

Hydrodynamic and Salinity Modeling in Florida Bay

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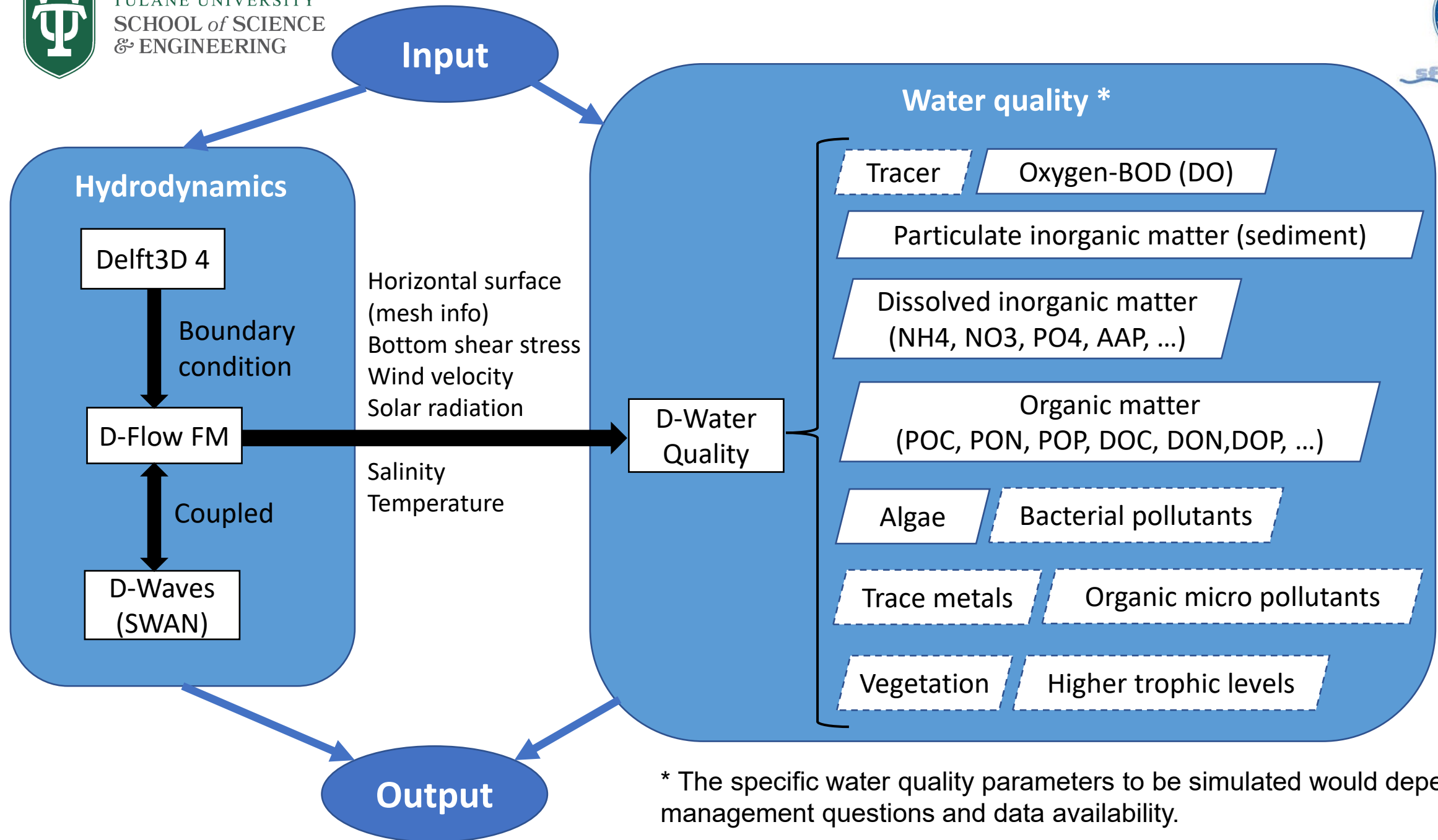
Objectives

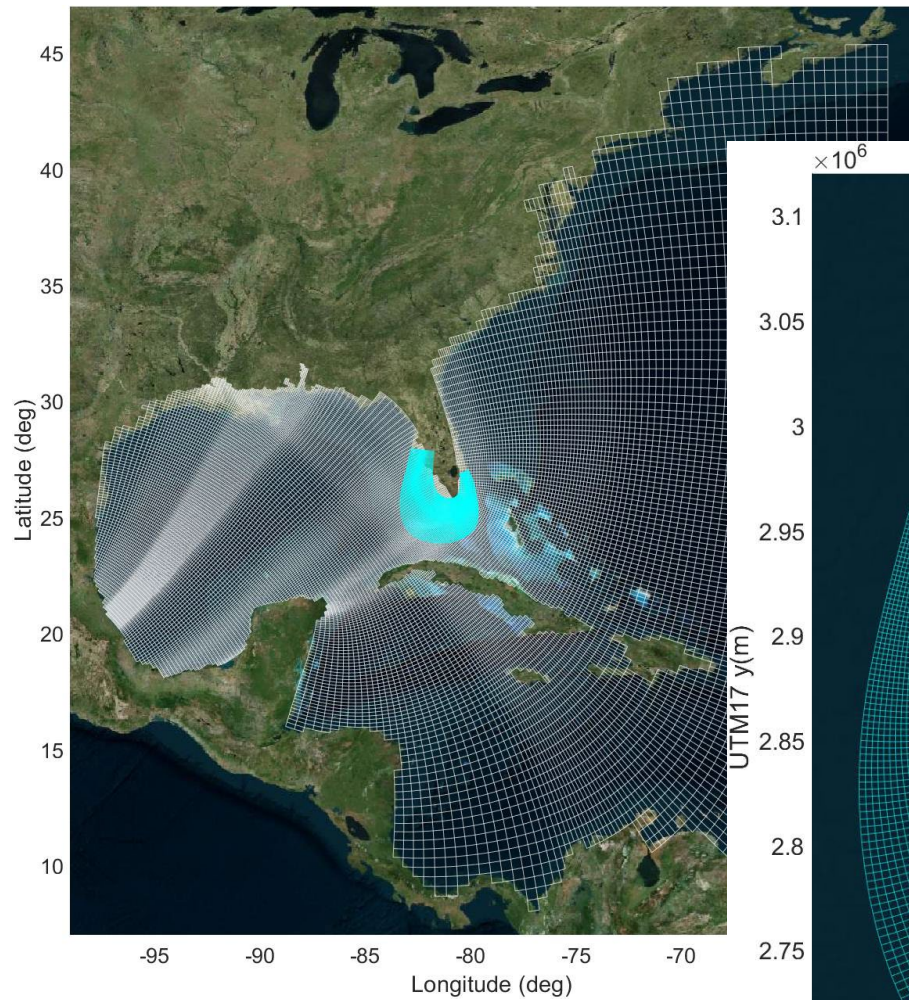
- Develop a Delft3D hydrodynamic and water Quality model for Florida Bay in support of the Groundwater Exchange Monitoring and Modeling (GEMM) Project
- Serve as a quantitative platform for evaluating various factors affecting Florida Bay ecology
- Evaluate current and future water management practices
- Assess impact of SLR on surface and groundwater hydrology



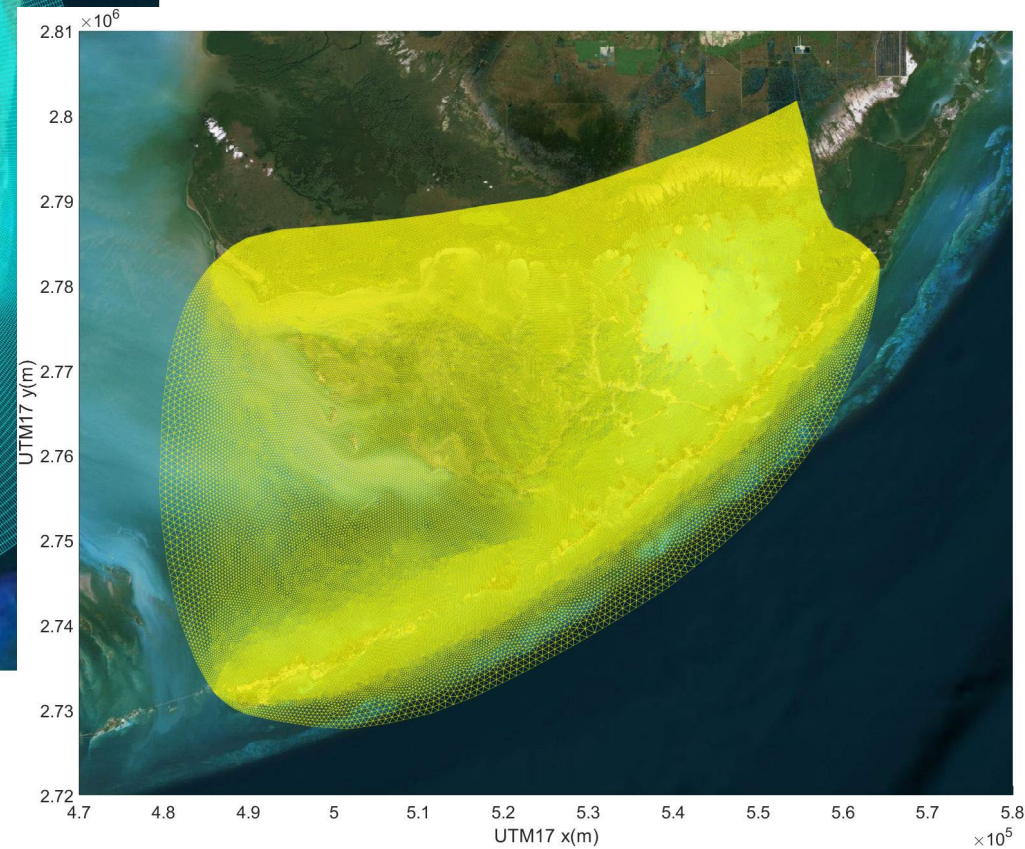
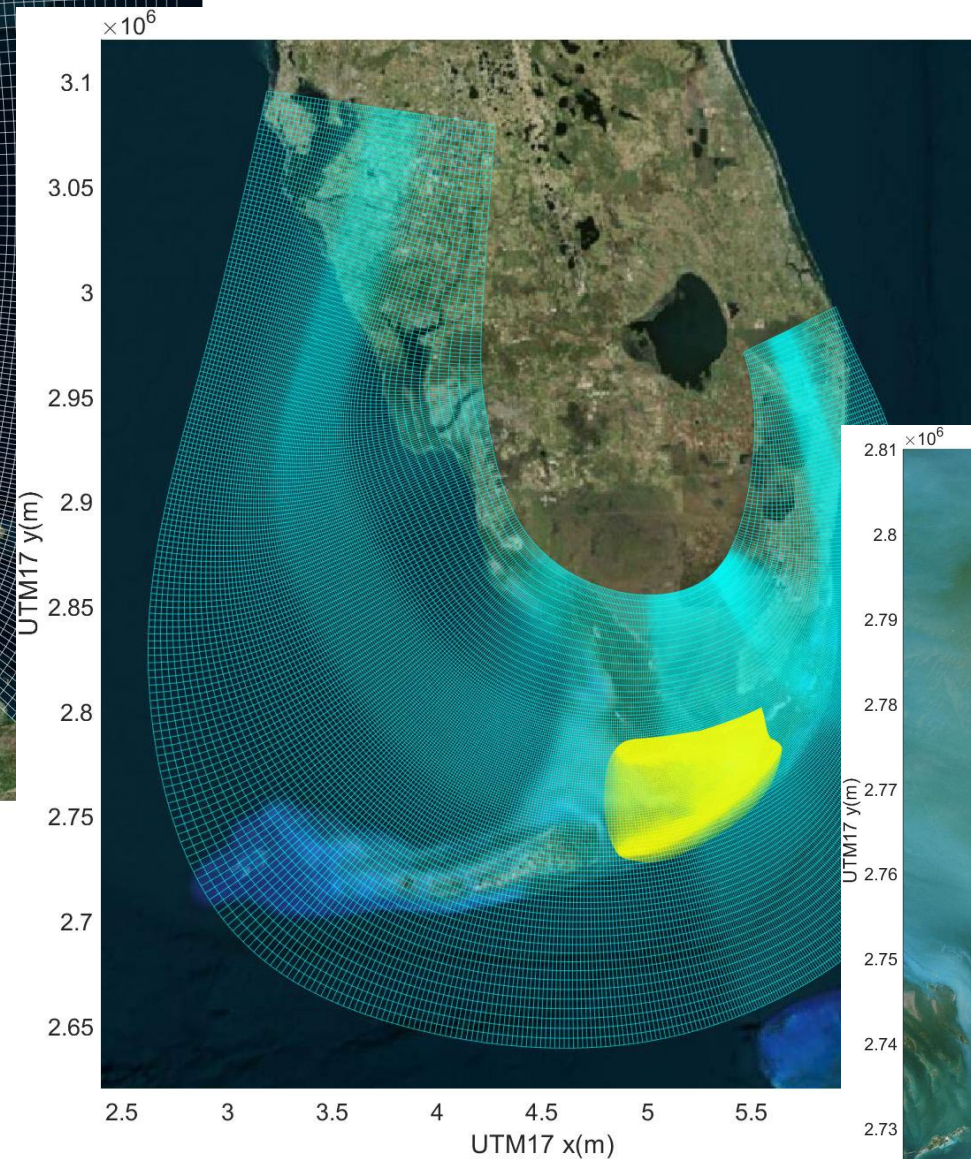


Parameter	Delft3D
Bathymetry & Topography	SFWMD Districtwide Digital Elevation Model (2023 Version)
Boundary Condition	Offshore water level/salinity/temperature: Nested from the regional southern Florida model; Surface water /Groundwater sources: RSMGL
Evapotranspiration	Calculated internally by D-Flow FM
Wind	NCEP/DOE Reanalysis II (T62 Gaussian grid, 6-hourly) https://psl.noaa.gov/data/gridded/data.ncep.reanalysis2.html * Other wind products or observations can be applied if needed
Rainfall	NCEP/DOE Reanalysis II (T62 Gaussian grid, 6-hourly) https://psl.noaa.gov/data/gridded/data.ncep.reanalysis2.html * Other rainfall products (e.g., NOAA Multi-Radar/Multi-Sensor System (MRMS)) or observations can be applied if needed



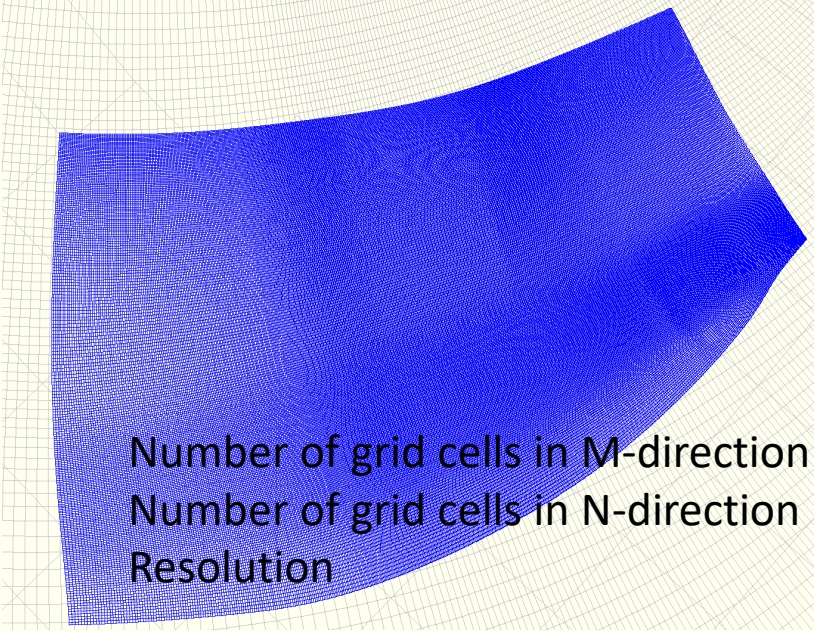
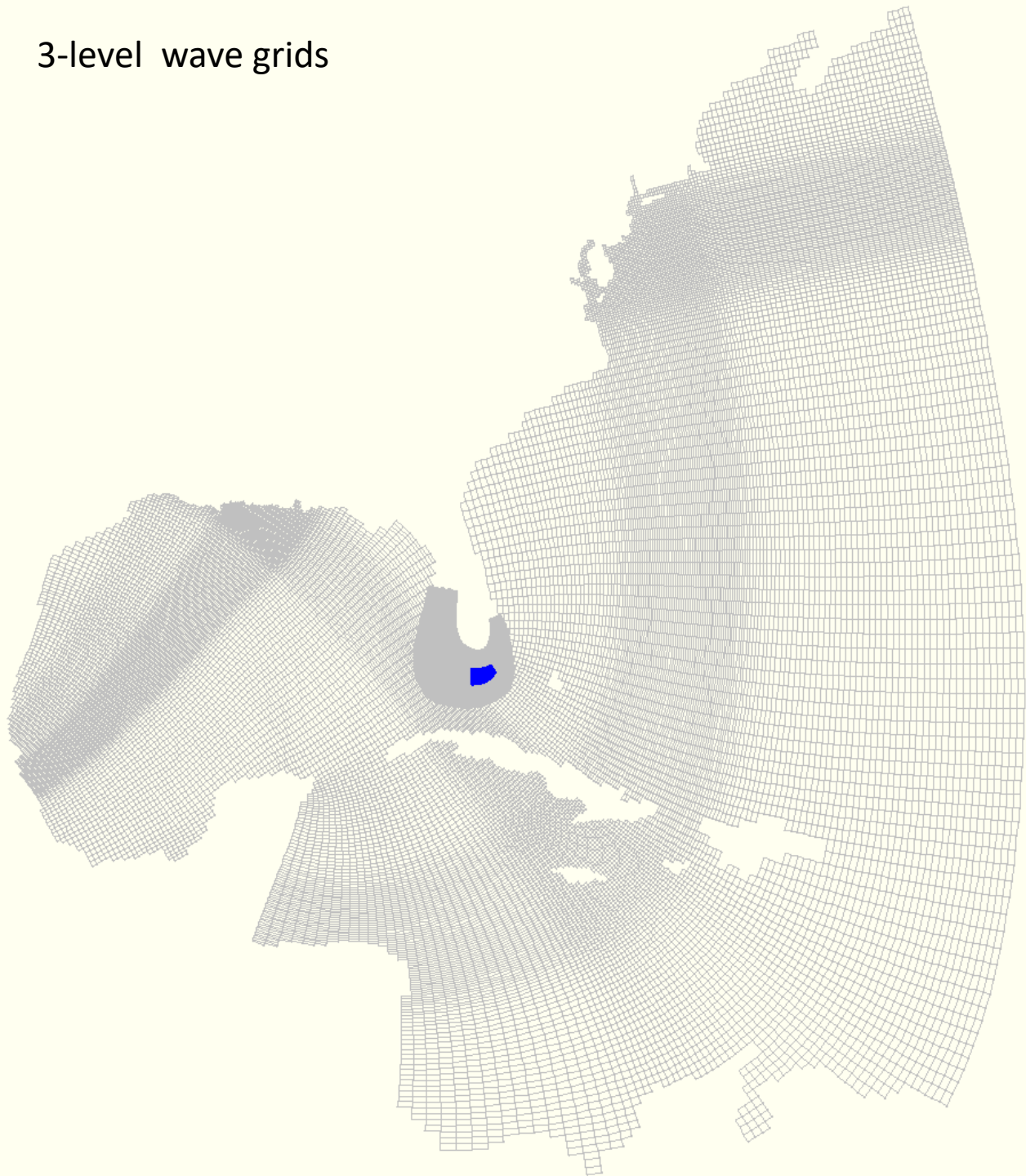


3-level model domains

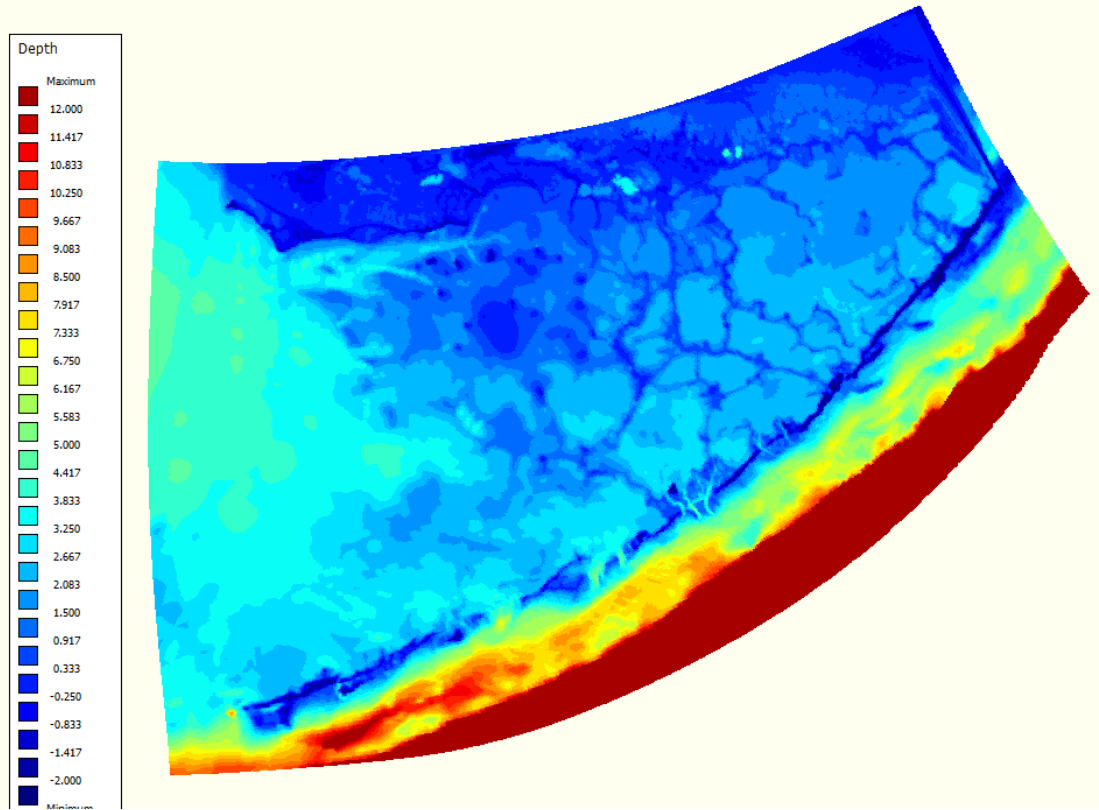


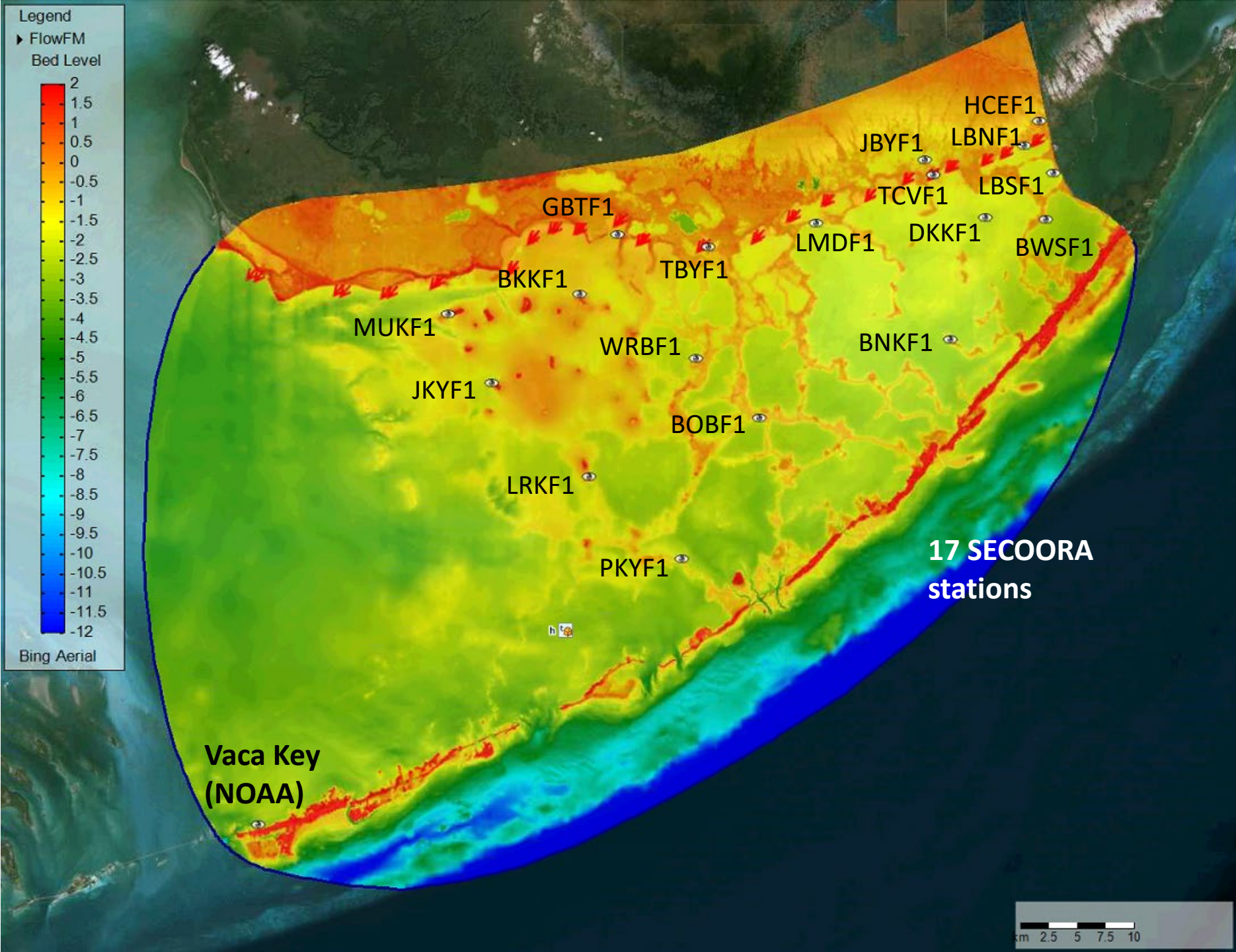
# of elements	274,012
# of nodes	137,454
Resolution	87 – 1,245 m

3-level wave grids



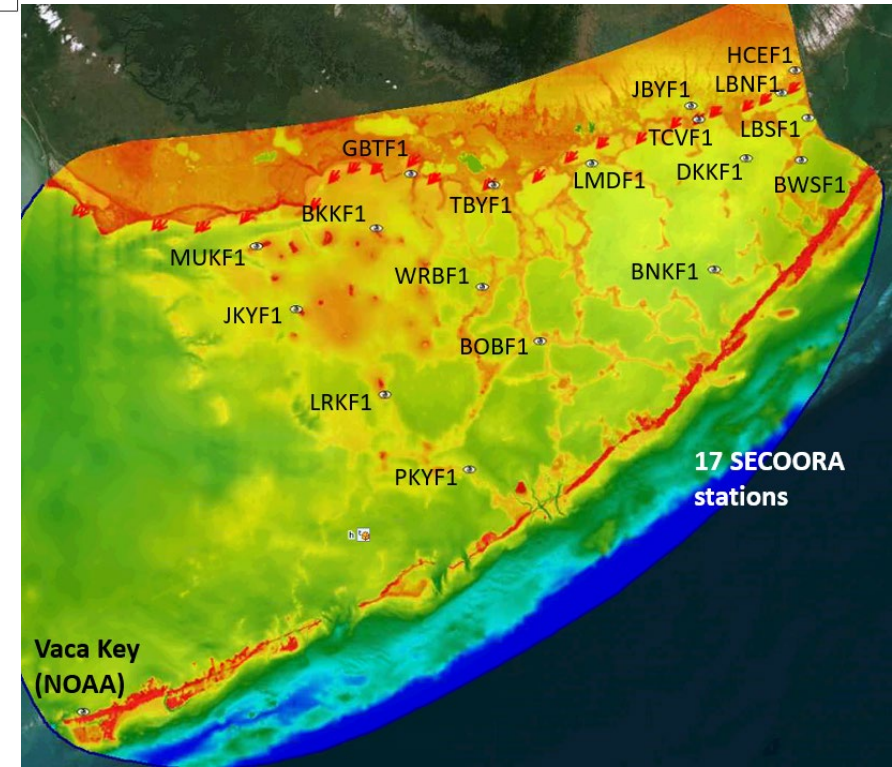
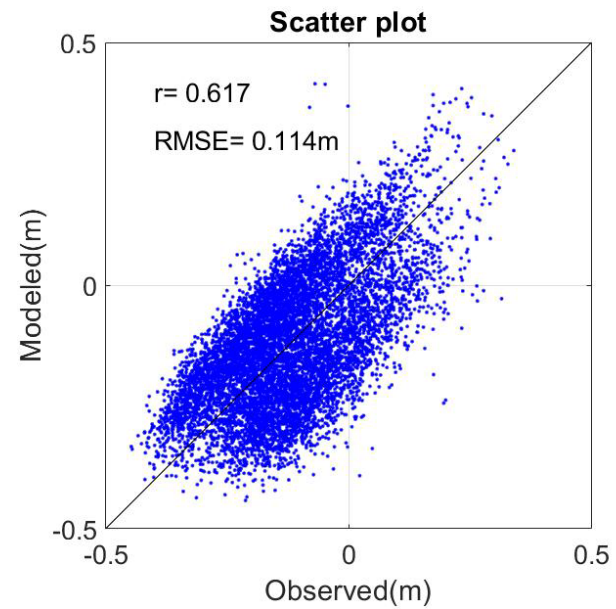
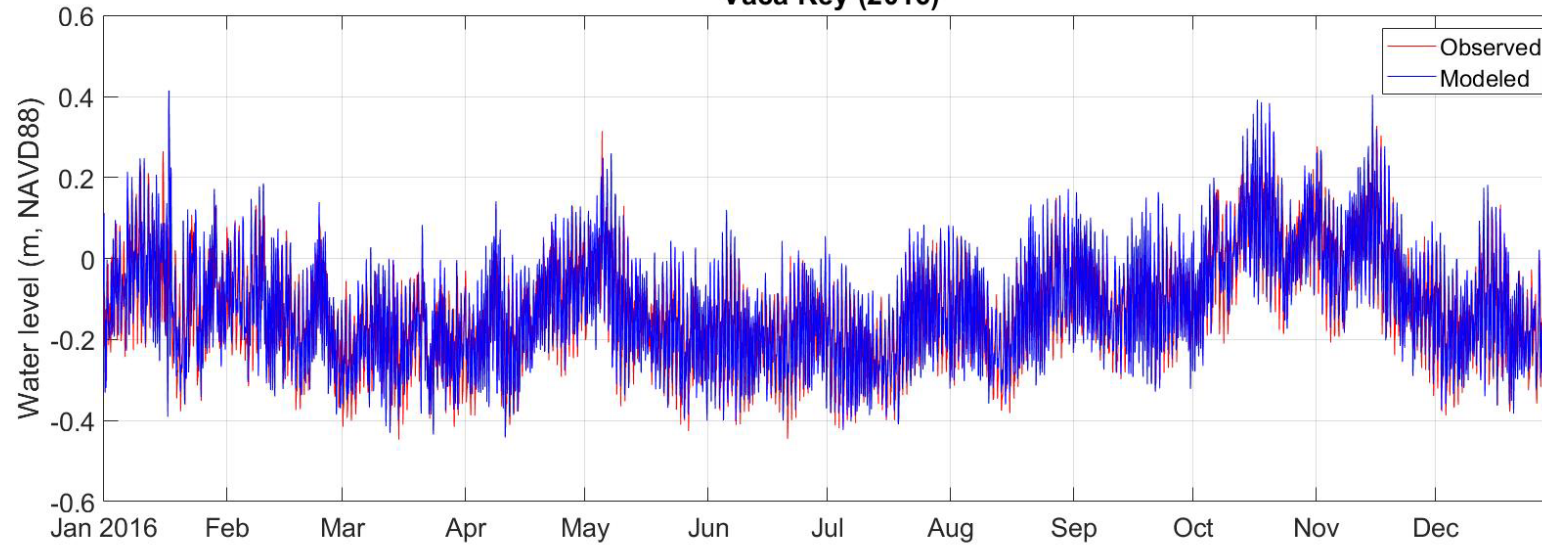
Number of grid cells in M-direction 600
Number of grid cells in N-direction 228
Resolution 80 – 360 m



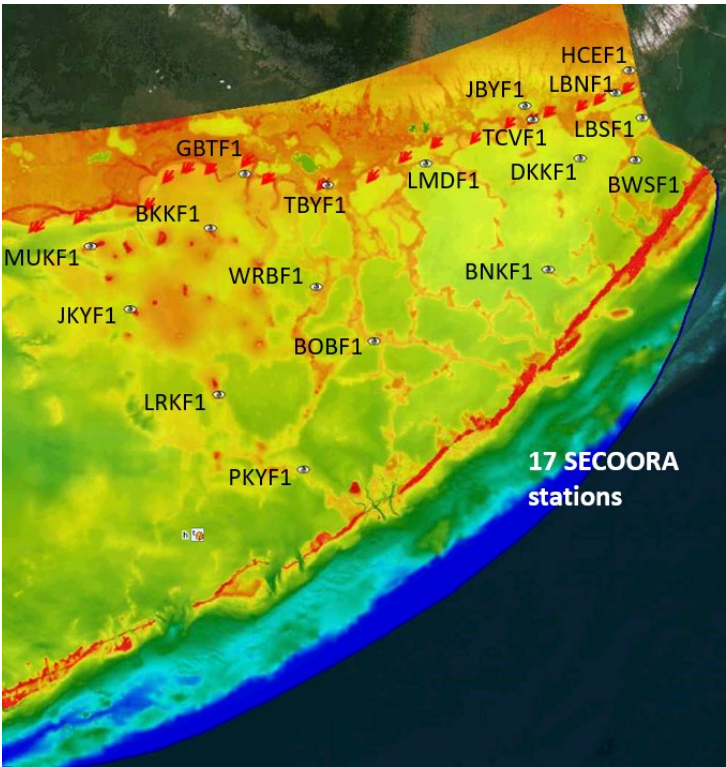
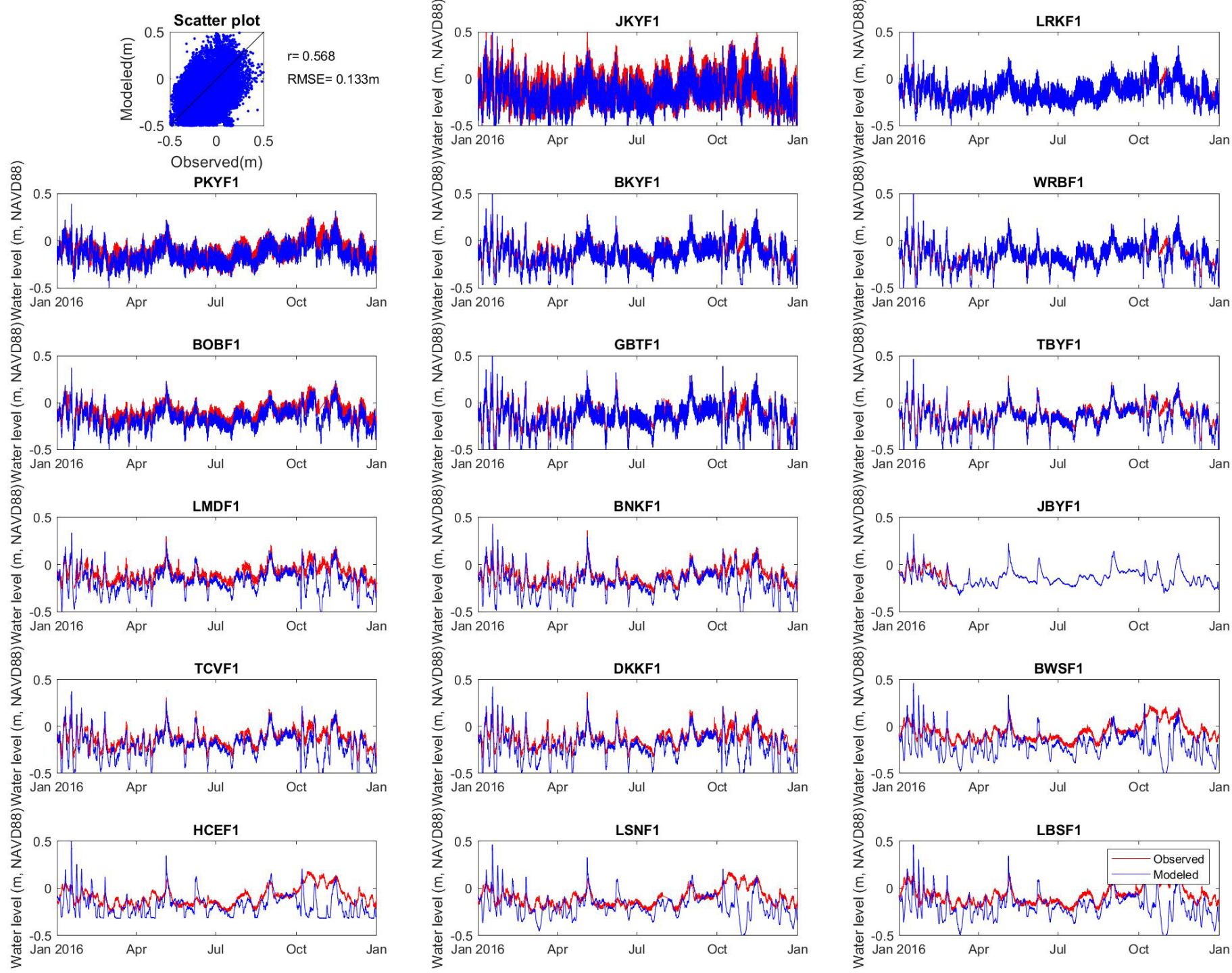




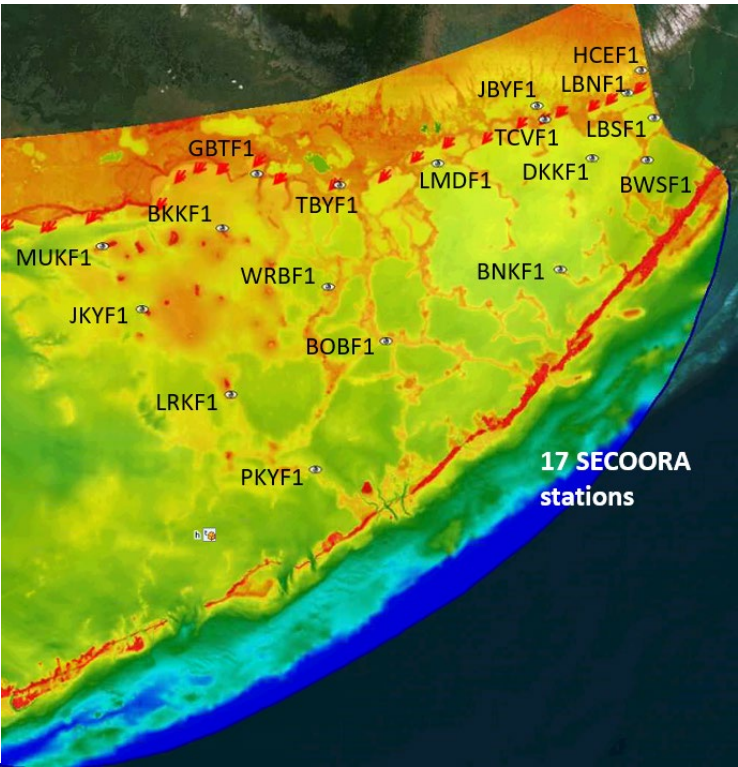
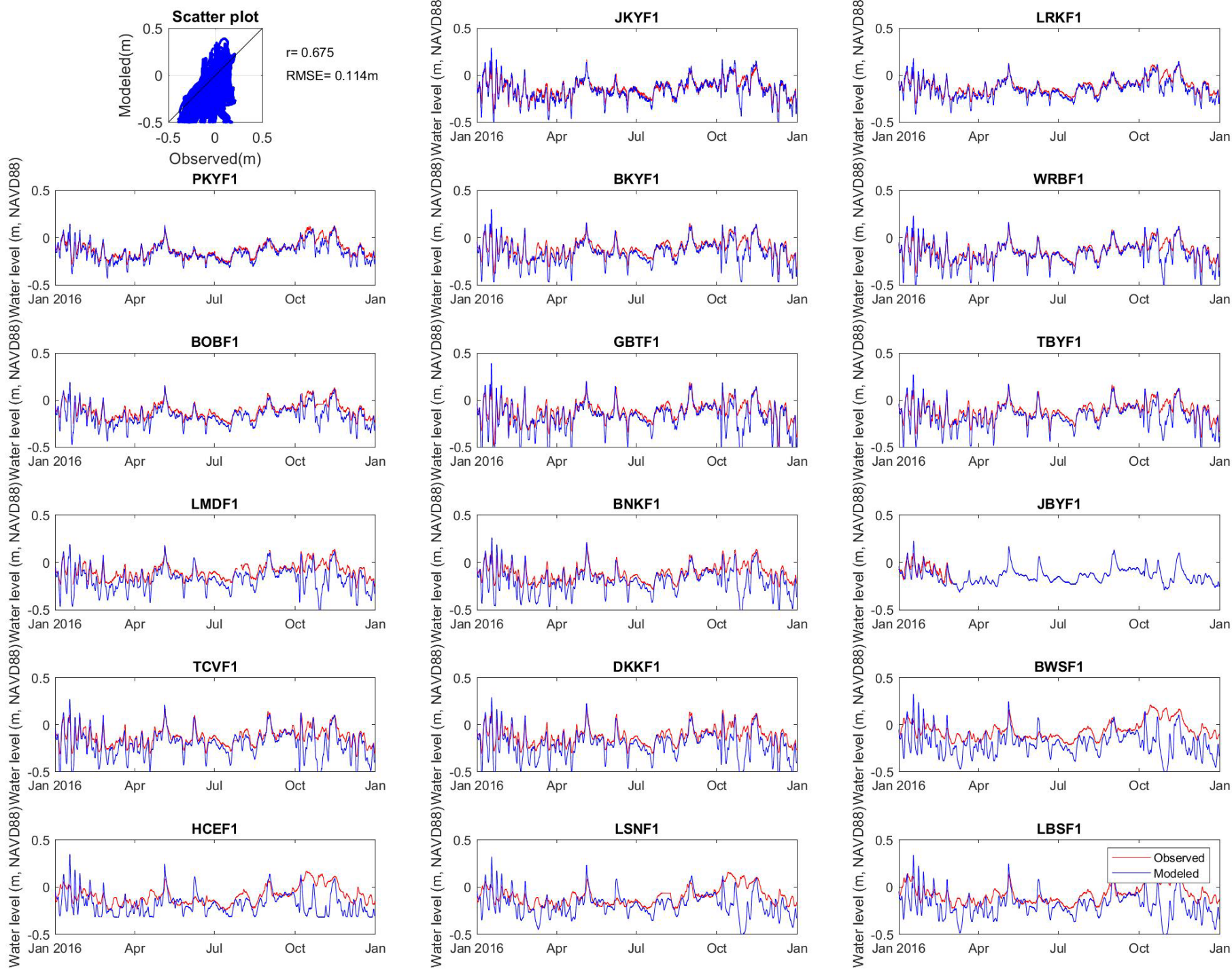
Vaca Key (2016)



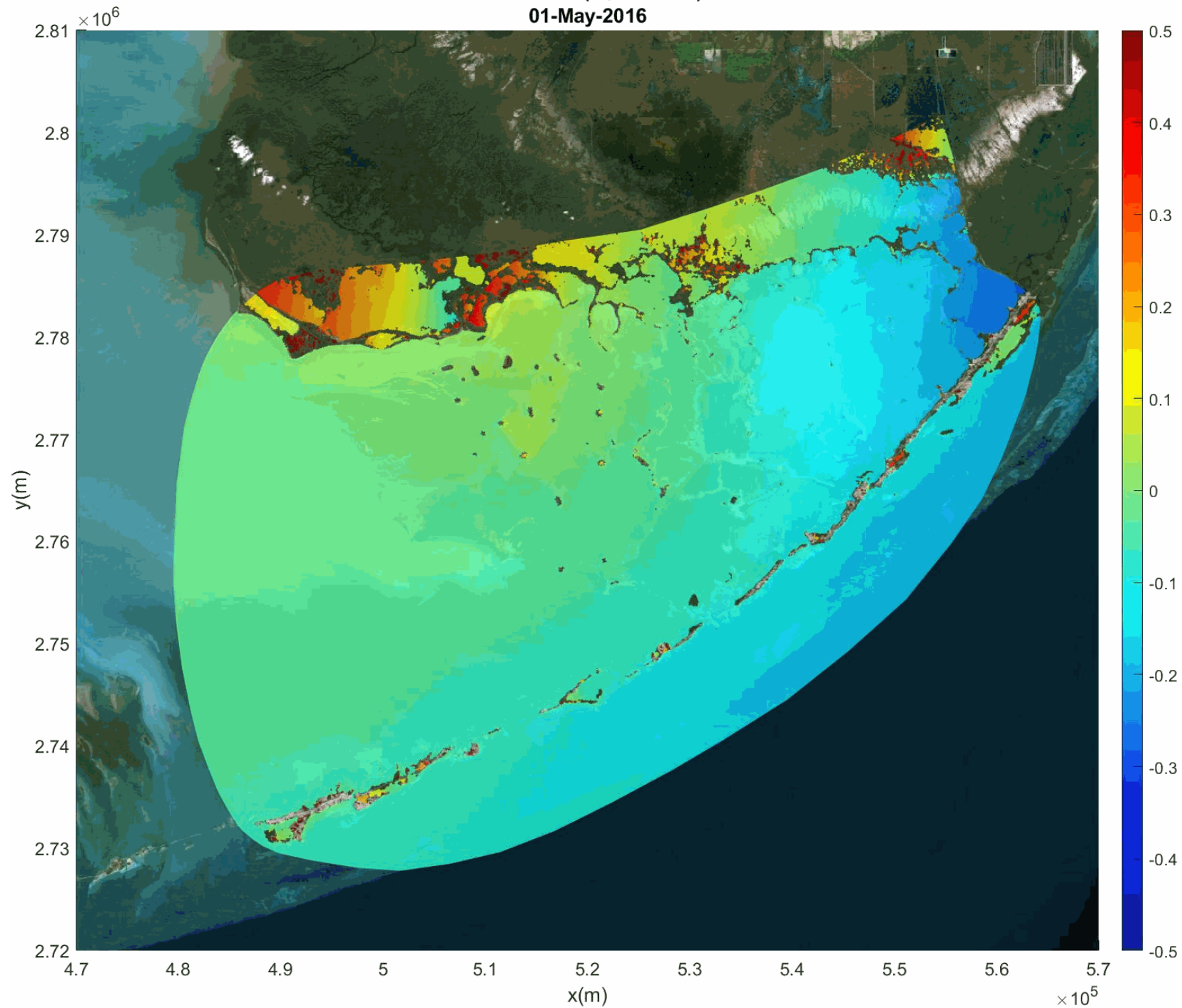
Hourly water level comparison

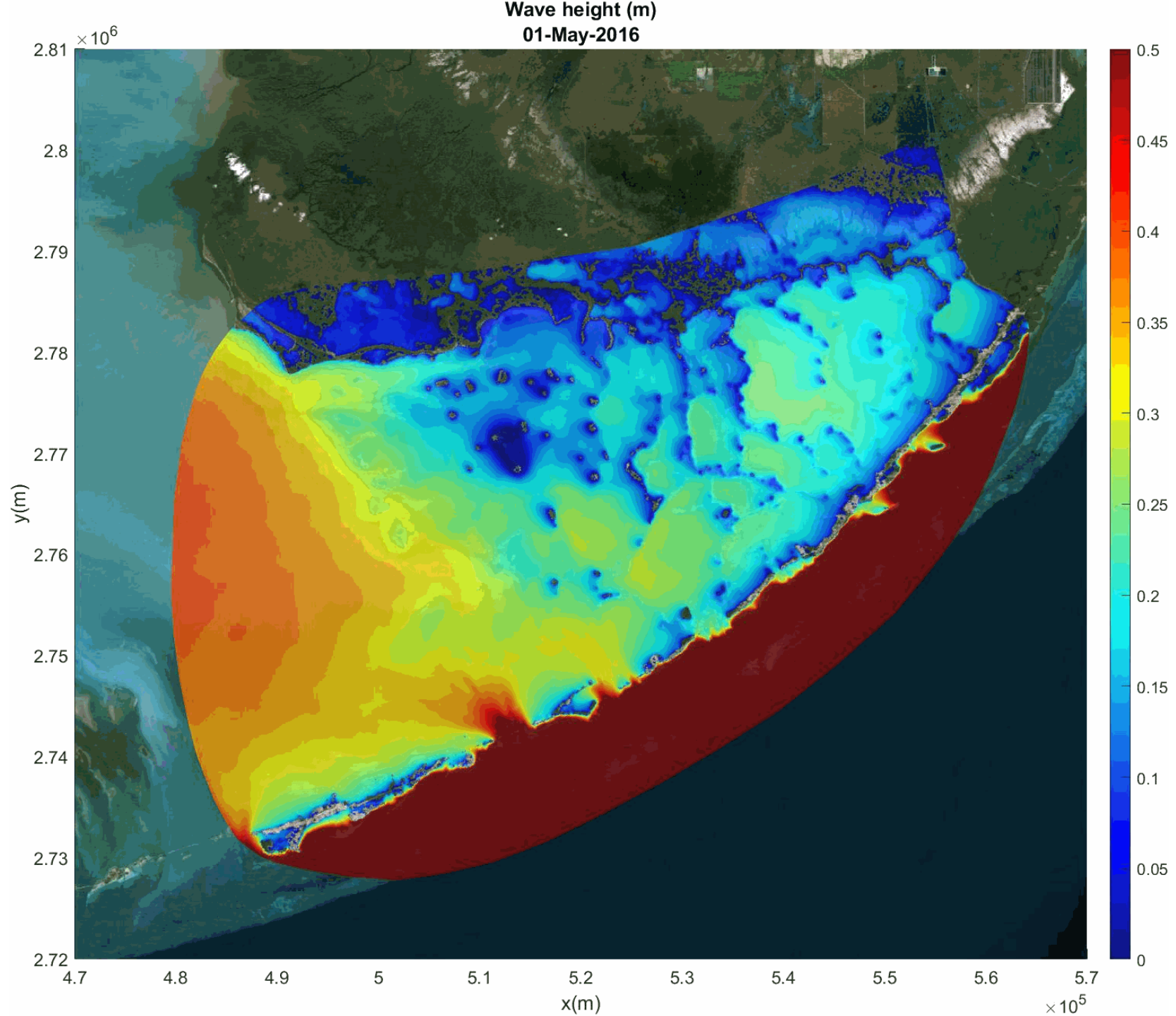


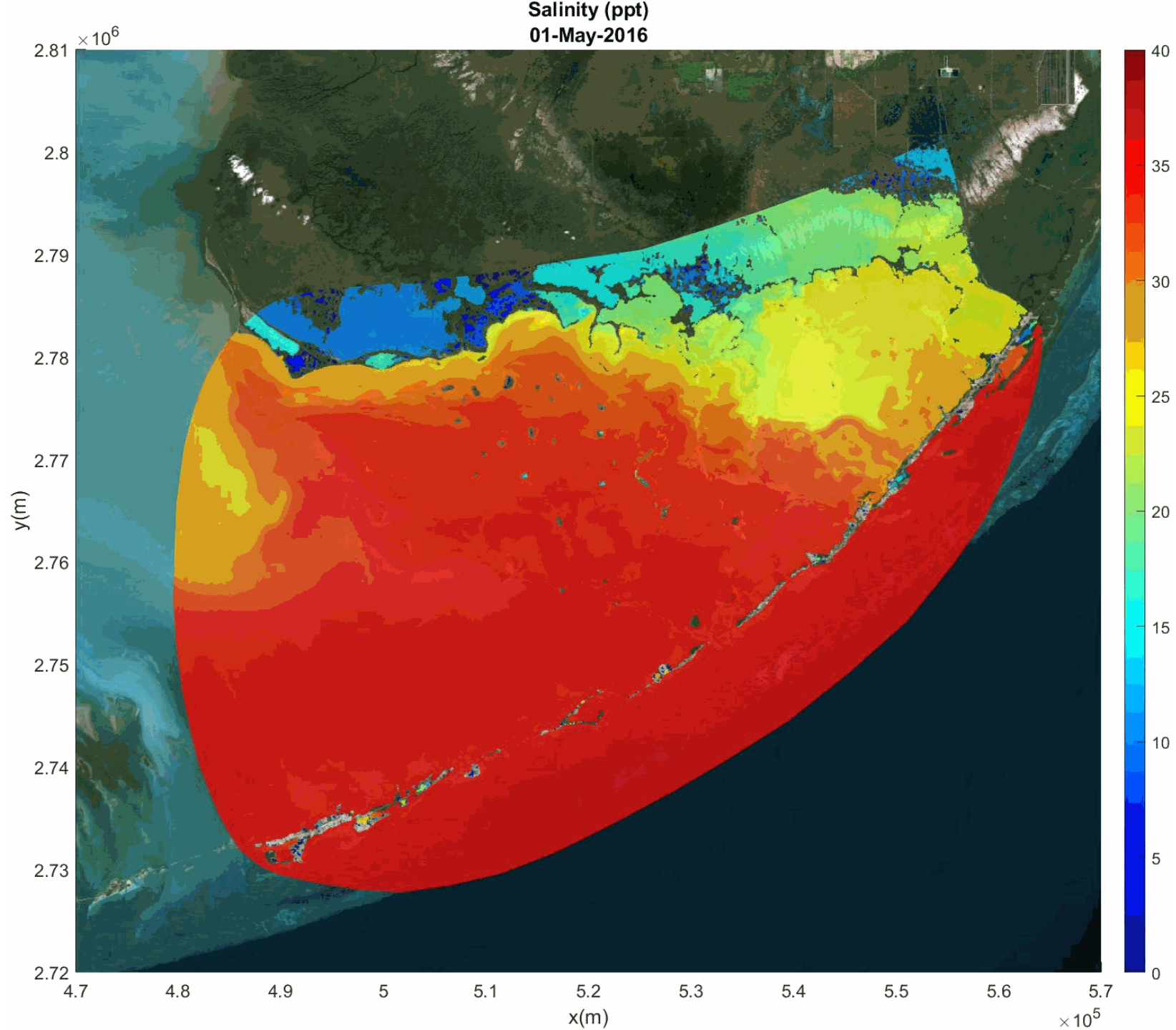
Daily water level comparison

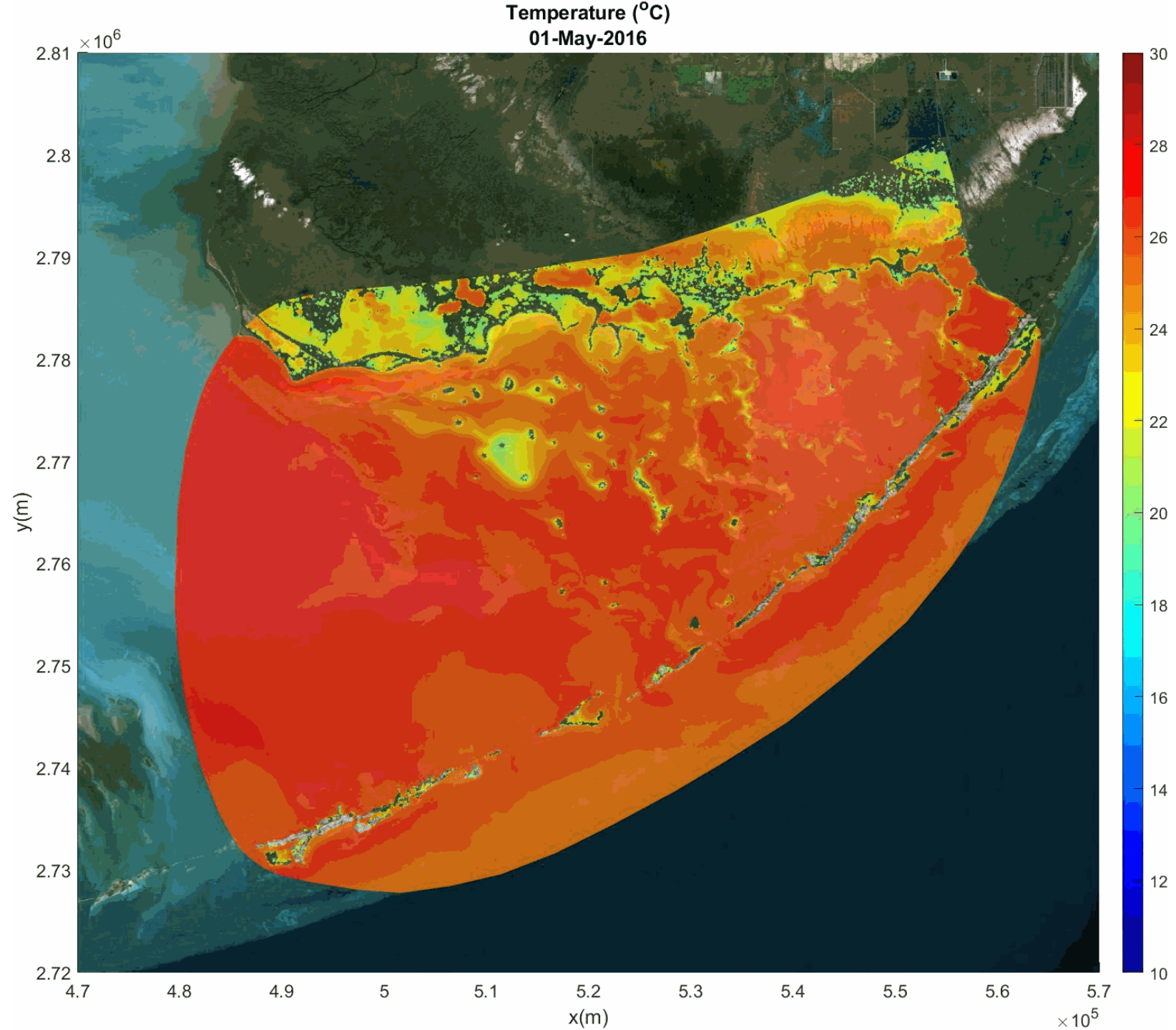


Water level (m, NAVD88)
01-May-2016











Summary of Model Features

- 2D and 3D modes available
- Surface/ground water inputs
- Following features can be considered:
 - Impact of sea grasses
 - Coupling with SWAN wave model (3-level nesting computation)
 - Salinity and temperature
 - Integrated WQ processes for parameters such as DO, Chlfa, NH4, NO3, PO4, etc.
 - Major storm events
- Run time (1 year):
 - 2D: Flow + Sal + temp: 5 hours [+WQ: 10 hours]
 - 3D (10 layers): Flow + Sal + temp: 2 days [+WQ: 4 days]
 - Multiple scenarios can run simultaneously

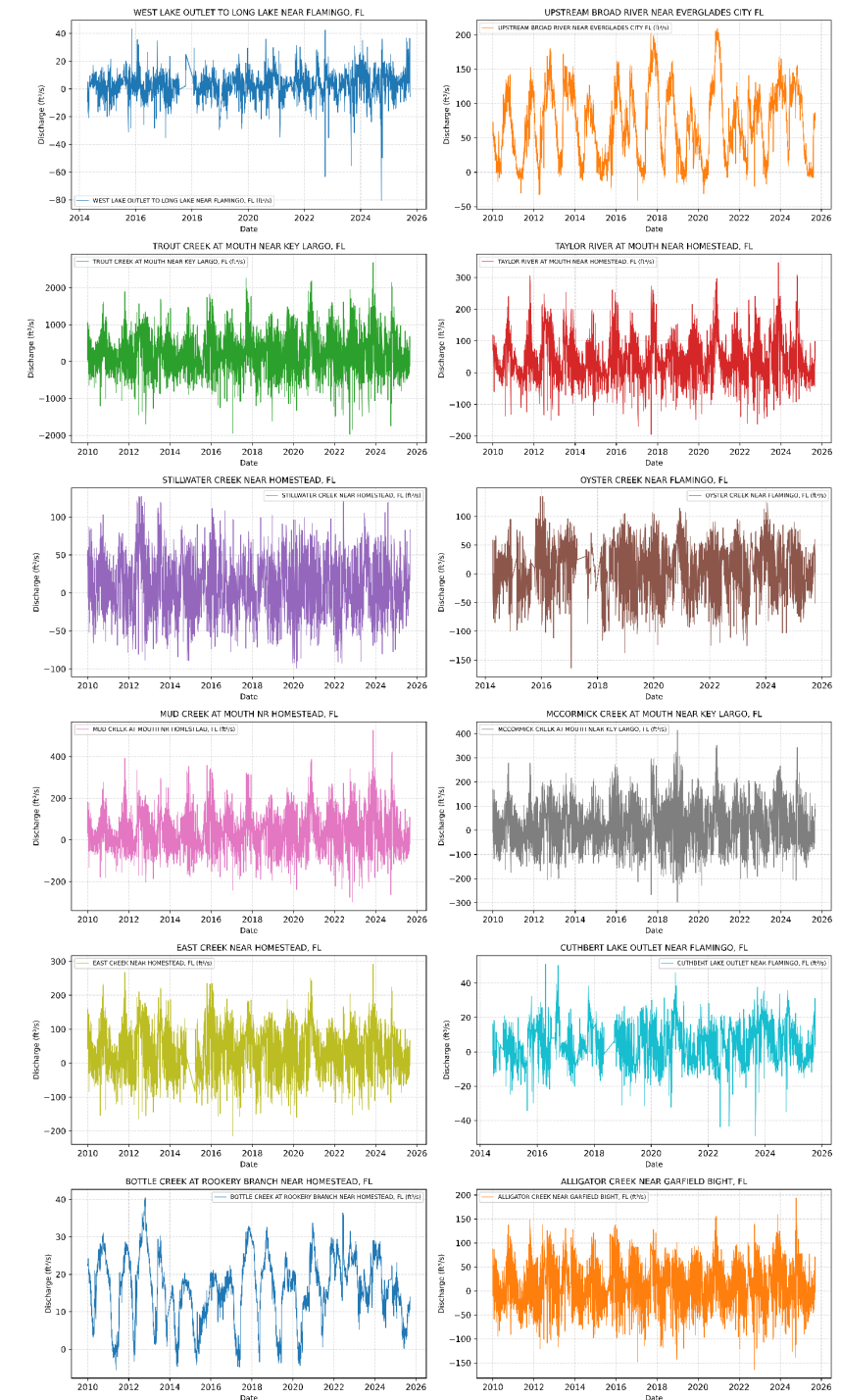
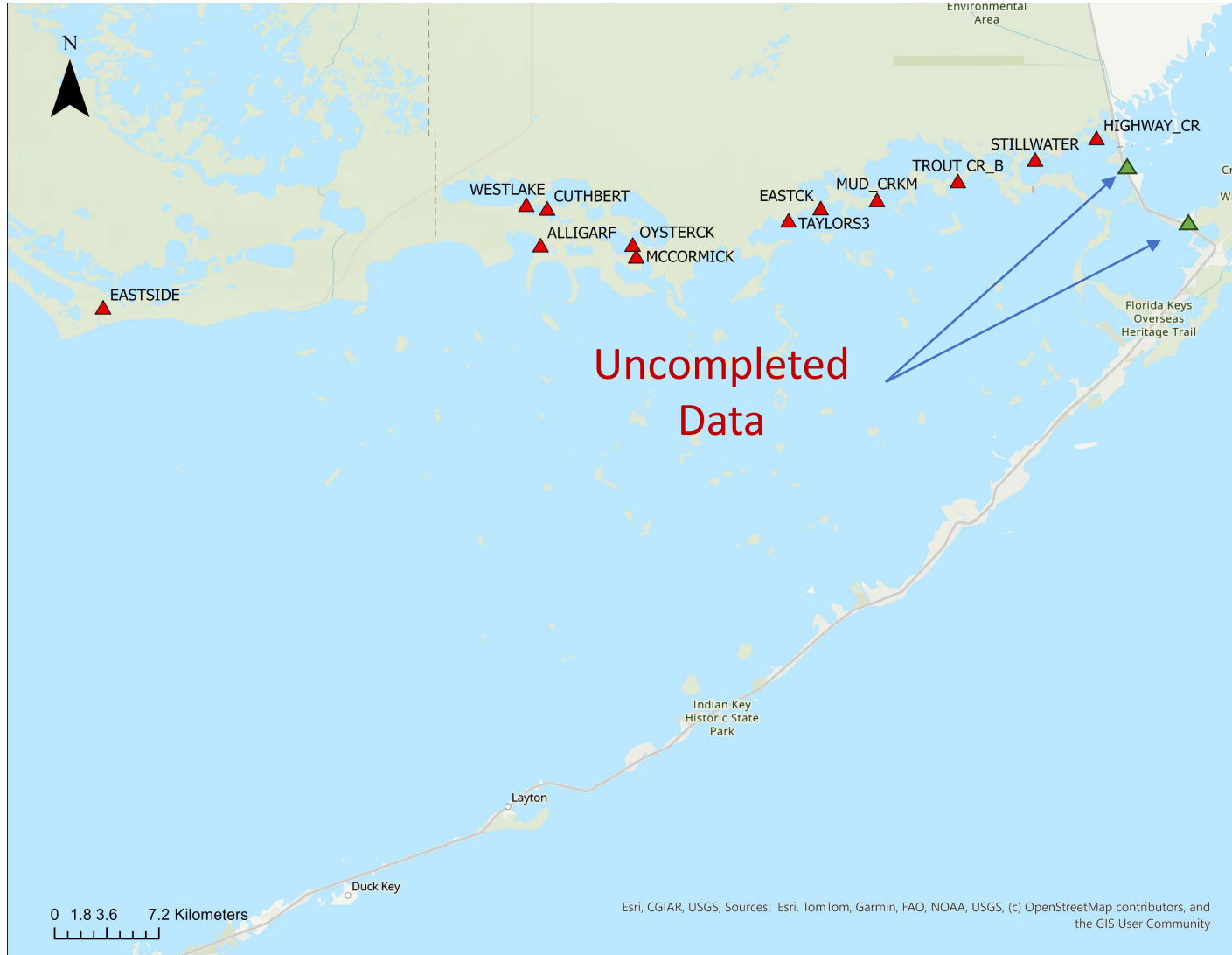


Phase II

- Further model development (e.g., domain adjustment, forcings/boundary conditions, seagrass modeling, etc.), calibration and validation (both wet and dry periods).
- Forecast hydrodynamic, ecological, and hydrological responses to different climatic (e.g., storm surge events), operational, and environmental conditions in Florida Bay and its upstream watershed.
- Integrate with water management operations to minimize the occurrence of hypersalinity events in Florida Bay.

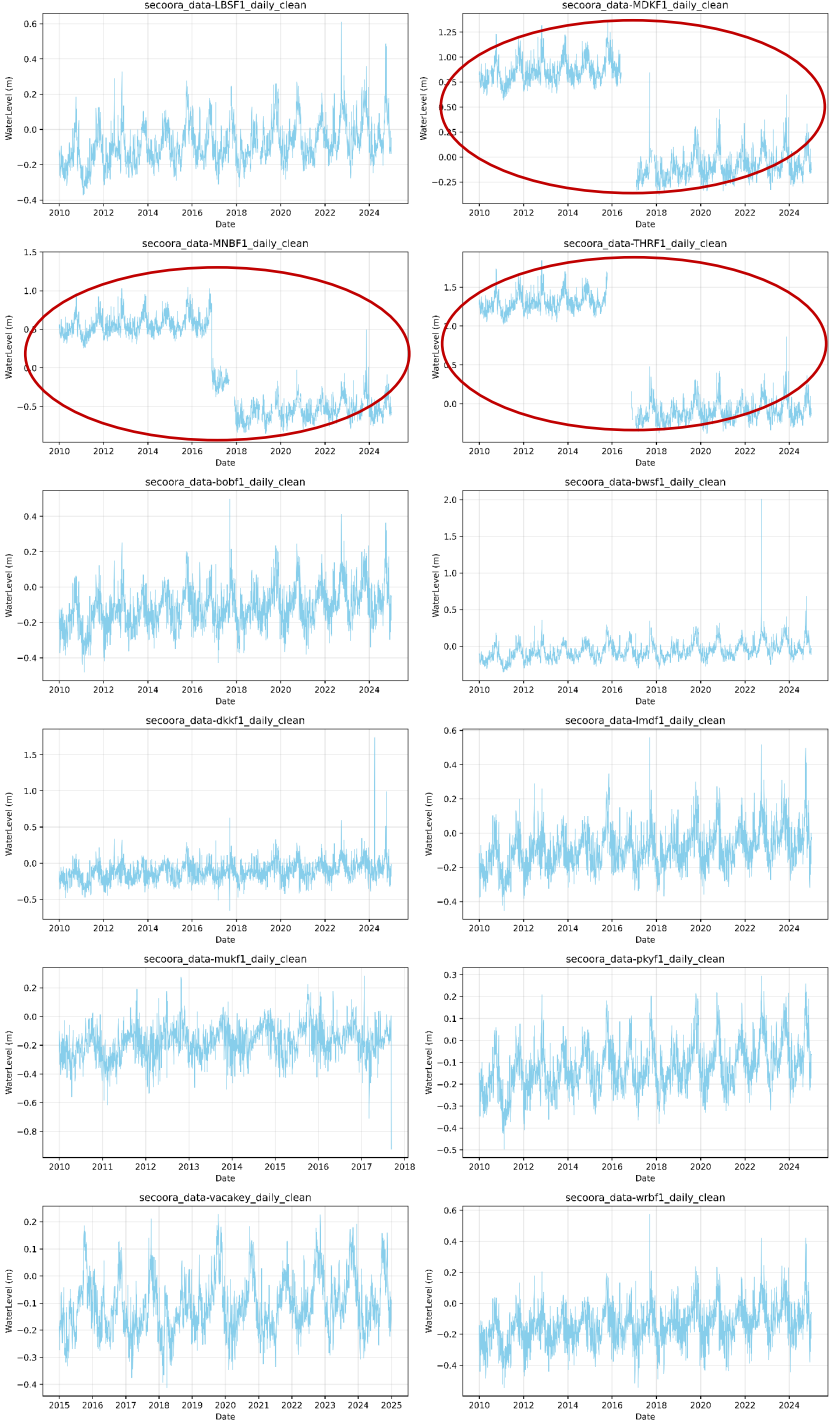
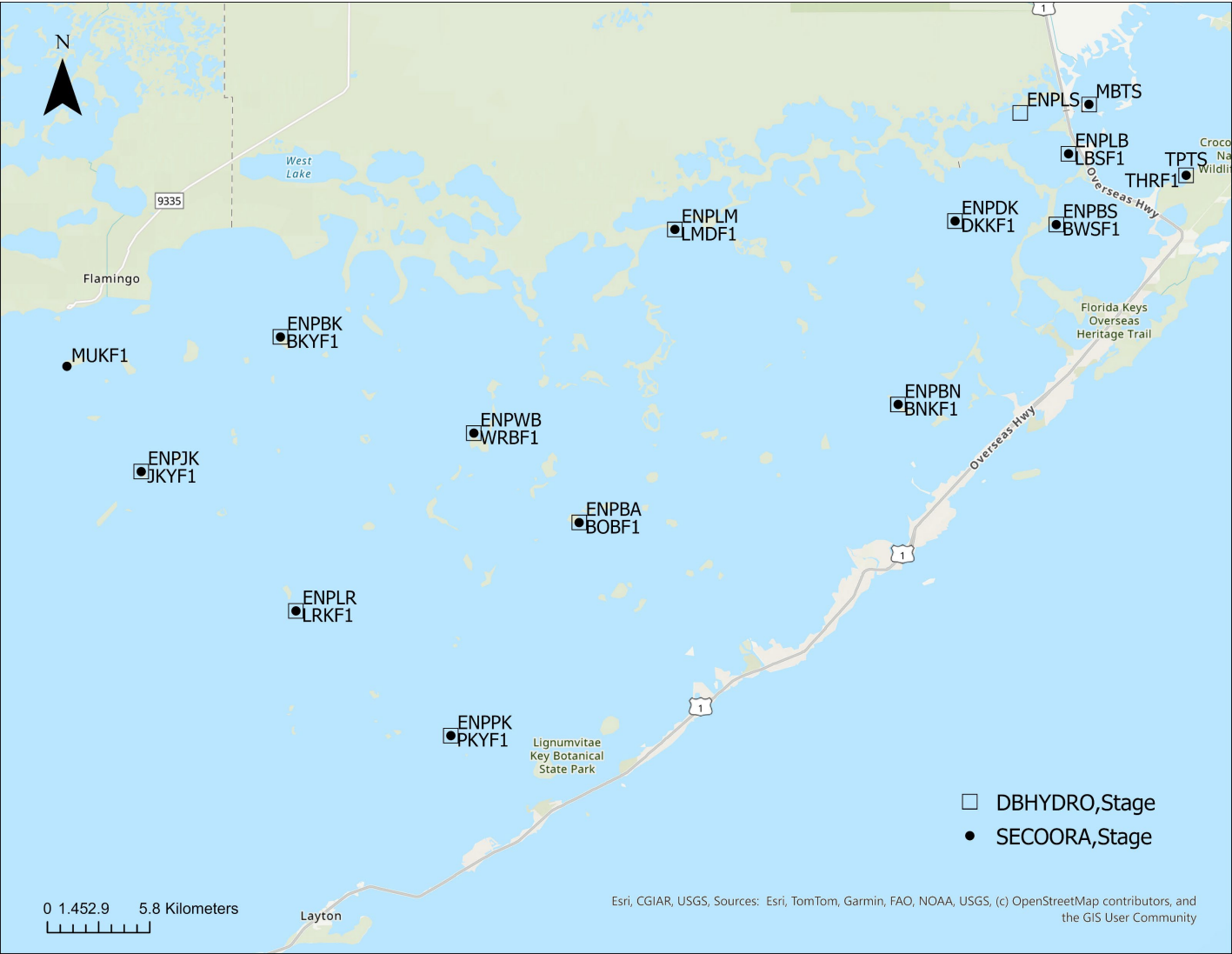
Freshwater Flows into Florida Bay

- Daily flow data (1995–present) compiled from USGS records for 14 inlets into Florida Bay



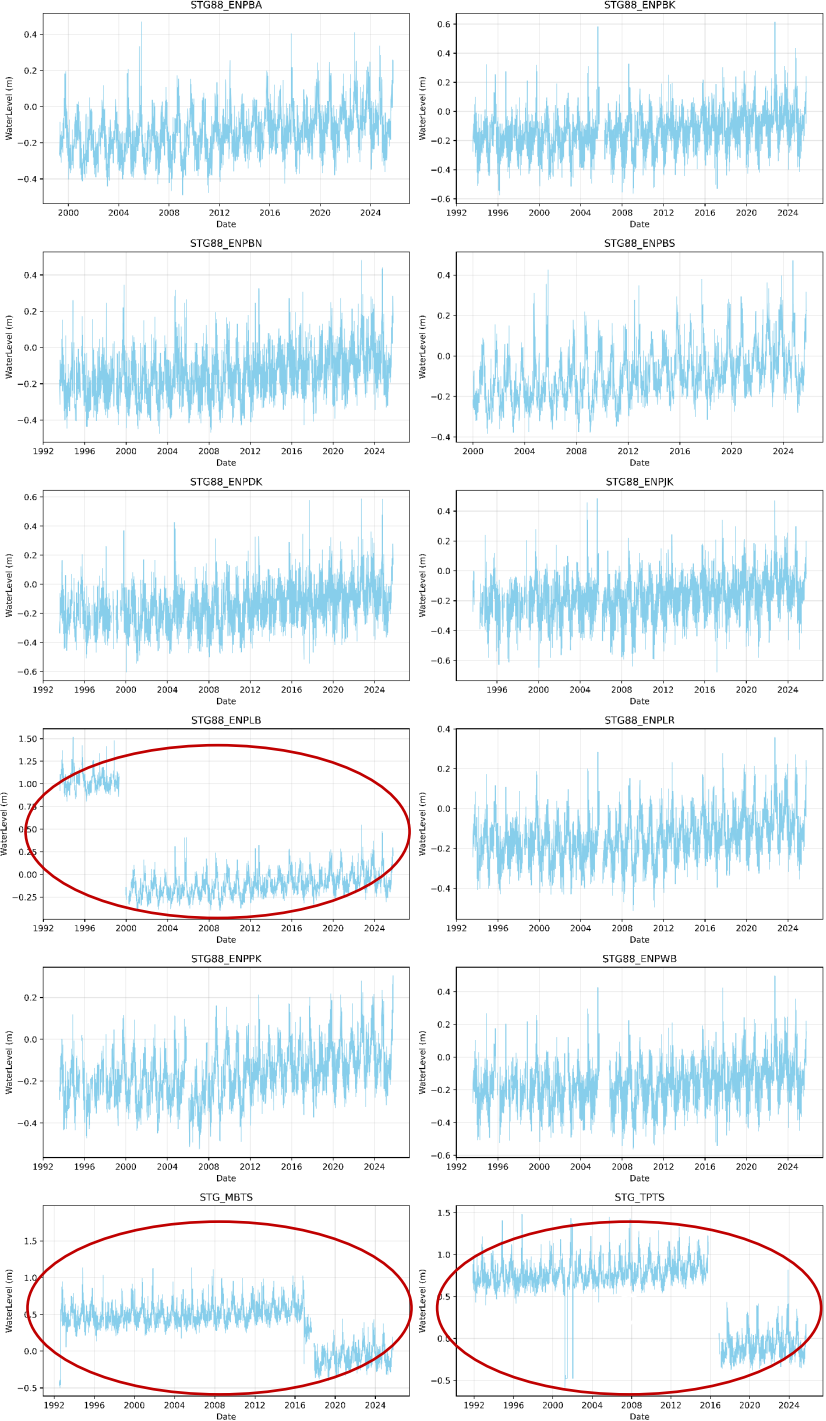
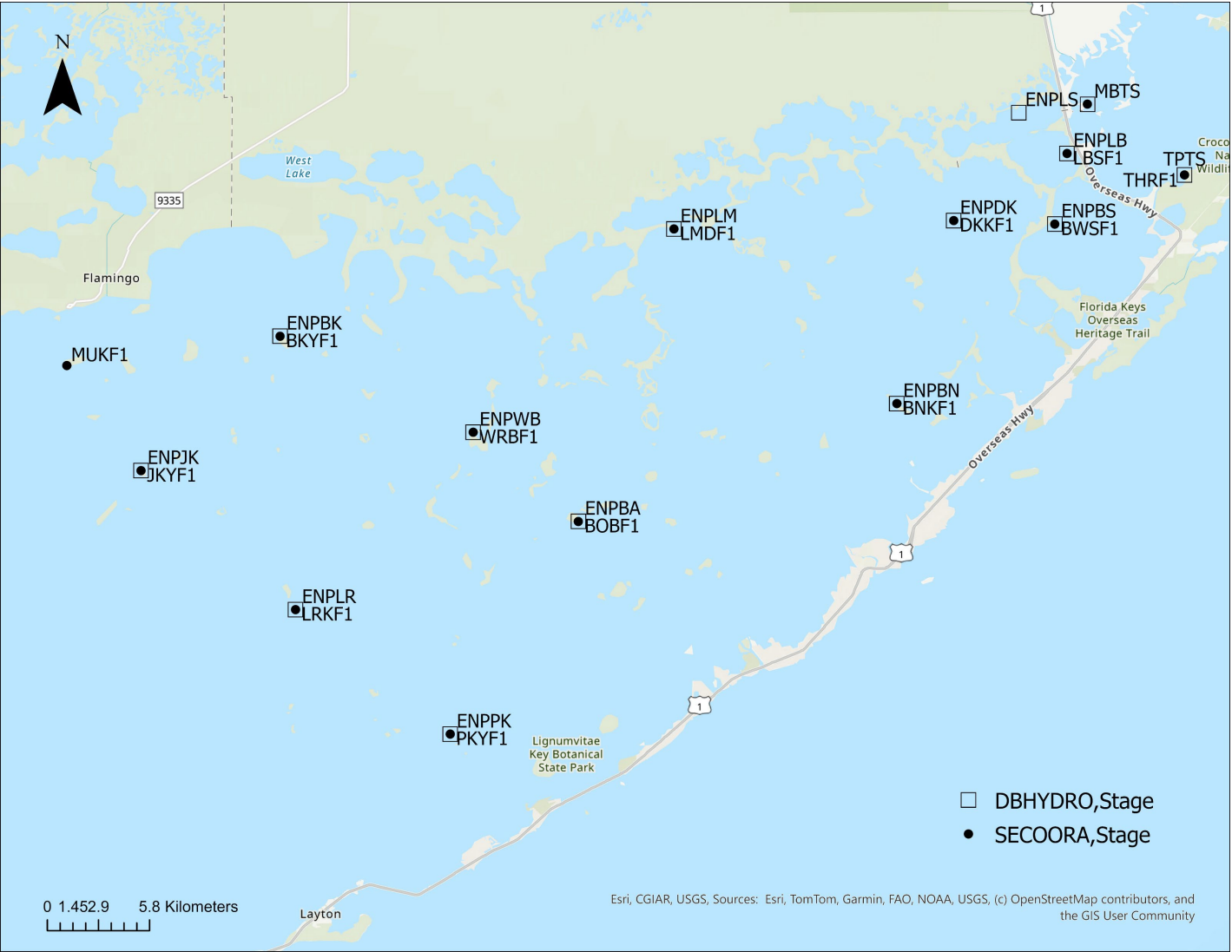
Water Levels Data in Florida Bay

- 14 SECOORA stations providing fine temporal scale water level data (~ 6 minutes).



Water Levels Data in Florida Bay

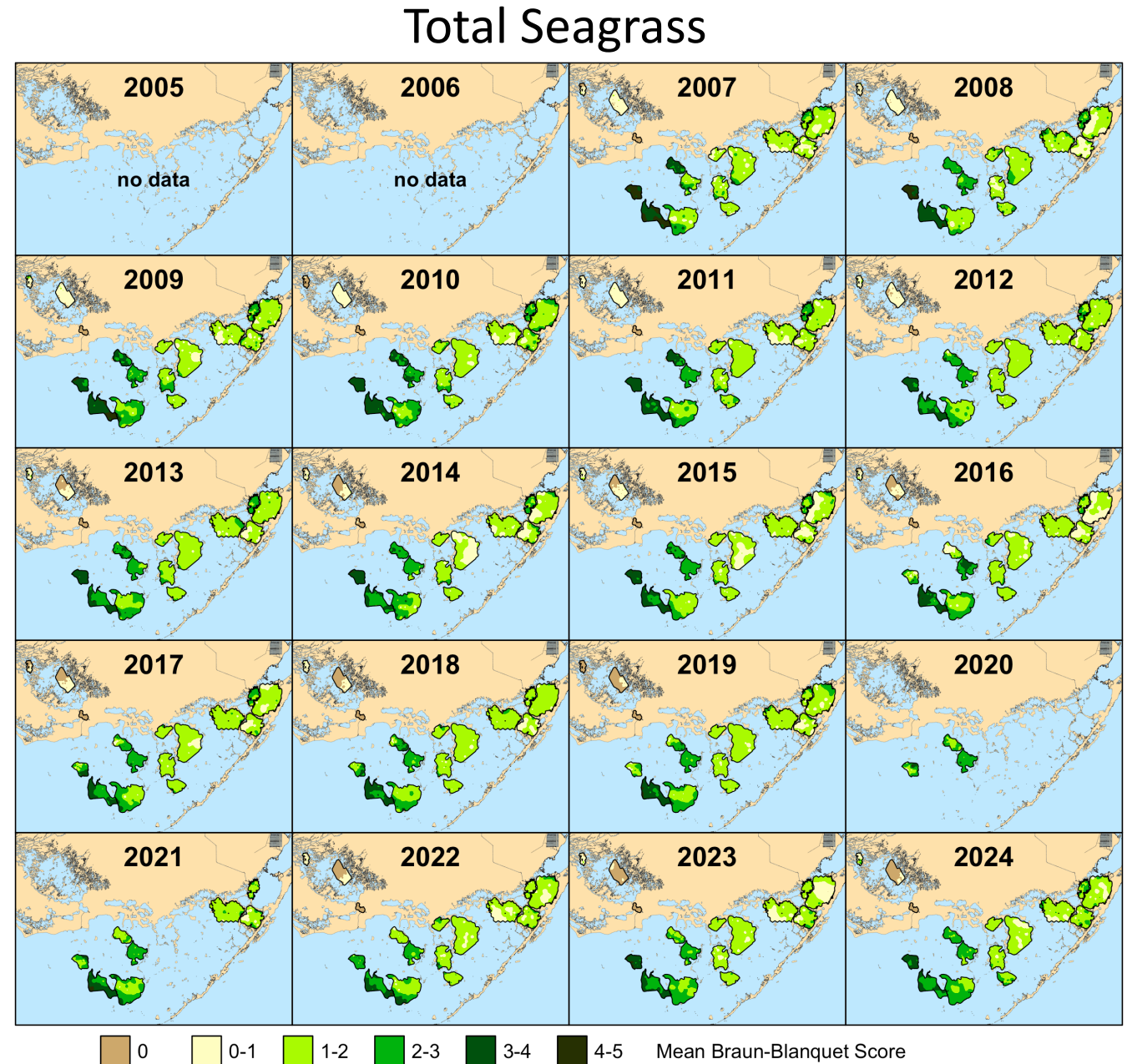
- 14 DBHYDRO stations providing daily water level data.



Seagrass communities in Florida Bay

Maps representing spatial coverage of seagrass for individual years will be generated following the South Florida Fisheries Habitat Assessment Program (FHAP-SF) measurements

These maps will be input into Delft3D model to simulate the effects of different seagrass coverages on Hydrodynamics in Florida Bay



Seagrass modeling in Delft3D

- Seagrass is modeled in Delft3D by correcting the bed roughness using the equation proposed by Baptist (2005).
- Vegetation is modeled as rigid cylinders characterized by **height, density, stems diameter, and drag coefficient**.

- For the bed resistance, the Chezy coefficient is defined as:

$$C = C_b + \frac{\sqrt{g}}{\kappa} \ln \left(\frac{h}{h_v} \right) \sqrt{1 + \frac{C_D n h_v C_b^2}{2g}}$$

- The vegetation drag coefficient (λ) is a separate parameter calculated by:

$$\lambda = C_D n \frac{h_v}{h} \frac{C_b^2}{C^2}$$

Seagrass in Florida Bay (Hansen and Reidenbach, 2017)

Seagrass coverage	Canopy height (cm)	Density (shoots m ⁻²)	Blade width (cm)
Sparse	15.2 ± 2.0	259 ± 26	0.74 ± 0.27
Dense	37 ± 4.8	484 ± 78	0.80 ± 0.19