A 43-Year NOAA Reanalysis of Coastal Waves and Water Levels

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Billy Sweet – NOAA
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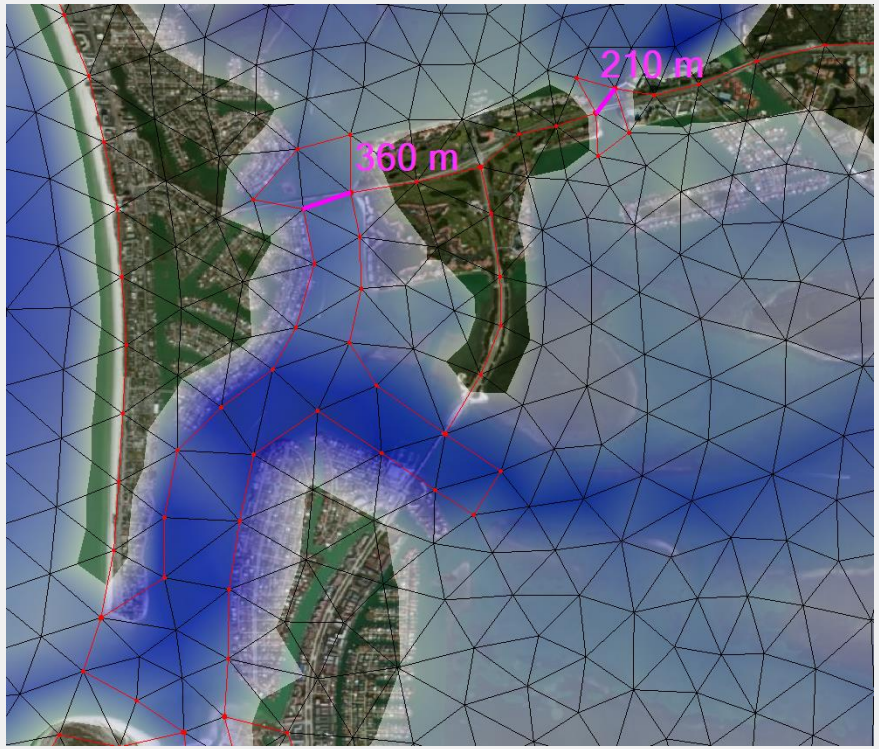
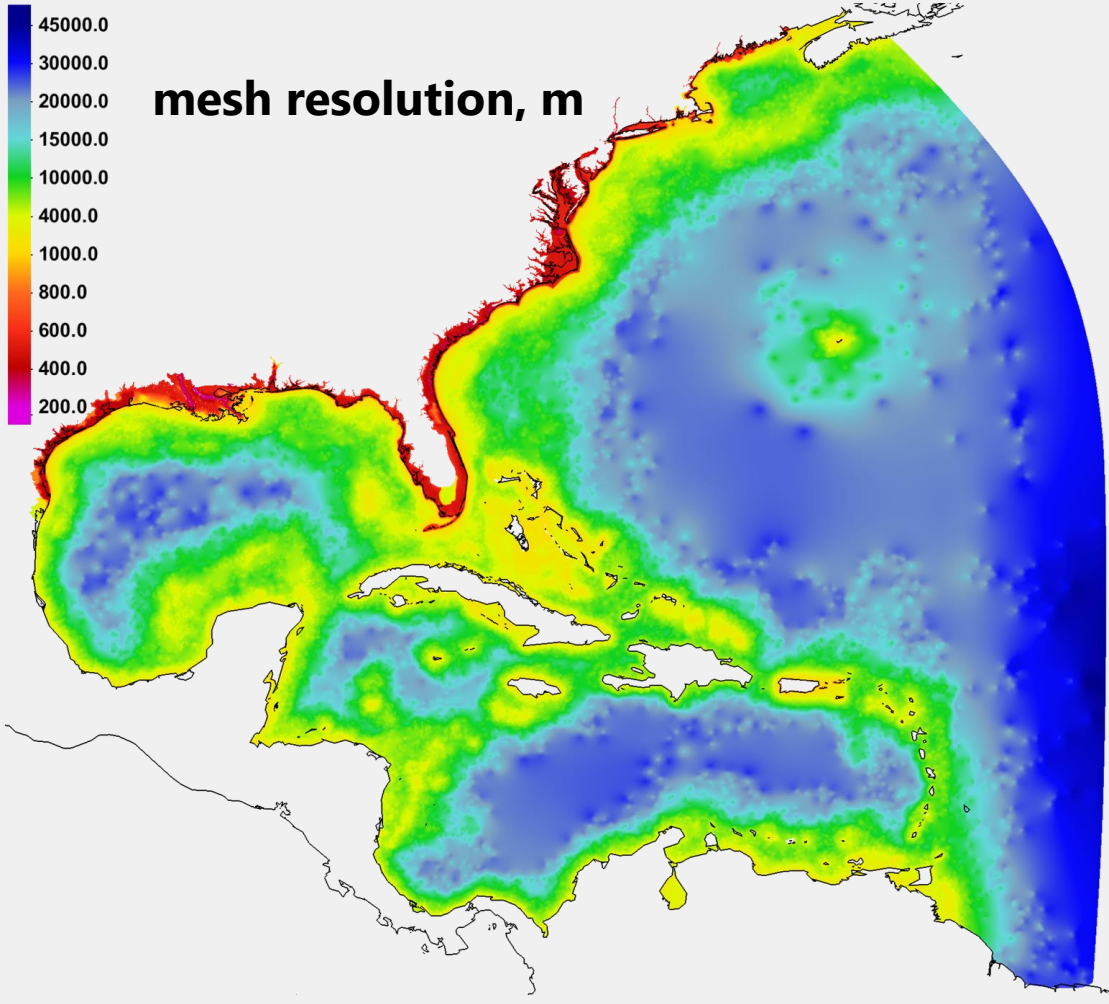
2023-10-03

Basics

- Producing hourly water levels and waves across all U.S. coasts & overland
- 1979-present
- ~500 m coastal resolution





Data Assimilation Goals

Correct for unresolved drivers

- Steric effect (seasonal, ~0.1 m)
- Major rainfall events (days-weeks, ~0.1 m)
- Changes in major ocean currents (days-weeks, 0.1-0.3 m)
- Sea level rise (a while)
- Far-field meteorology

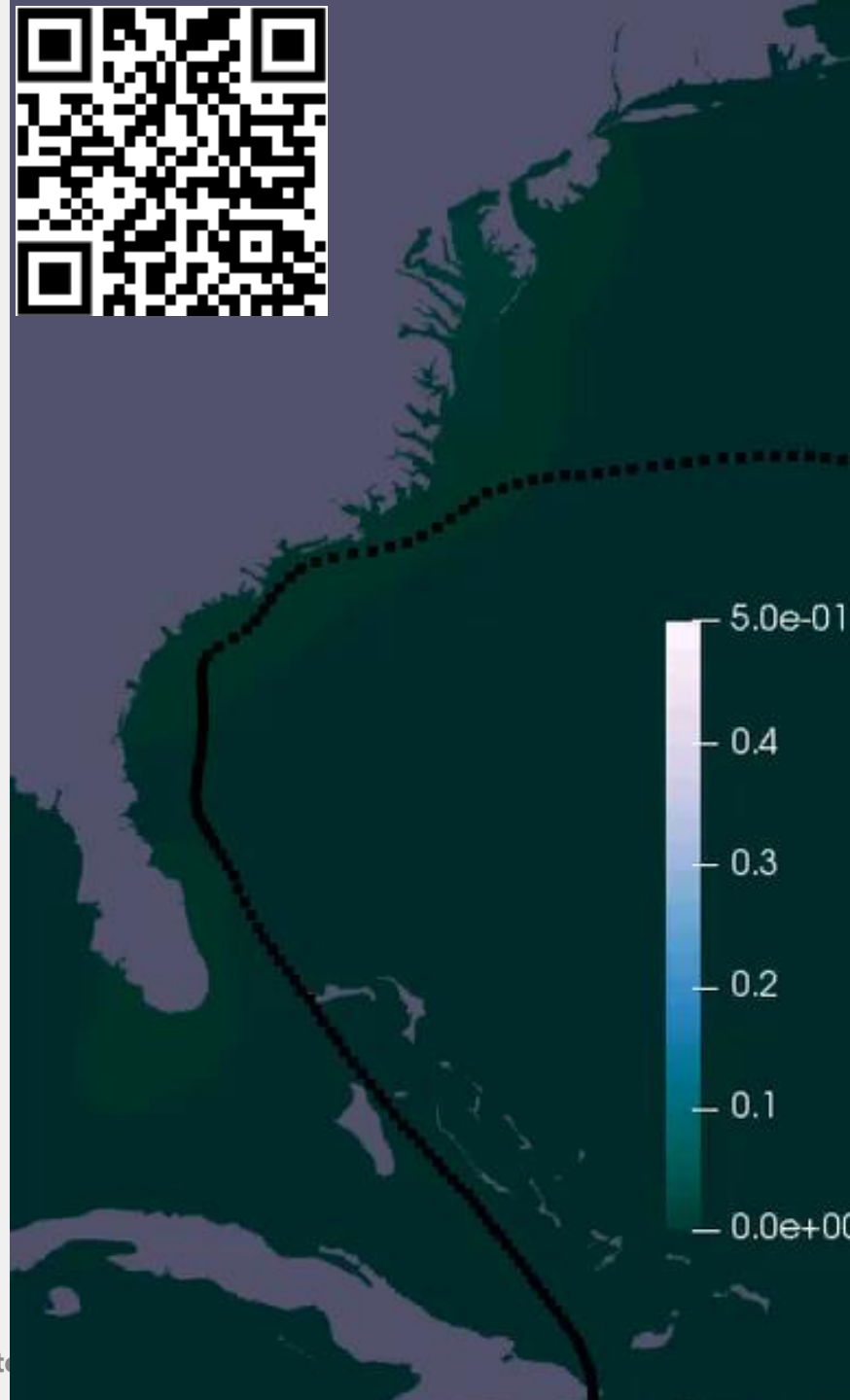
Asher et al. 2019 in Ocean Mod.

ADCIRC+SWAN tides+ECMWF

Lowpass filter errors, create spatial field

tides+ECMWF + **corrections** = **Reanalysis**

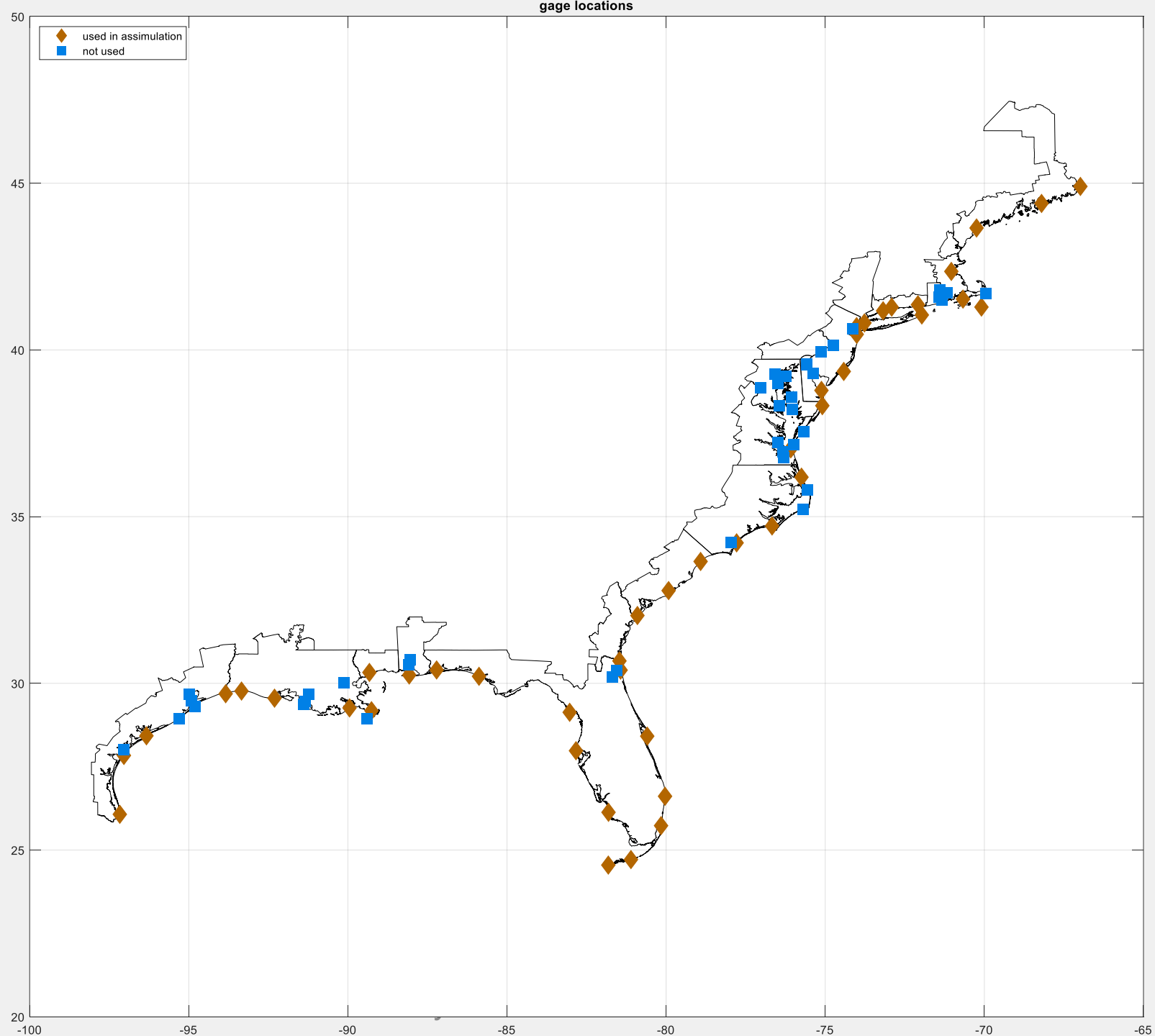
Compute errors via **NOAA gages**



86 gage

45 in **training**

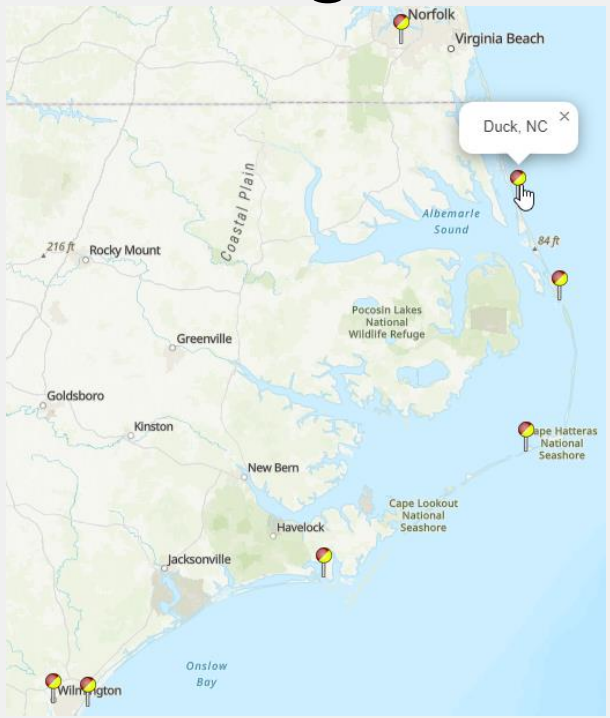
41 in **validation**



(meters)	RMSE
Post all	0.13
Post train	0.11
Post valid	0.15
Prior all	0.20
Prior train	0.19
Prior valid	0.21

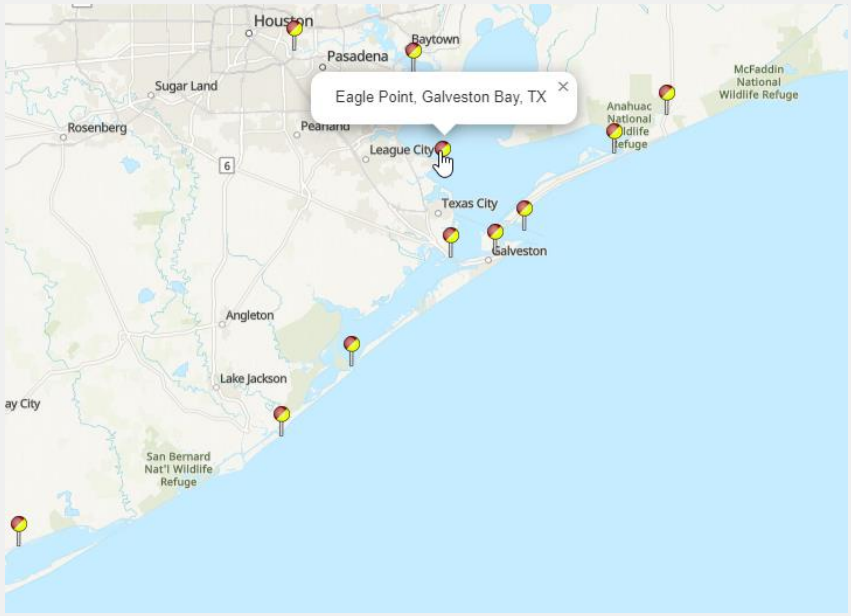
(meters)	RMSE	MAE	ME	STD
Post all	0.13	0.10	0.01	0.12
Post train	0.11	0.09	0.00	0.11
Post valid	0.15	0.12	0.02	0.14
Prior all	0.20	0.16	-0.06	0.17
Prior train	0.19	0.15	-0.06	0.17
Prior valid	0.21	0.17	-0.07	0.18

Duck, NC (training)



Error (cm)	mean	STD	MAE
Prior	-7.5	14	12
Posterior	-0.3	6.5	5.0

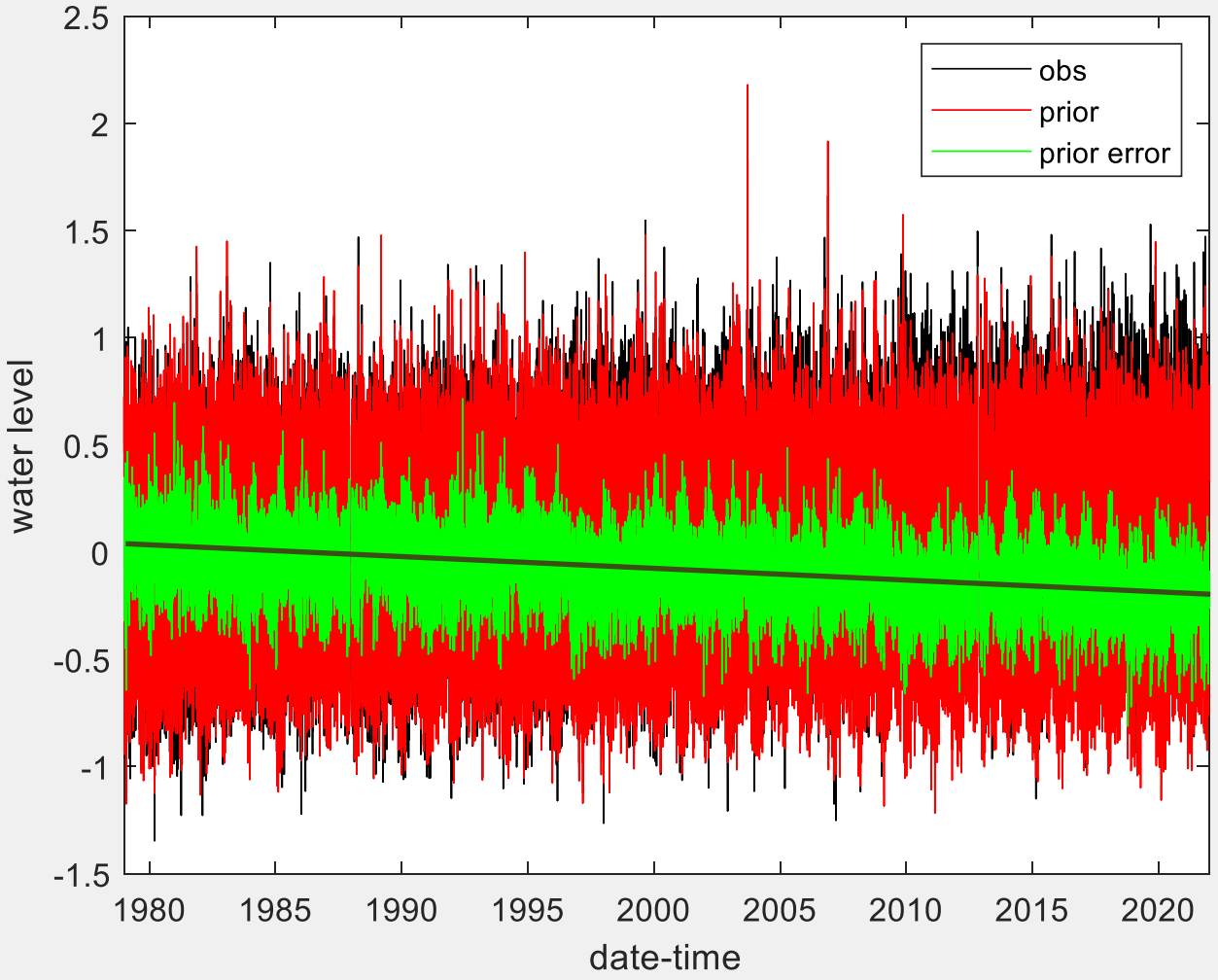
Eagle Point, TX (validation)



Error (cm)	mean	STD	MAE
Prior	-0.9	19	15
Posterior	0.7	12	9.6

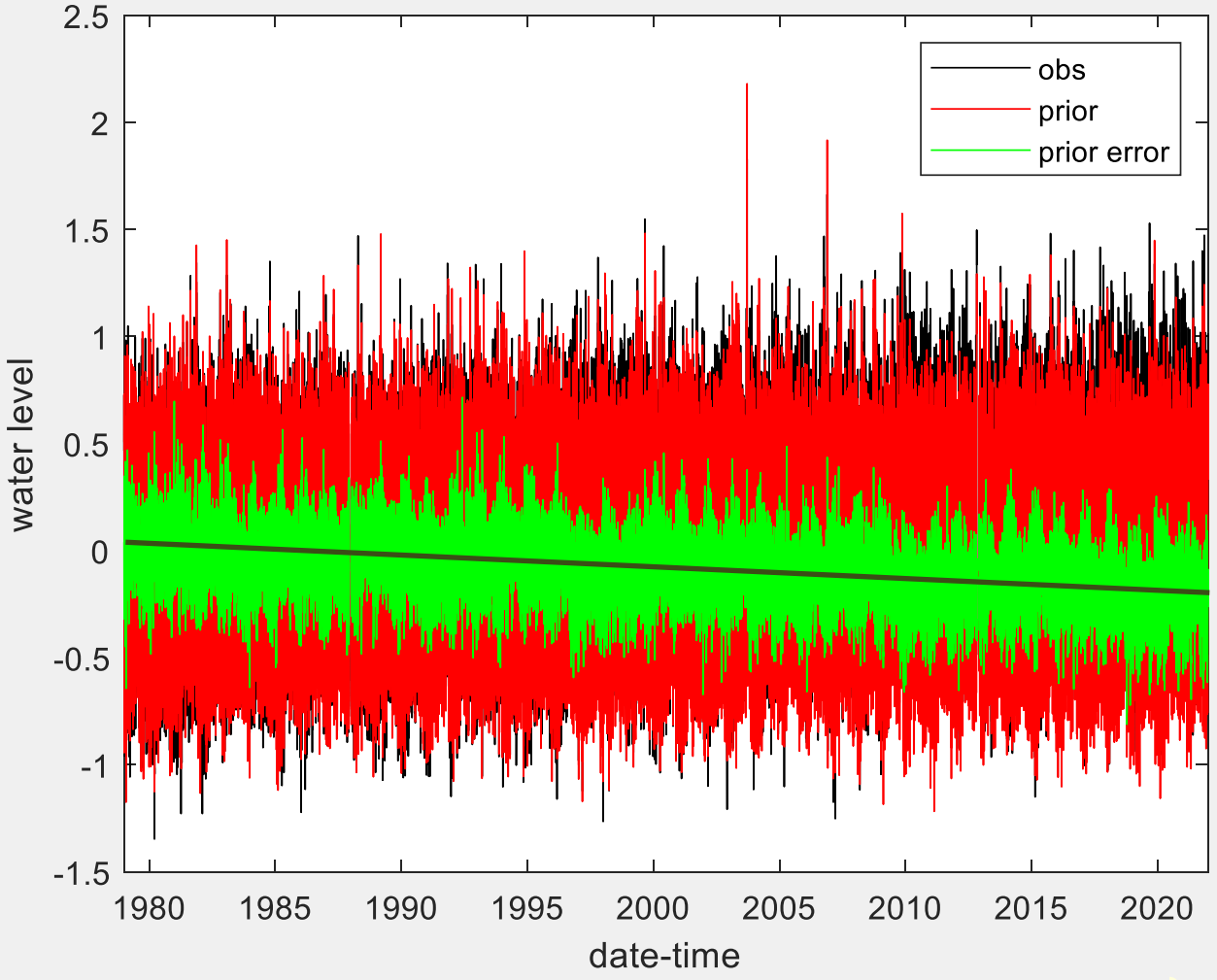
Reanalysis Results

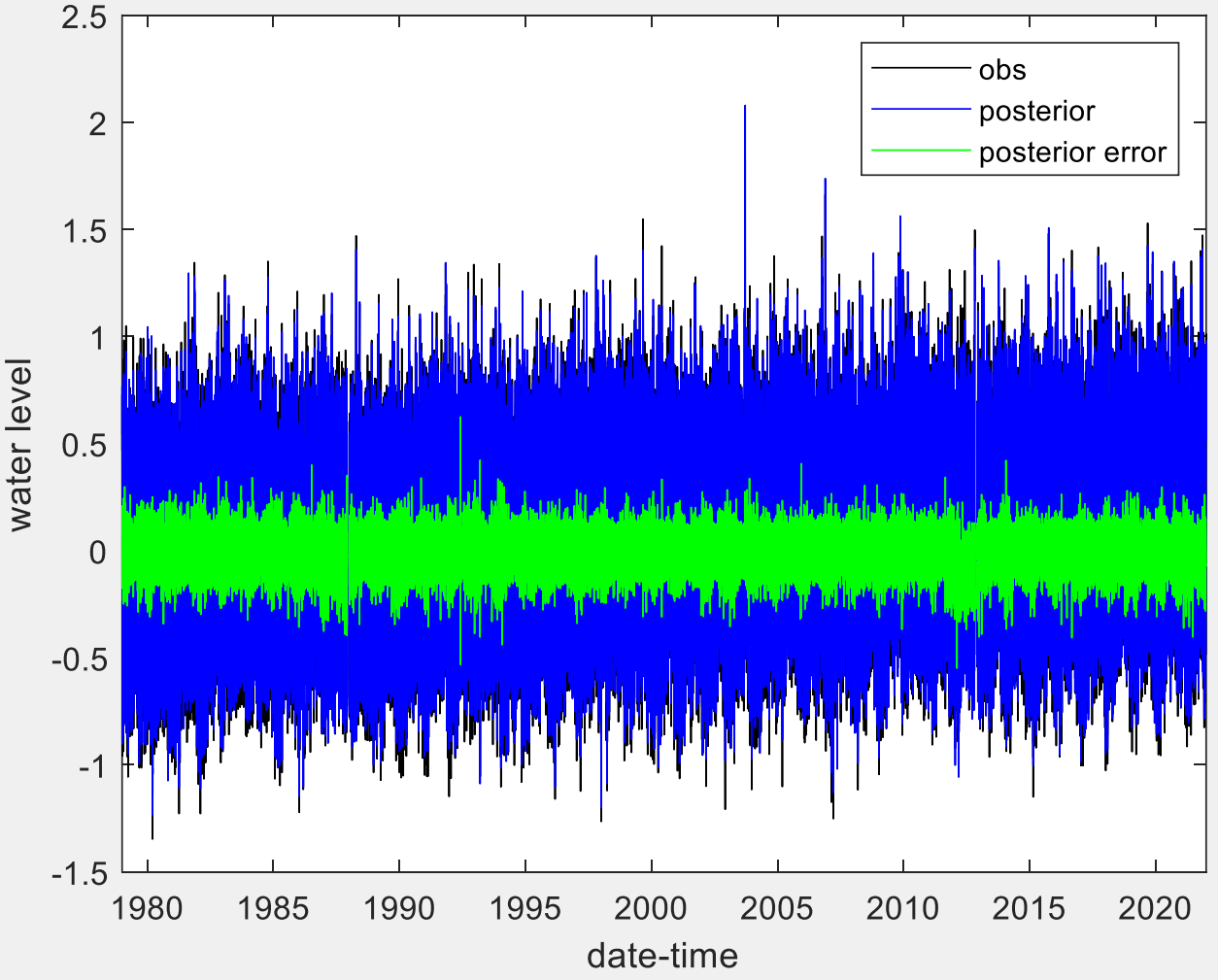
Duck, NC sea level rise?



Reanalysis Results

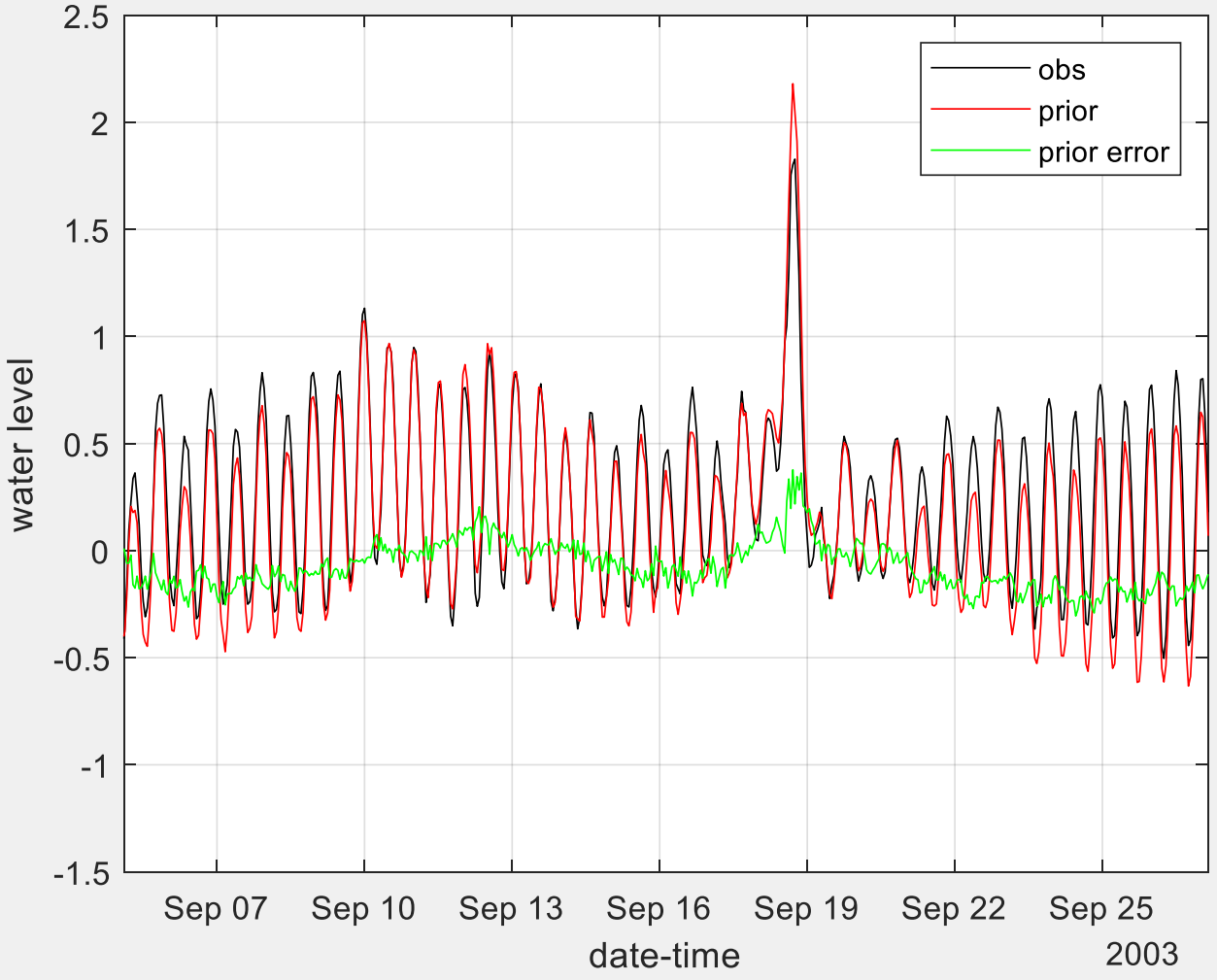
Duck, NC sea level rise **Solved.**

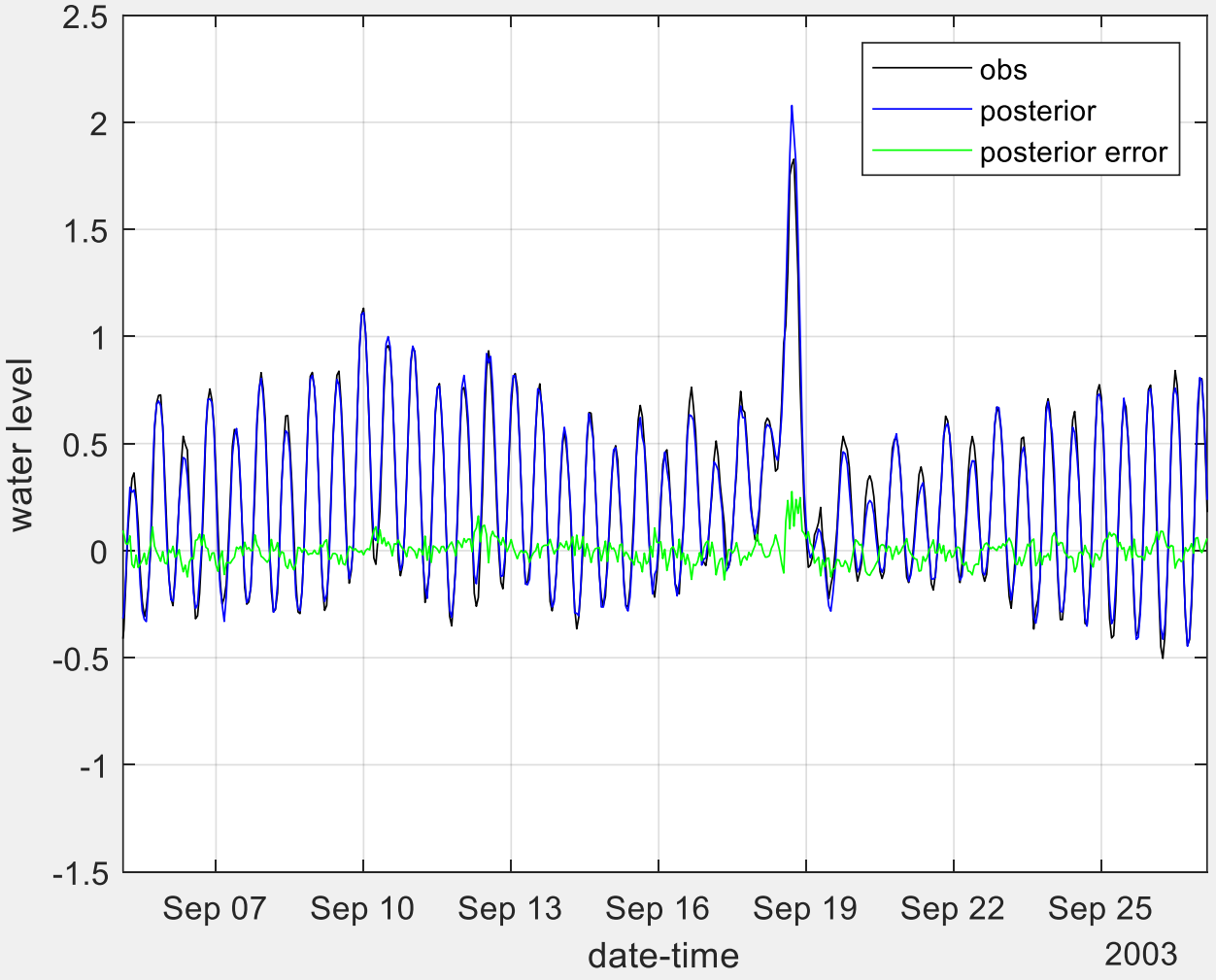




Reanalysis Results

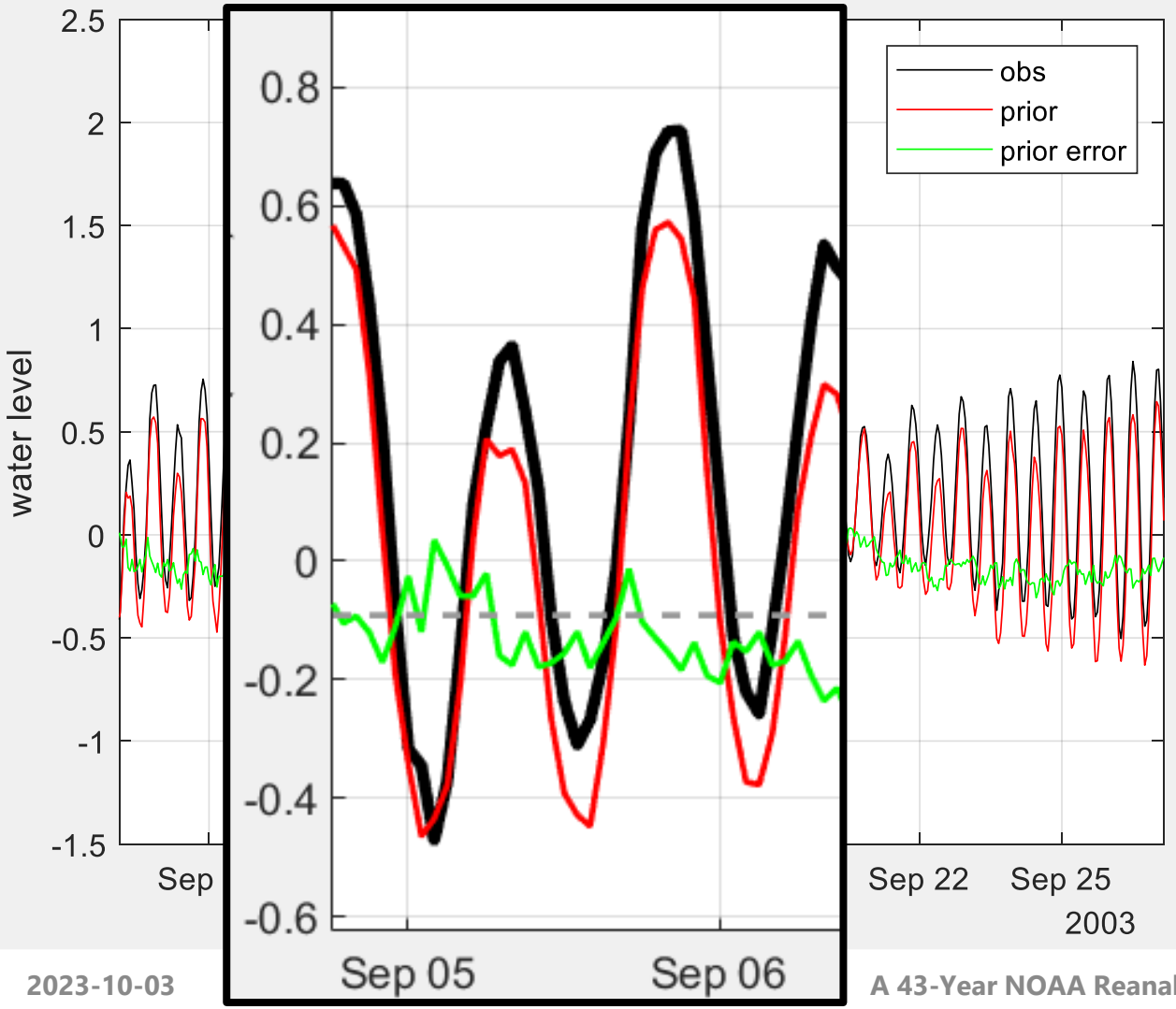
Duck, NC

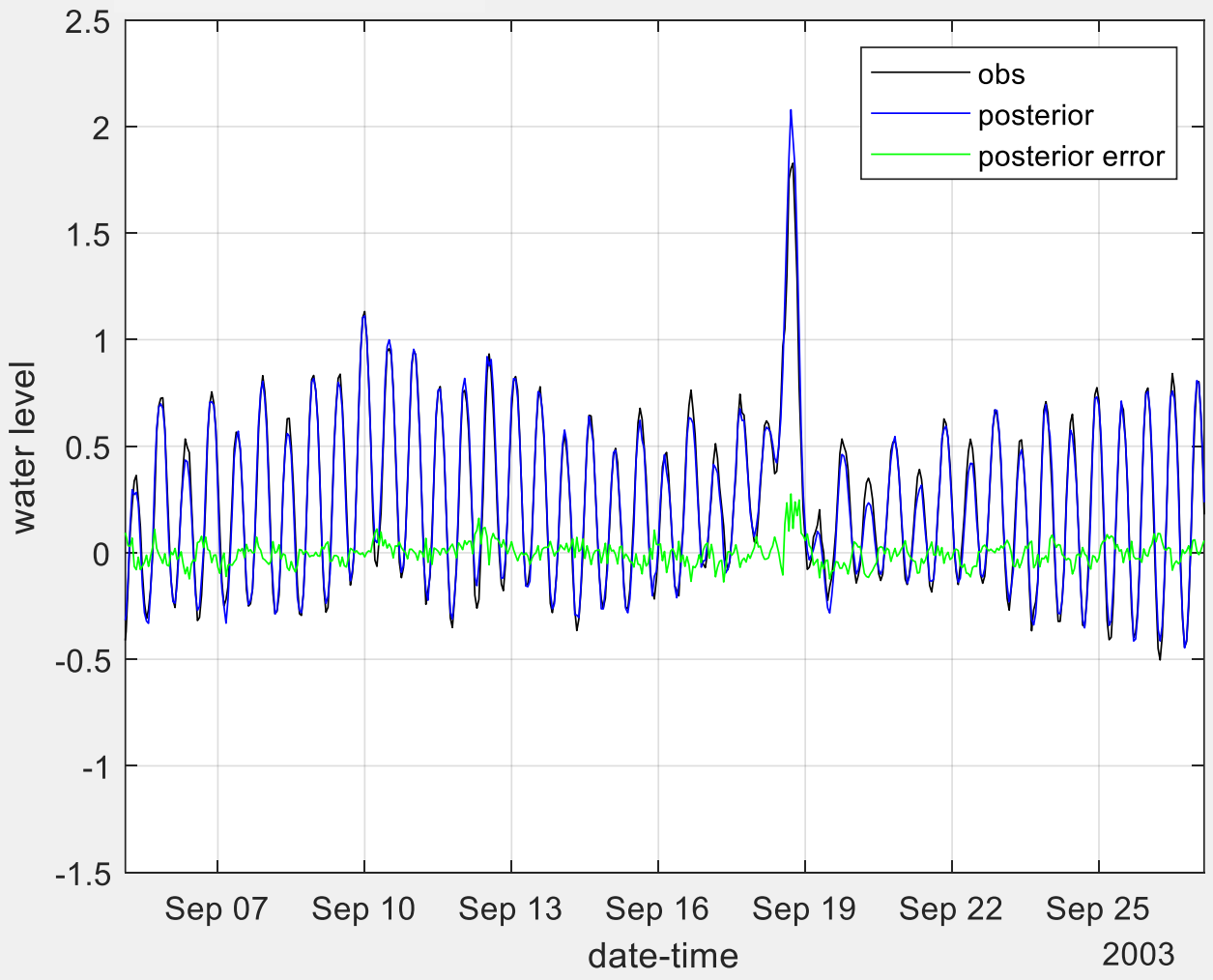




Reanalysis Results

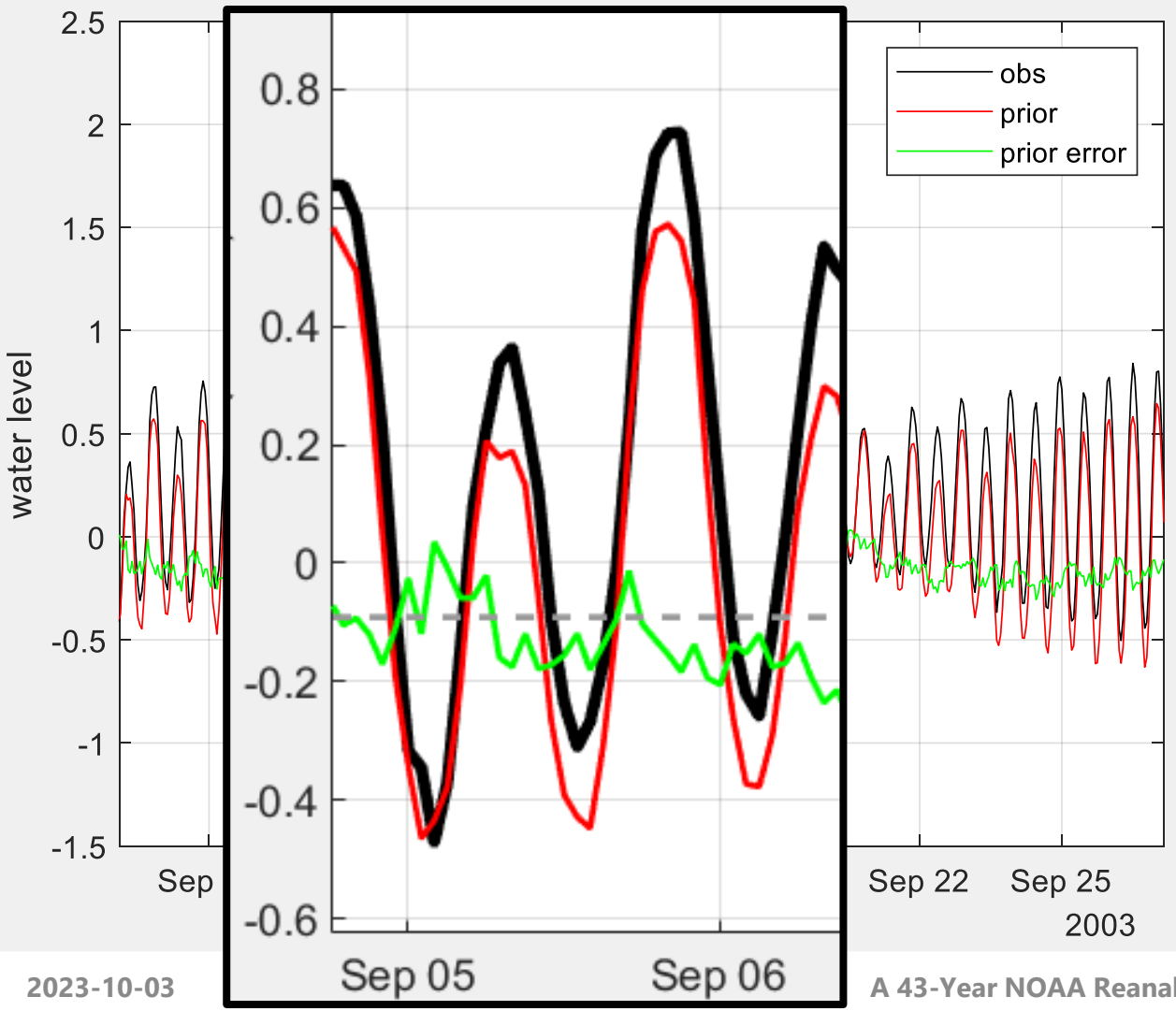
Duck, NC bias around storm?

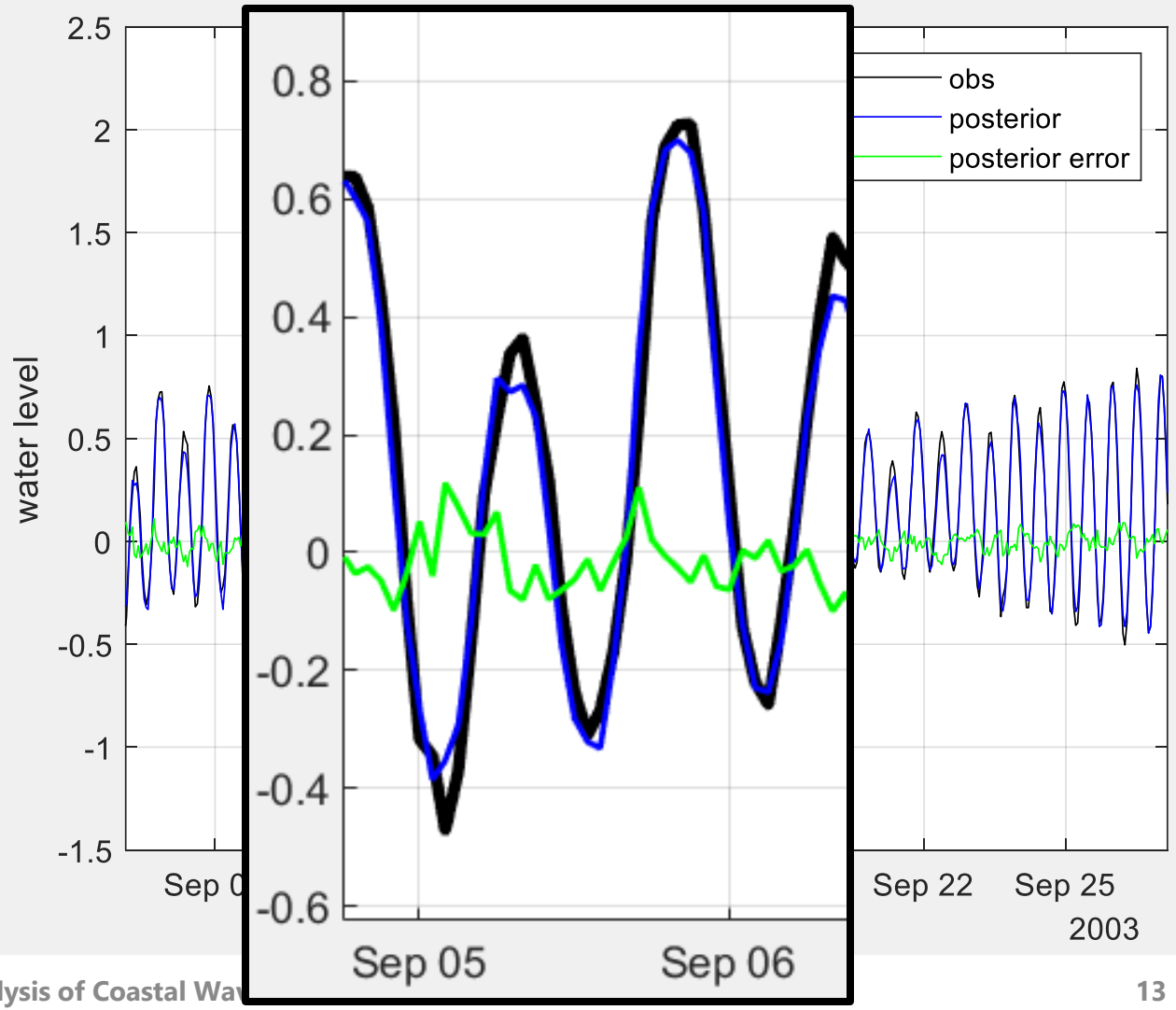




Reanalysis Results

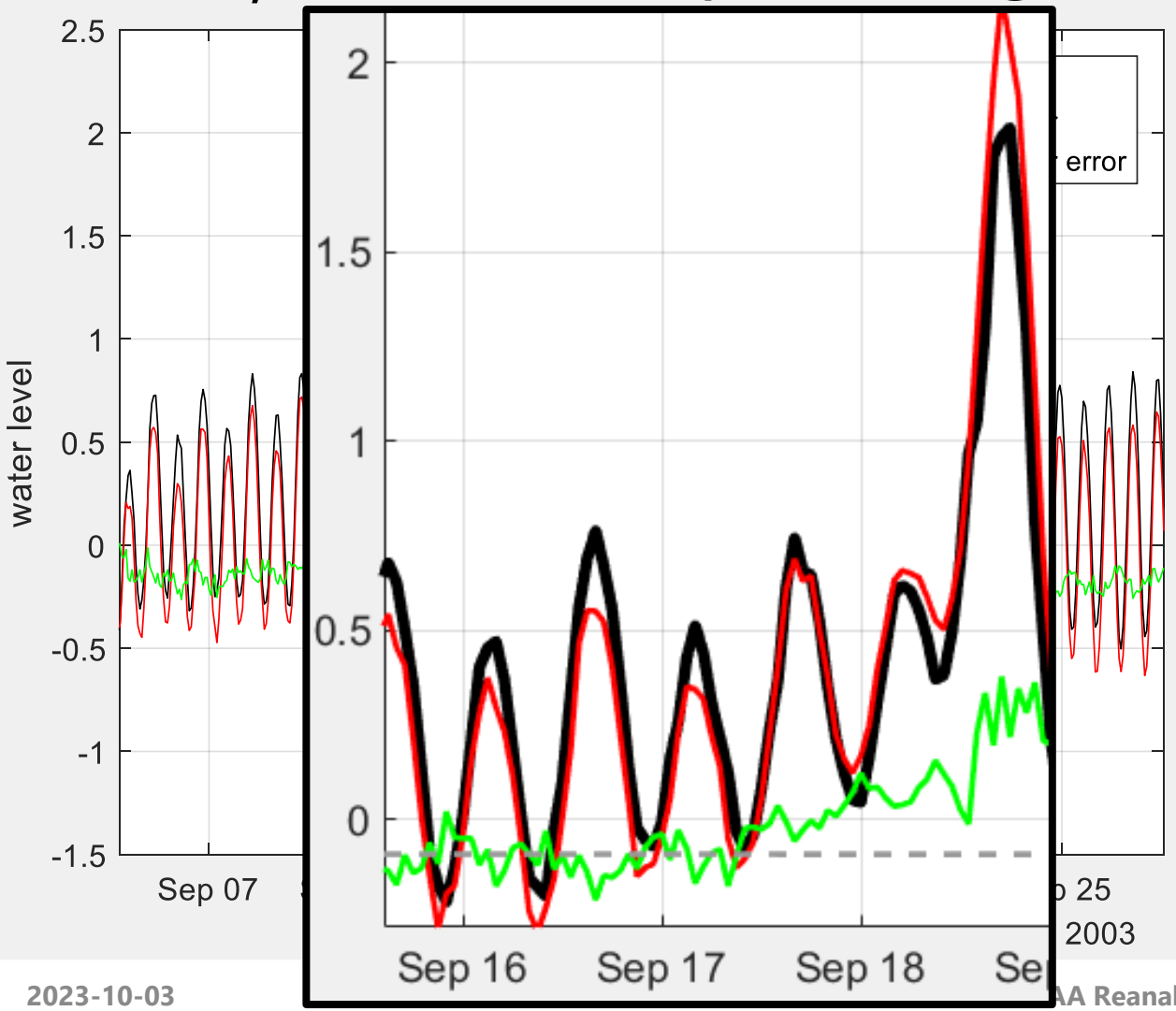
Duck, NC bias around storm? **Solved.**

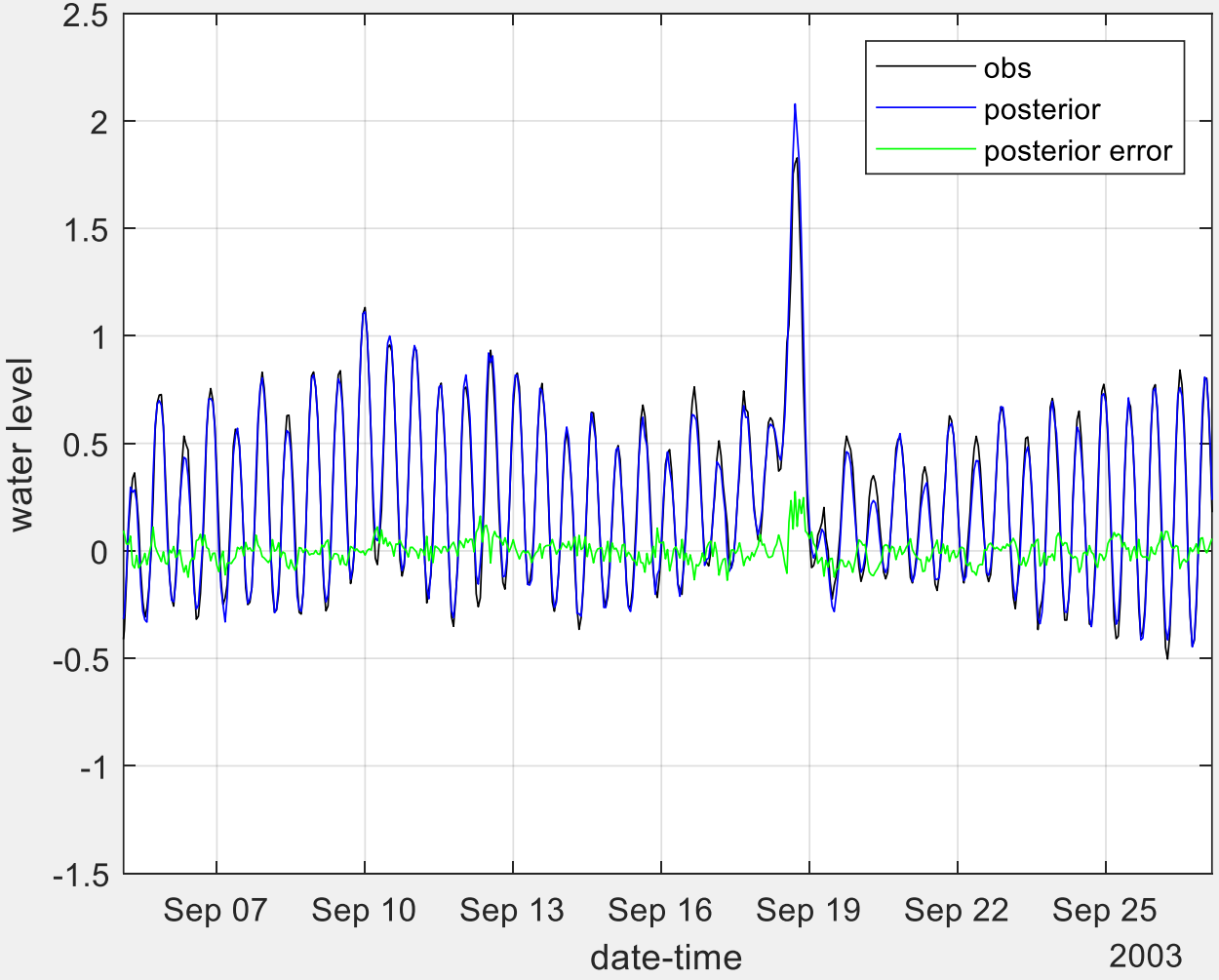




Reanalysis Results

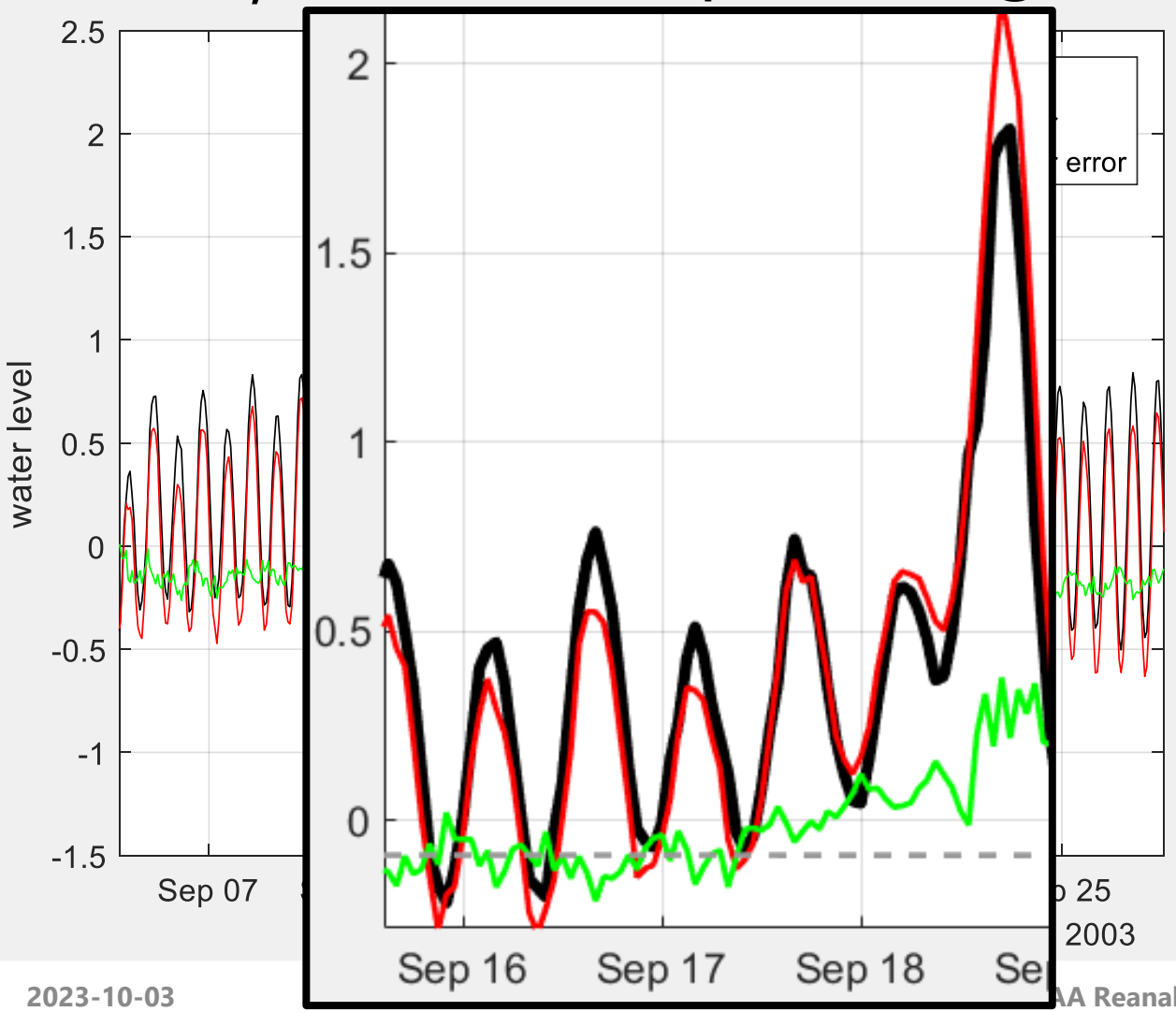
Duck, NC peak surges?



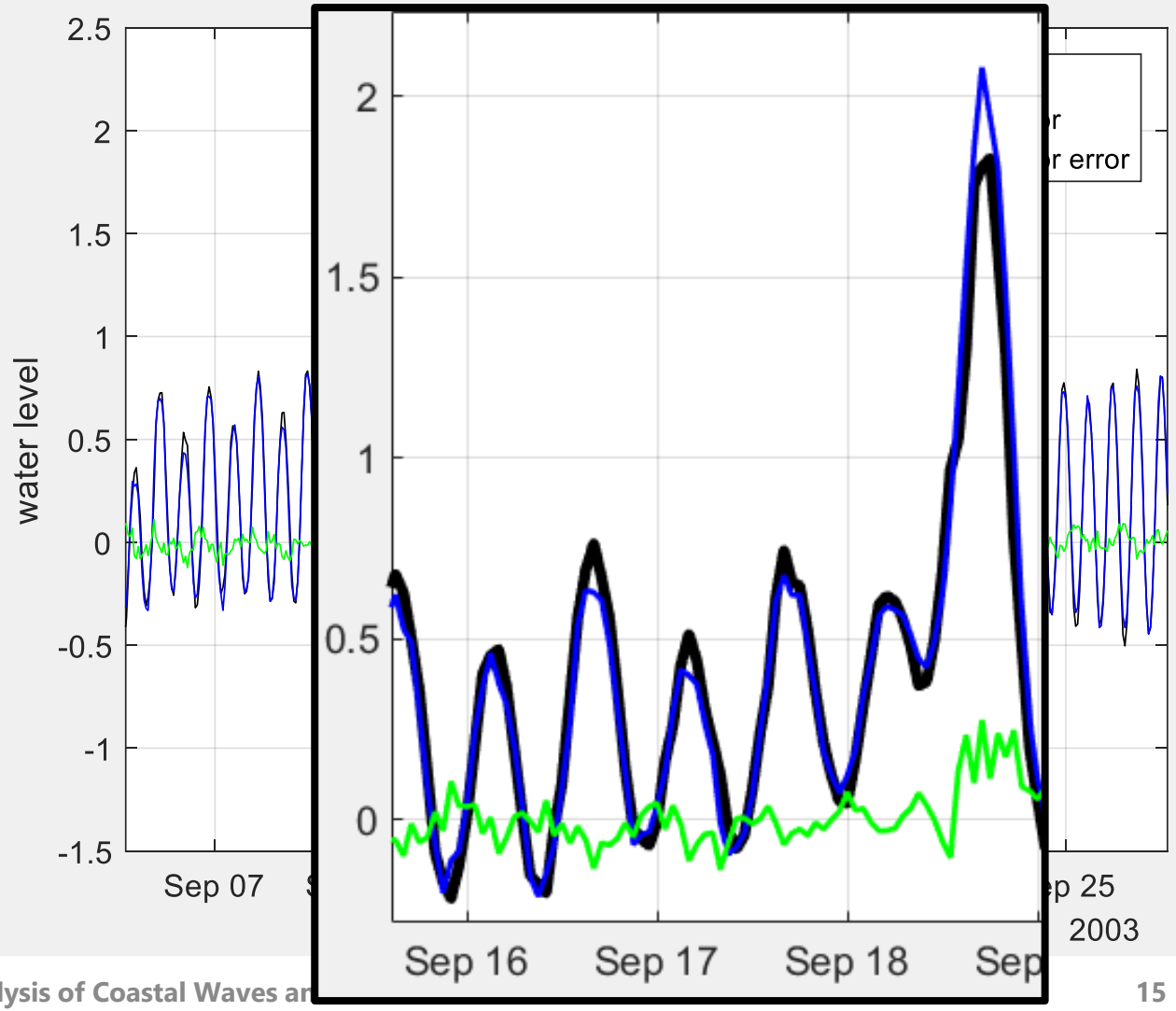


Reanalysis Results

Duck, NC peak surges?

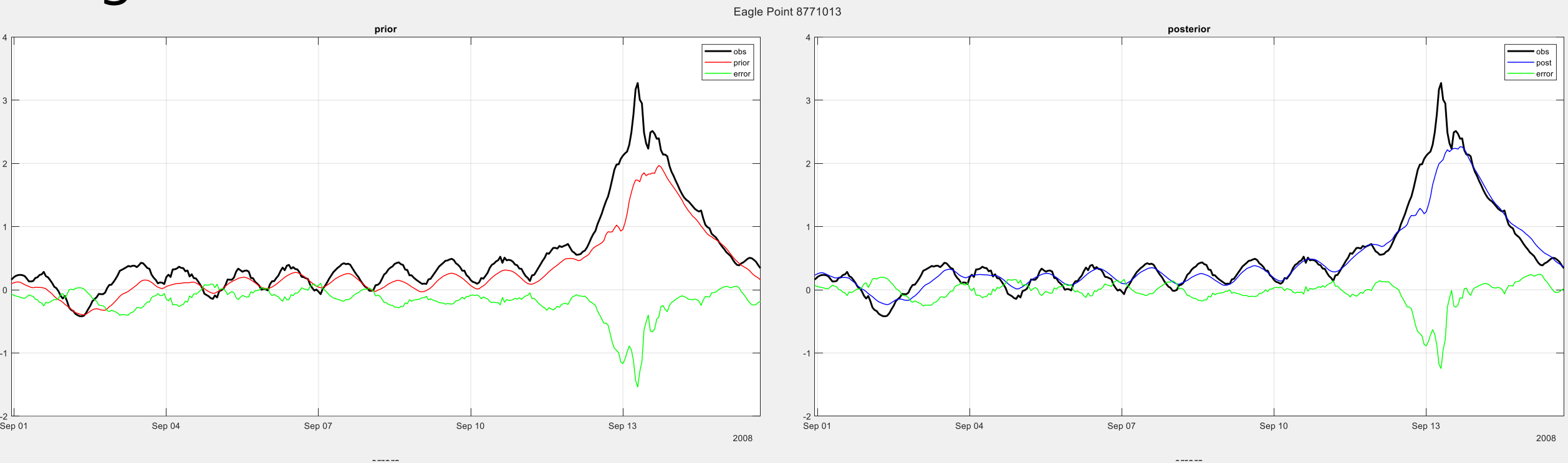


Improved.



Reanalysis Results

Eagle Point, TX bias around storm? **Solved.**

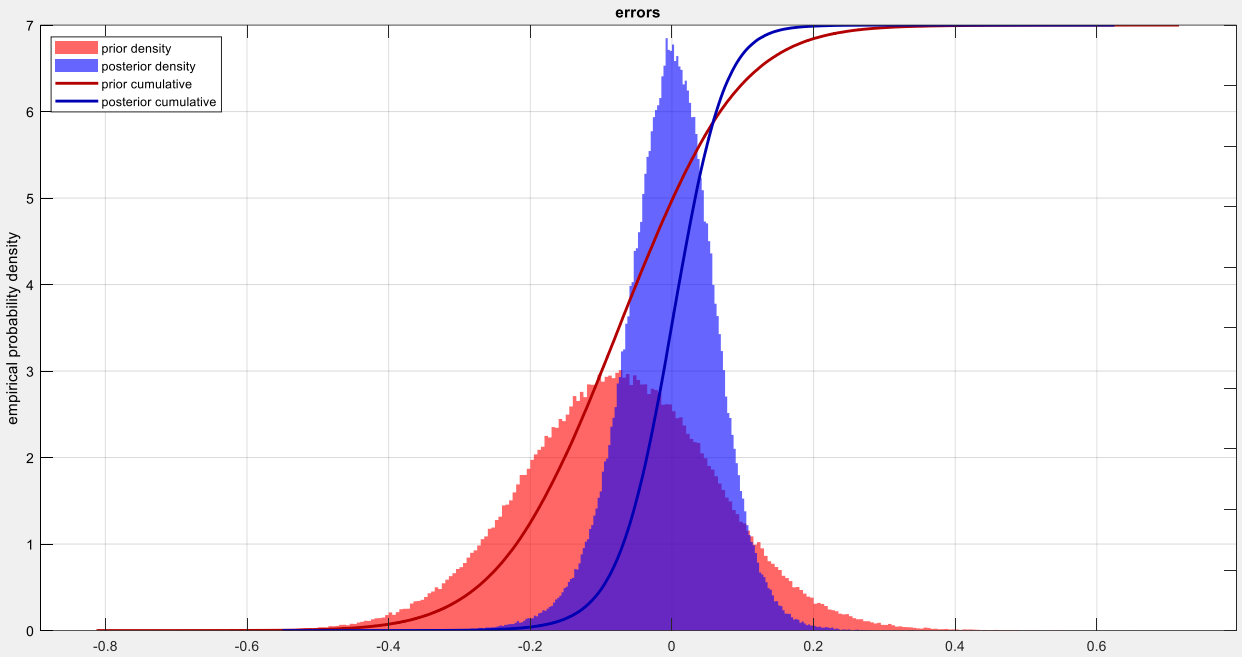


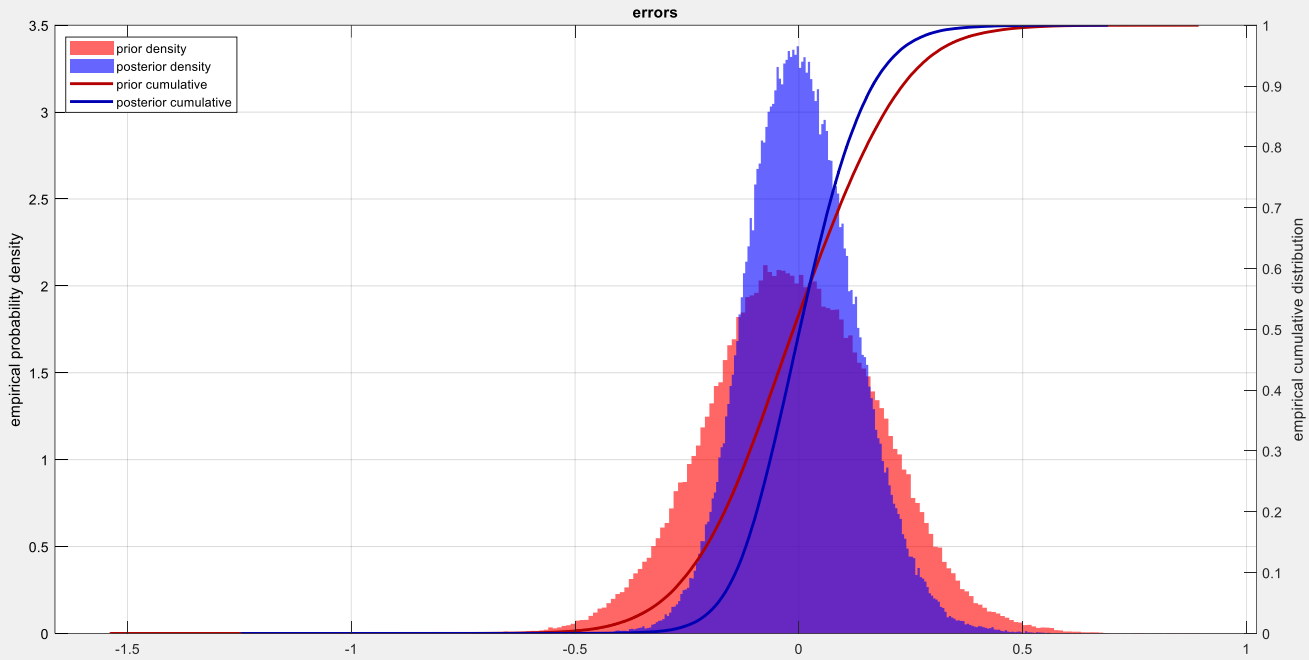
peak surges? **Improved, but…**

Duck, NC (training)

Eagle Point, TX (validation)

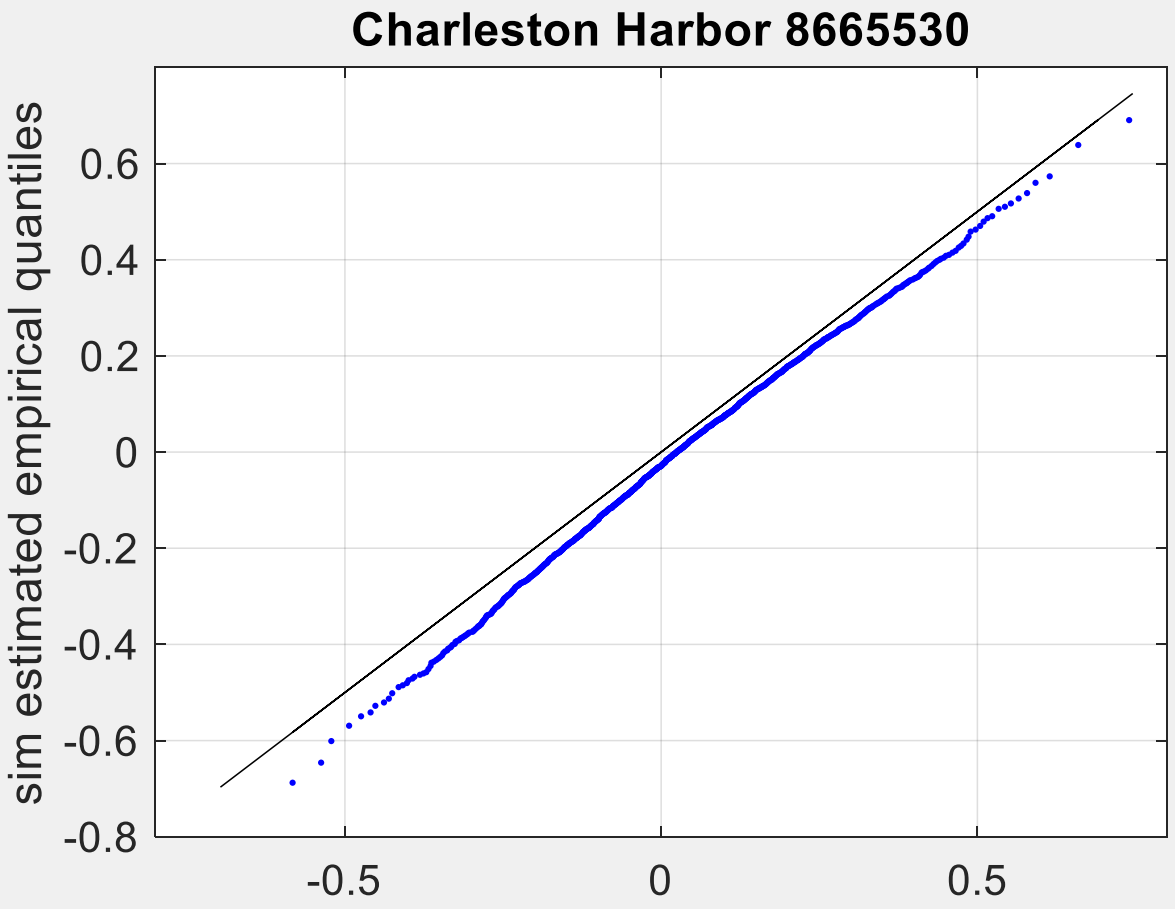
Hourly water level error distributions

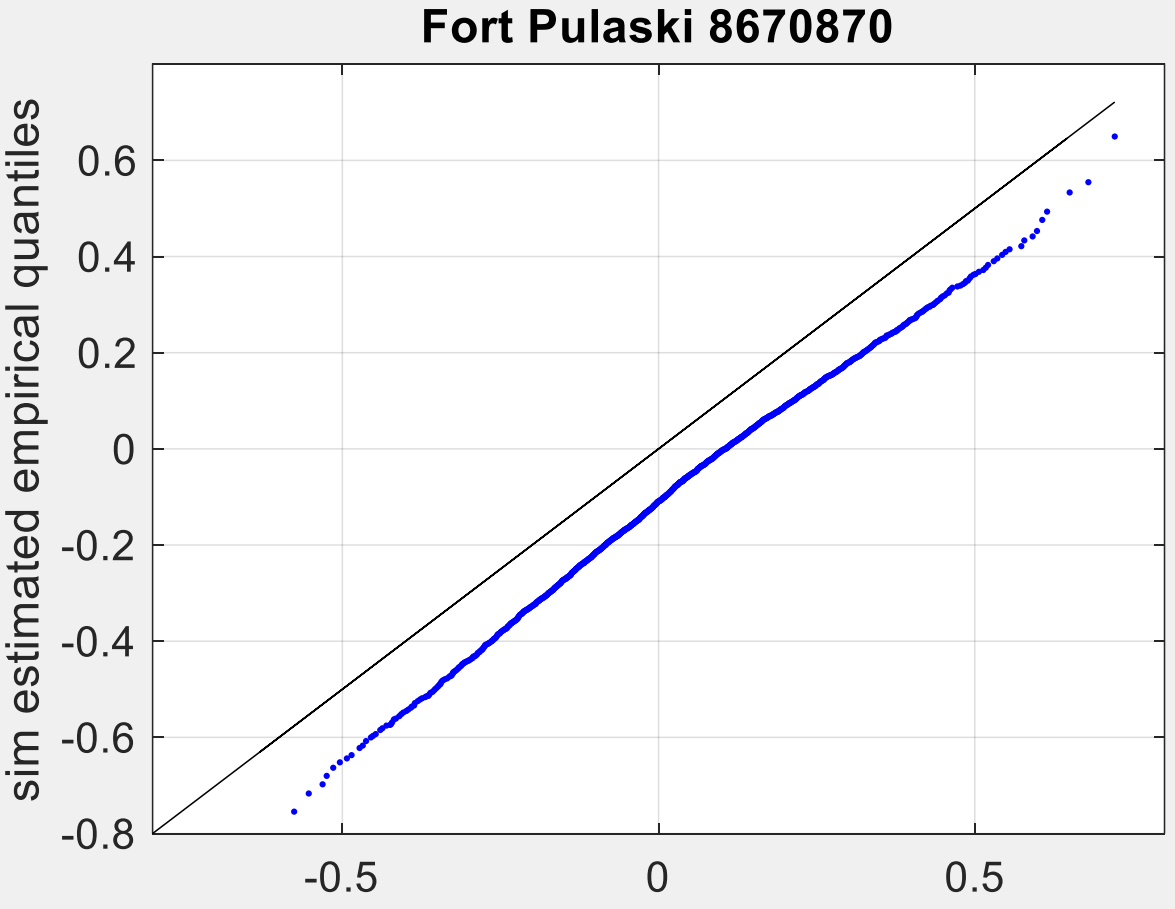




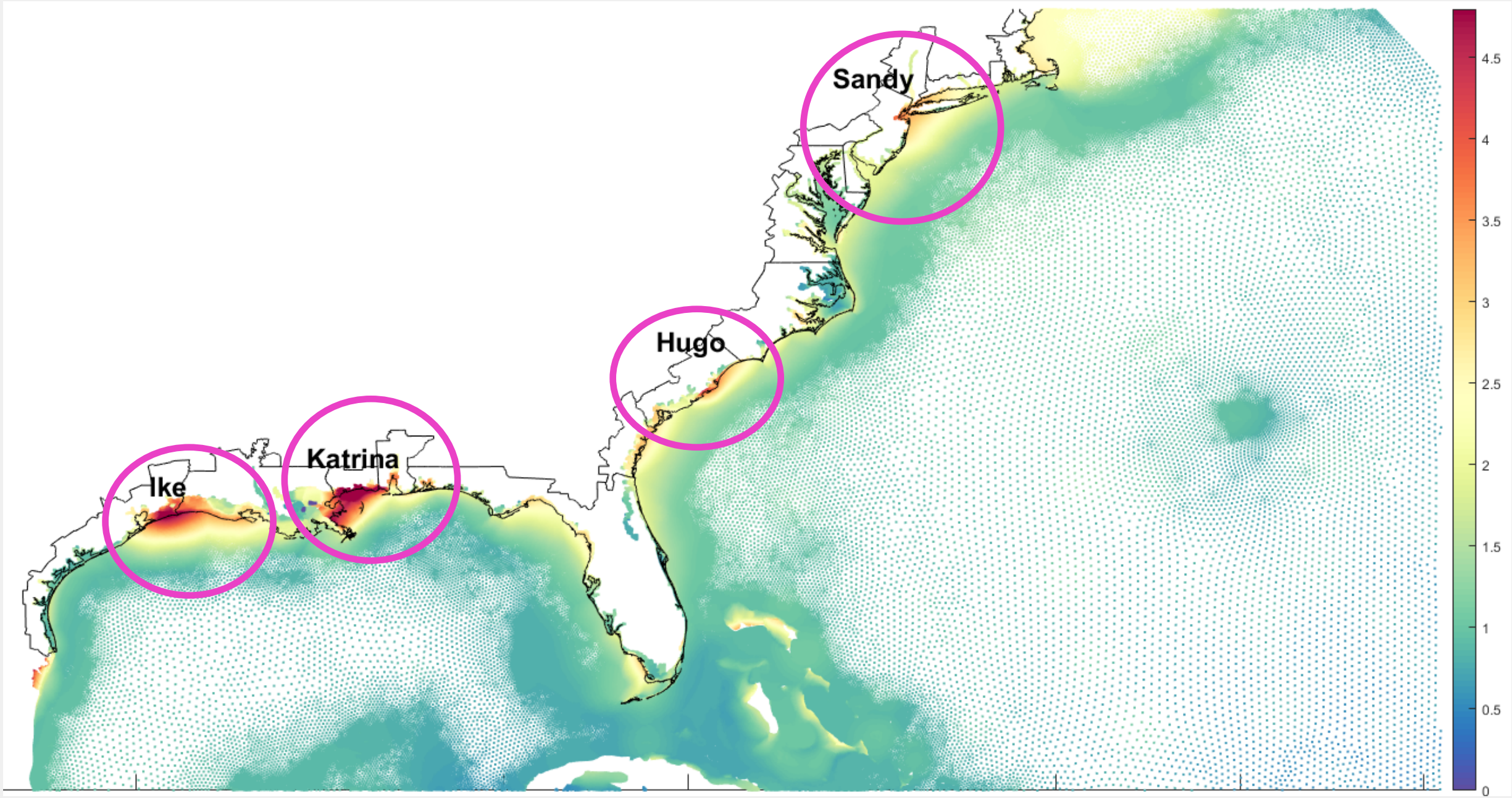
Limitations (Pobody's Nerfect)

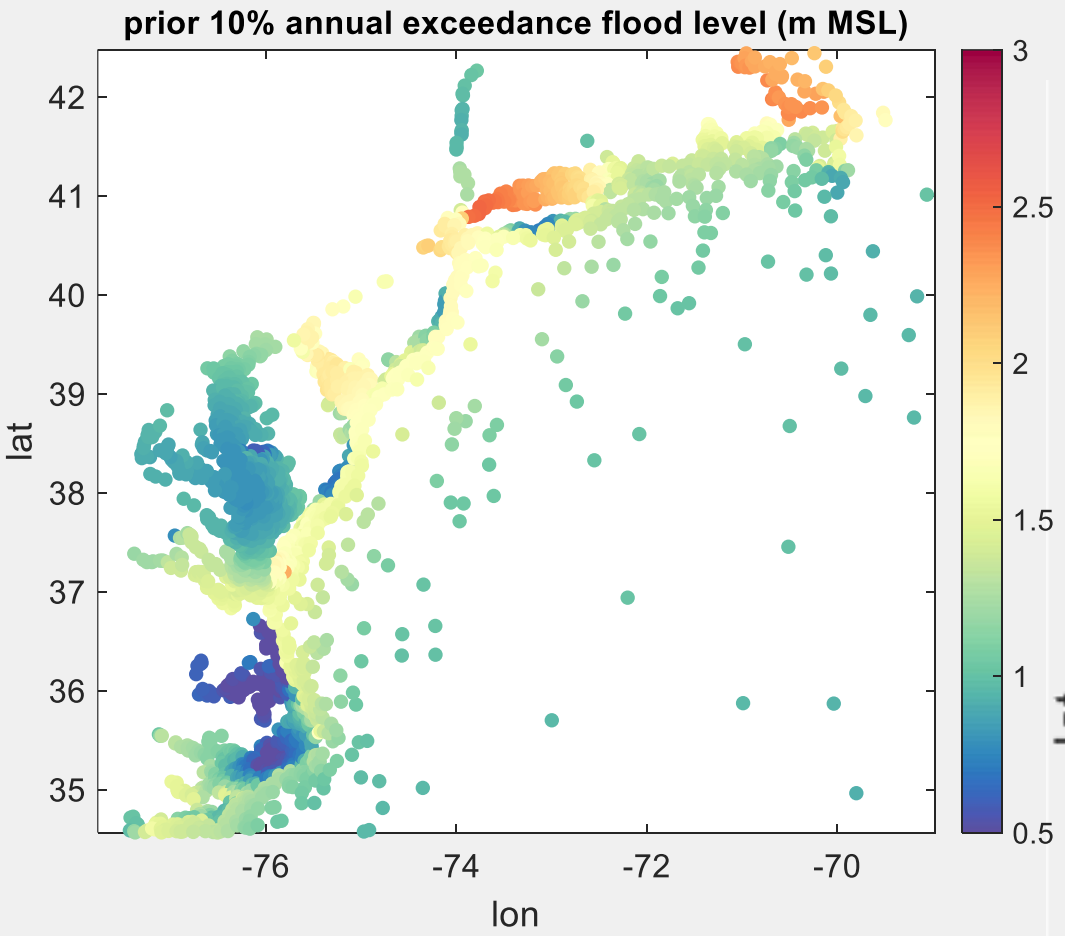
QQ plot of 4-day peak water levels
(meters above local MHHW)

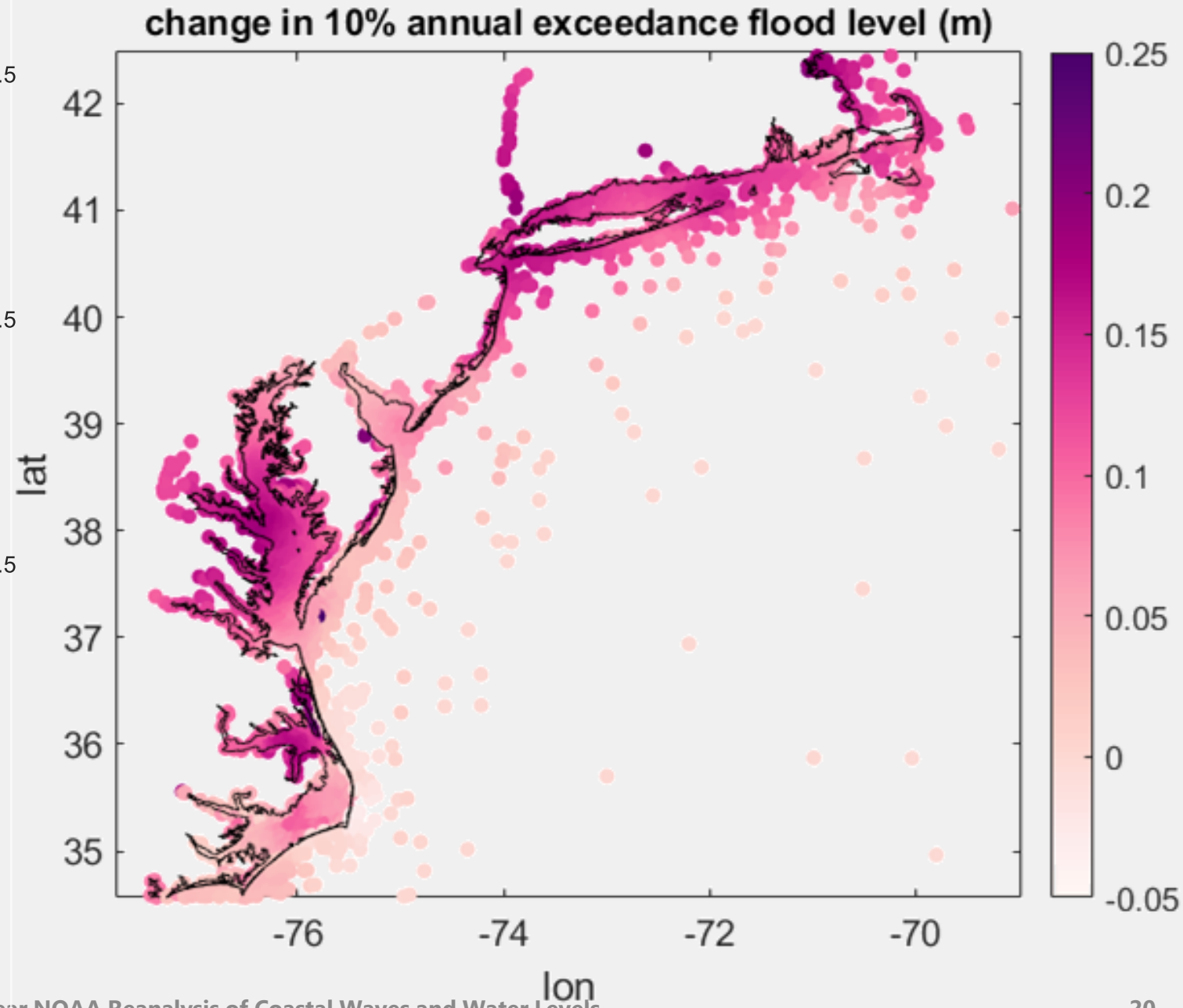




Full-reanalysis max water level, m MSL




prior 10% annual exceedance flood level (m MSL)
lat
lon
42
41
40
39
38
37
36
35
-76
-74
-72
-70
3
2.5
2
1.5
1
0.5


change in 10% annual exceedance flood level (m)
lat
lon
42
41
40
39
38
37
36
35
-76
-74
-72
-70
0.25
0.2
0.15
0.1
0.05
0
-0.05

Uses

- Inputs to further modeling/downscaling
- Historical storms
- Flood frequency estimation
- Sub-seasonal to annual water level prediction
- Nuisance flooding
- AI/ML
- Freely available data, convenient & accessible interface

Data Access

- Online interface & cloud computing to permit:
  - Data download
  - Data subsetting, extraction in space/time
  - Cloud calculation of quantities of interest
    - E.g. max water level in New York City in the 1980's
- All data provided in
  - Original model formats
  - 500-m and 2500-m rectangular grids (GIS-friendly)

Future Plans

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

The assimilation paper:
https://doi.org/10.1016/j.ocemod.2019.101483

END

Questions?

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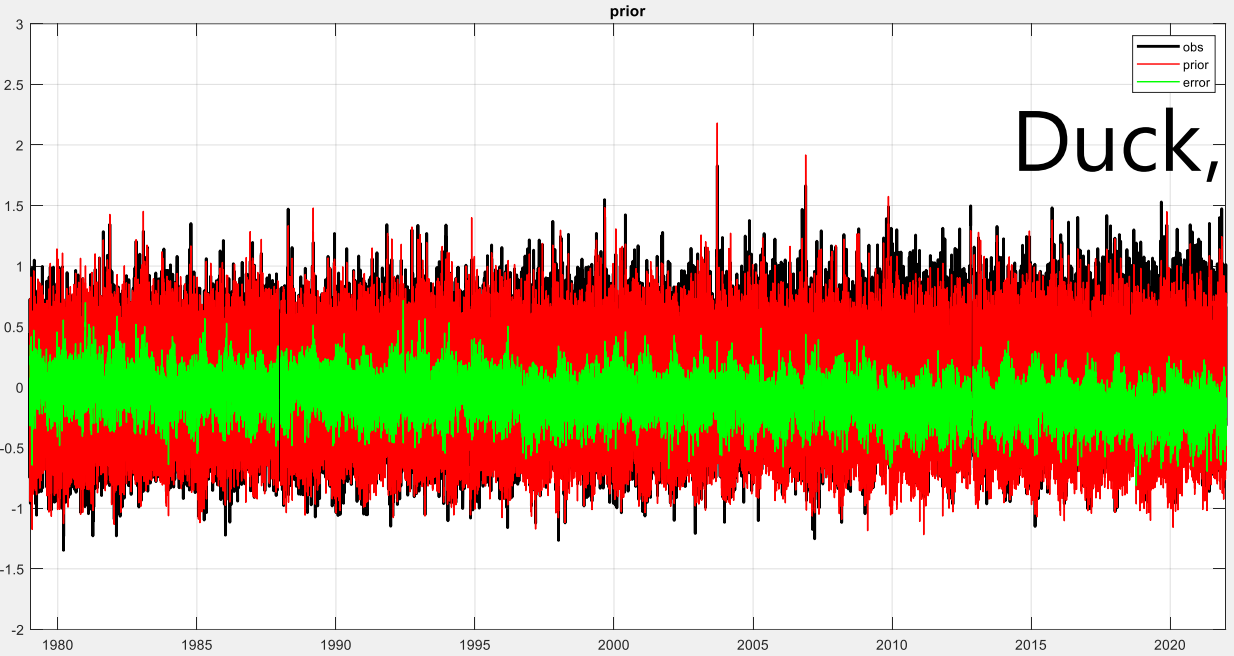
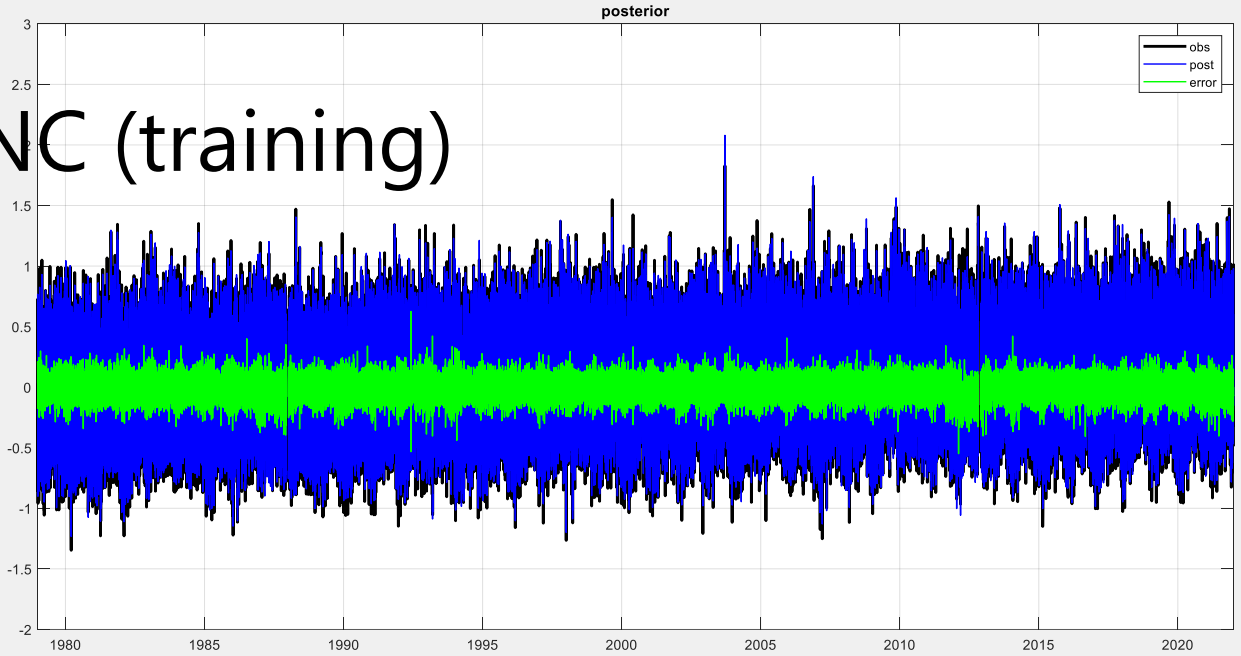
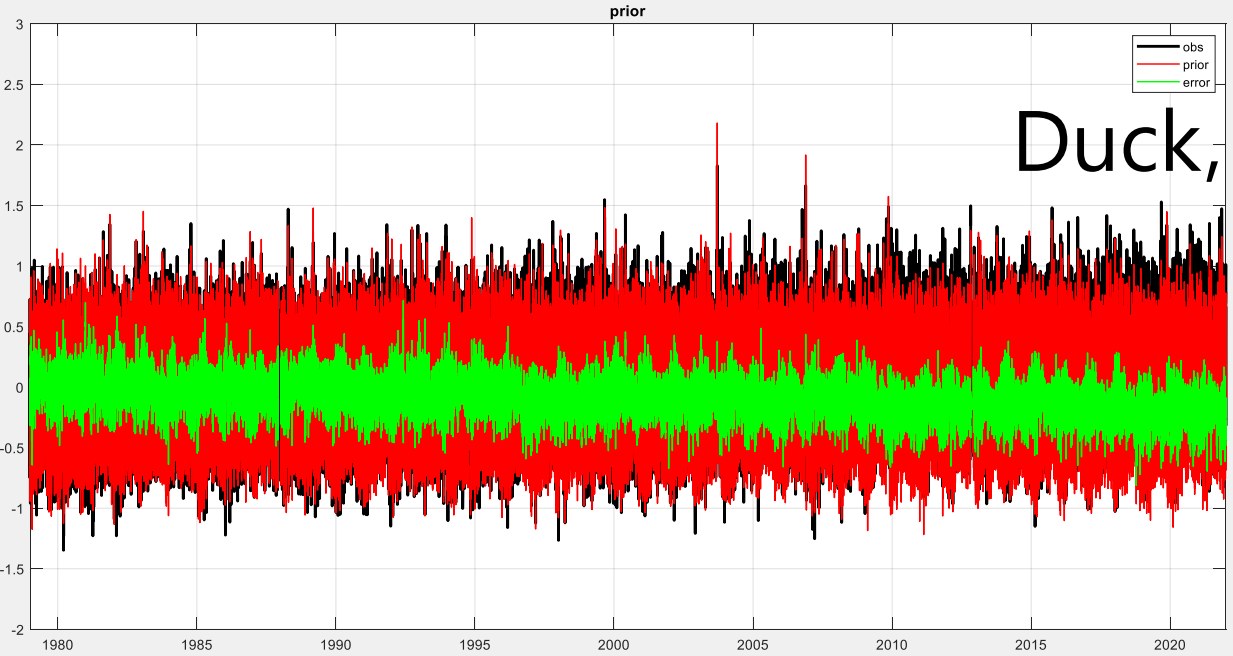
Duck Pier 8651370

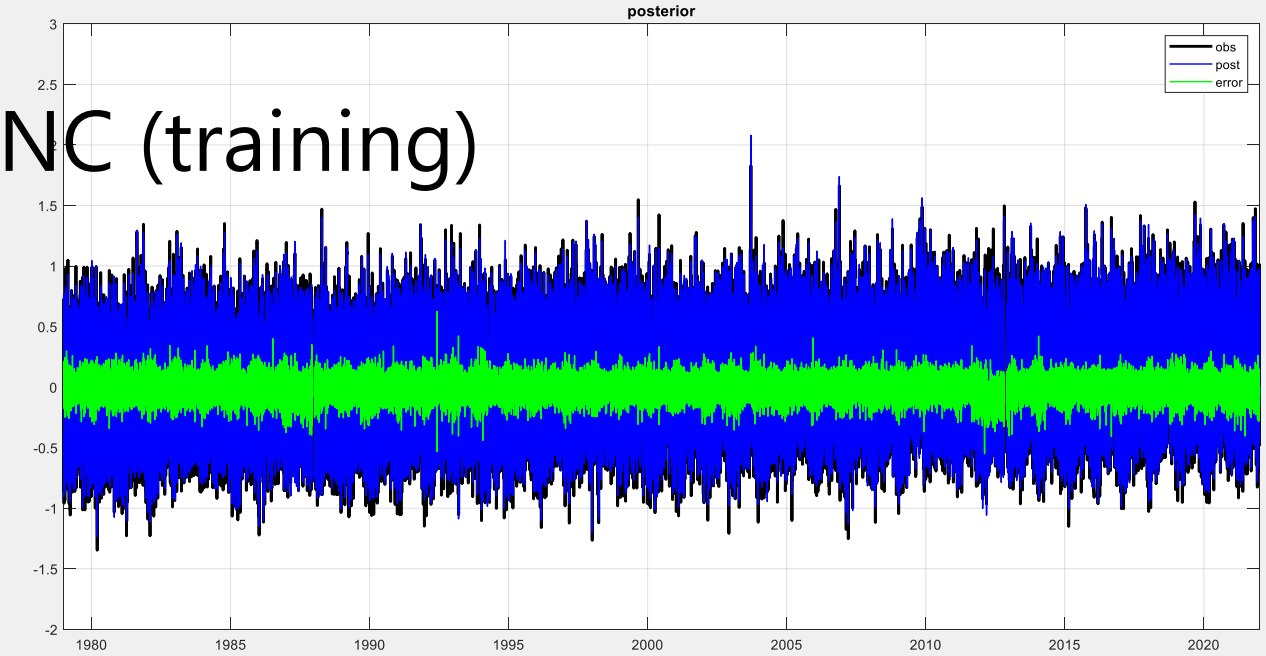
Duck, NC (training)

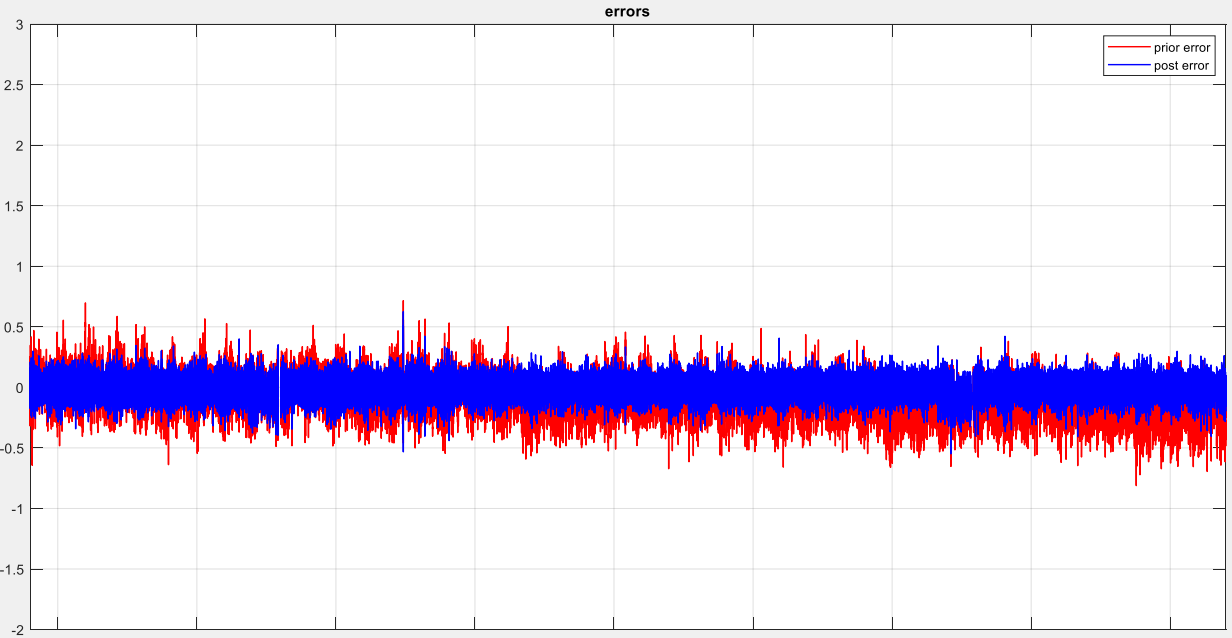


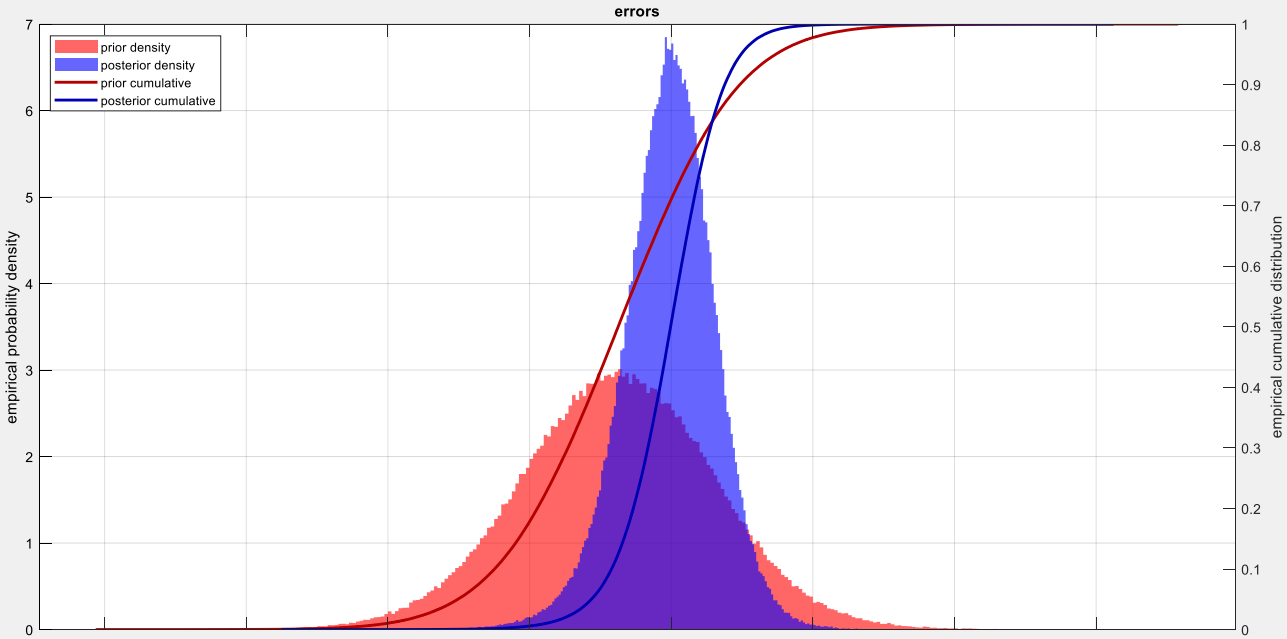


Duck, NC (training)

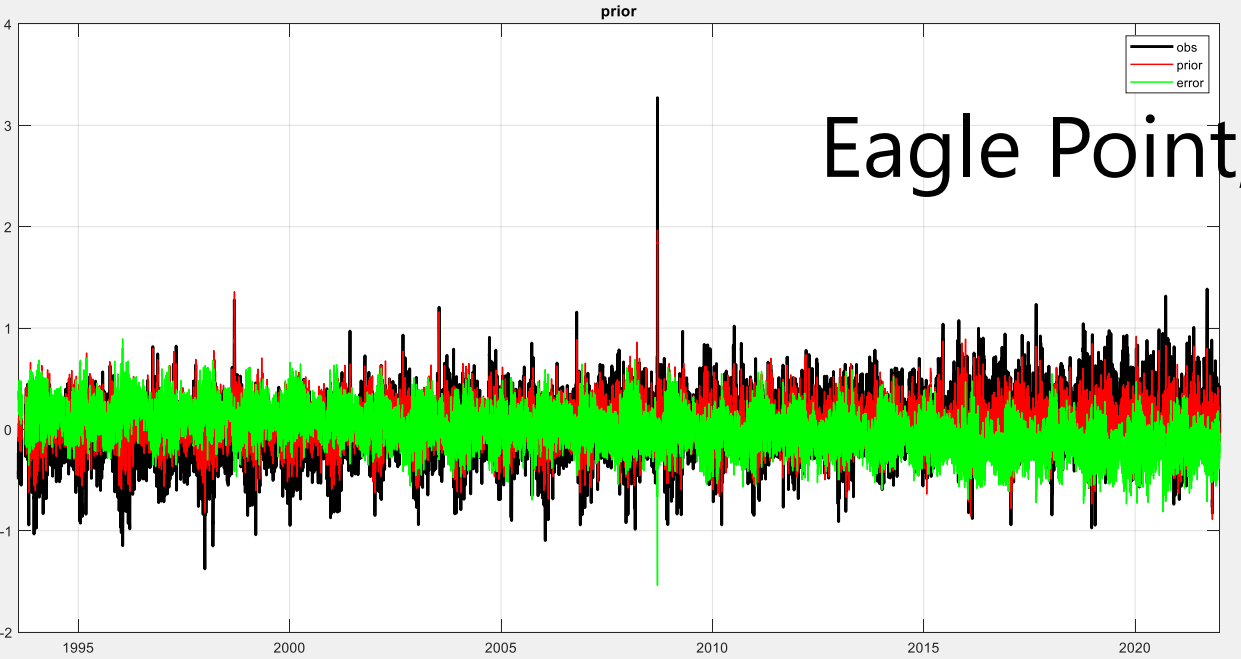


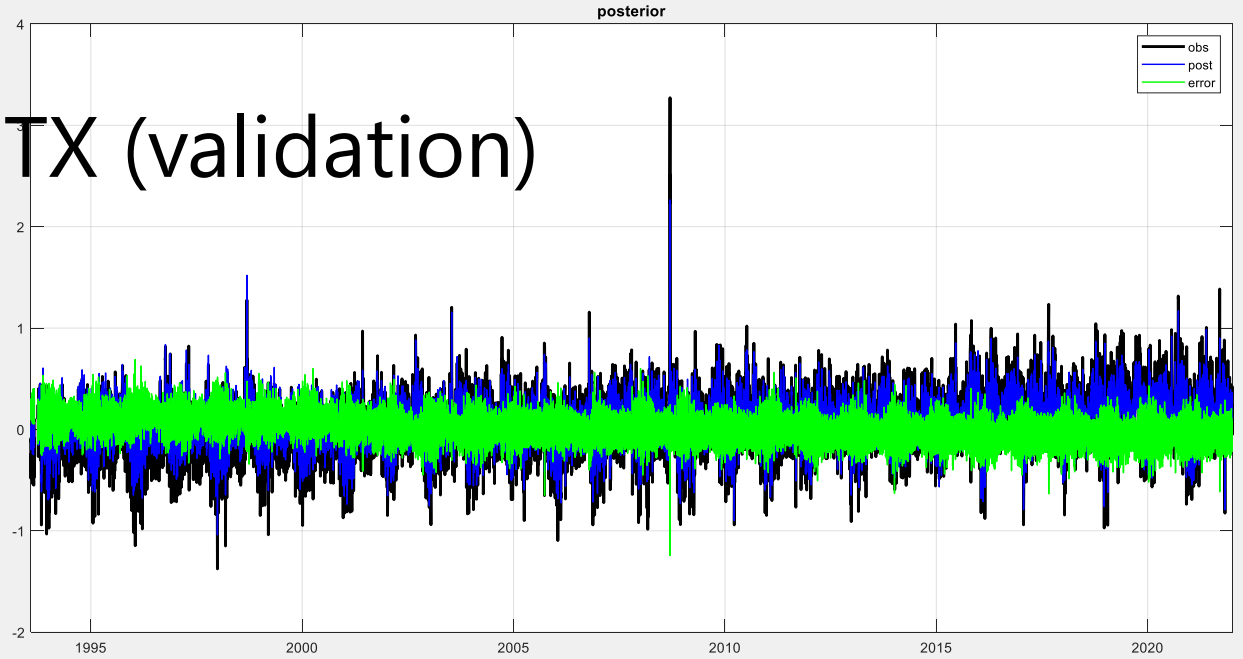


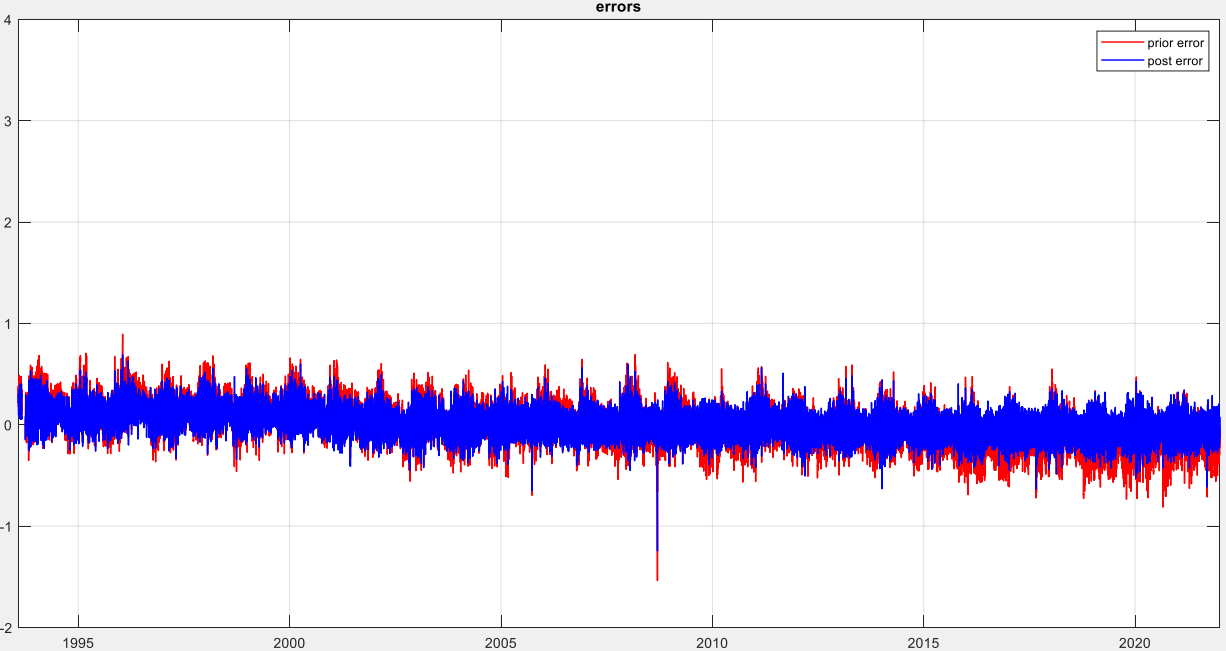


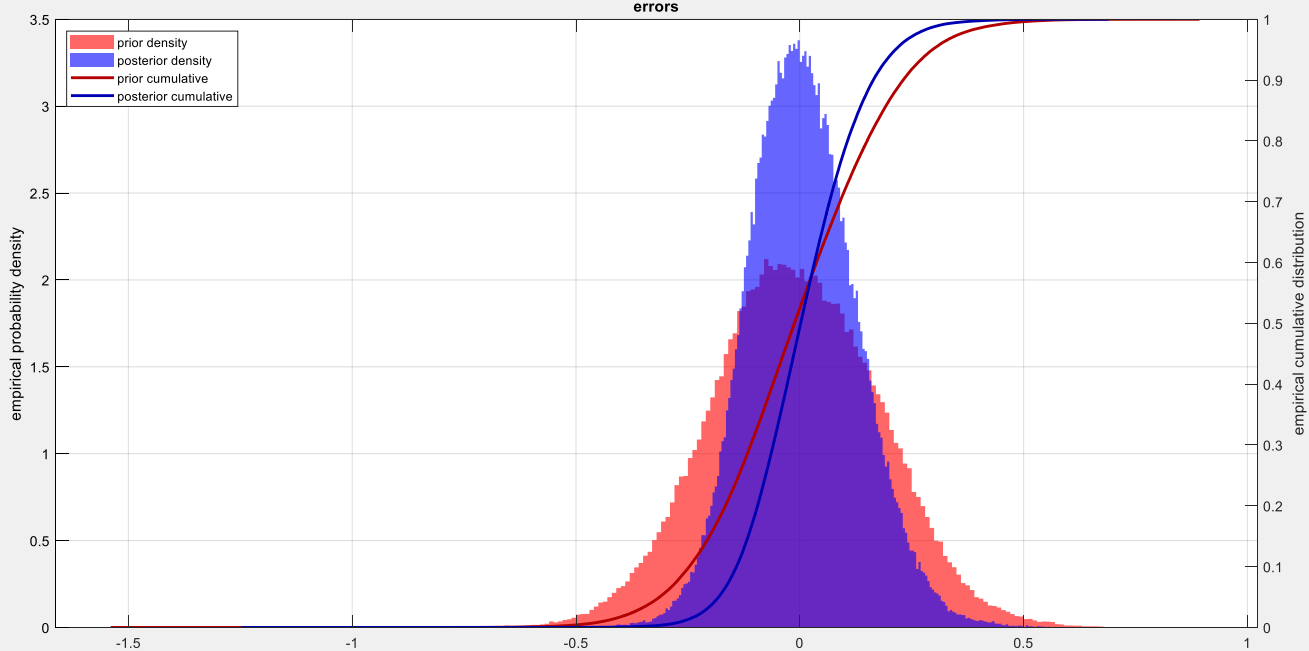


Eagle Point, TX (validation)









Overview

First Item

- Text
  - Sub text

equation

Sub item 1

- Text
  - Sub text

Second

- Text
  - Sub text