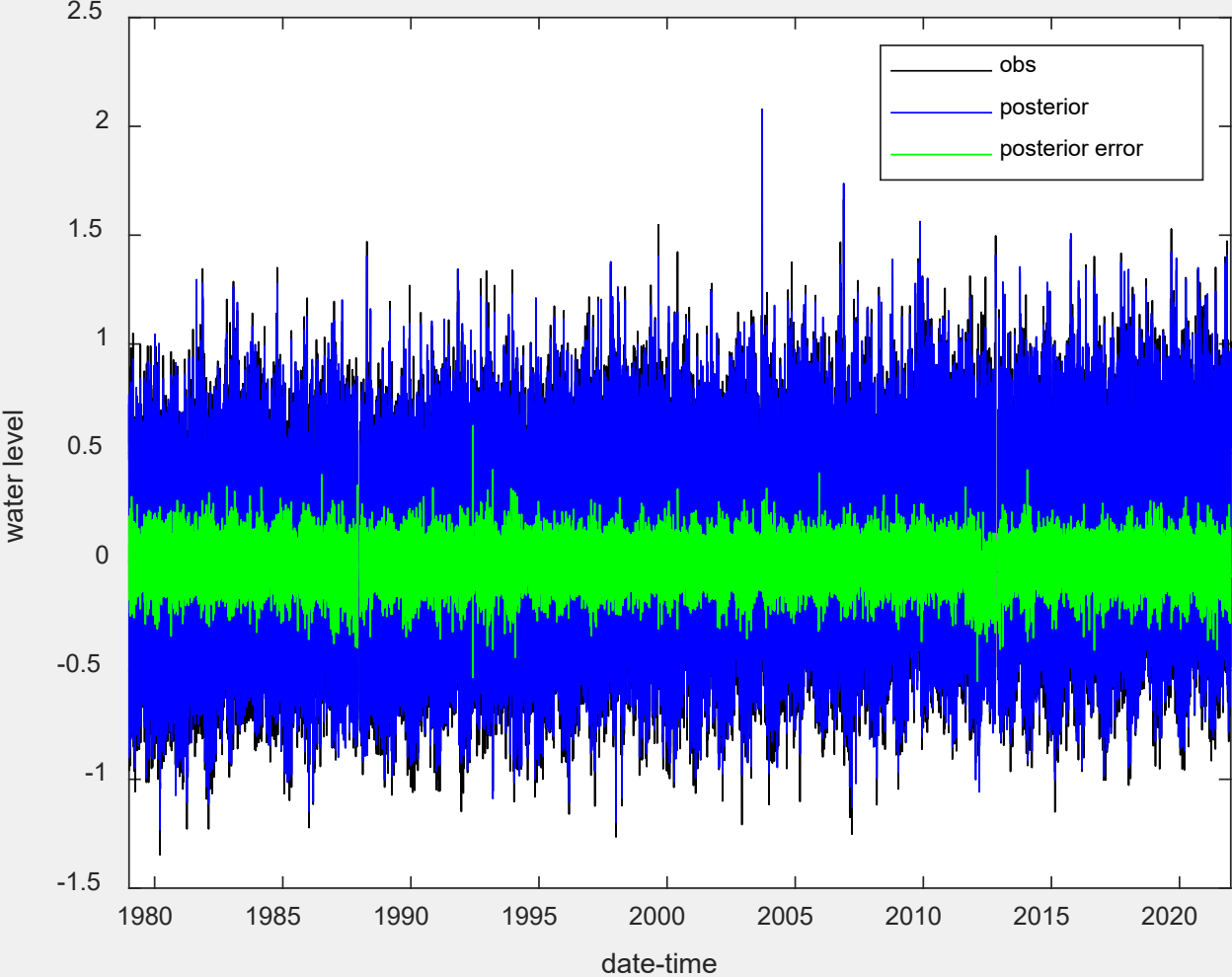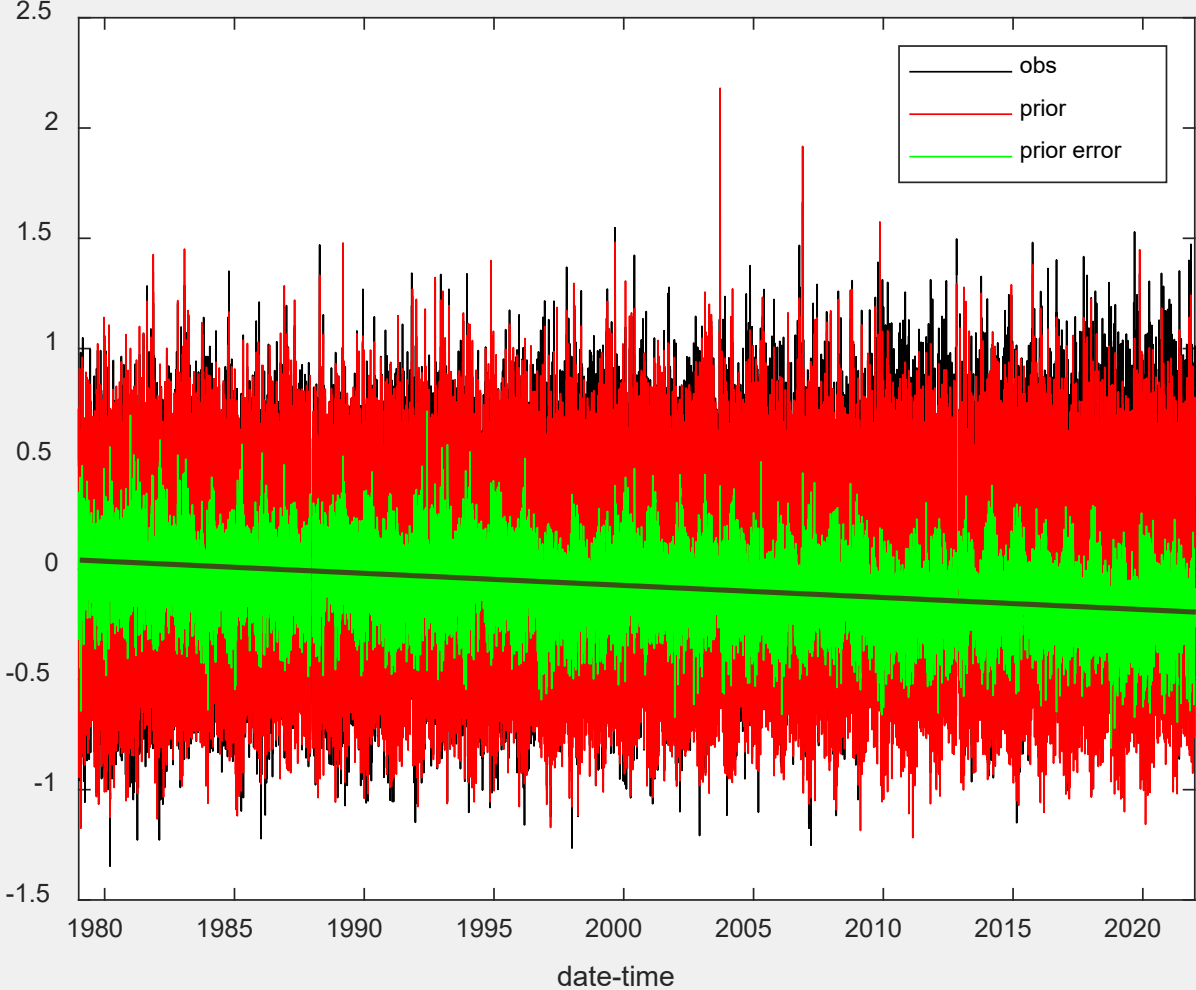
errors
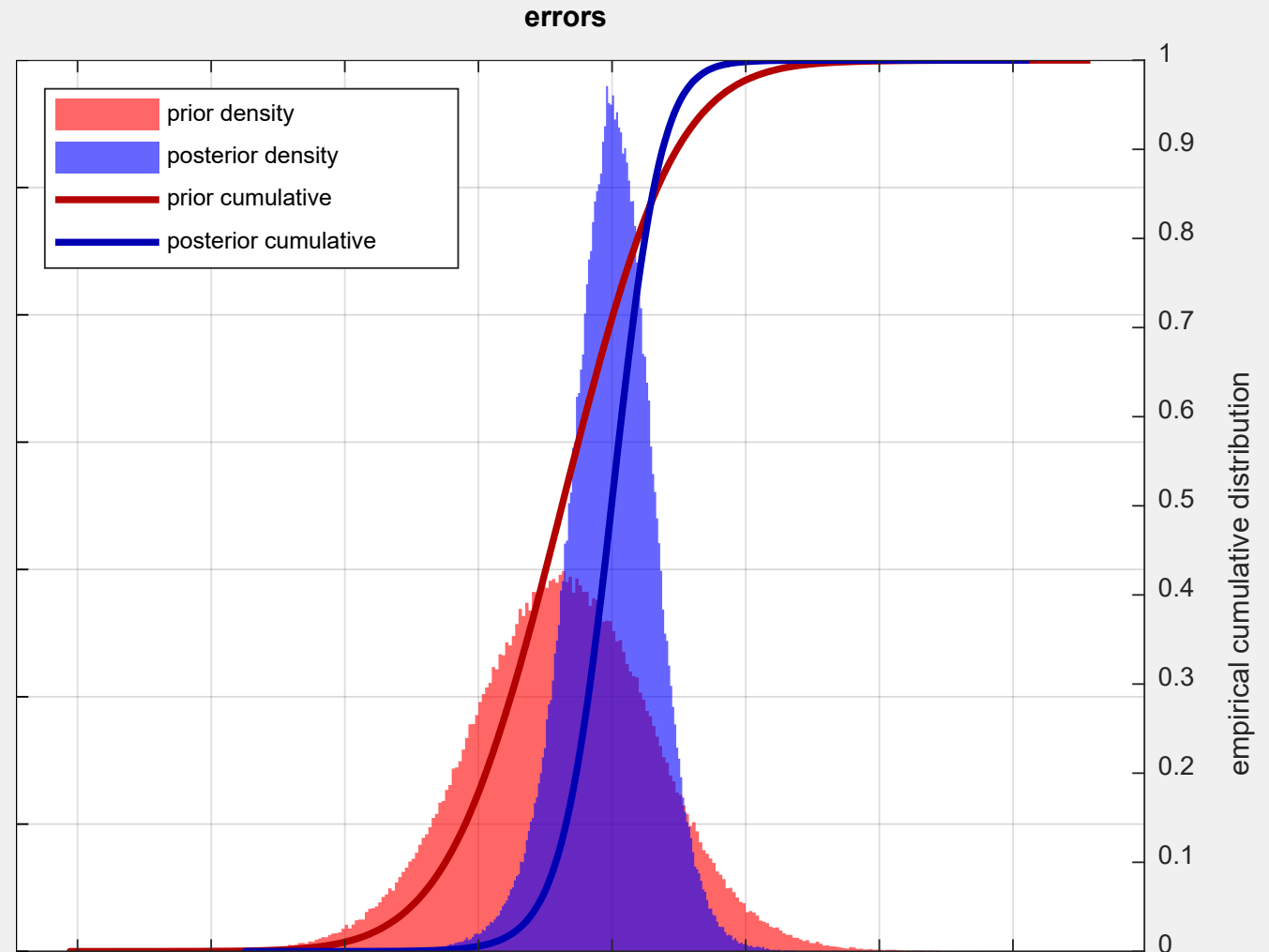
Reanalysis Results

Duck, NC   sea level rise?

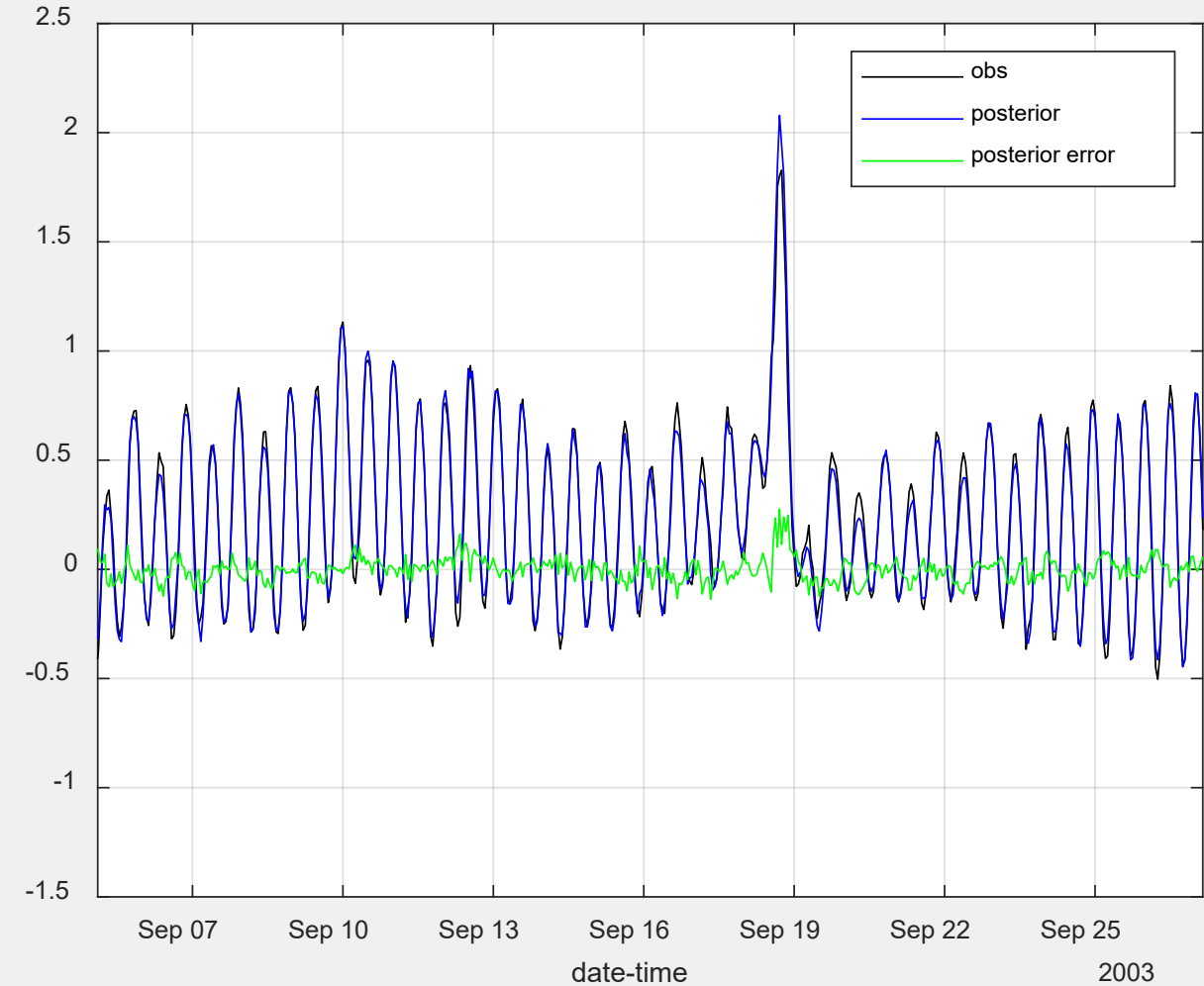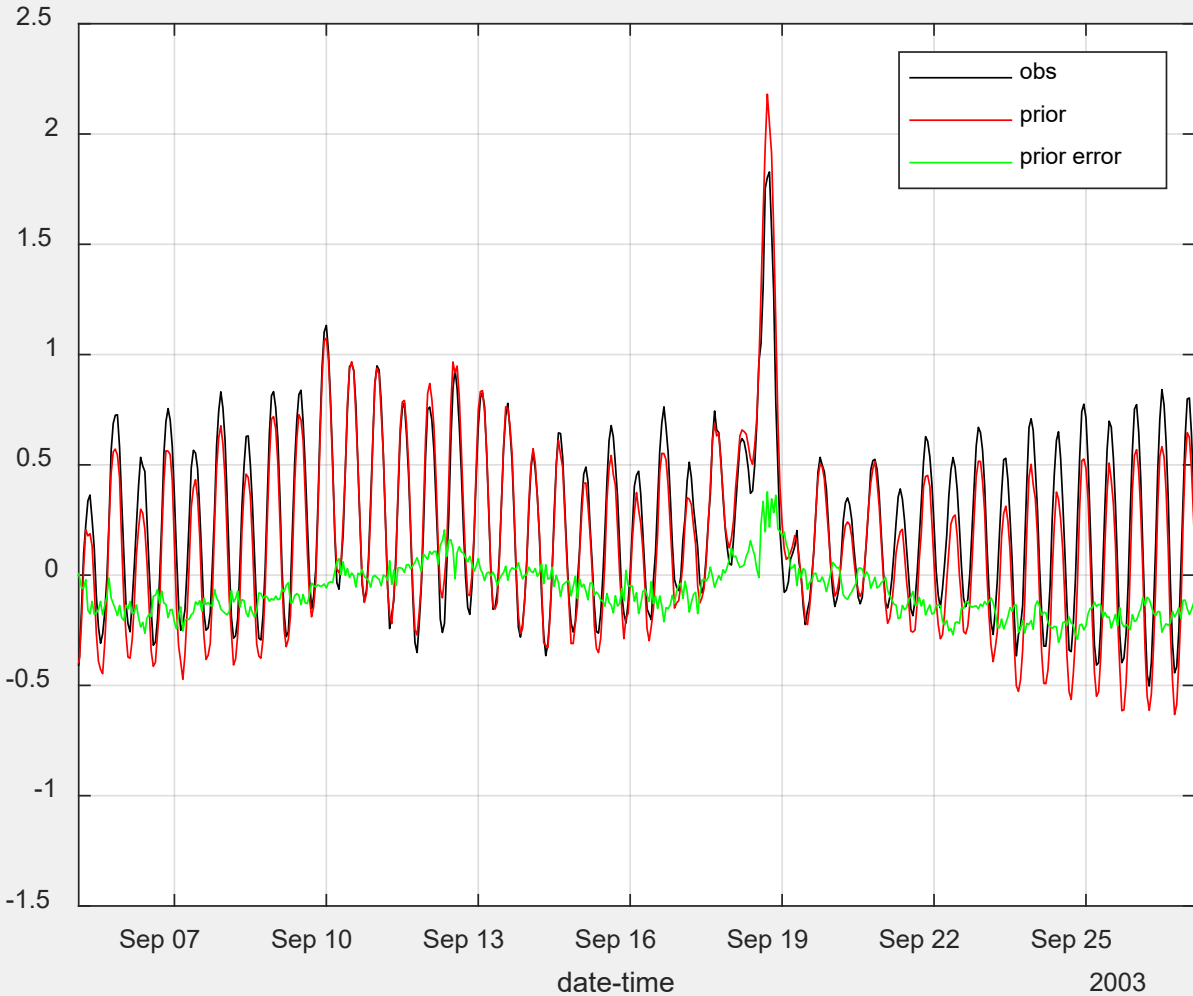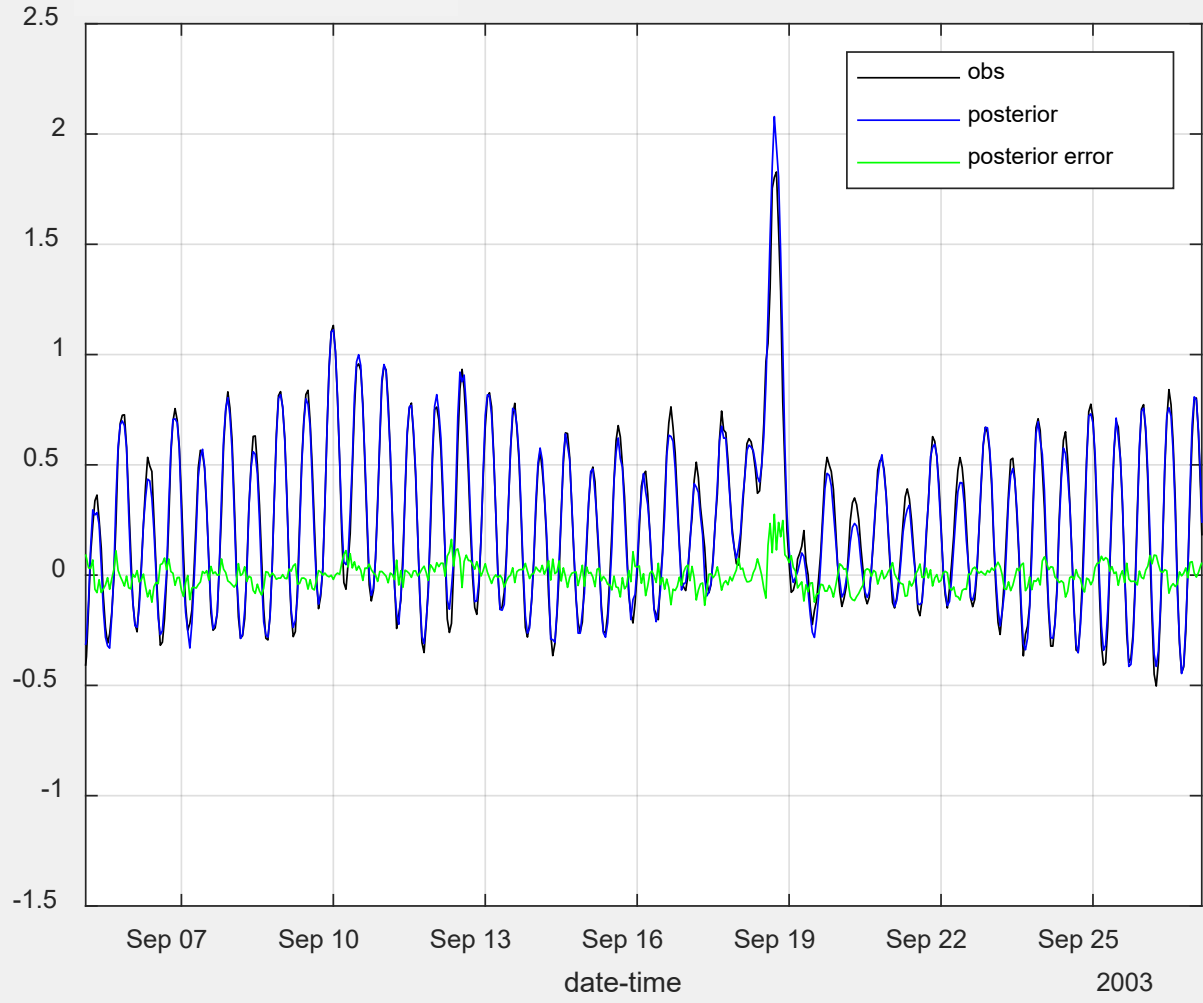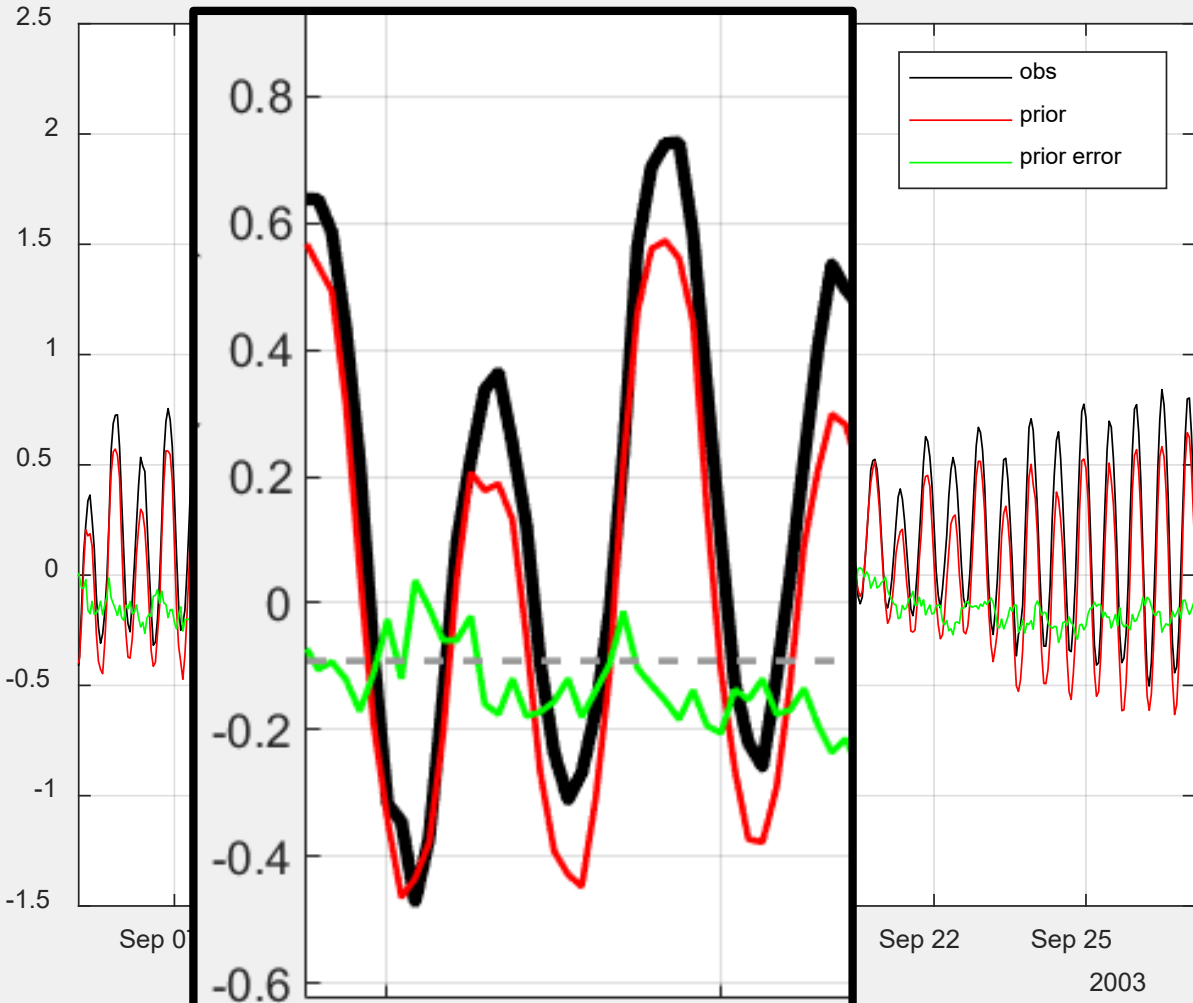# Reanalysis Results

Duck, NC   sea level rise   **Solved.**
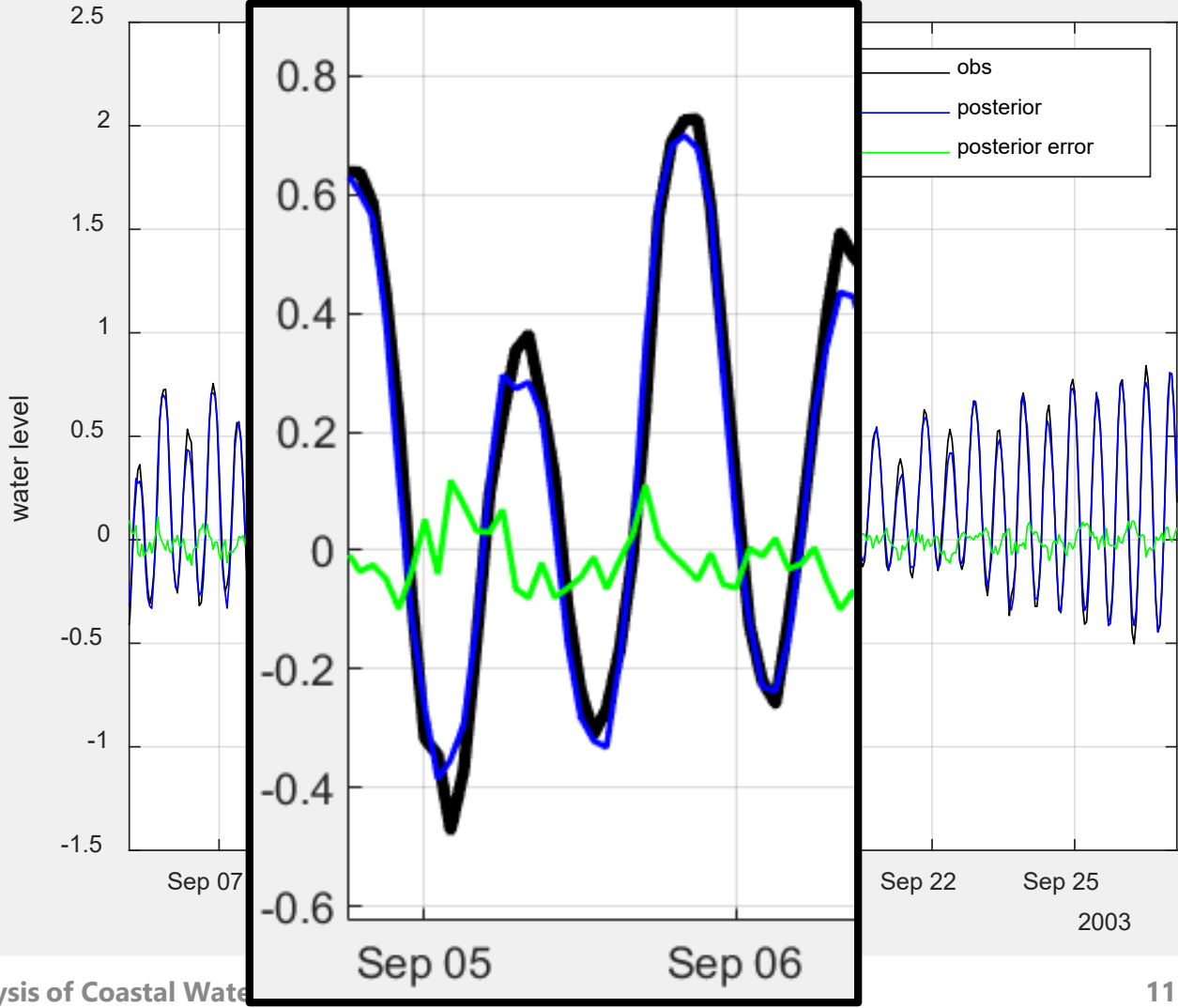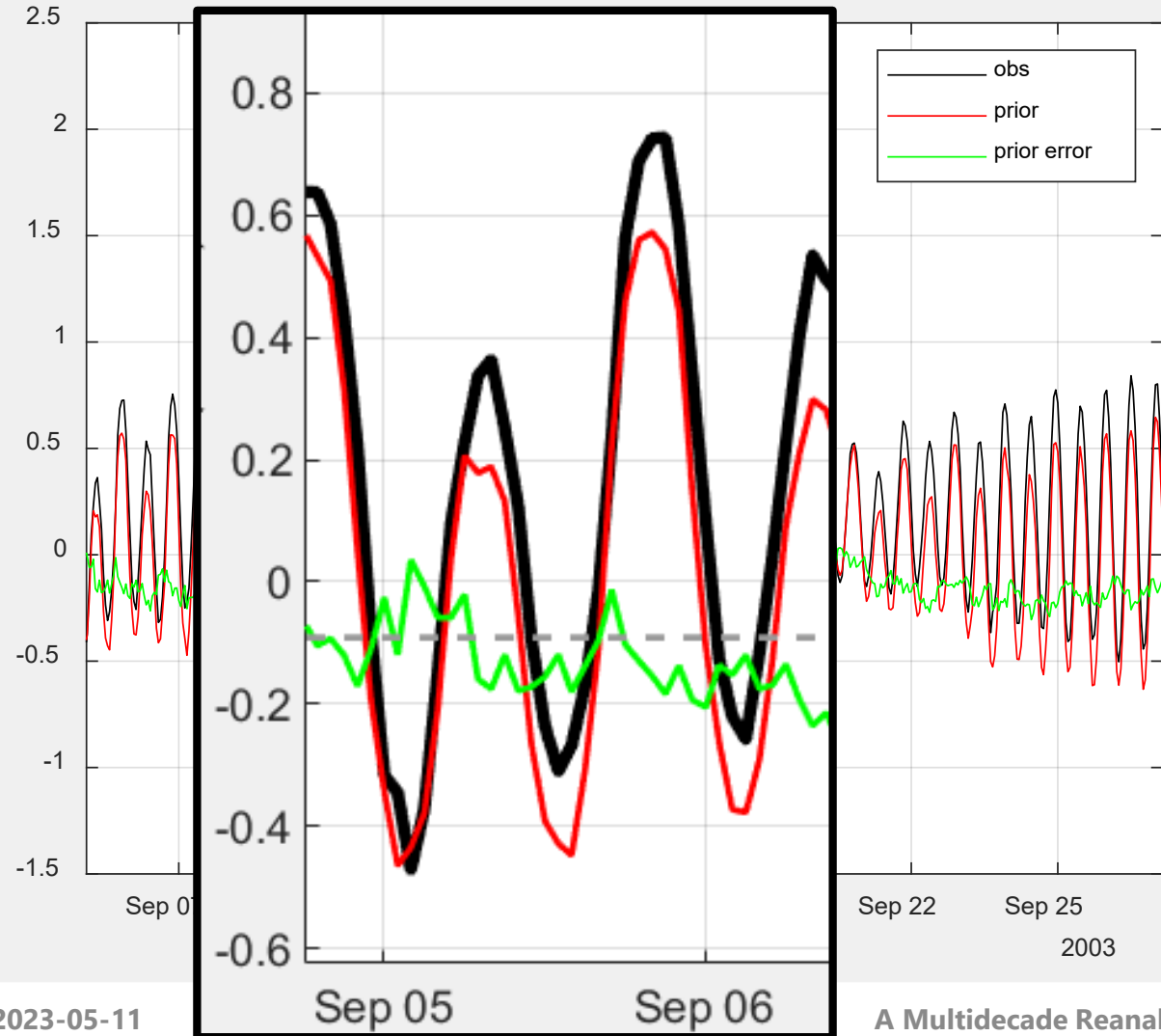
Reanalysis Results

Duck, NC

Reanalysis Results

Duck, NC   bias around storm?

A Multidecade Reanalysis of Coastal Water Levels and Waves

Reanalysis Results

Duck, NC   bias around storm?   **Solved.**

A Multidecade Reanalysis of Coastal Wate

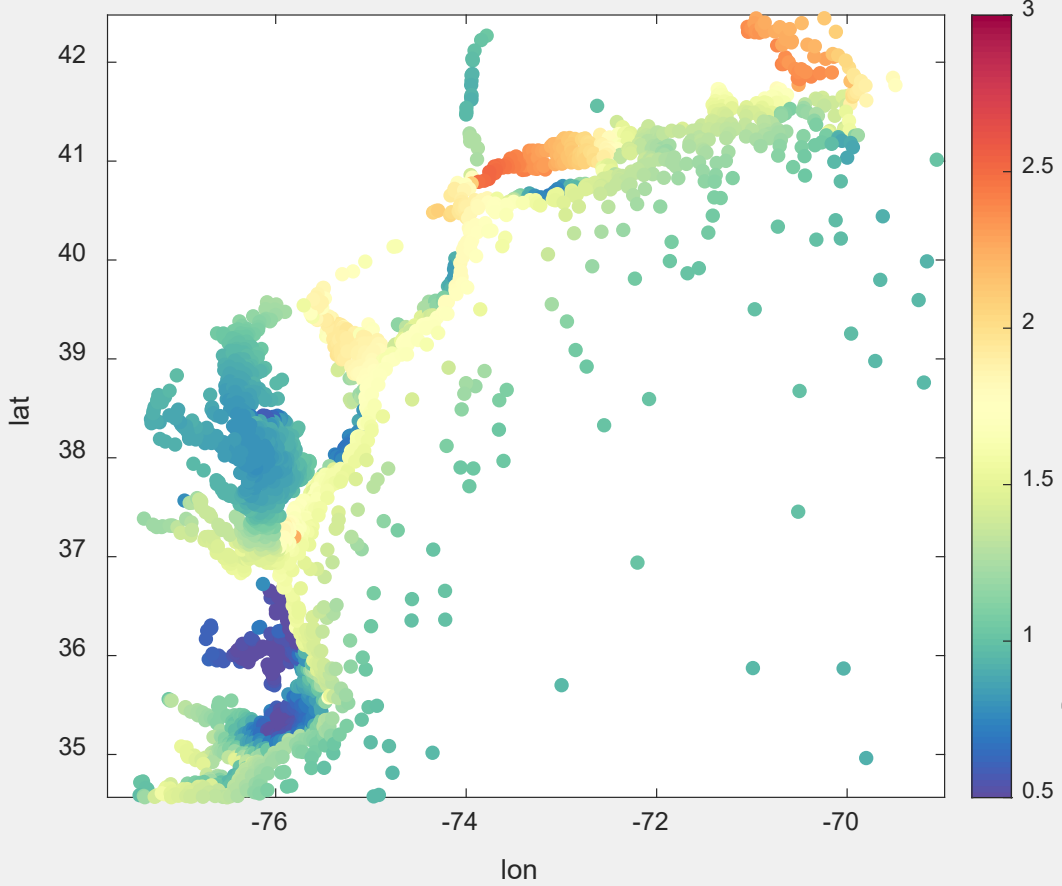# Reanalysis Results

Duck, NC

e Reanalysis of Coastal Water Lev
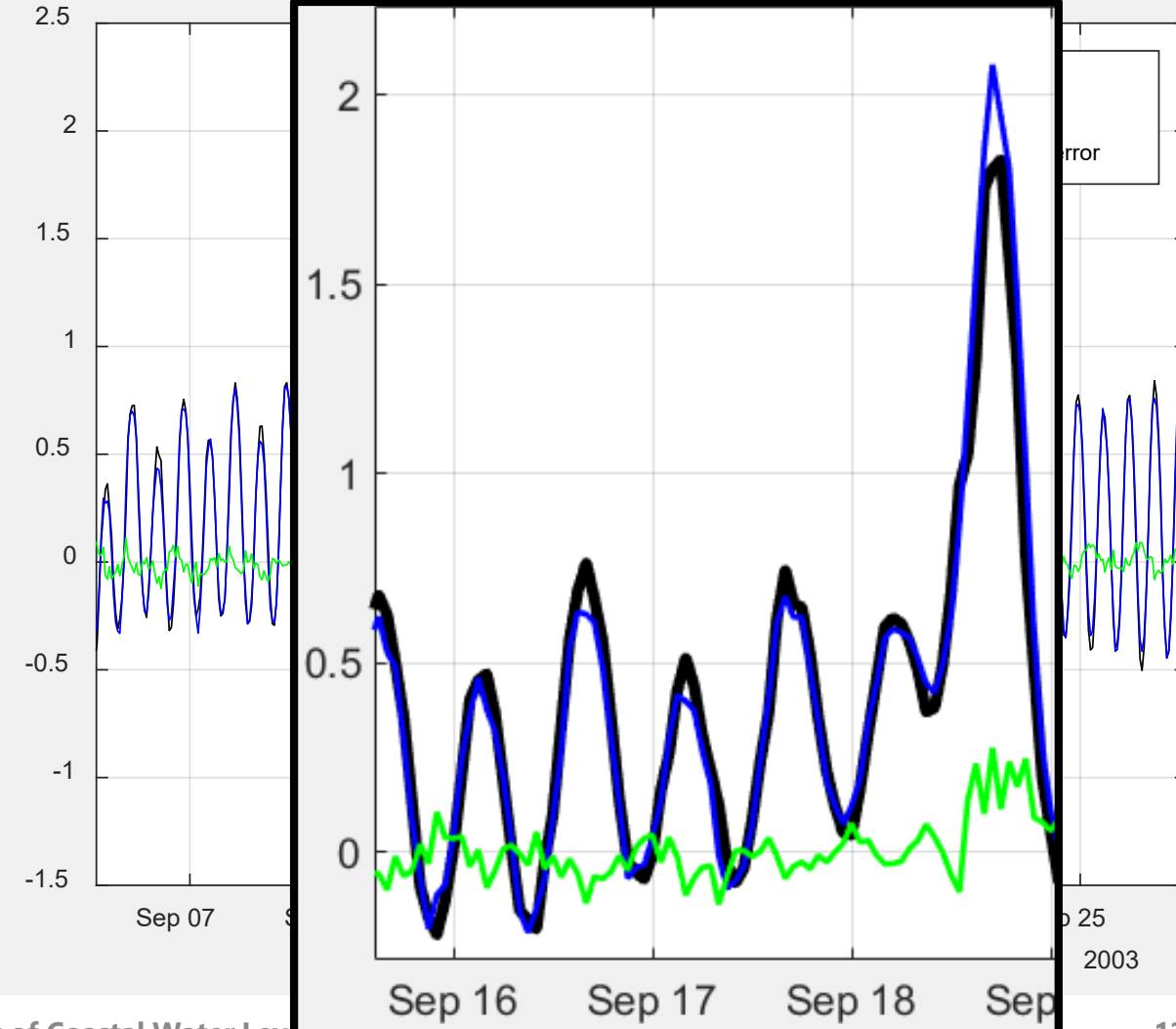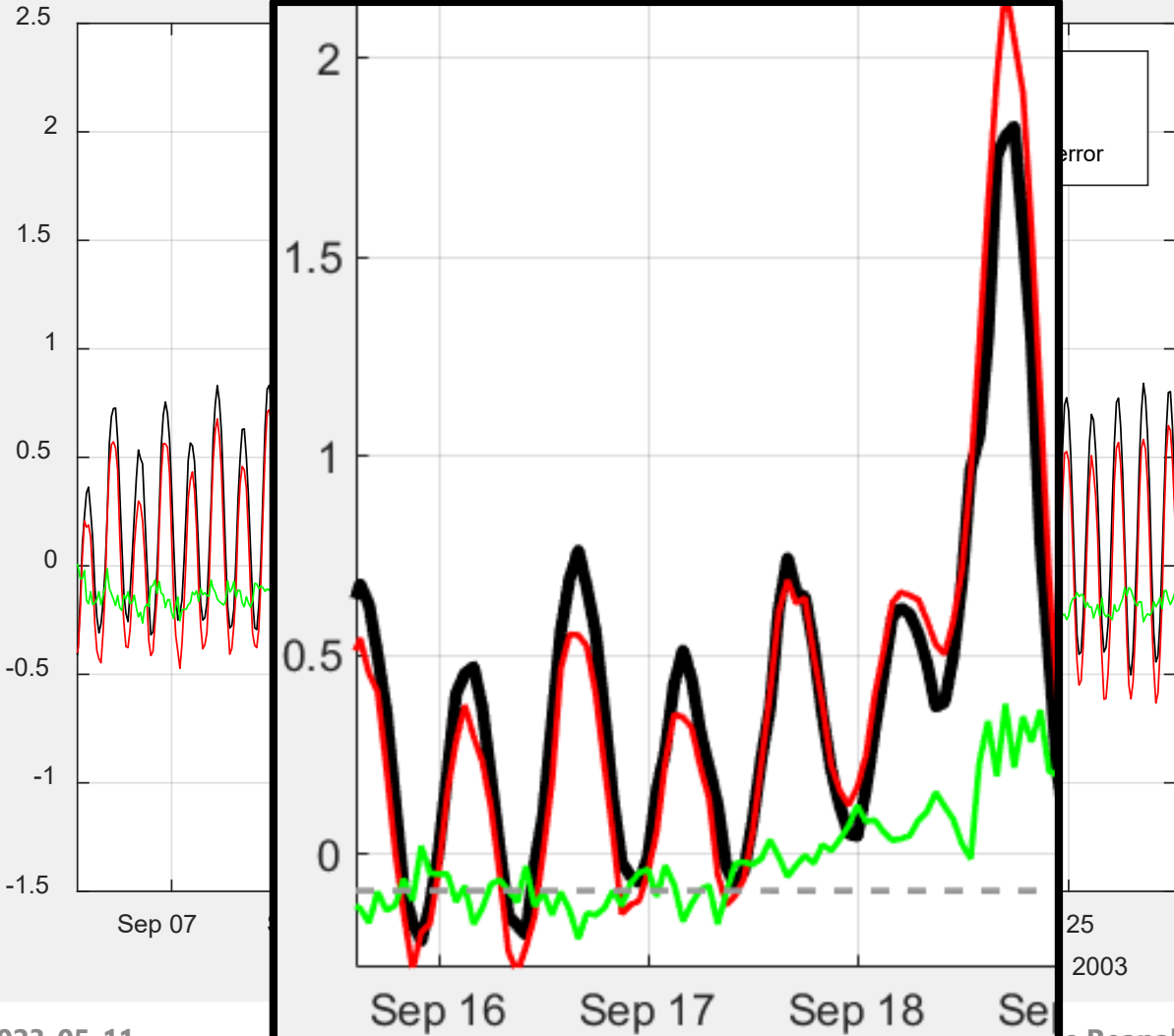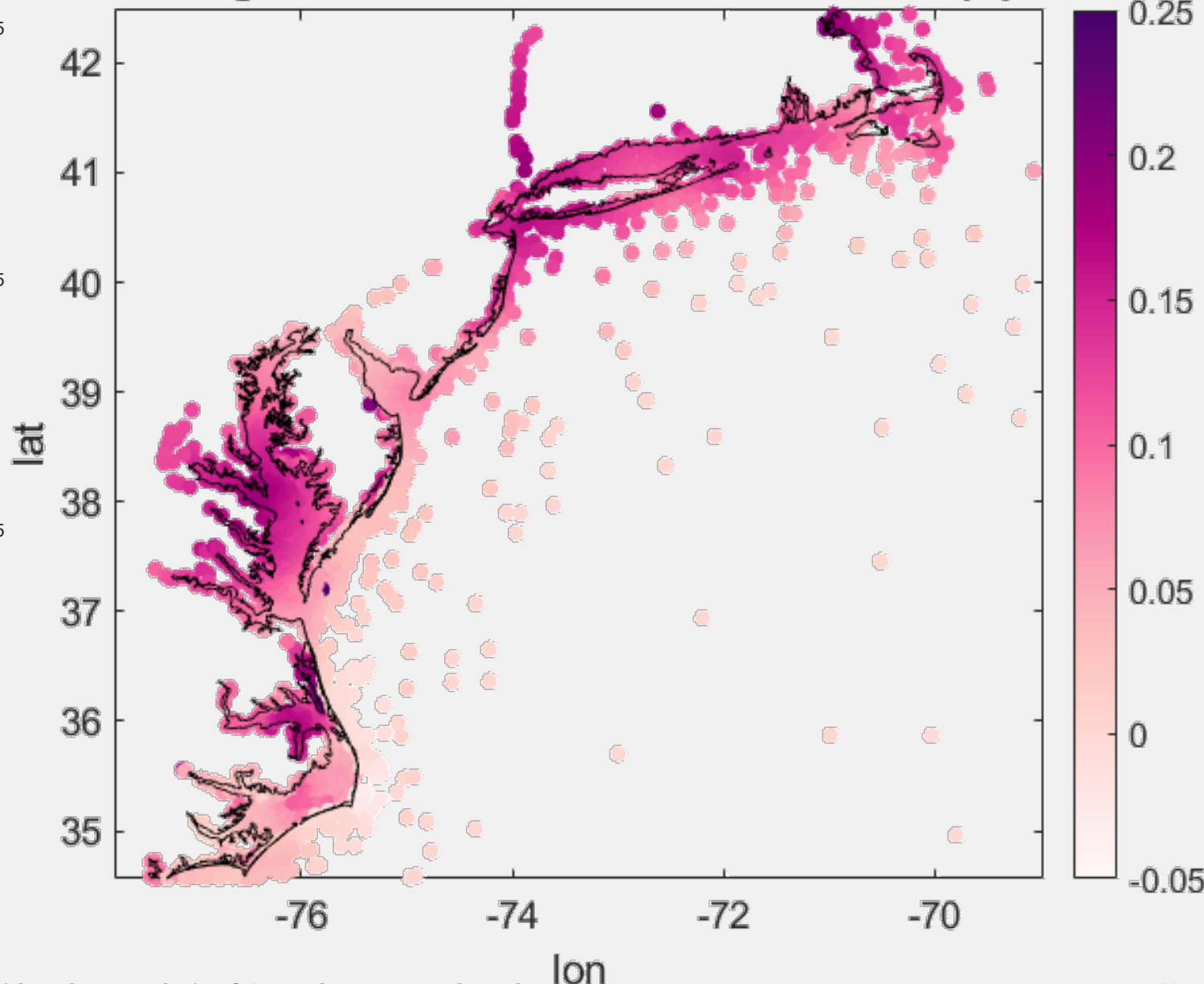
prior 10% annual exceedance flood level (m MSL)

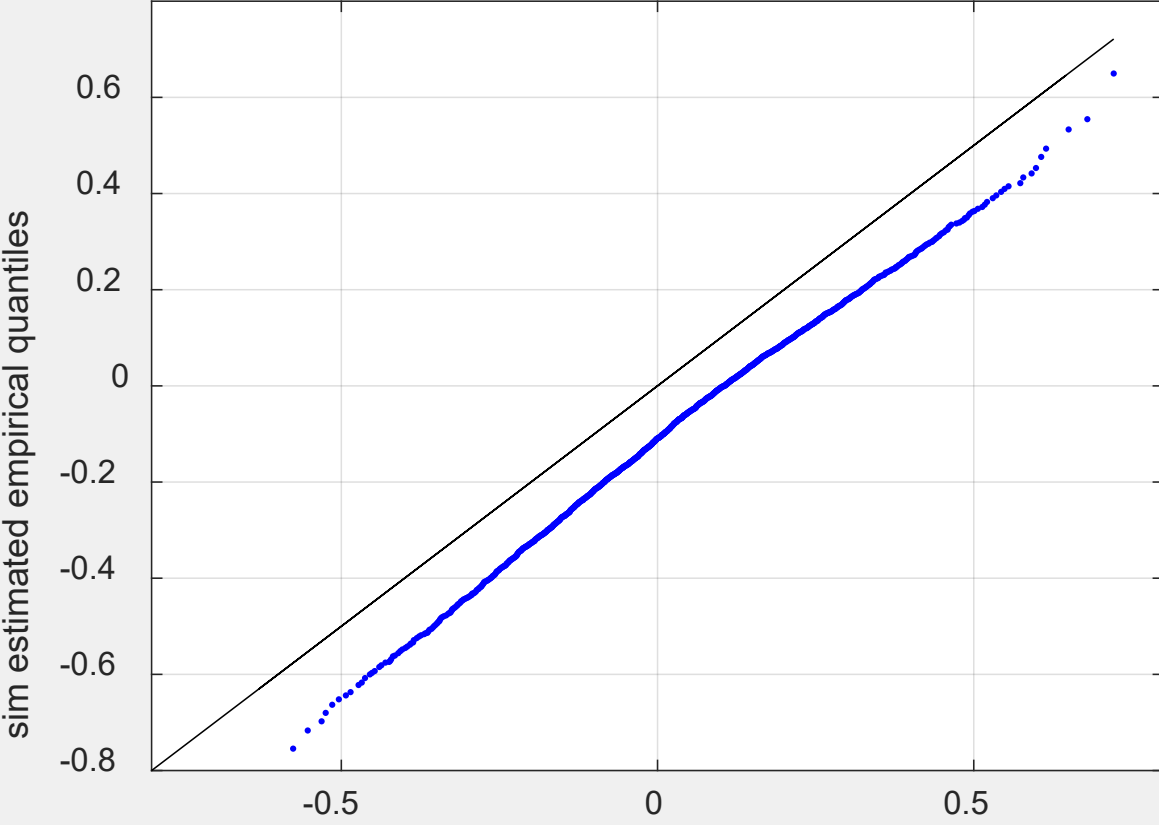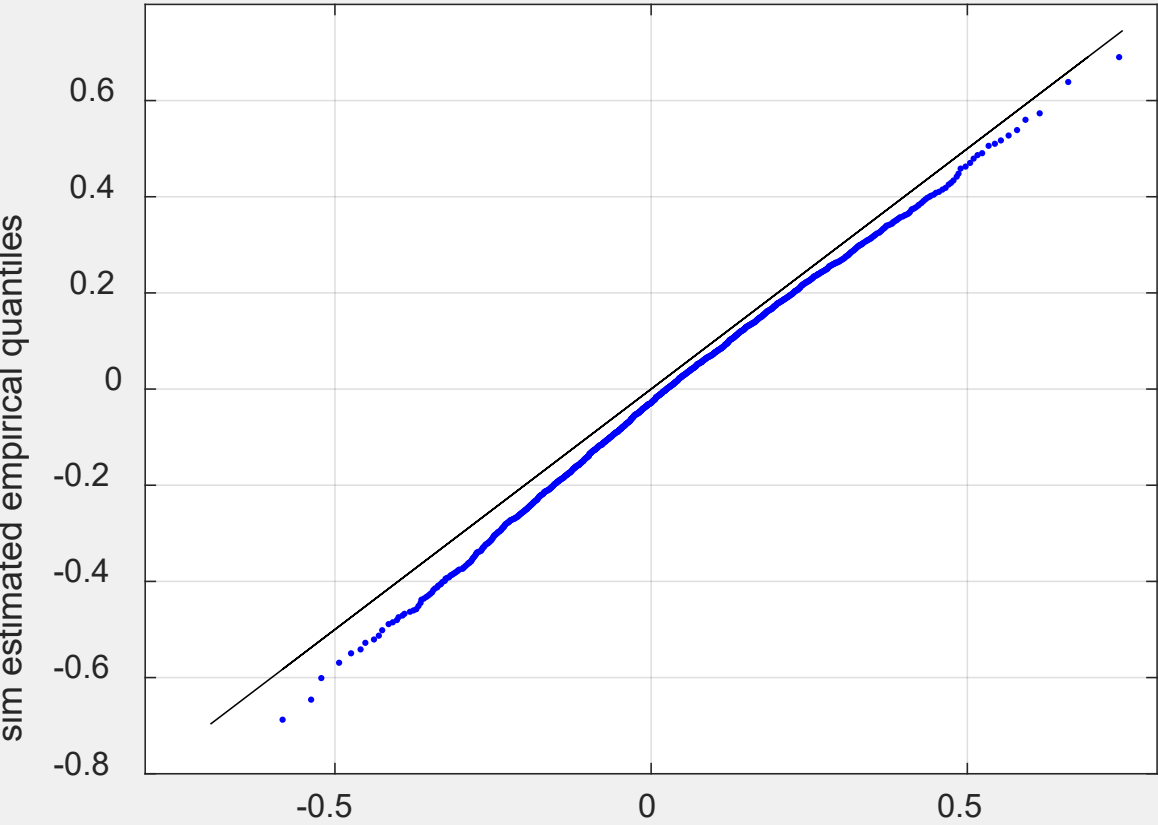change in 10% annual exceedance flood level (m)

Pobody's Nerfect

QQ plot of 4-day peak water levels

Charleston Harbor 8665530

Fort Pulaski 8670870

obs estimated empirical quantiles

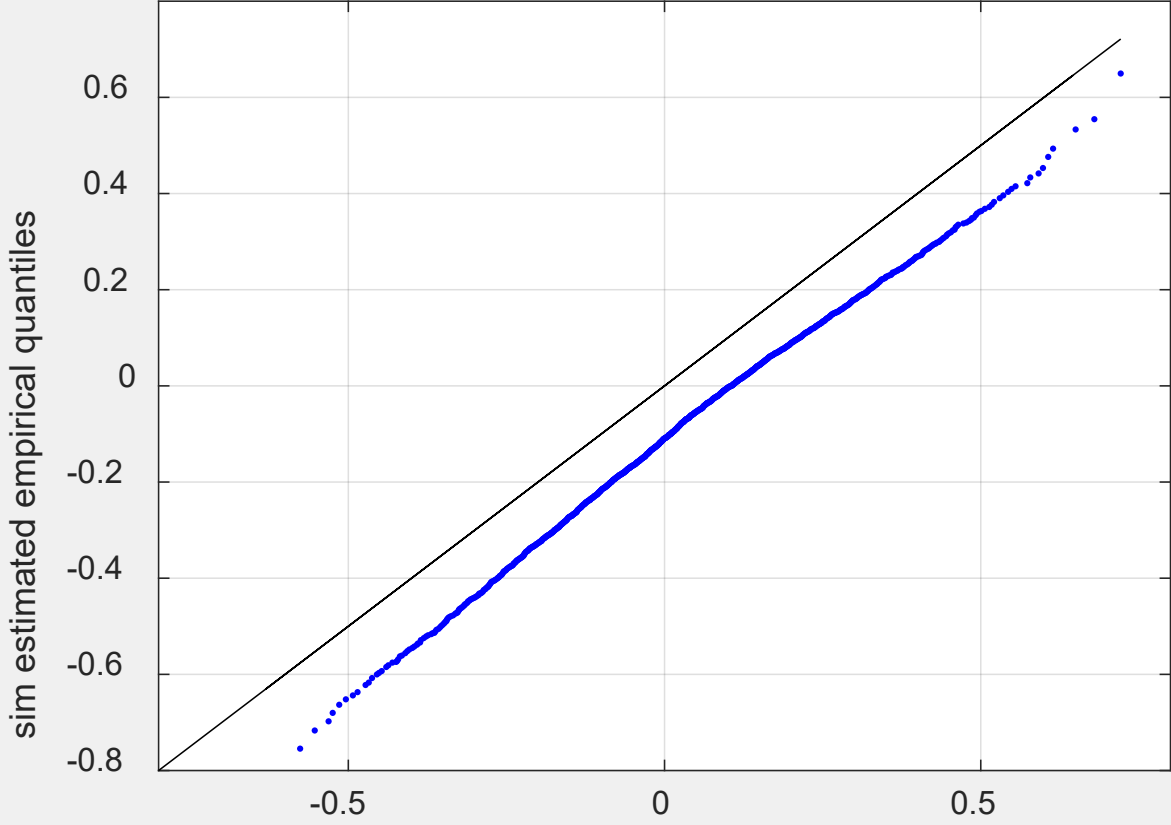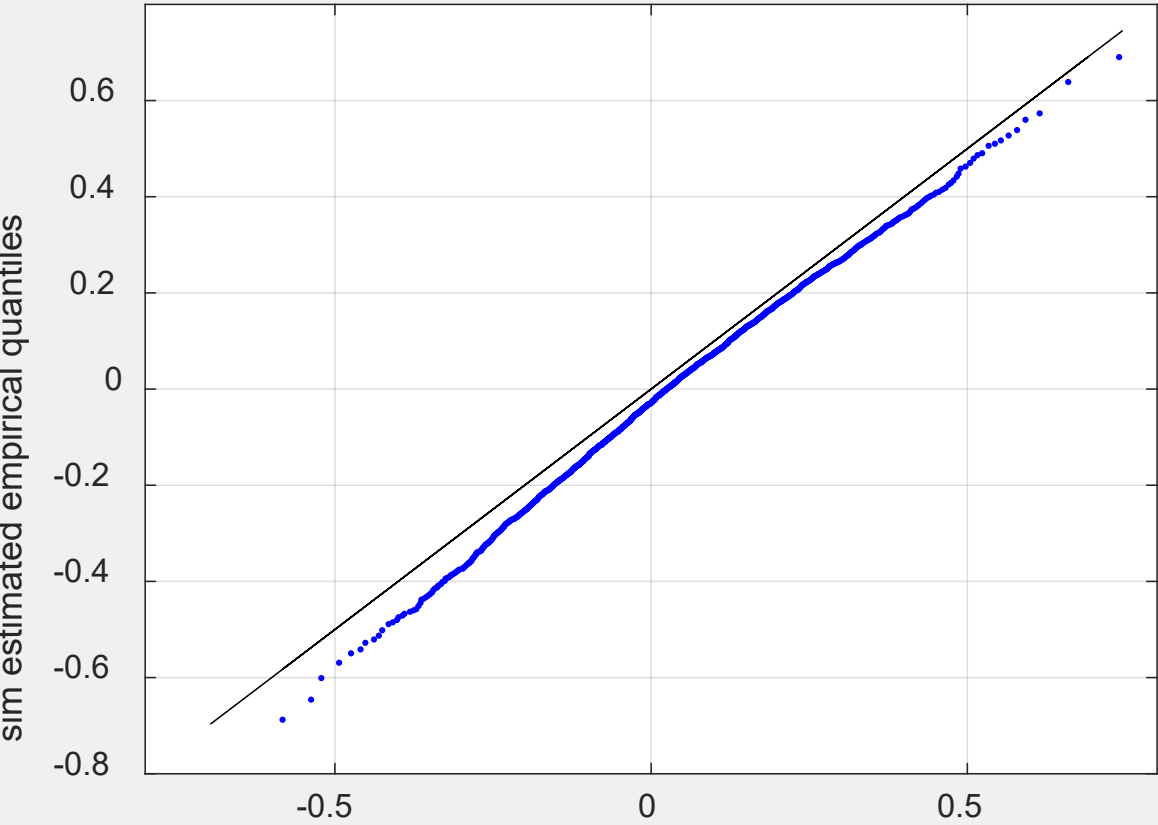*A Multidecade Reanalysis of Coastal Water Levels and Waves*

Pobody's Nerfect

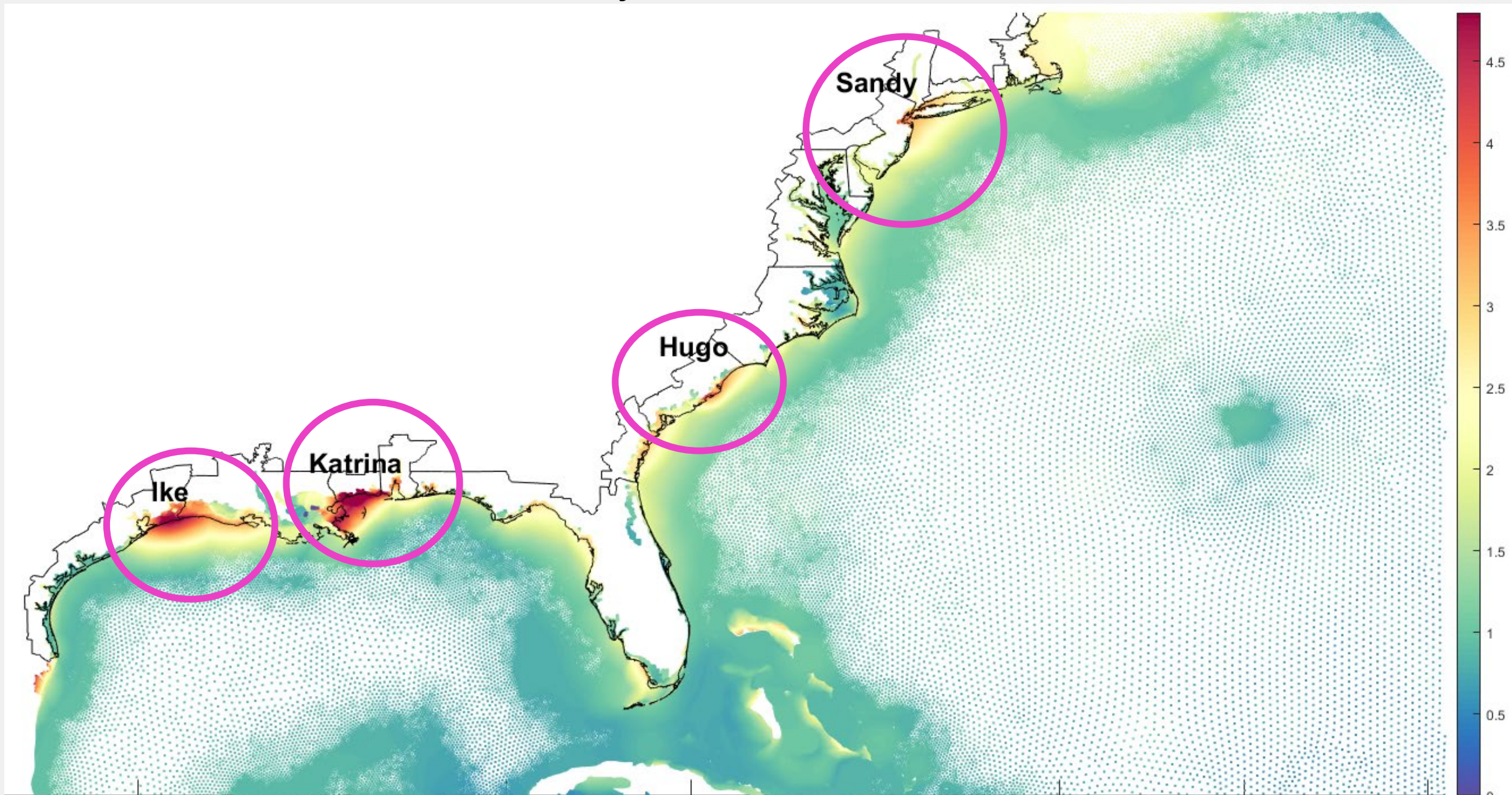**TAKEAWAY:** Simple corrections can remove biases, guidance on such issues will be in report.

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Fort Pulaski 8670870

A Multidecade Reanalysis of Coastal Water Levels and Waves
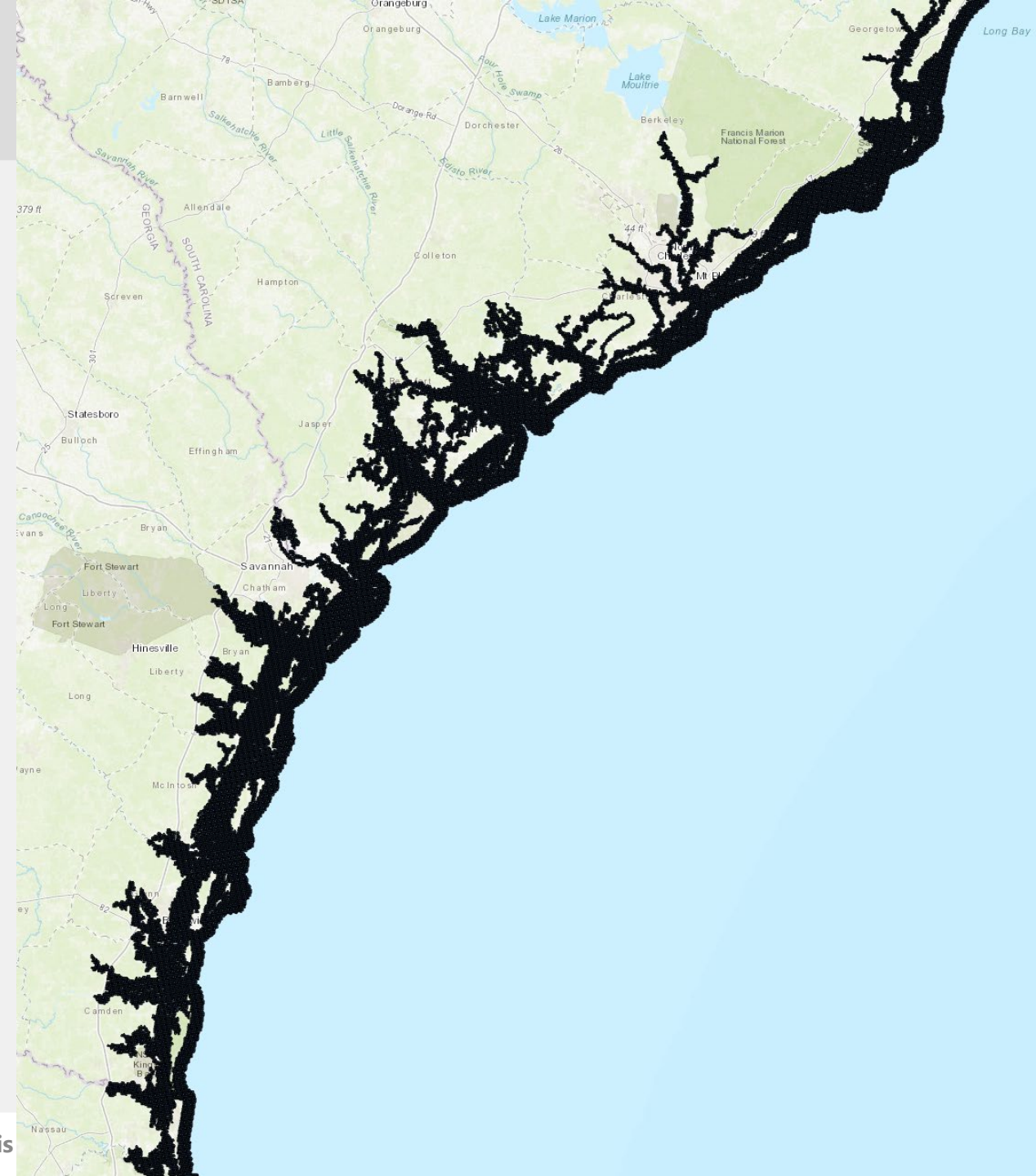
Data Access

- User interface for easy data subsetting, extraction in space/time

- Web accessible notebooks permit calculation of quantities of interest
  - E.g. max water level in New York City in the 1980's

Gridded Data

- All data provided in
  - Original model formats (mostly standards-conforming netCDF)
  - 500-m and 2500-m rectangular gridded formats (GIS-friendly)

Products

- Sub-seasonal to annual water level outlook
- Sea level rise
- High tides
- Historical storms
- Nuisance flooding
- Extreme floods

Future Plans

- Funded – support by NOS & Bipartisan Infrastructure Law
    - Everything I've shown thus far
    - Pacific
    - Great Lakes
- Unfunded
    - Annual updates with simulations of the latest year
    - Intermittent updates with better models, methods
        - Better representation of tropical cyclones
        - Extend to 1950
        - Baroclinicity
    - Integration with other products
        - USGS coastal change analysis
        - NOAA/NASA RISE program
        - FEMA/USACE/NOAA extreme flood estimates

END

Questions?

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