Patuxent Estuary Model: Hydrodynamic Setup (Improvements)

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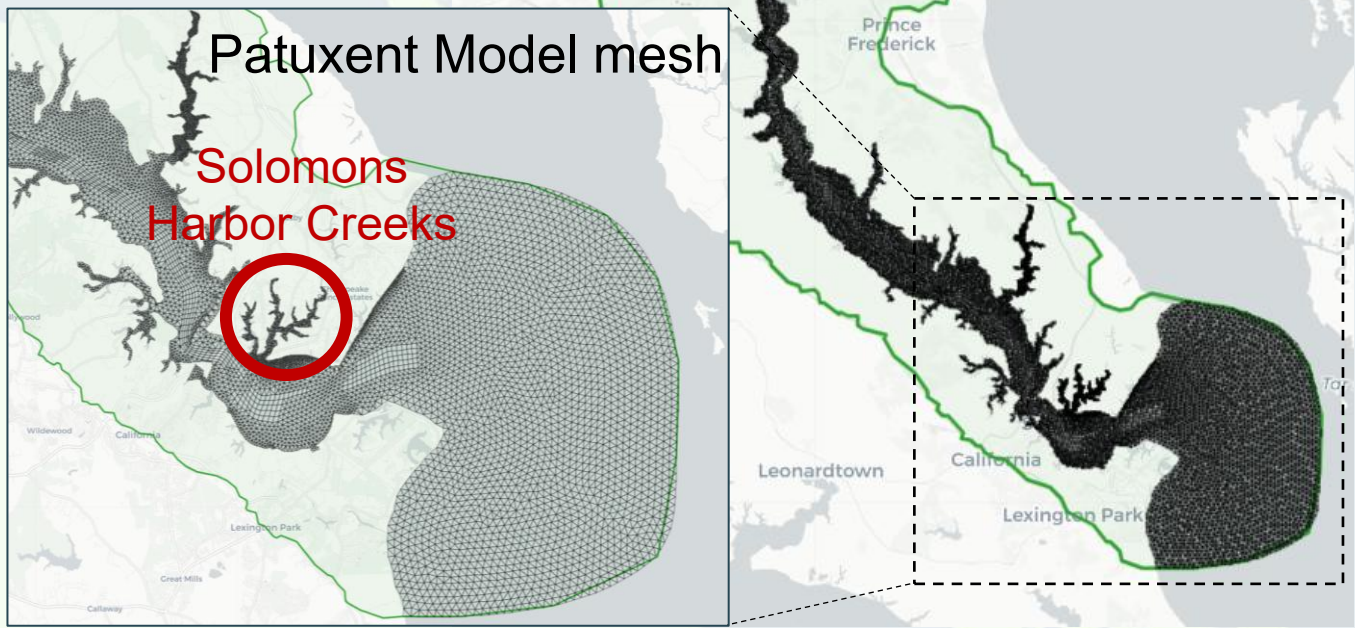
7/15/2026

Hydrodynamic Setup

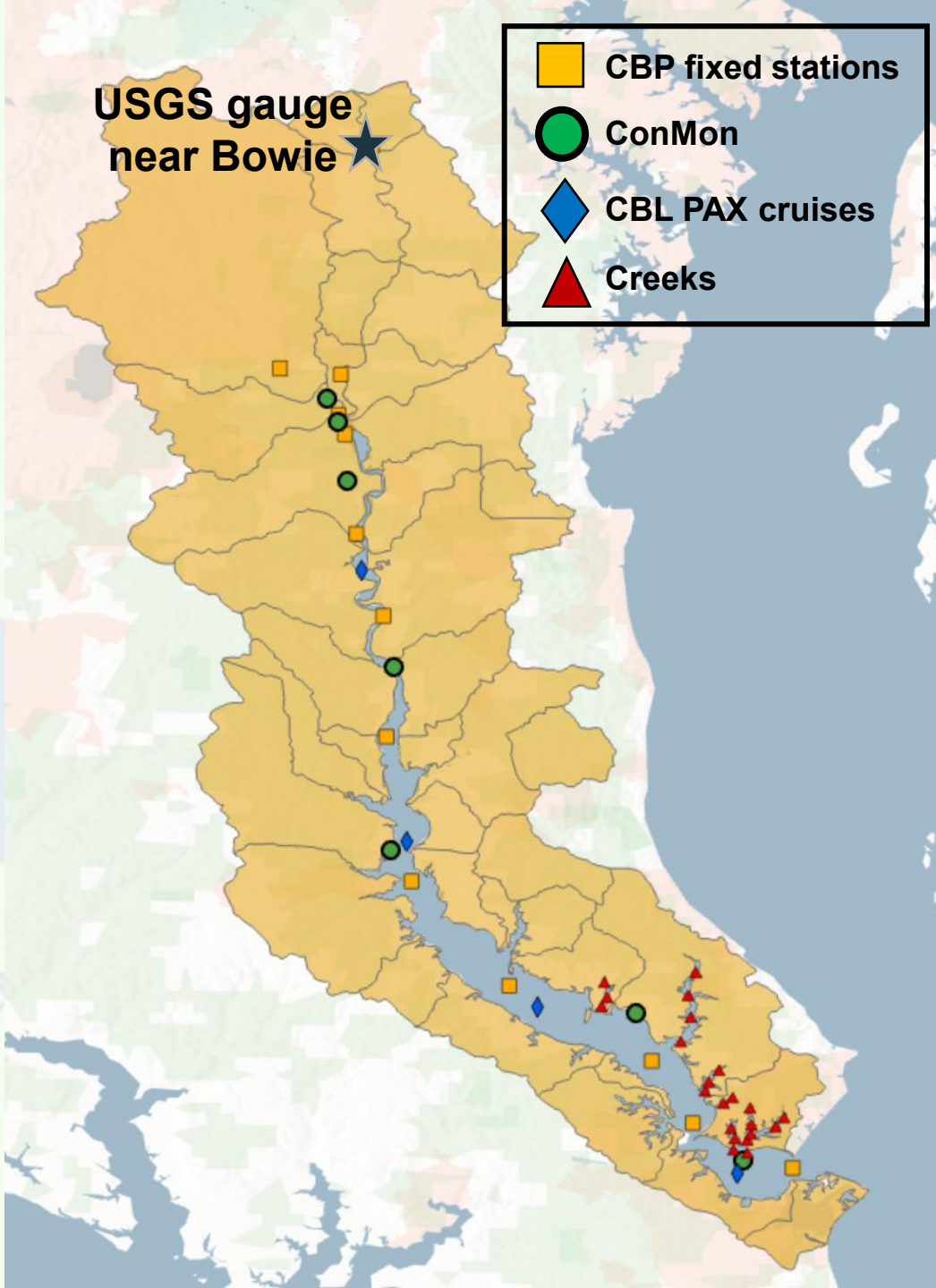
- Unstructured SCHISM grid covering full estuary
- Open boundary at Chesapeake Bay (CBP Main Bay Model (Run 11fb))
- 3D boundary forcing for elevation, velocity, temperature, and salinity
- Watershed inputs from Phase-7 CBP WSM
- Patuxent river flow replaced by USGS (near Bowie) daily flow data
- Atmospheric forcing from ERA5 (sflux)
- 10-year continuous simulation (1991-2000)
- Resolves mainstem and tributary creeks
- Higher resolution in lower estuary and creeks
  - Min element area ~55 m^2
  - Max element area ~73600 m^2



Validation Stations and Data

- CBP fixed monitoring stations and Continuously Monitoring stations across the Patuxent estuary
- CBL PAX cruises
- Selected tributary / creek locations

- Evaluation focused on salinity and temperature
- Only 1991-2000 data were only available at CBP fixed monitoring stations and Solomons Harbor creeks

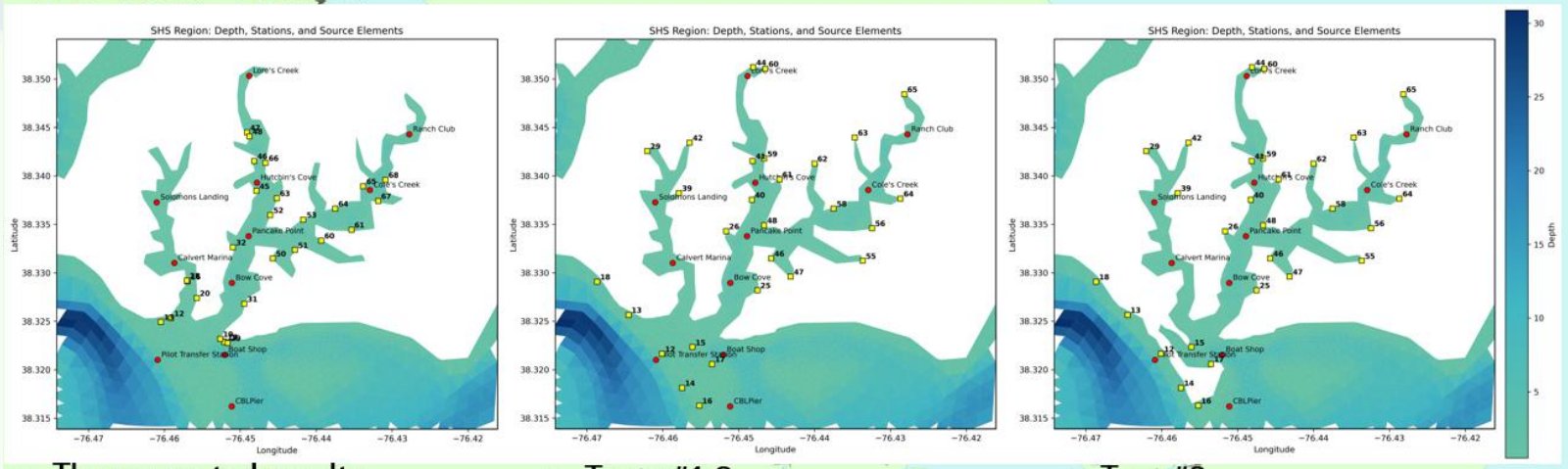


Where we were in the last meeting

- **What Worked Well**
  - Salt intrusion into the tidal fresh region is reasonably represented
  - Seasonal salinity and temperature variability are well captured

- **Issues**
  - Salinity bias at specific stations (e.g., RET1.1 too fresh; LE stations slightly too salty)
  - Salinity minima and maxima not well captured in some shallow creeks
  - High temperatures in the upper reaches of Solomons Harbor not well reproduced

NEXT STEP



- The presented results
  - WSM is too cold in this area
  - Sources are not in the accurate location
  - Solomons Island is ignored in the mesh
- Tests #1,2
  - Test #1: sources in the right location
  - Test #2: using Bowie temperature here
- Test #3
  - Seeing Solomons Island in the mesh

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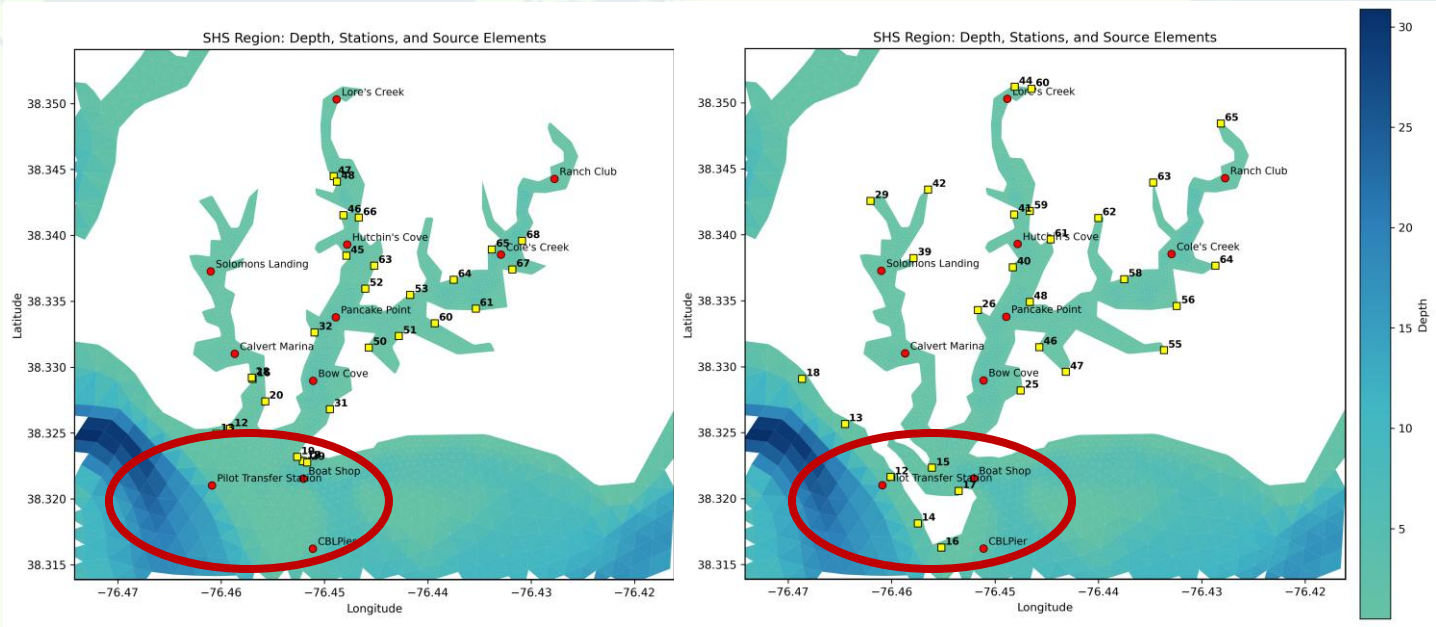
- **What I Changed and What Helped**
  - Boundary forcing updated from RUN7b → RUN11fb, resulting in improved salinity
  - Watershed inputs updated from Phase 6 → Phase 7 WSM, resolving prior inconsistencies
  - Atmospheric forcing updated from NARR → ERA5, leading to improved overall performance
  - Tested sensitivity to water type parameterization → no significant improvement in temperature bias
  - Refined freshwater source placement
  - Improved representation of Solomons Island region



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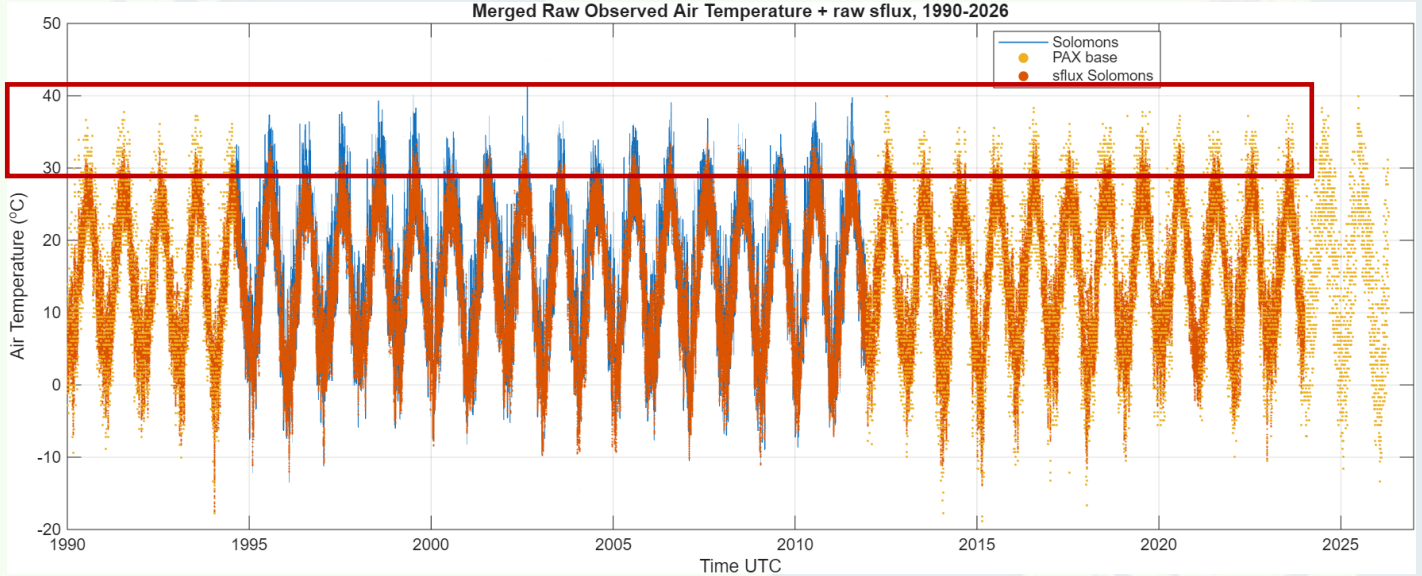

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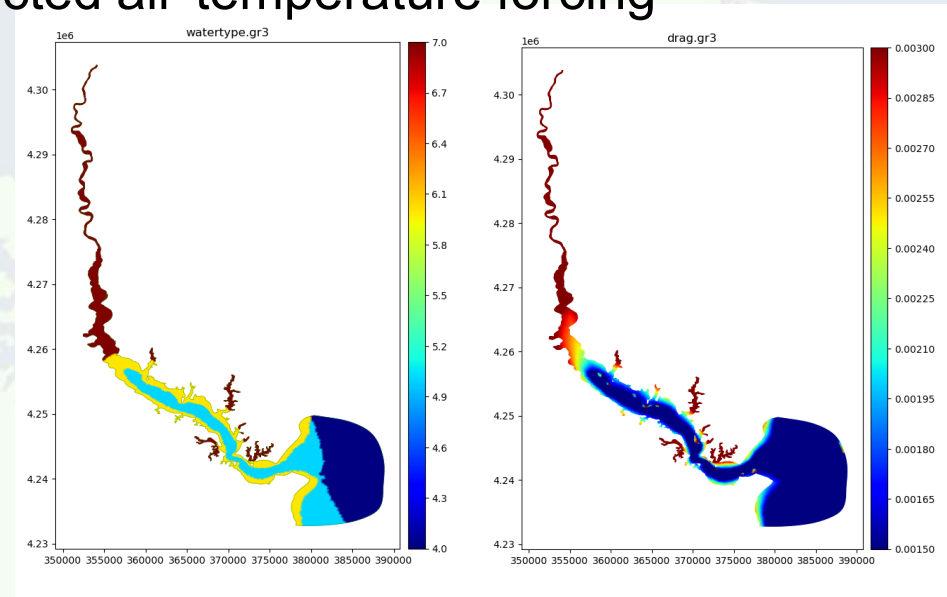
  - Improved representation of Solomons Island region
  - Investigated atmospheric forcing biases → Developed corrected air-temperature forcing
  - Changed albedo and drag coefficient
  - Changed water type again (with corrected air-temperature forcing)
    (Thanks to Wu et al., 2026)
  - Revalidated temperature and salinity



Validation Results

MAIN CHANNEL

Surface

Blue line: Model Simulation

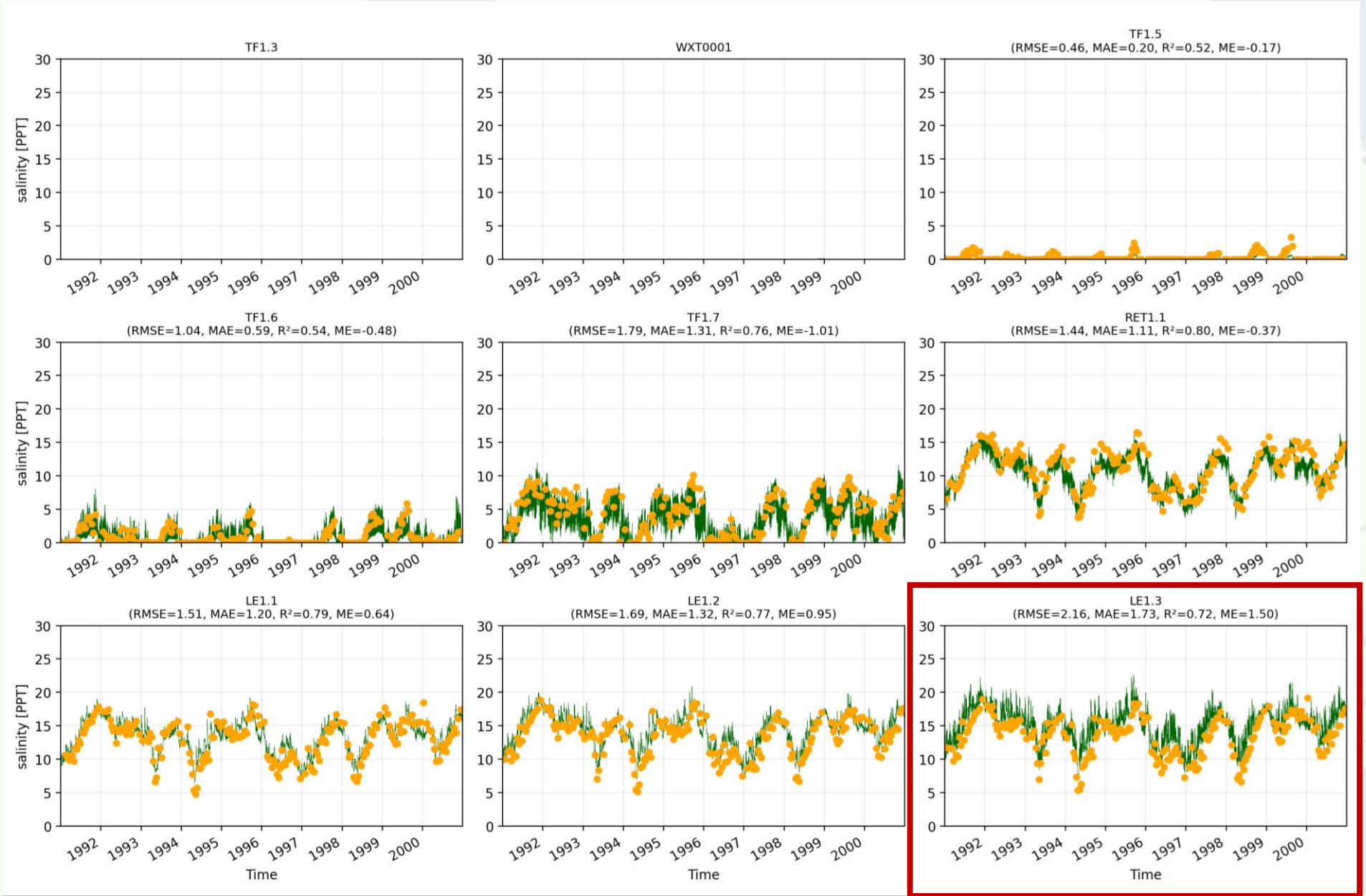
Red dots: Observations

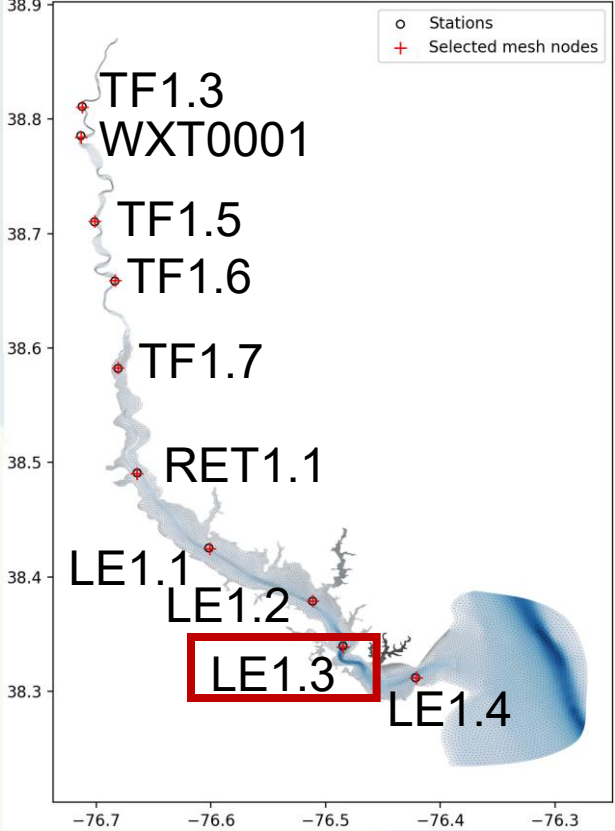
Bottom

Green line: Model Simulation

Orange dots: Observations

Salinity Validation (1991–2000)

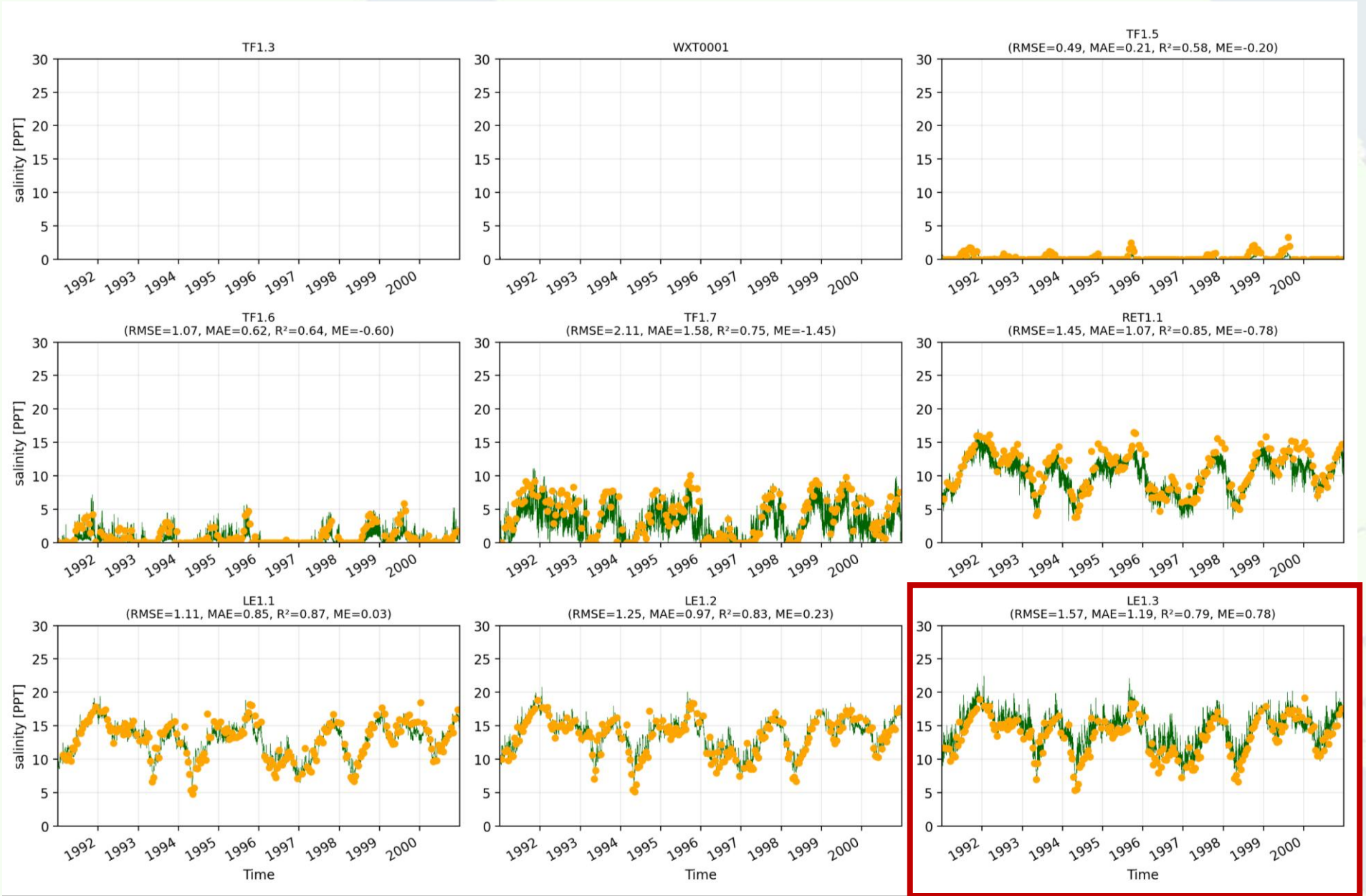


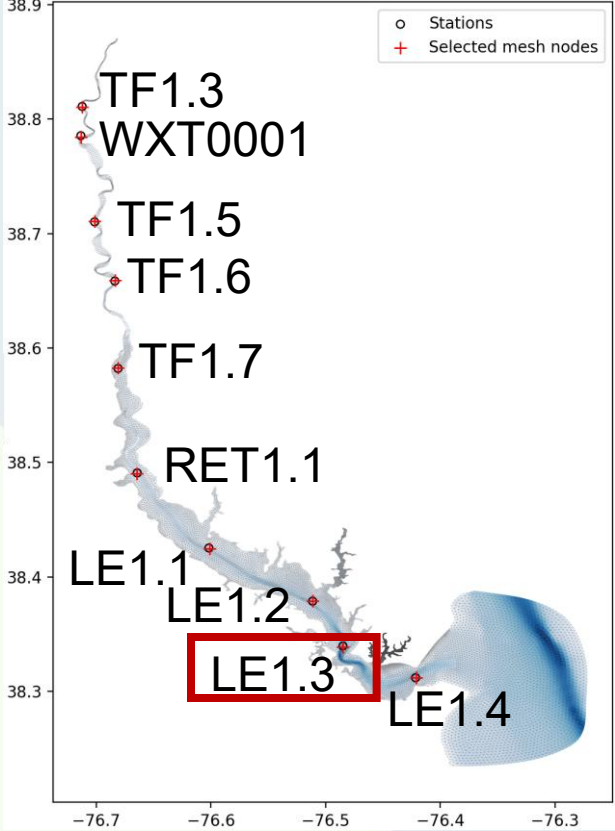


- Bottom Salinity in the Main channel
- CBP fixed stations

BEFORE

Salinity Validation (1991–2000)





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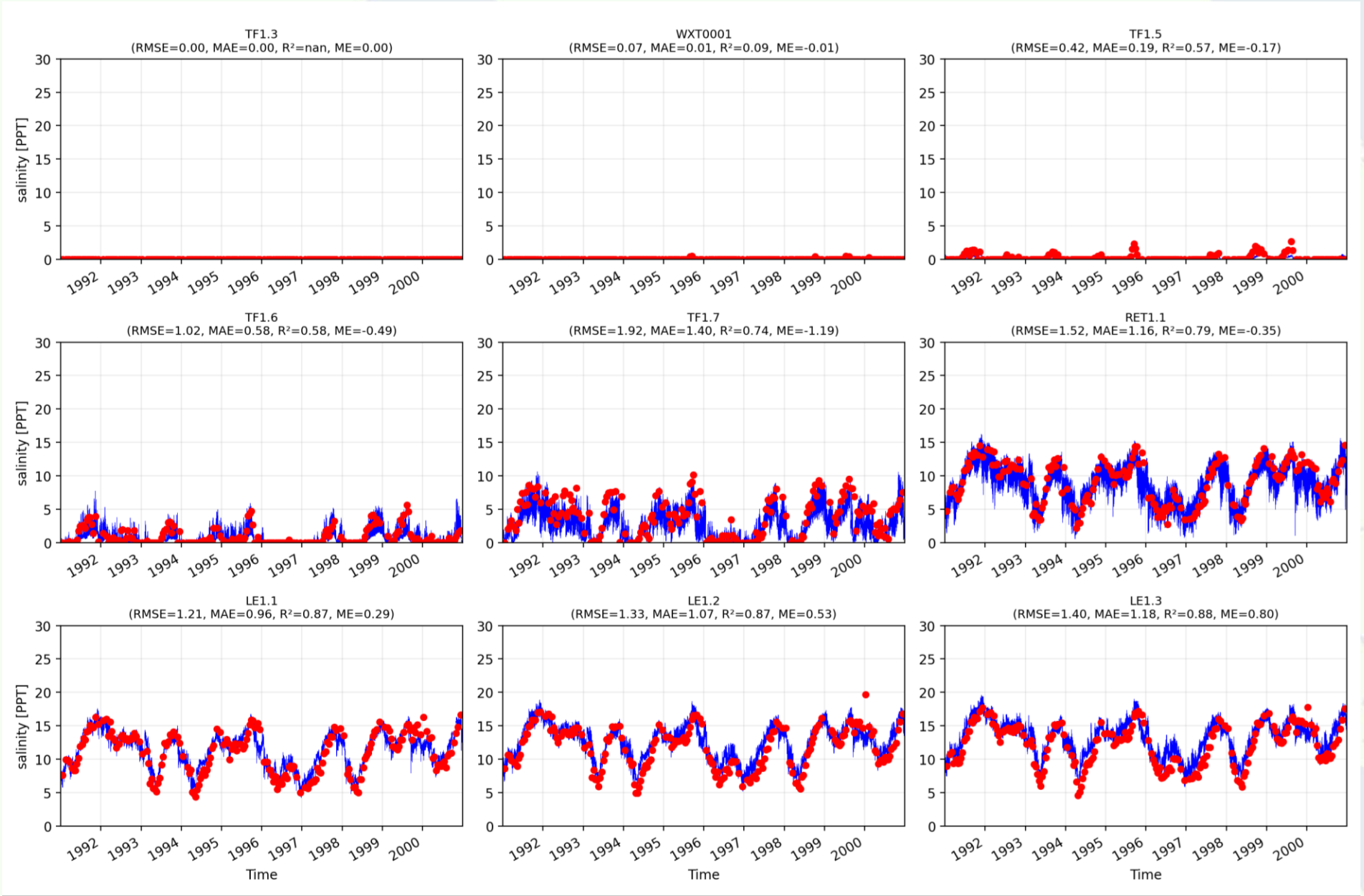

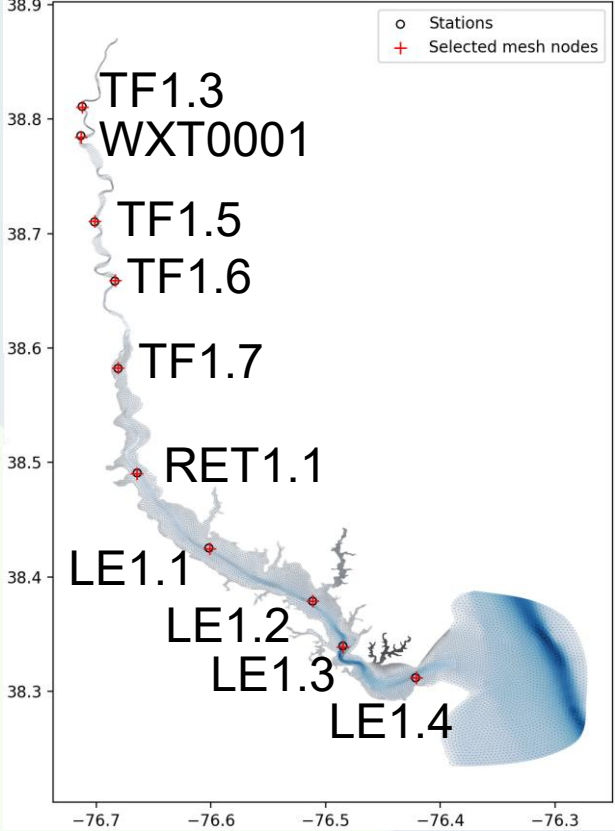

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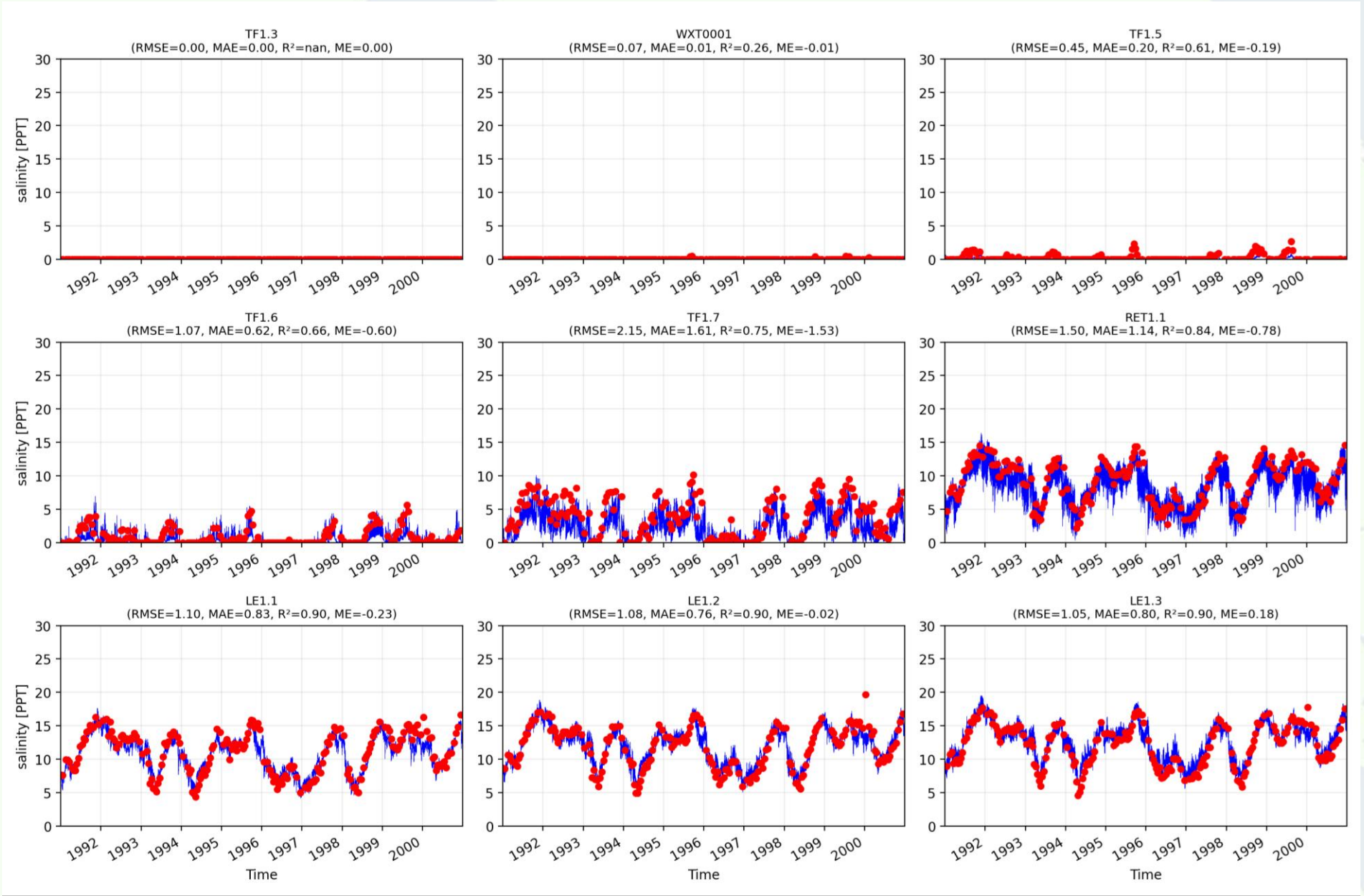

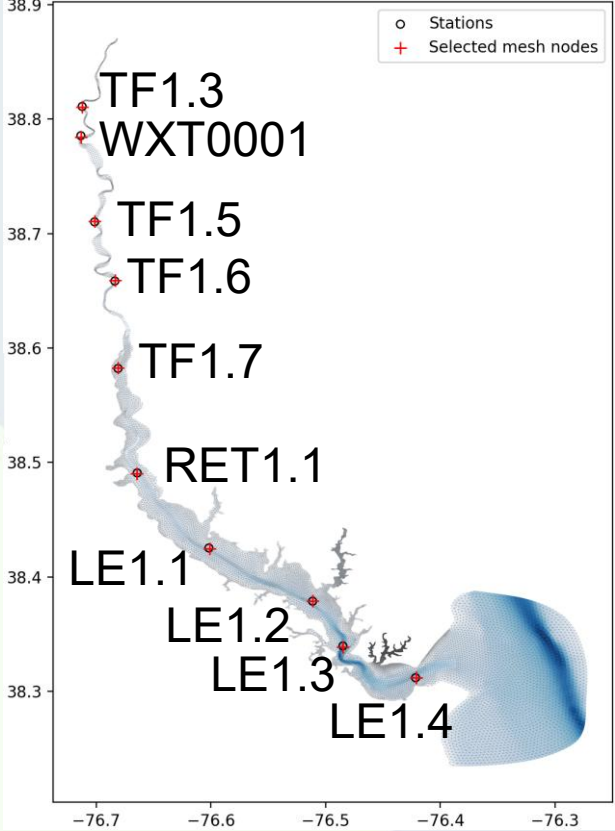

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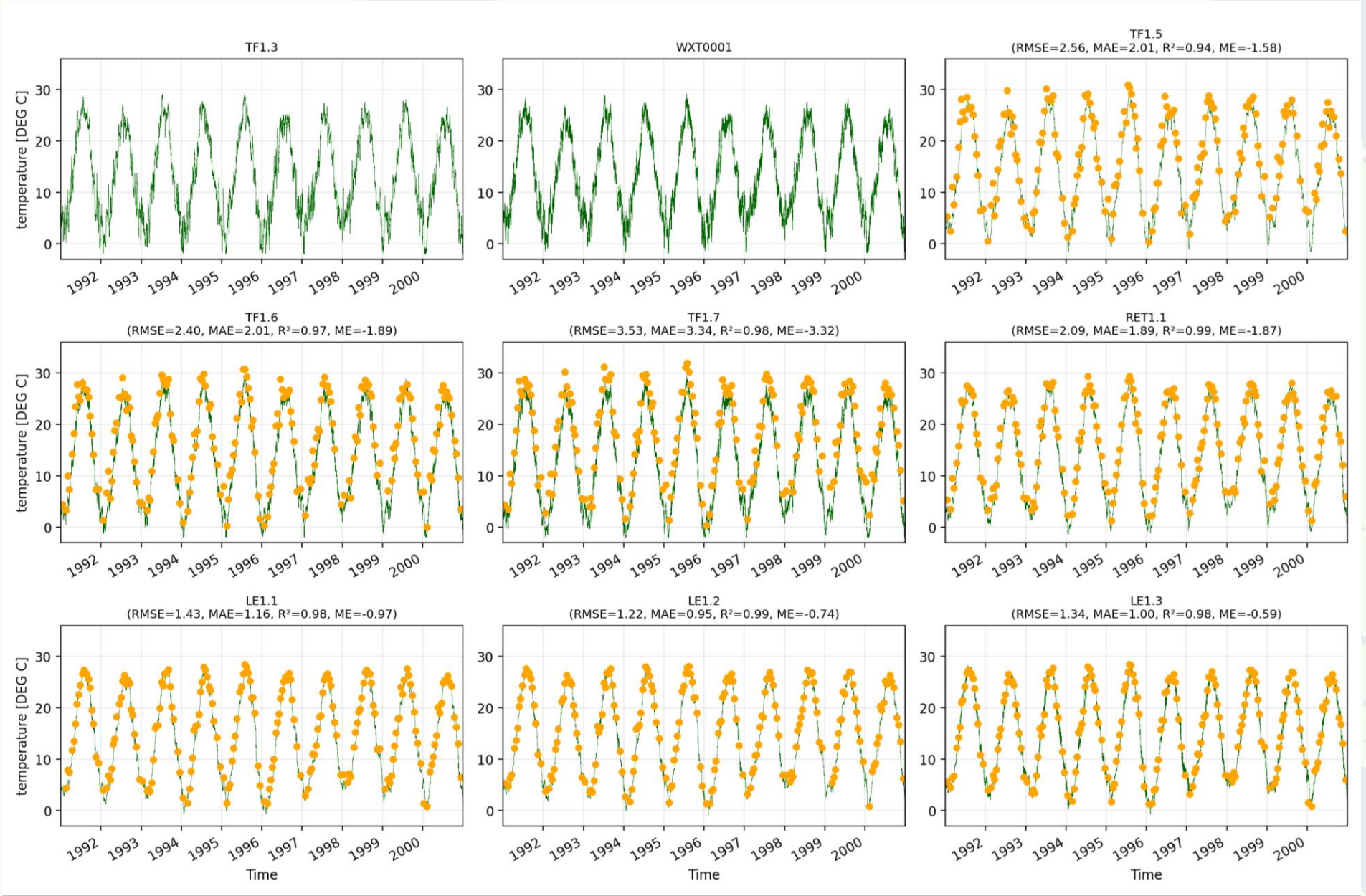

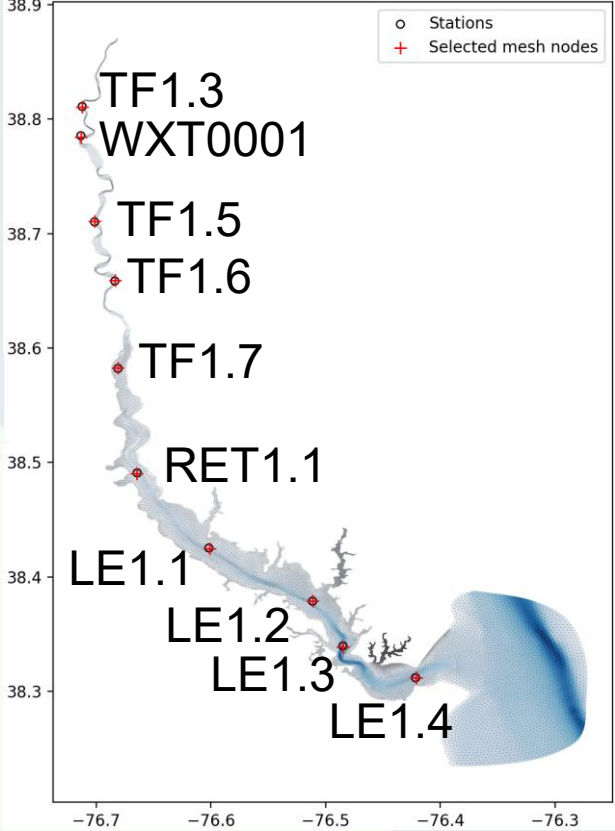

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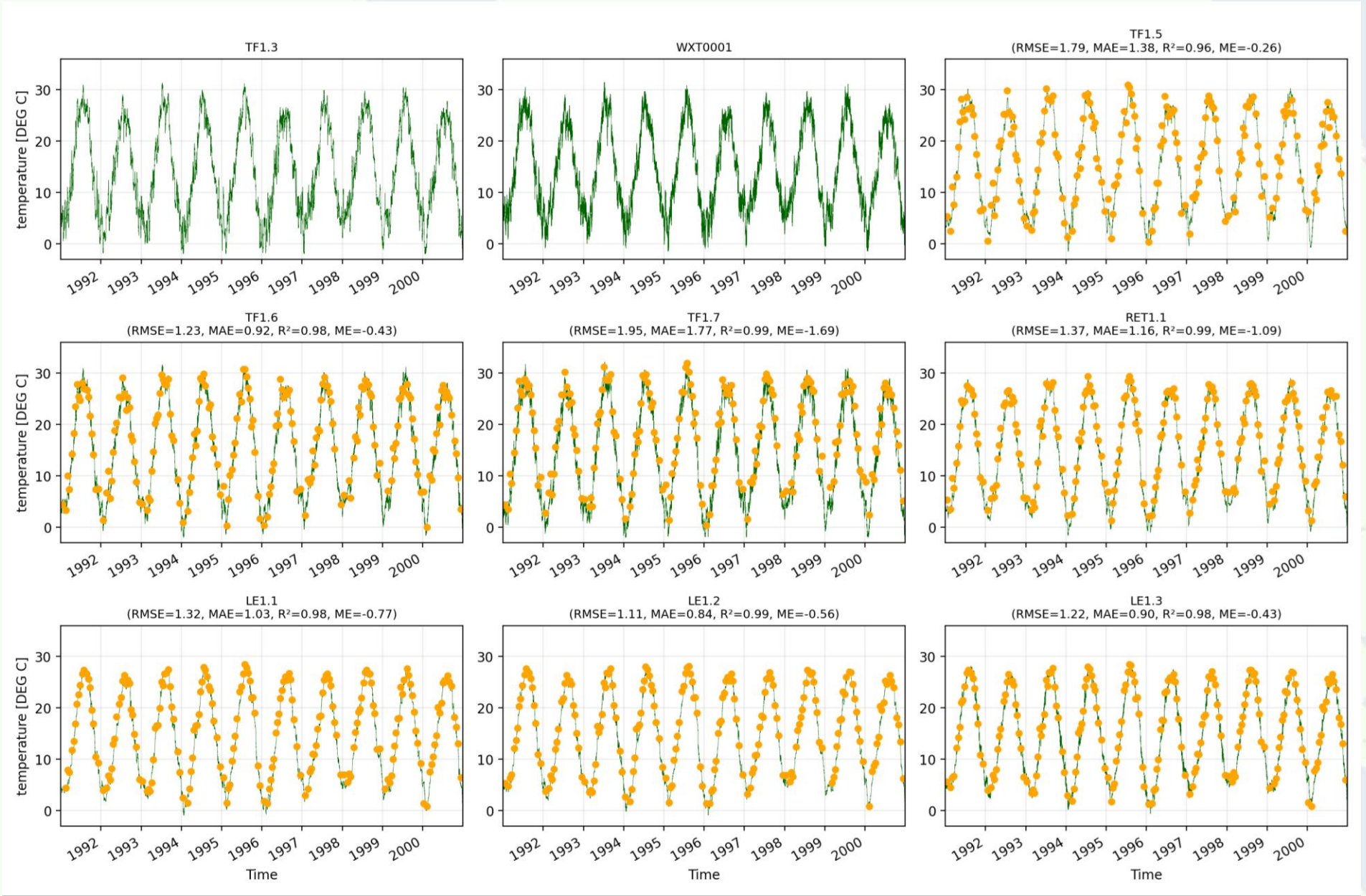

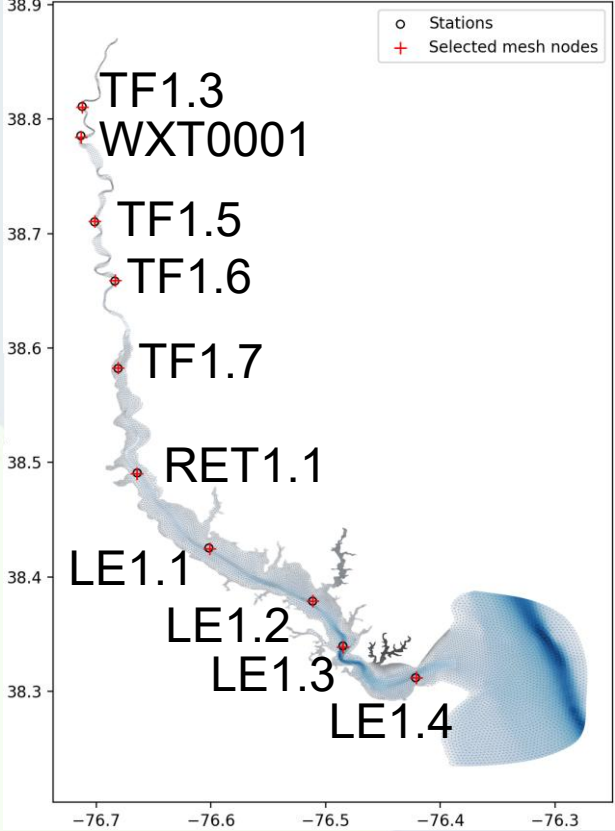

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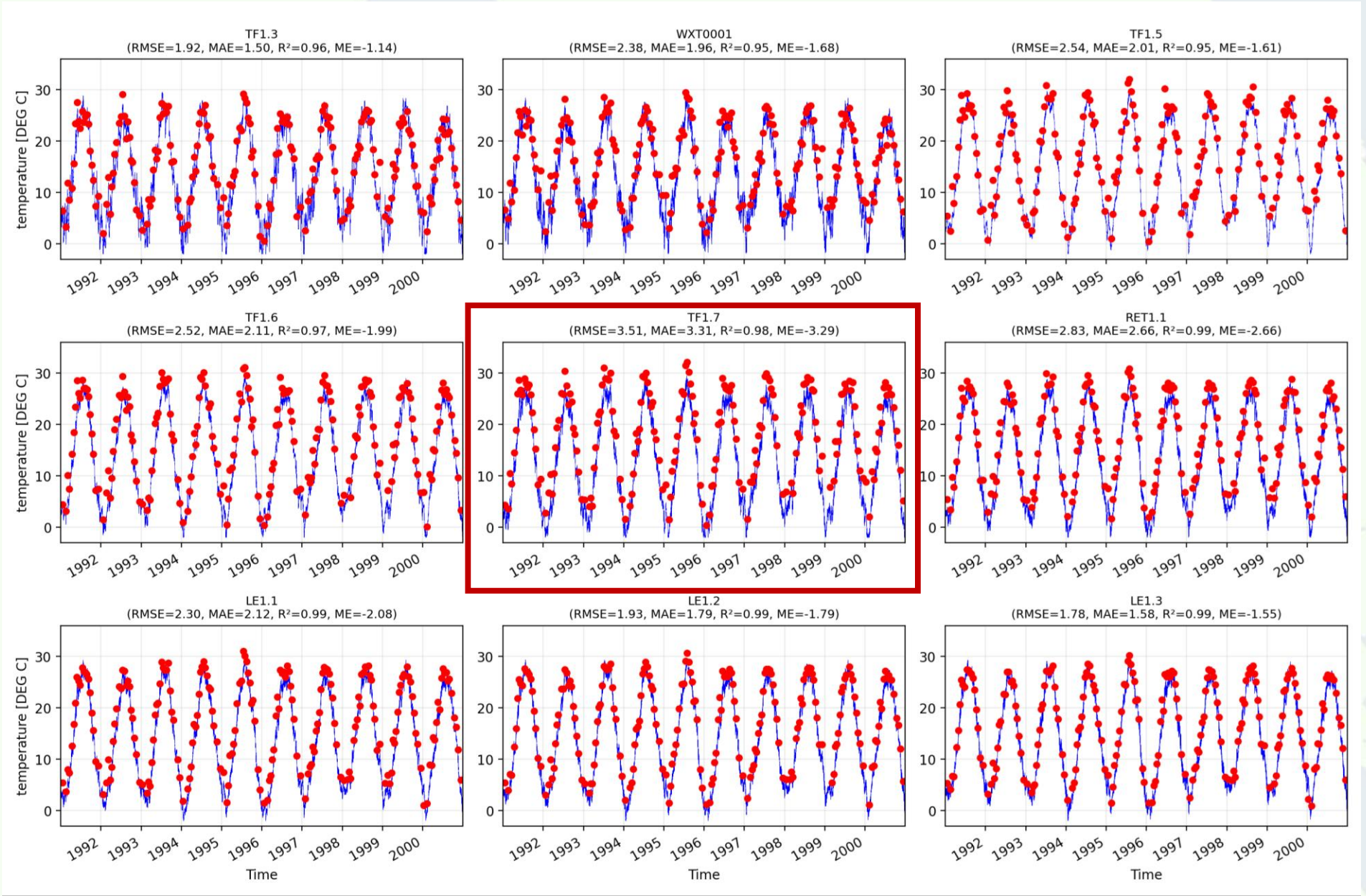

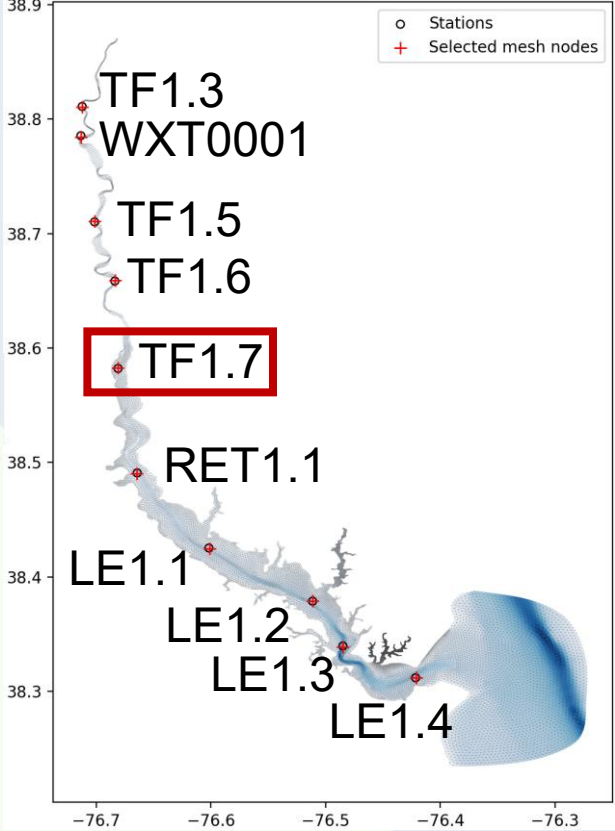

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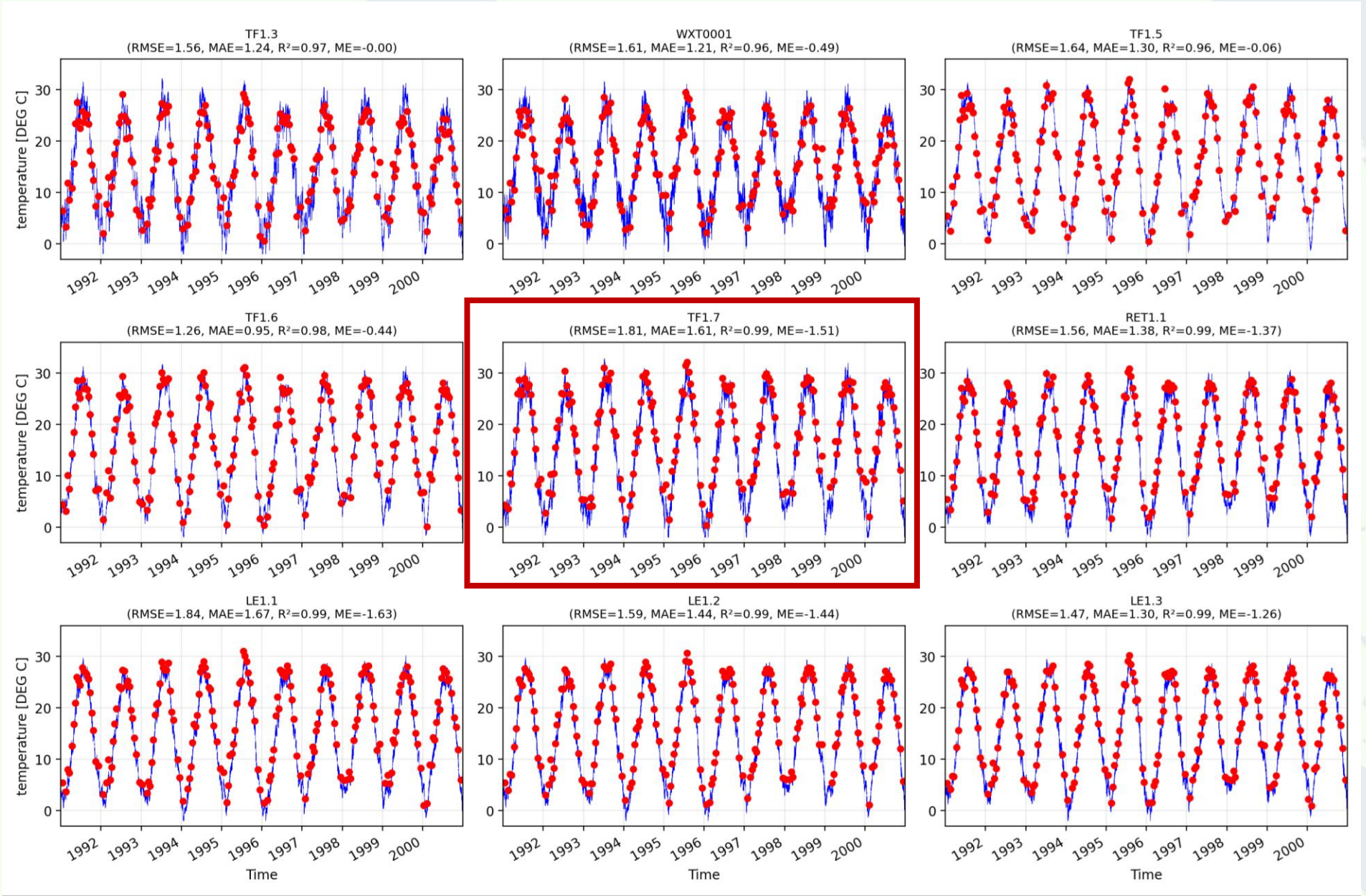

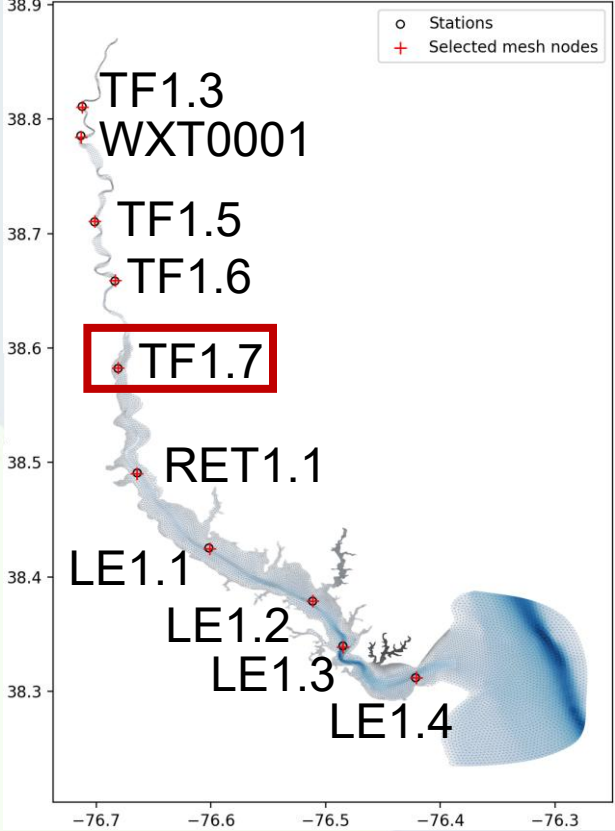

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Solomons Harbor Creeks

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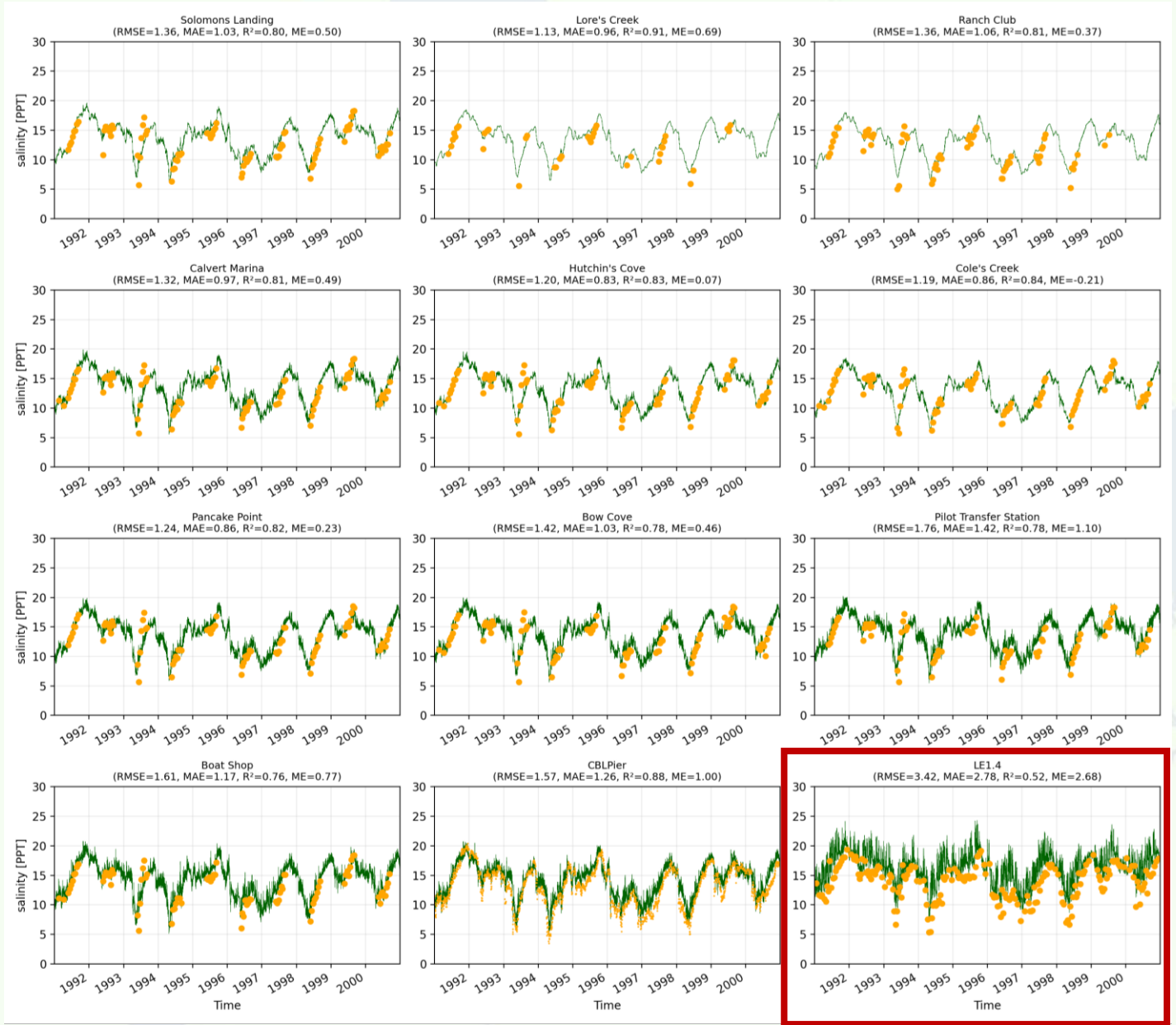

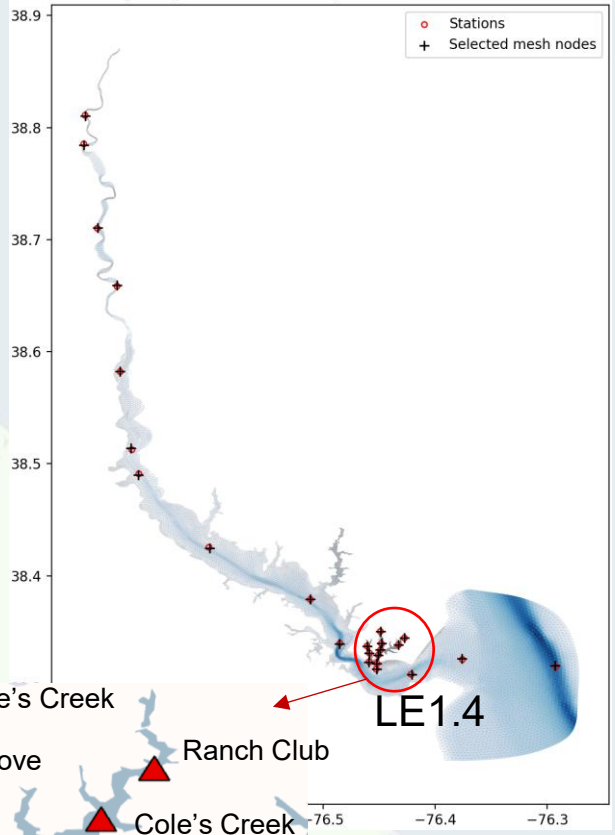

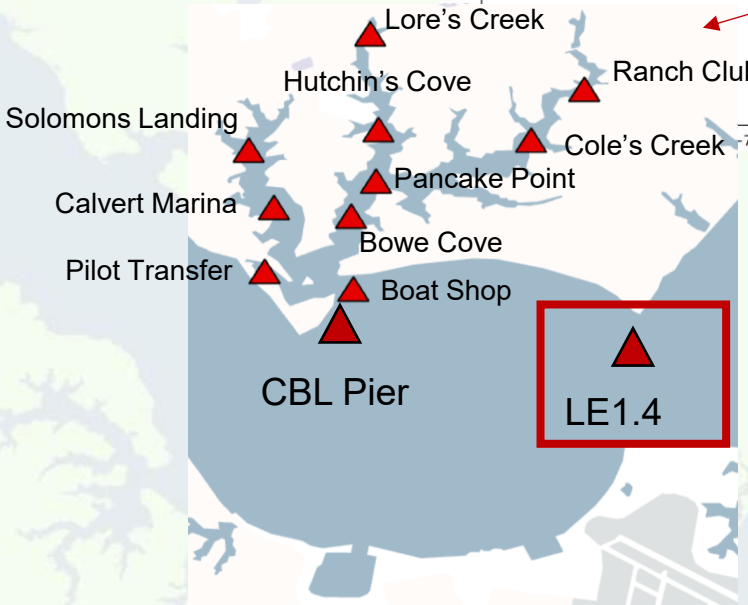

- Bottom Salinity in the creeks
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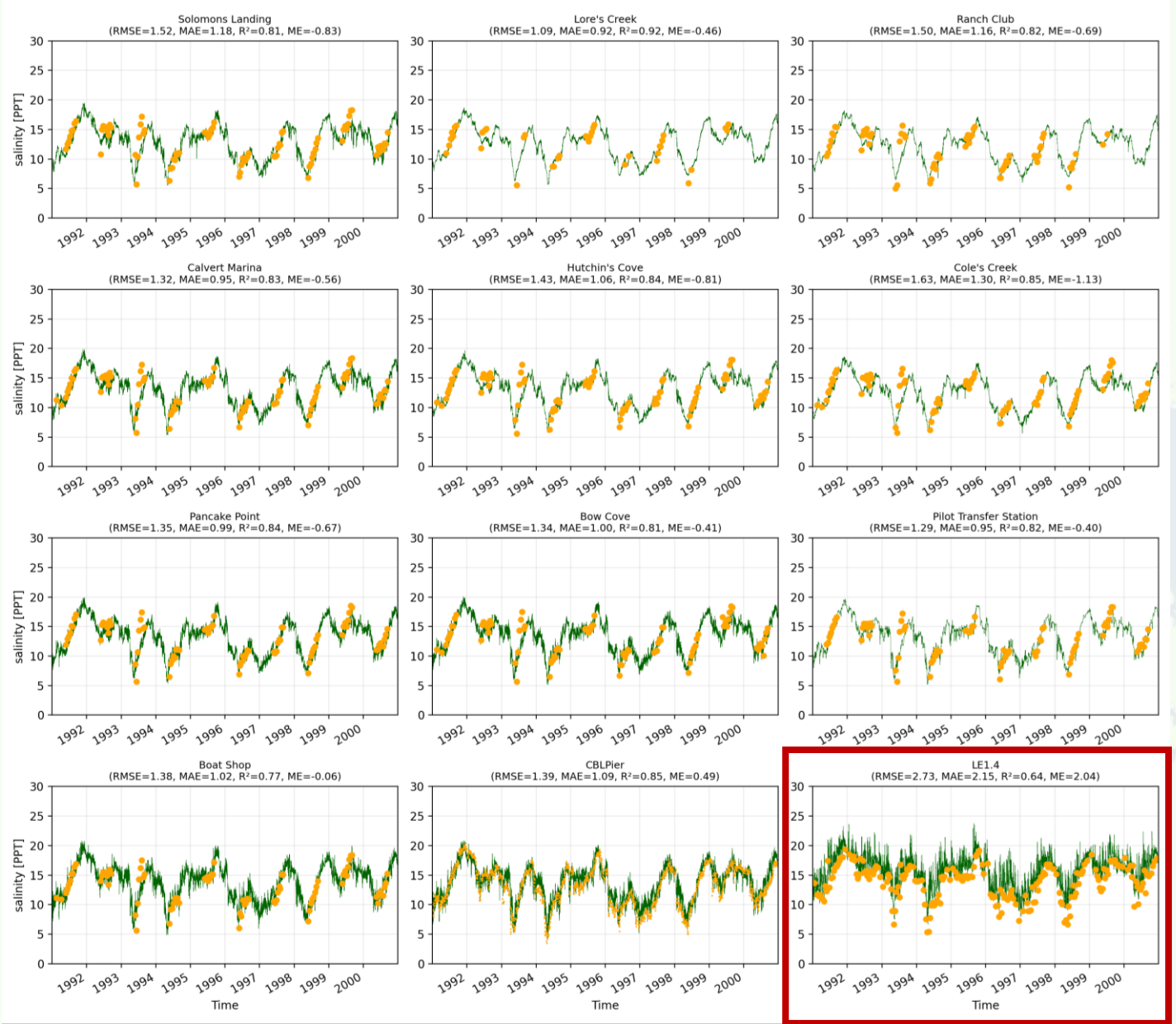

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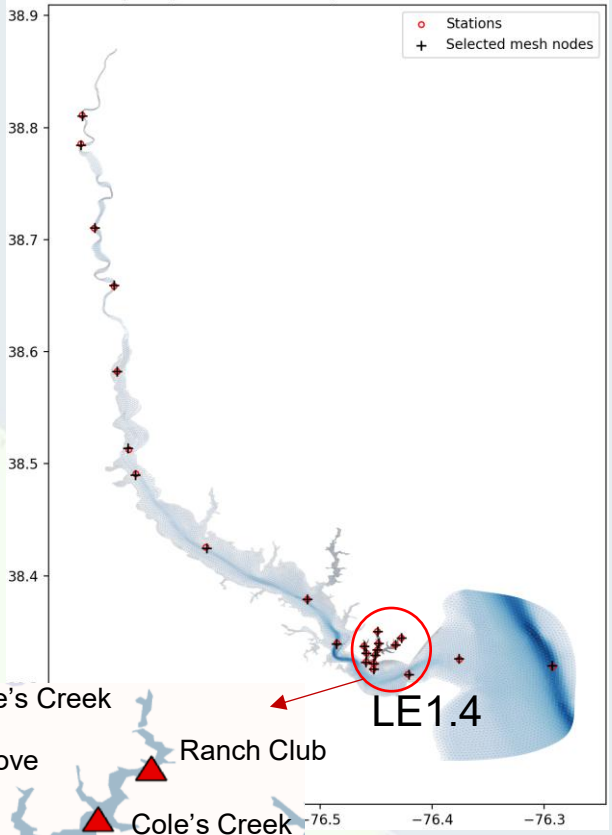

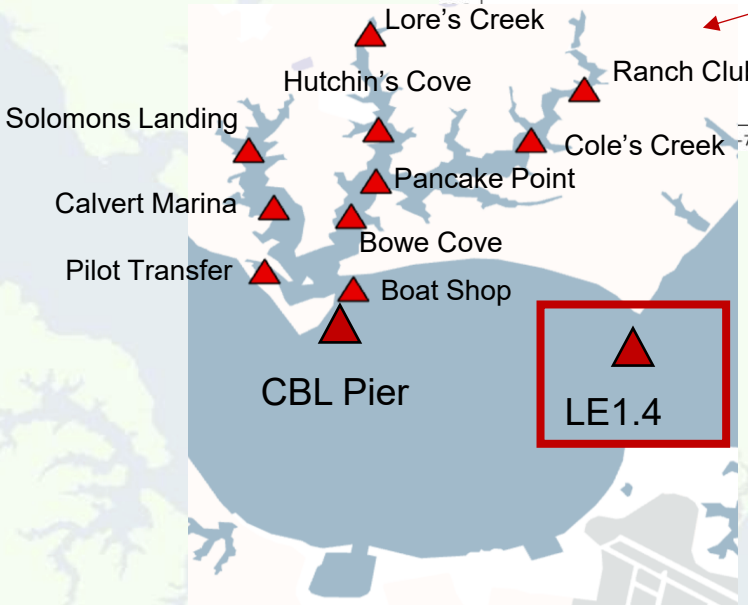

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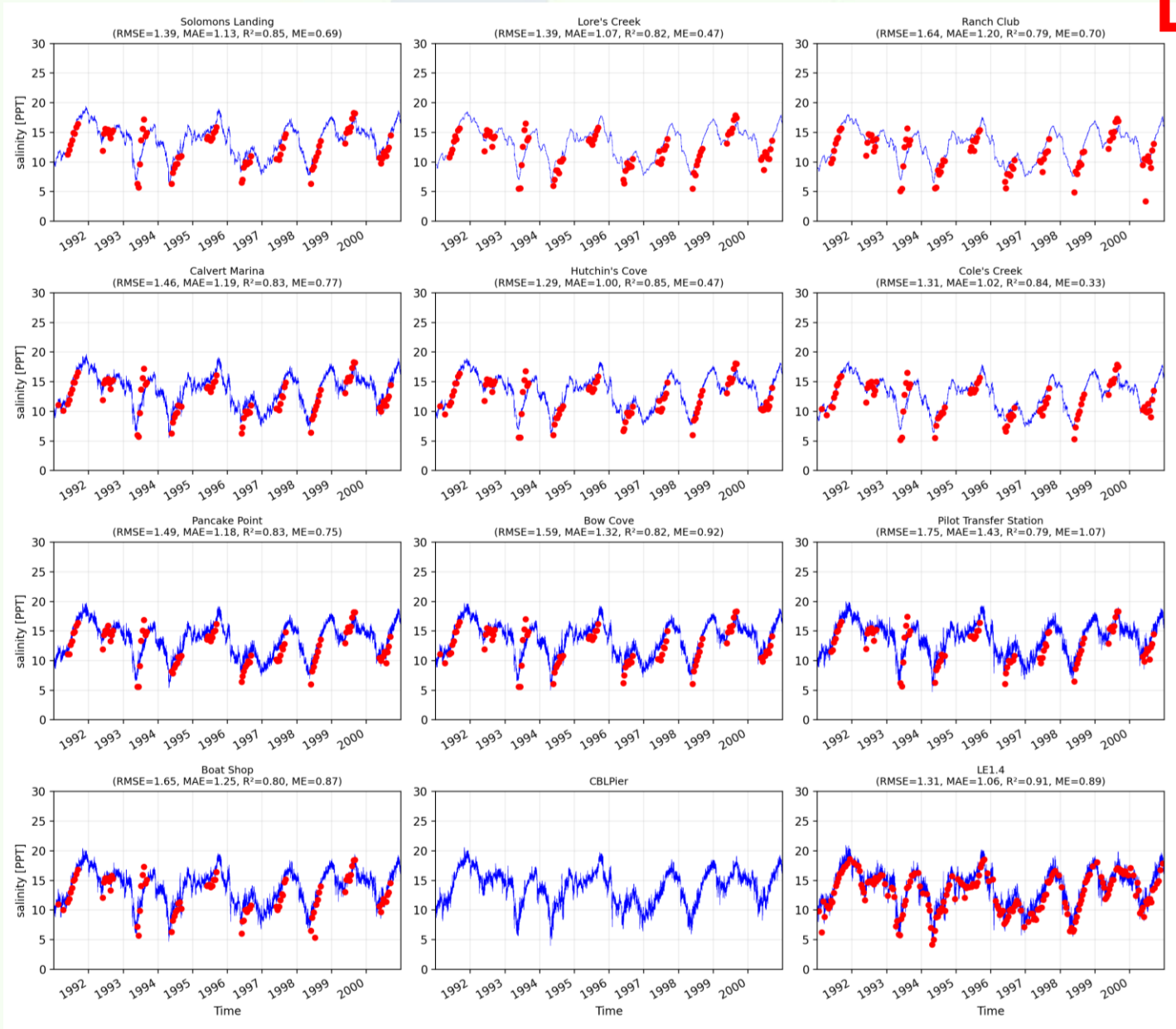

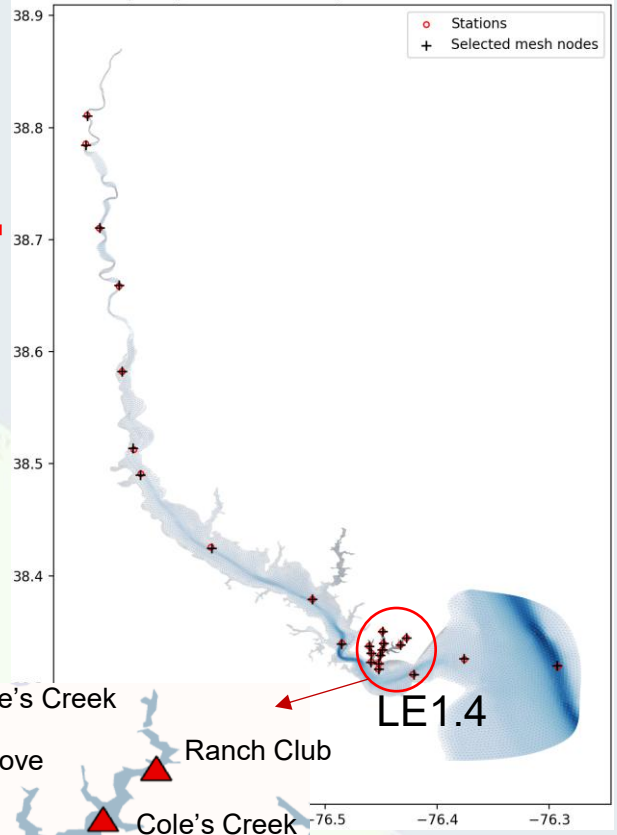

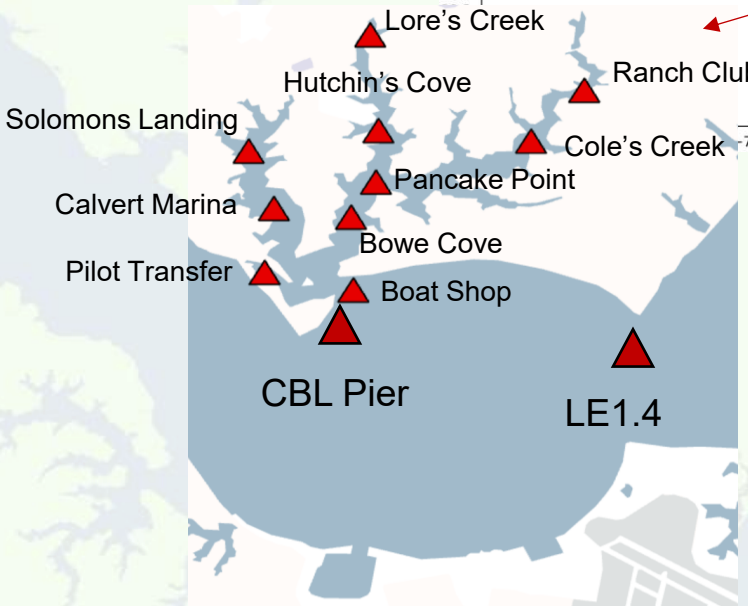

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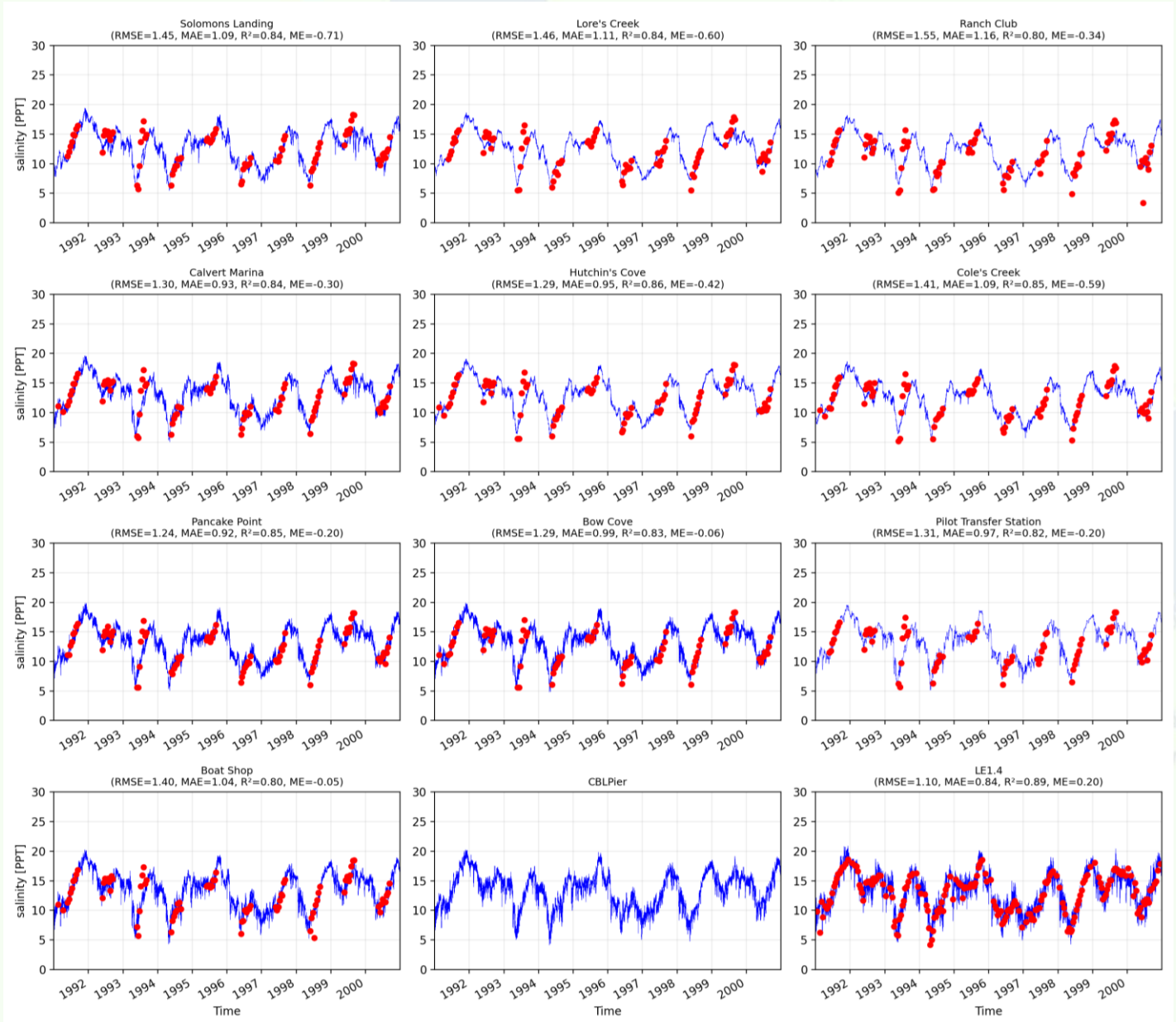

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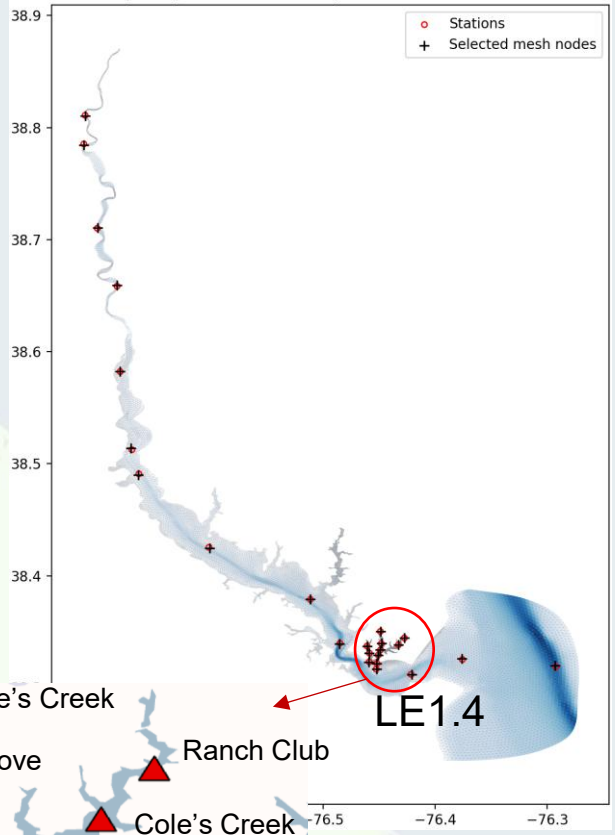

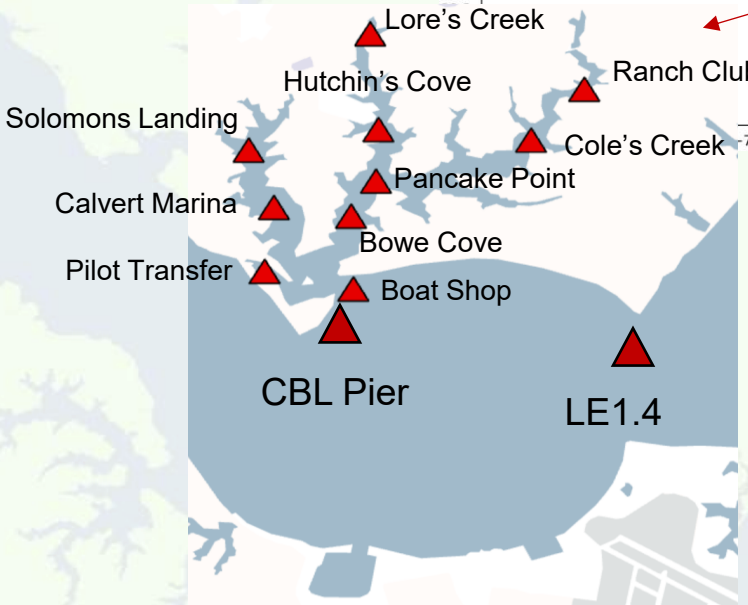

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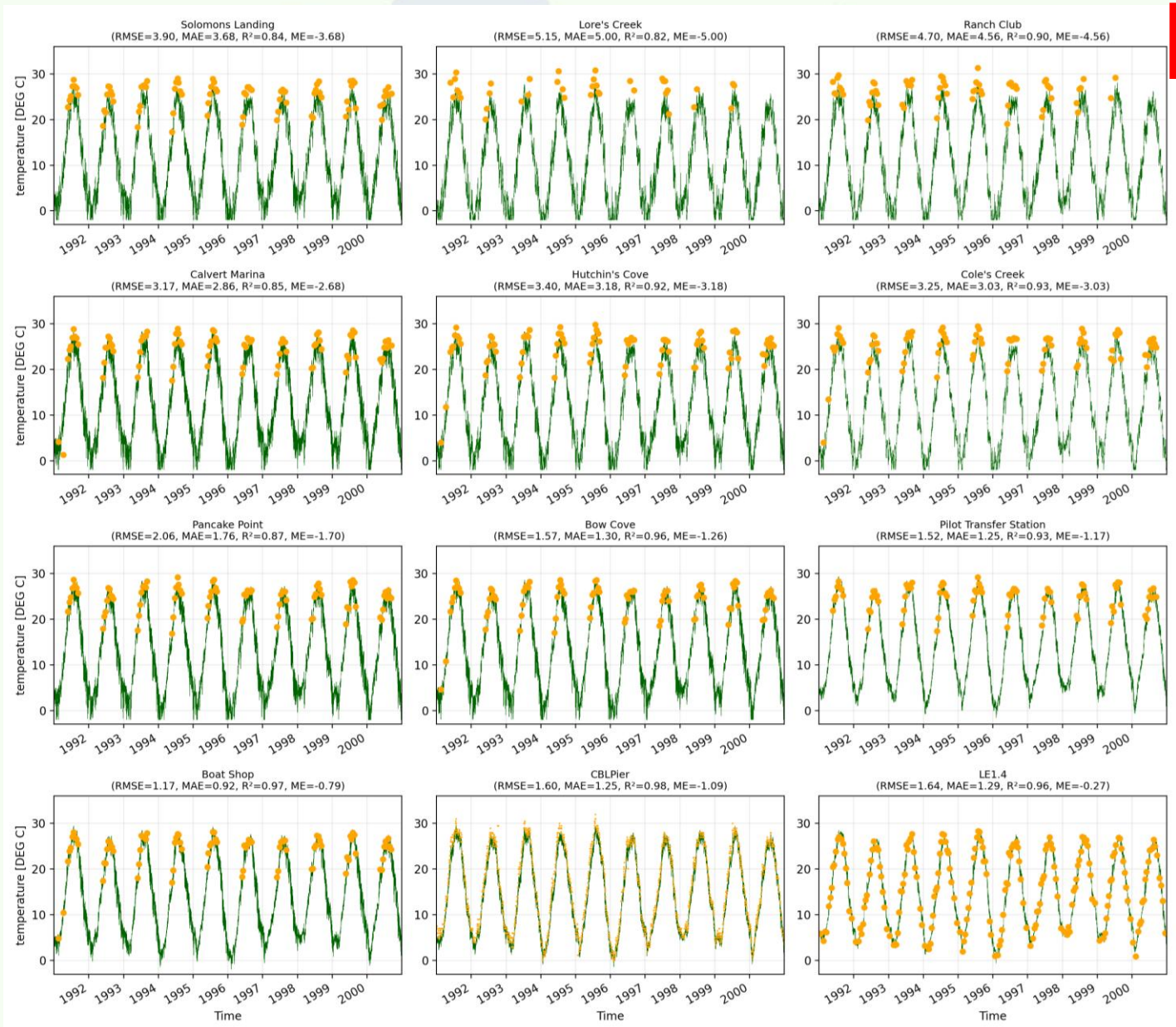

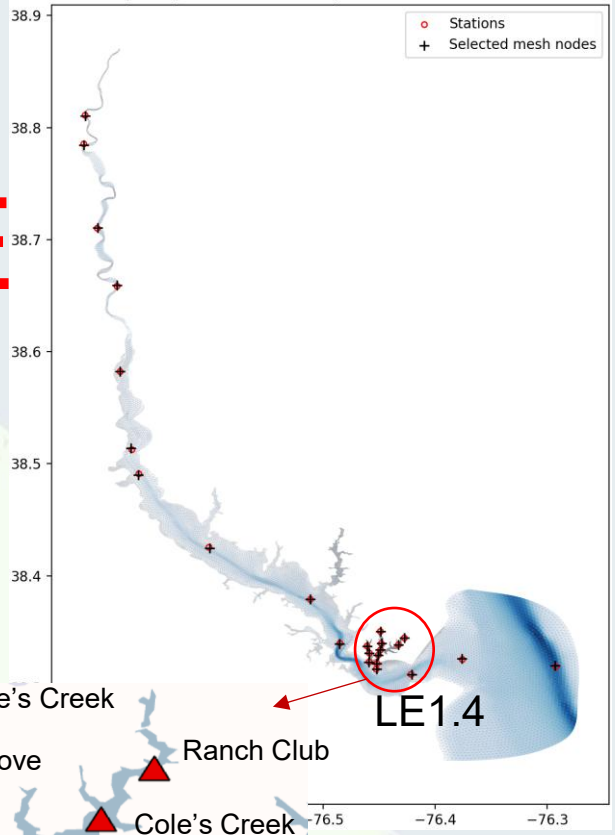

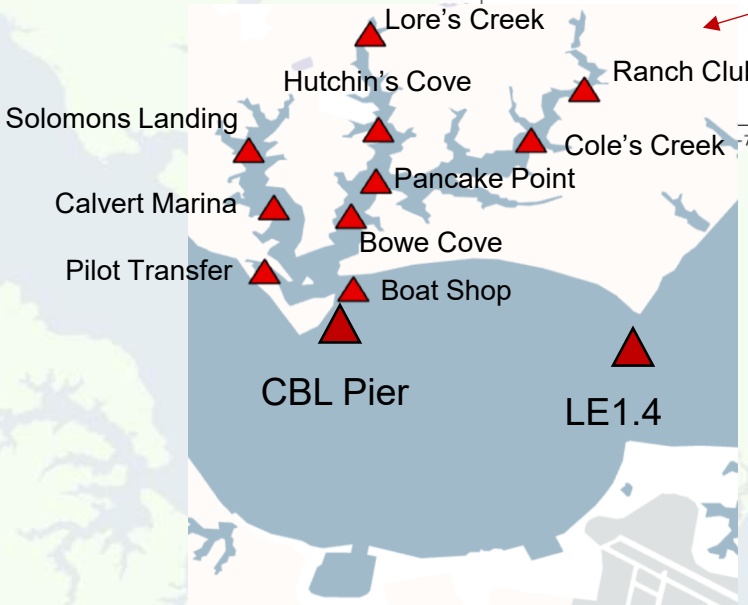

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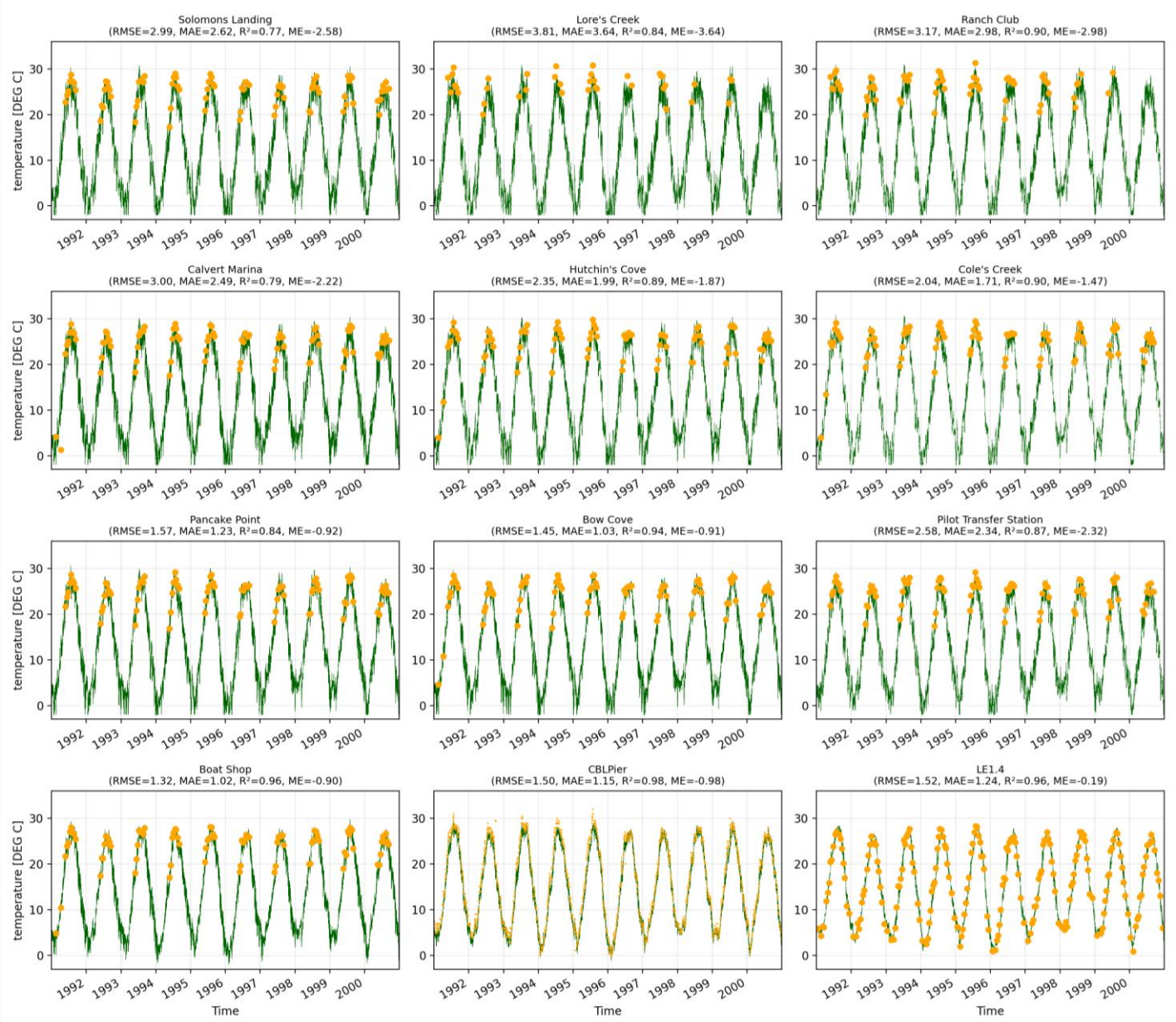
Temperature Validation (1991–2000)



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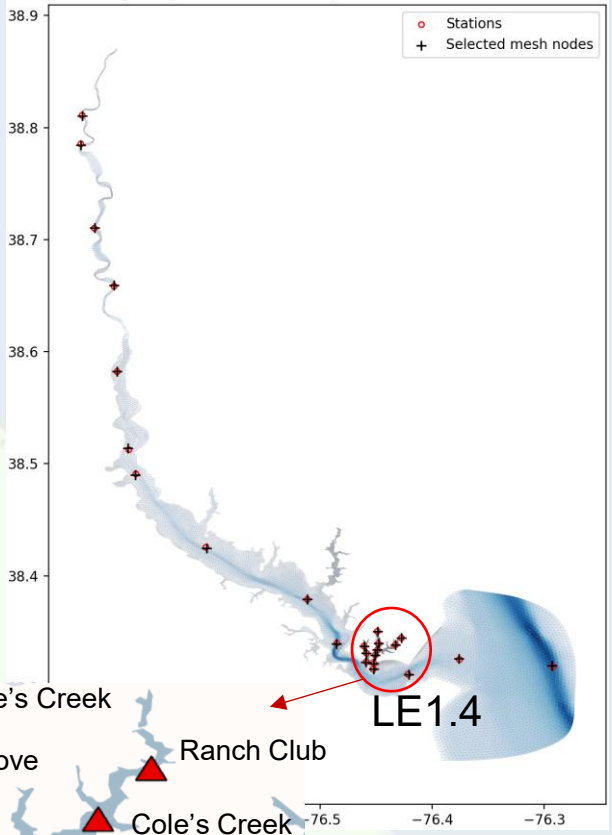

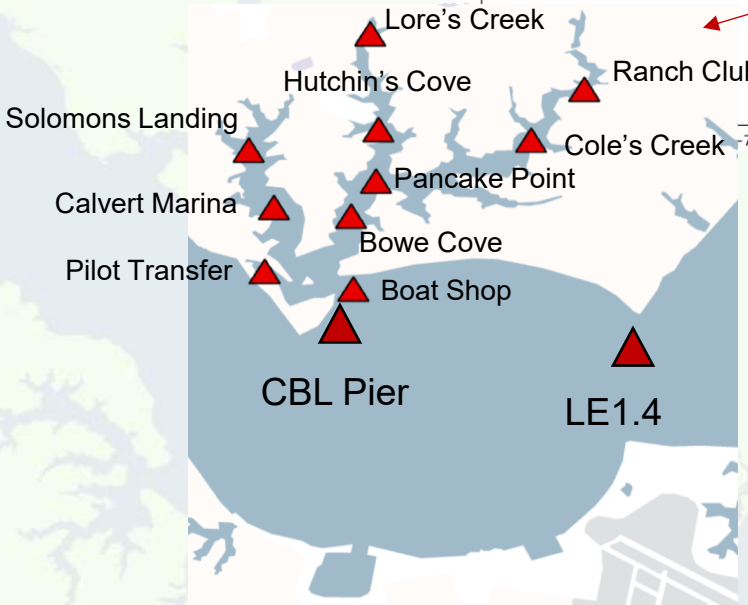

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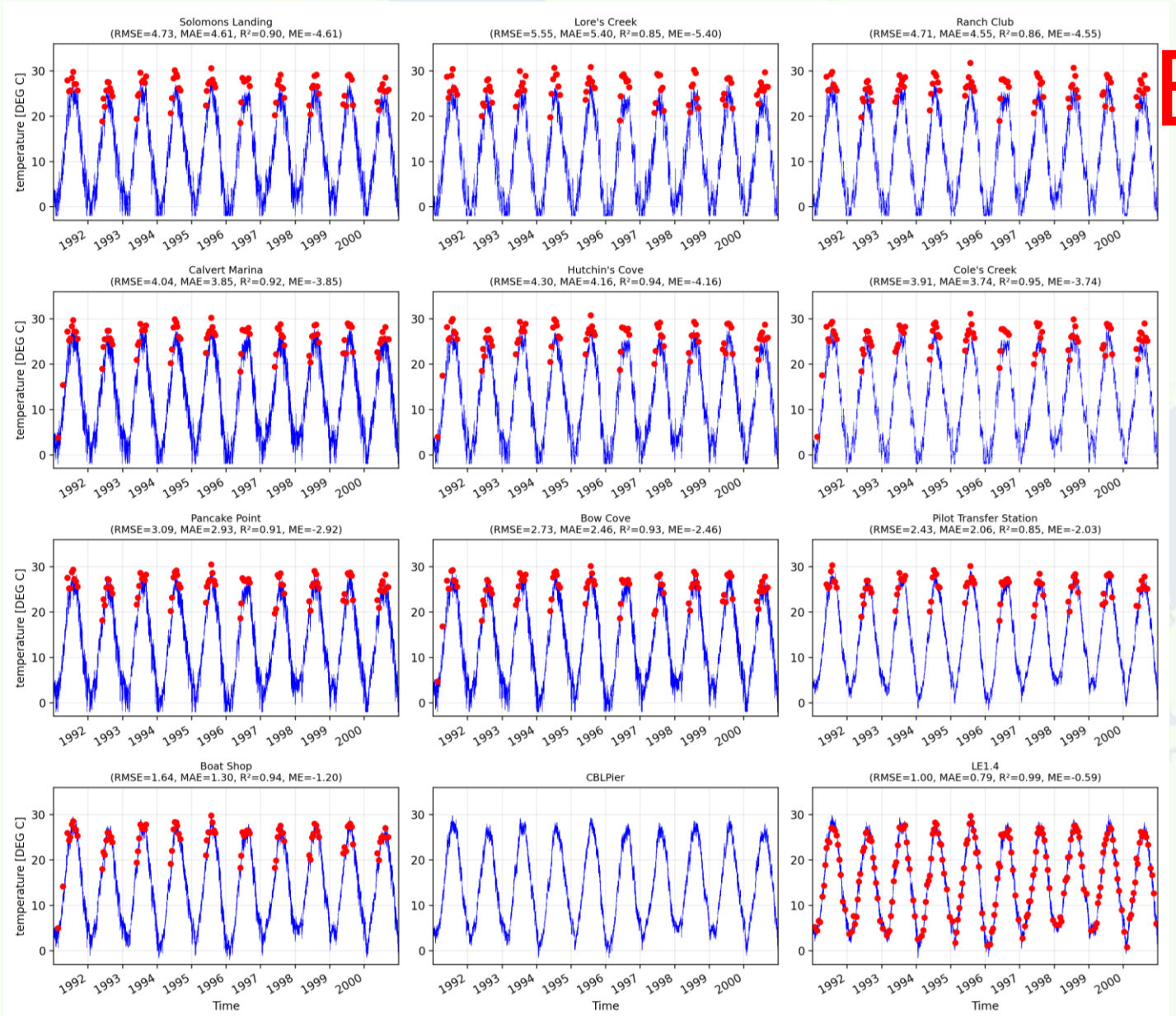

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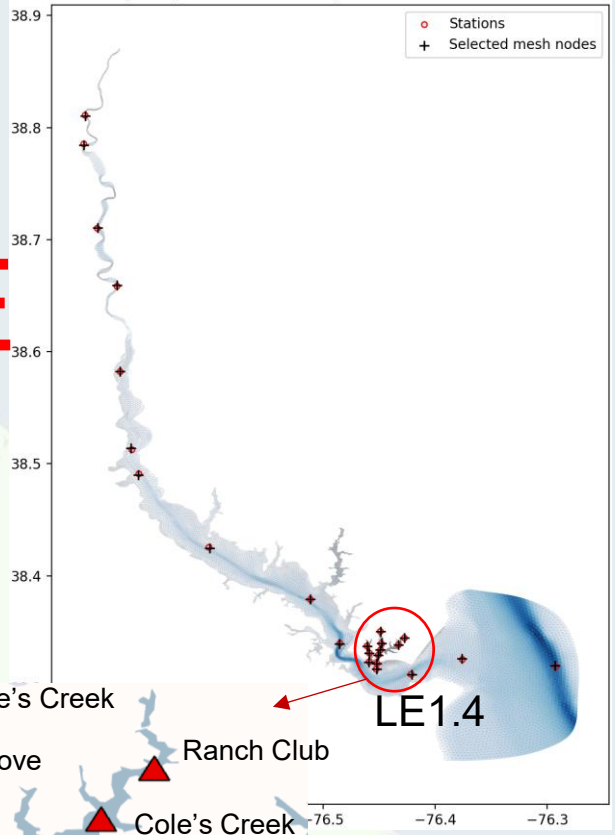

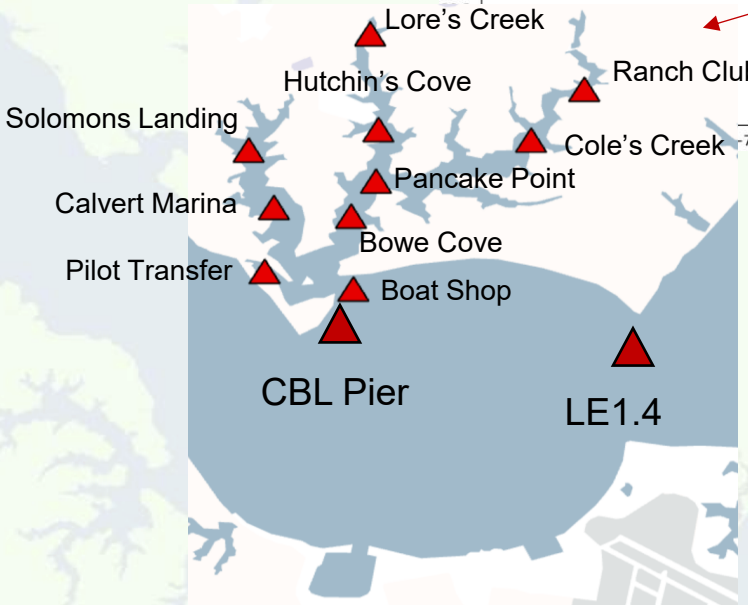

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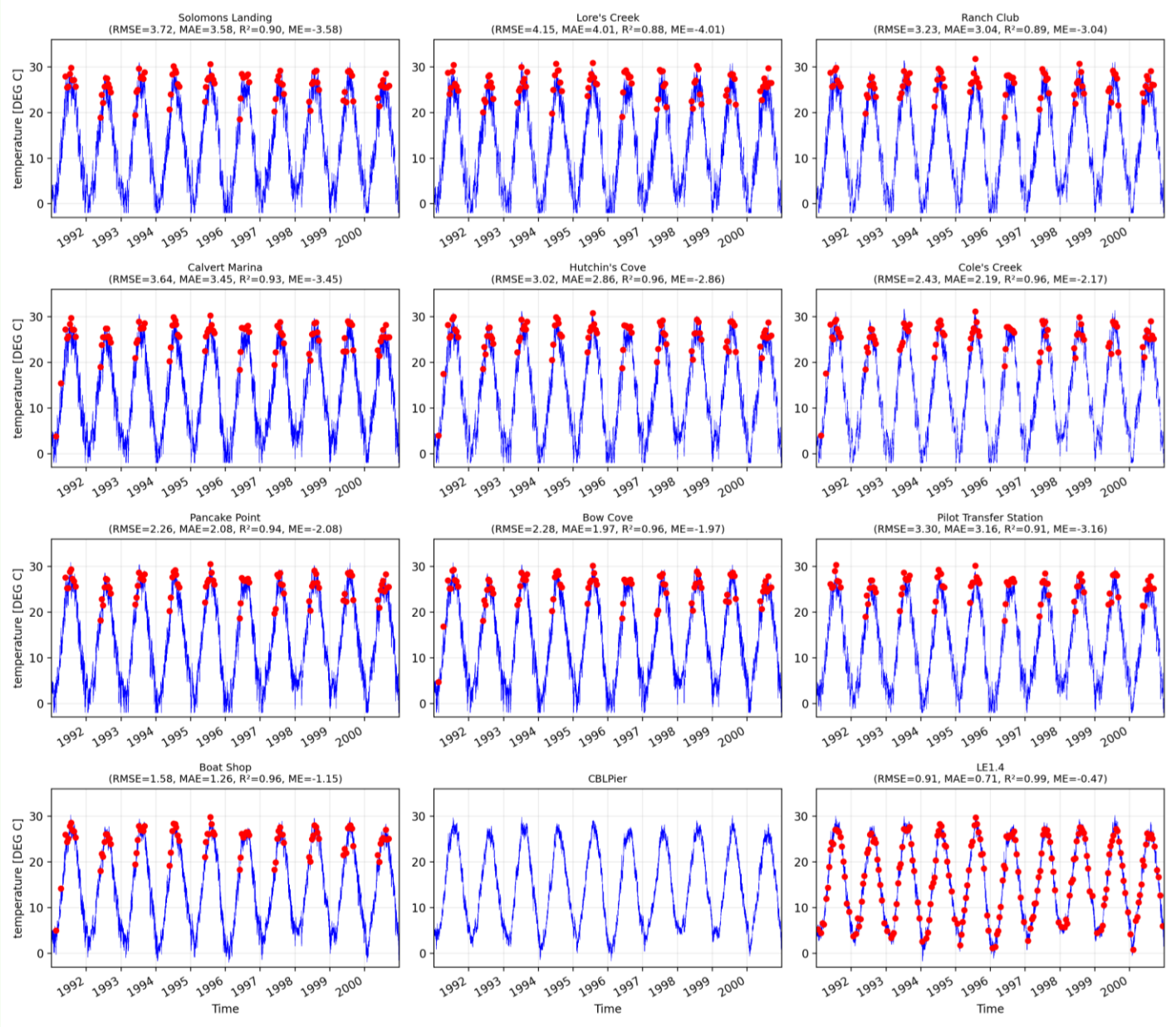

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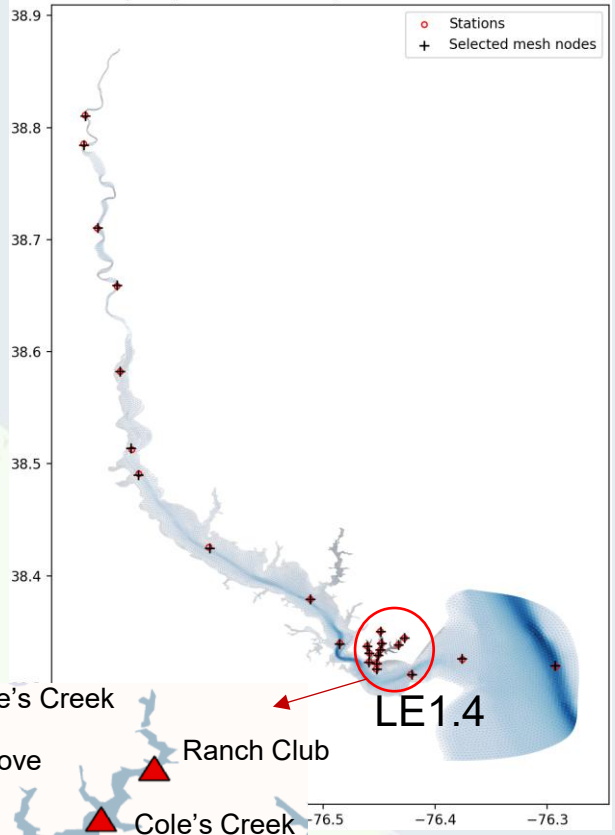
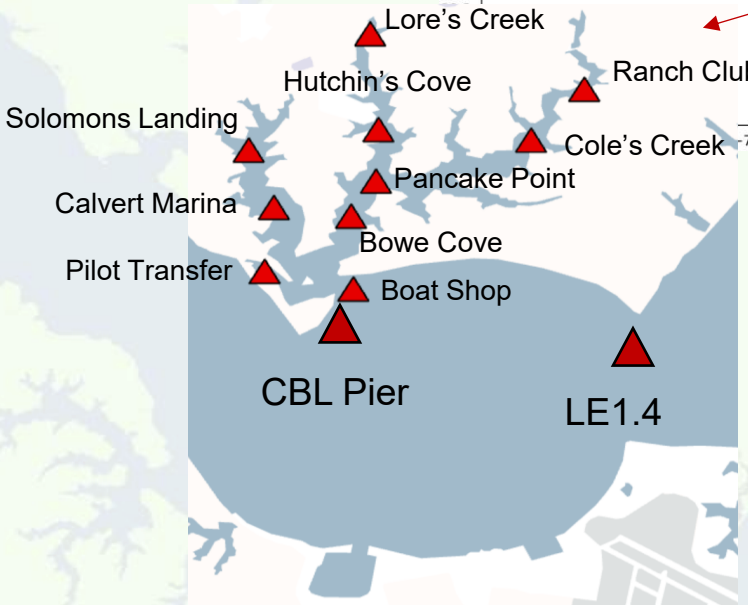




- Surface Temperature in the creeks
- Solomons Harbor stations

Investigation Path

Corrected Freshwater source placement → Include Solomons Island → Corrected air temperature → Adjusted albedo and drag coefficient → Adjusted water type

Main Channel

Average RMSE for Salinity

Surface:

0.99 → 0.94

Bottom:

1.44 → 1.29

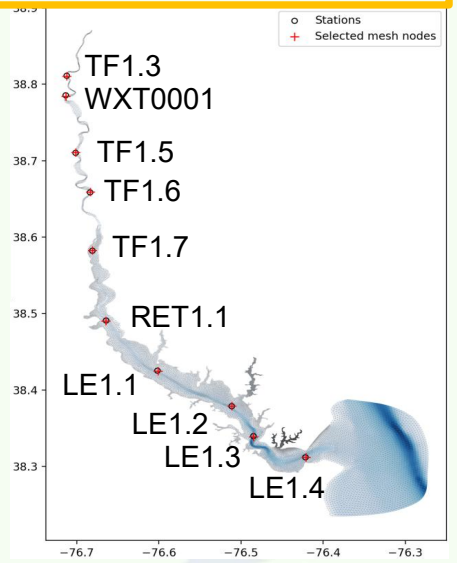
Average RMSE for Temperature

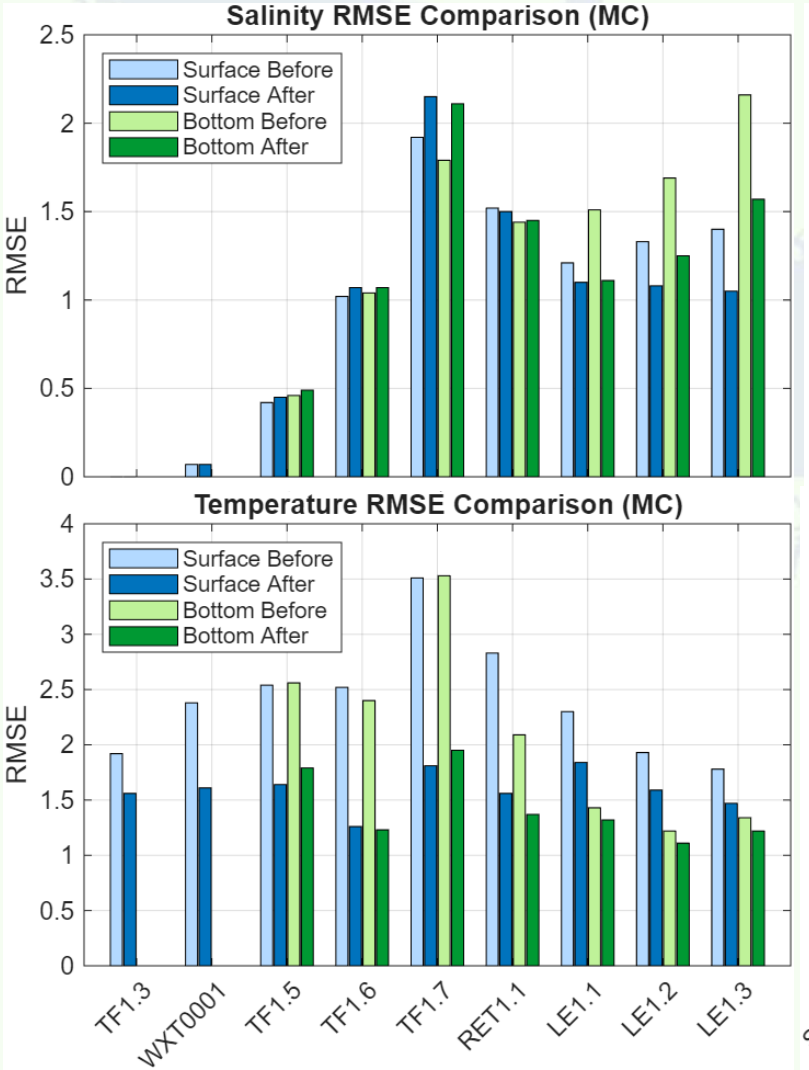
Surface:

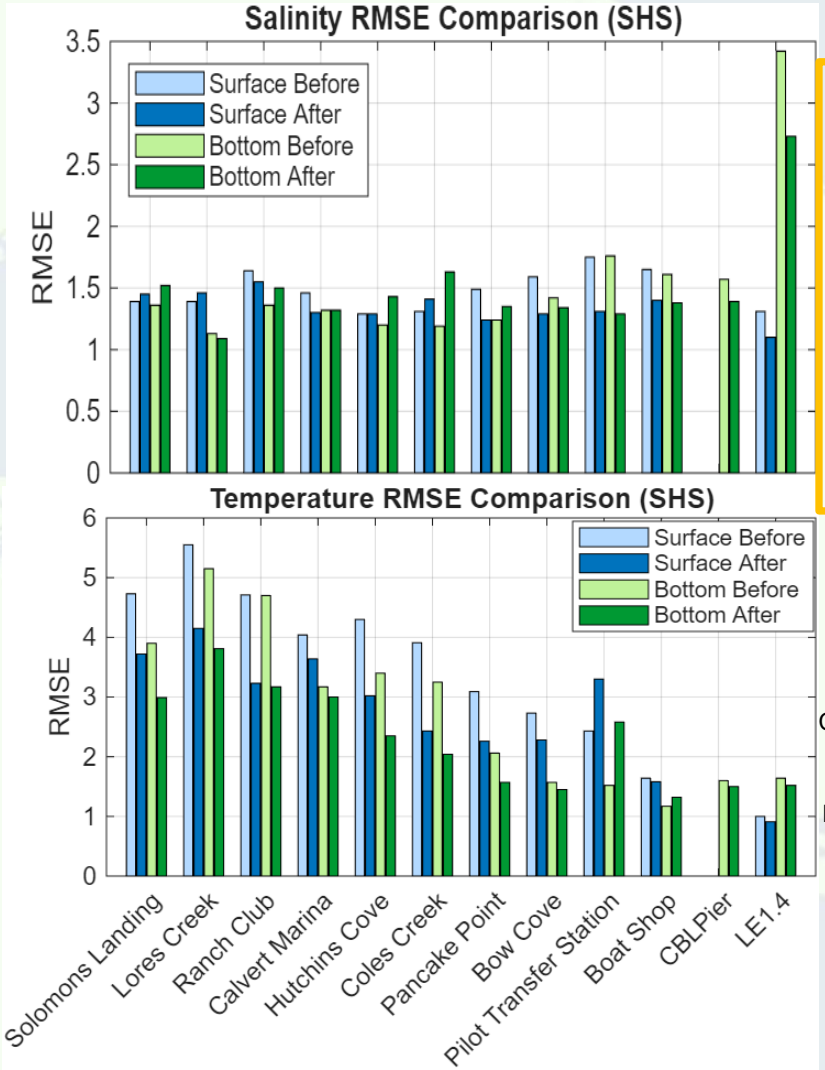
2.41 → 1.59

Bottom:

2.08 → 1.43







Solomons Harbor Creeks

Average RMSE for Salinity

Surface:

1.48 → 1.34

Bottom:

1.55 → 1.50

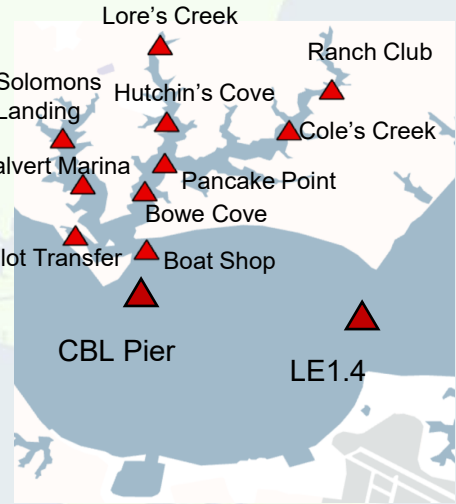
Average RMSE for Temperature

Surface:

3.47 → 2.77

Bottom:

2.76 → 2.27



What I Learned

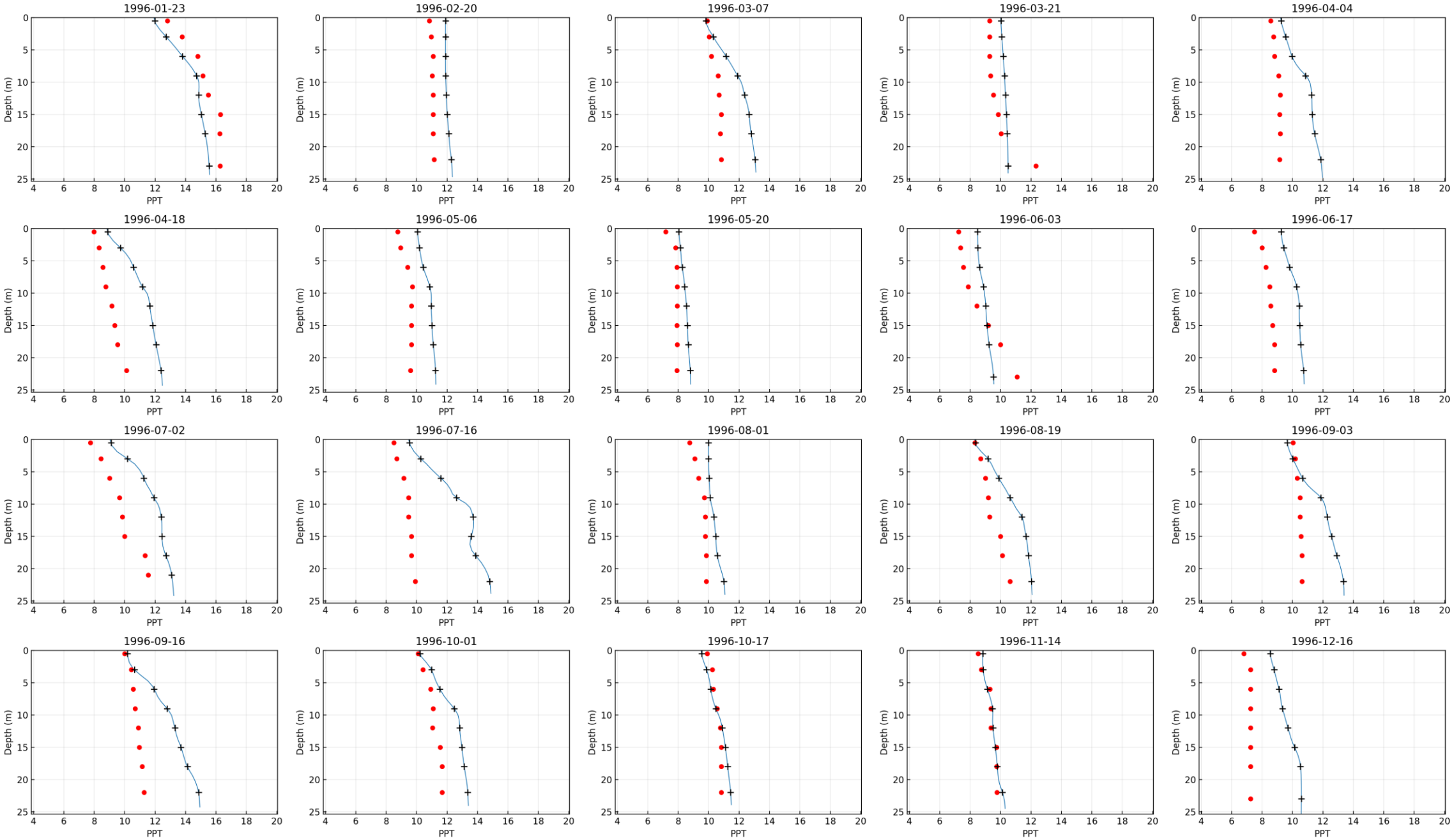
- Atmospheric forcing is critical for temperature accuracy in shallow areas.
- Model now reproduces observed temperature and salinity reasonably well.
- Scenario experiments provide hypotheses for future oxygen studies.

Next Step

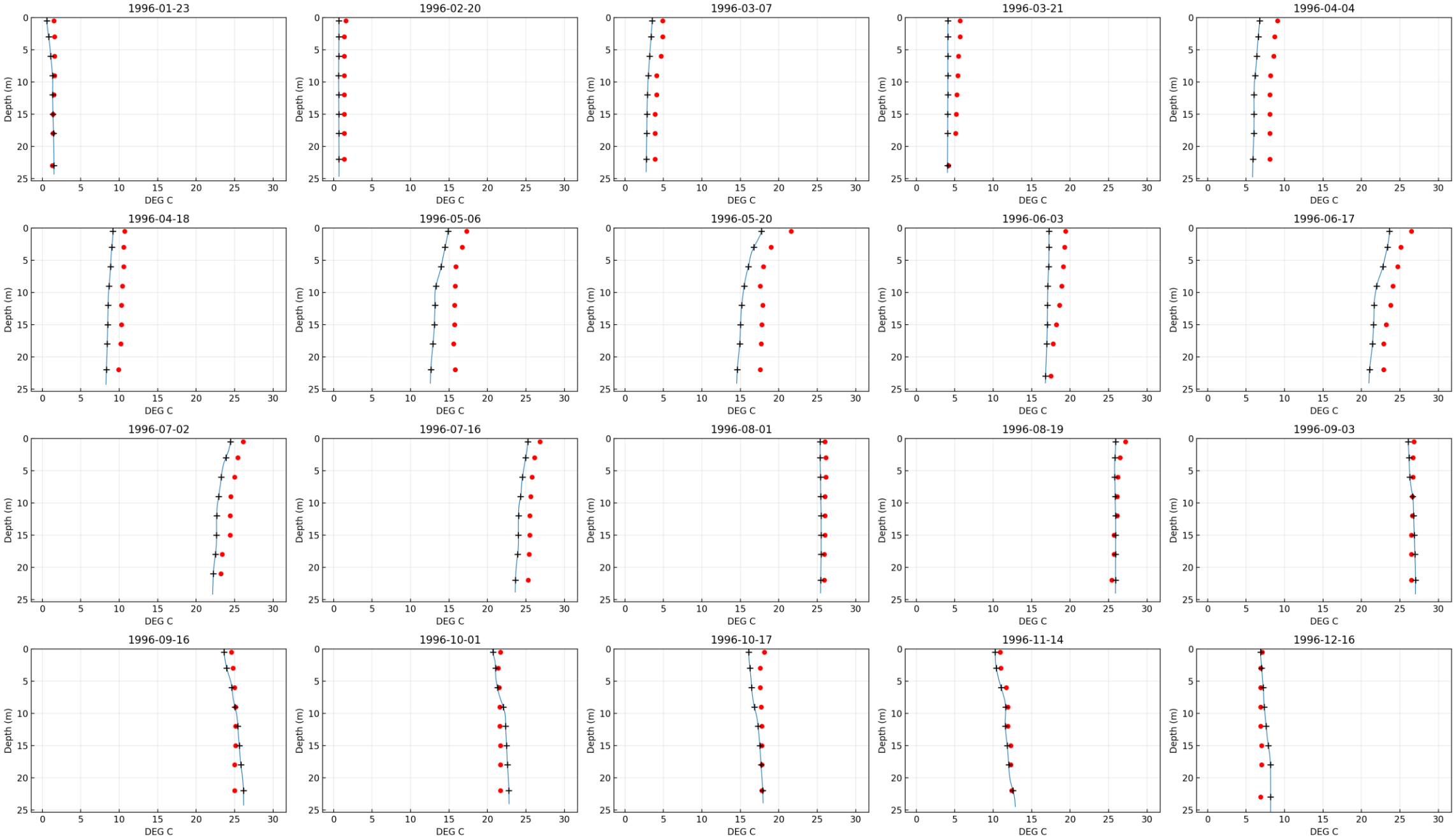
- Implement biogeochemical model
- Validate dissolved oxygen
- Quantify effects of warming and flow changes on oxygen dynamics
- Evaluate physical vs biogeochemical controls

Thank you

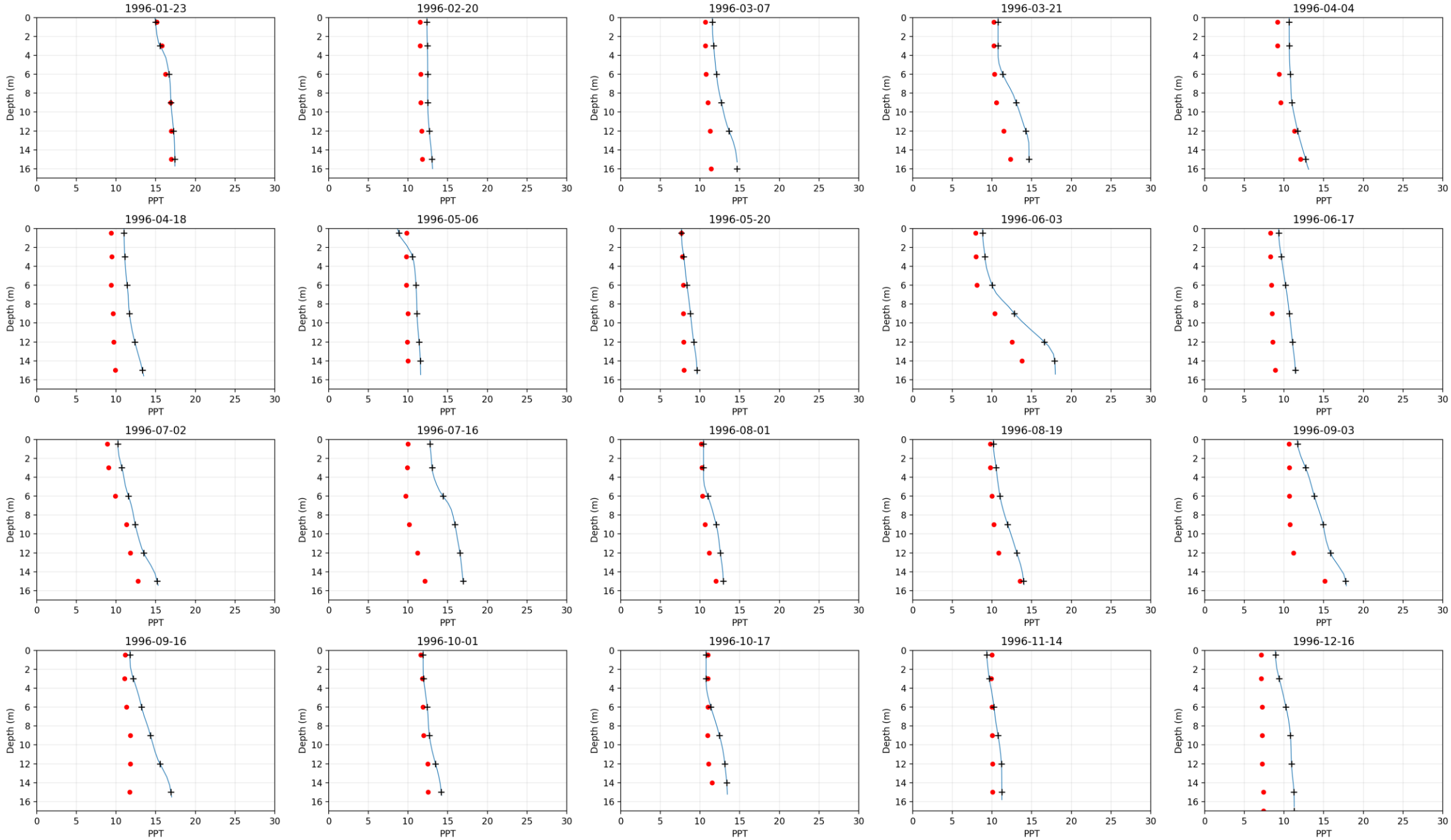
LE1.3 | SALINITY profiles | model=line, obs=red circles, model@obs=black plus



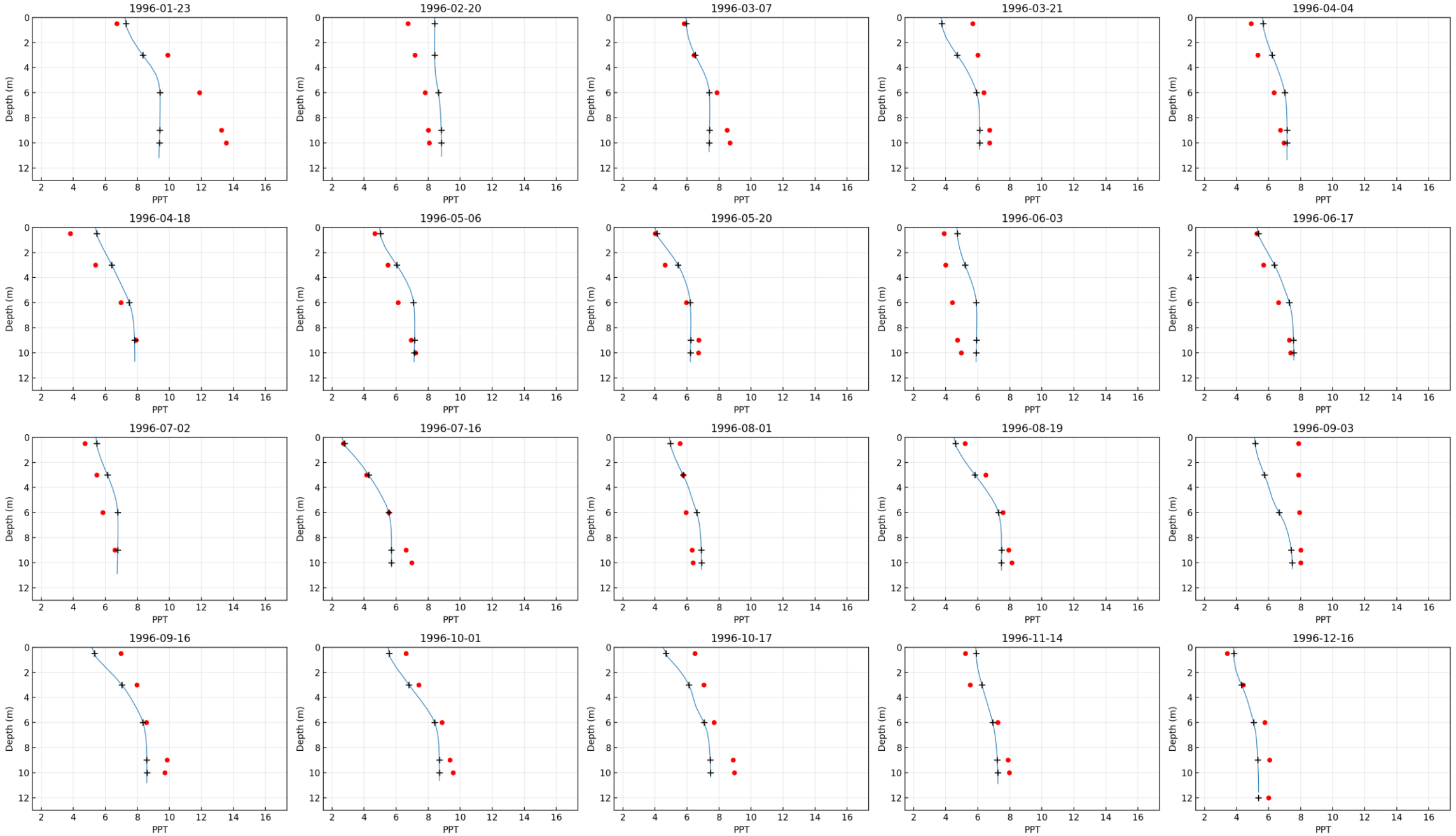
LE1.3 | WTEMP profiles | model=line, obs=red circles, model@obs=black plus



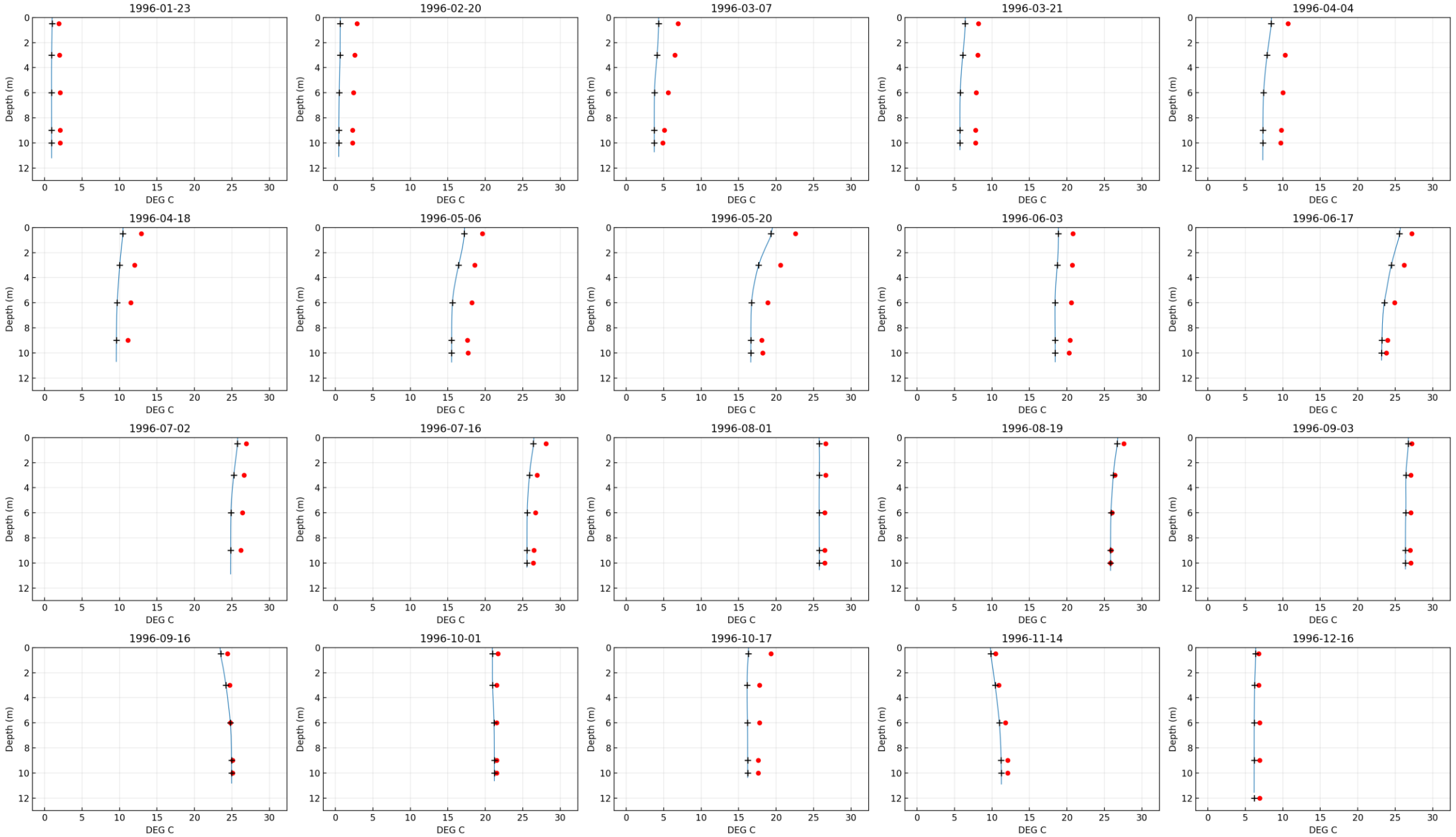
LE1.4 | SALINITY profiles | model: line; obs: circles; model@obs: plus



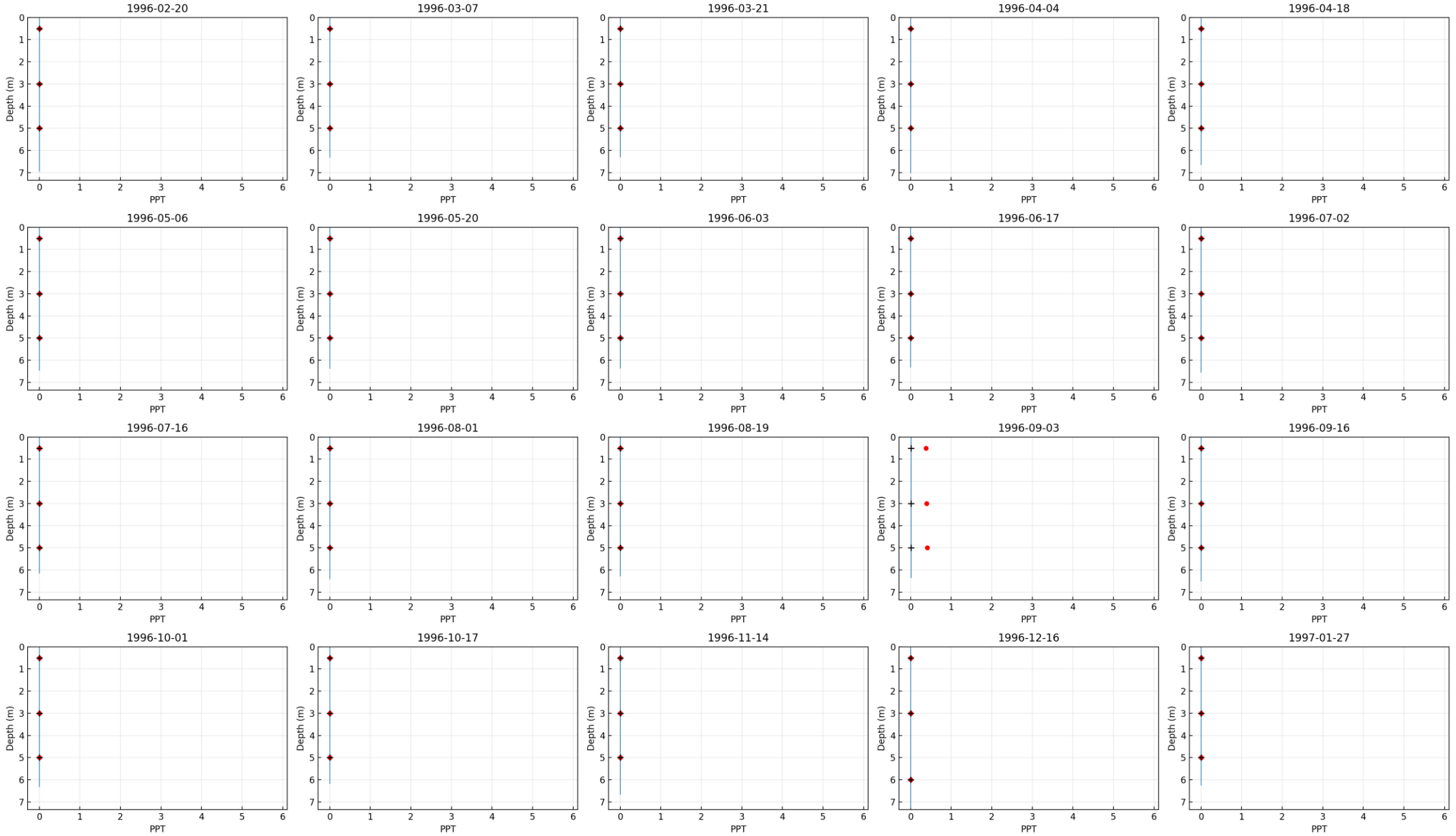
RET1.1 | SALINITY profiles | model=line, obs=red circles, model@obs=black plus



RET1.1 | WTEMP profiles | model=line, obs=red circles, model@obs=black plus



TF1.6 | SALINITY profiles | model=line, obs=red circles, model@obs=black plus



TF1.6 | WTEMP profiles | model=line, obs=red circles, model@obs=black plus