

Presentation on the Corpus Christi Bay, Nueces Bay, and ship channel Far Field Study with Modeler, Spheros Environmental Group with Far Field Committee member comments on study results

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Corpus Christi Water

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Spheros Environmental Group

June 2, 2026



History of Far Field Assessment

Far Field Assessment # 1

SUNTANS Model (2019)

Commissioned by the Port of Corpus Christi

- Stanford Model (originally created for oil spill response and adapted for seawater discharges)

Included:

- 50 MGD POCCA Harbor Island (95 MGD discharge)
- 30 MGD POCCA La Quinta (40 MGD discharge)

Results:

- Less than 1ppt increase, no long-term accumulation

Far Field Assessment # 2

EFDC+ Model (2023)

Commissioned by the Port of Corpus Christi

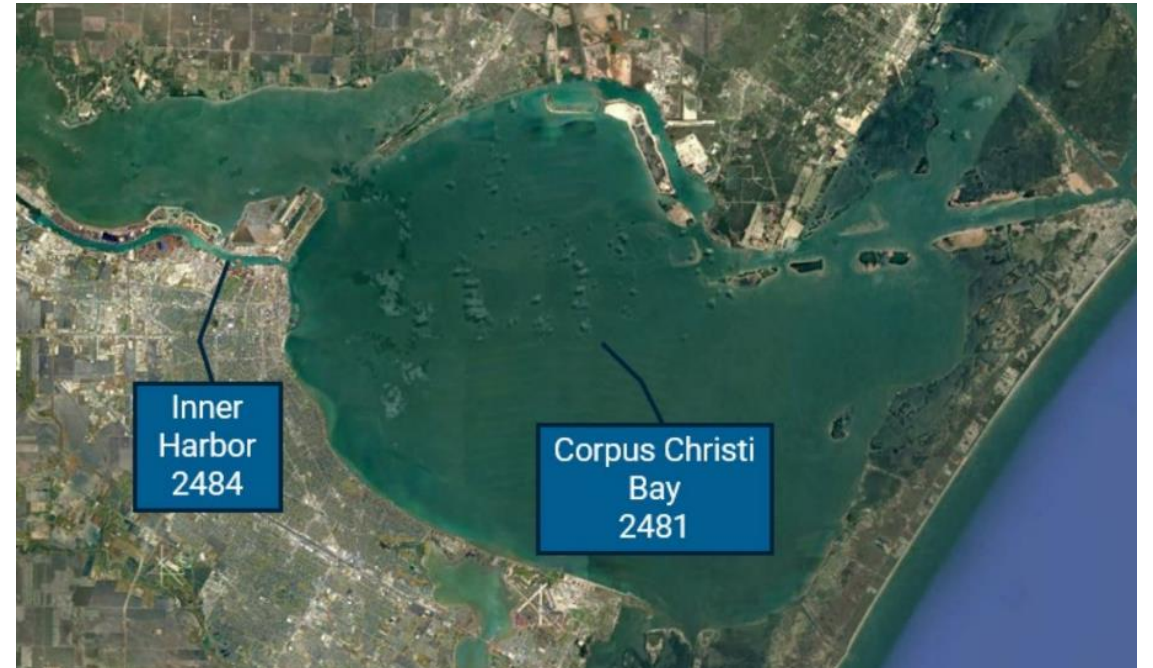
- VA Institute of Marine Science/William and Mary

Included:

- 30MGD POCCA La Quinta (40MGD discharge)
- 50MGD POCCA Harbor Island (95MGD discharge)
- CC Polymers (38.6MGD discharge)
- 30MGD Corpus Christi Inner Harbor (51.5MGD discharge)

Results:

- Less than 0.6ppt increase for 30MGD POCCA La Quinta + 50MGD POCCA Harbor Island



History of Far Field Assessment (cont.)

Far Field Assessment # 3

FNI Mass Balance Evaluation (2024)

Commissioned by the City of Corpus Christi

Included:

- 30 MGD CoCC Inner Harbor (51.5MGD discharge)
- 40 MGD CoCC La Quinta (68.6MGD discharge)

Results:

- 0.3 to 0.6ppt increase

Far Field Assessment # 4

Kiewit/ GHD (2025)

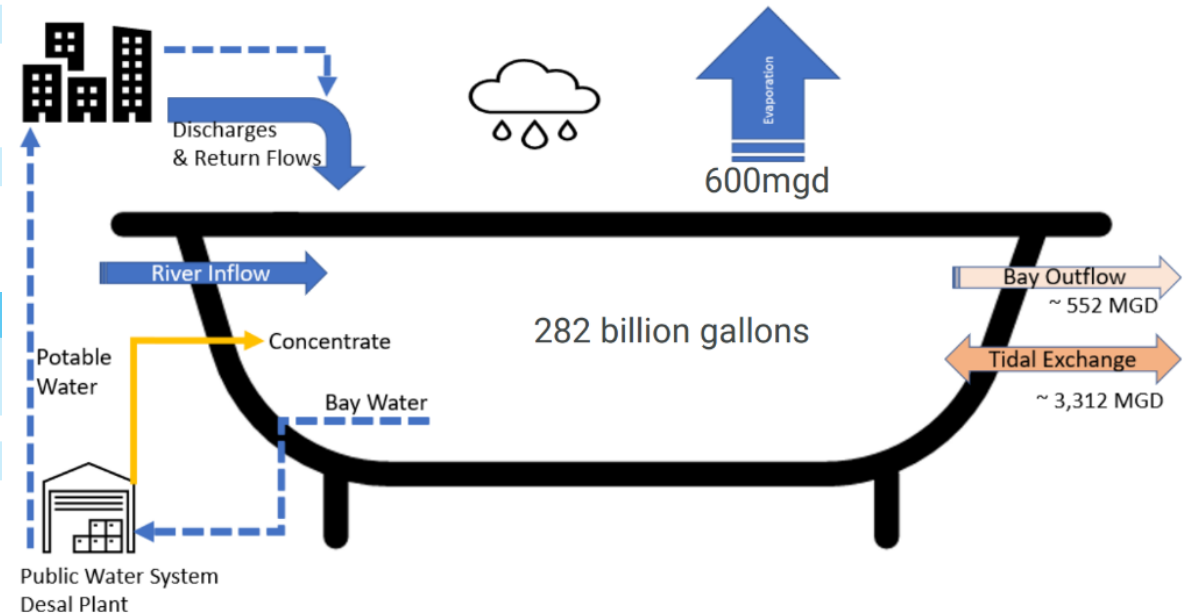
Commissioned by the City of Corpus Christi

Included:

- Near Field
 - Optimization of diffuser design to be compliant with TCEQ discharge permit requirements
- Far Field
 - Prediction of intake characteristics for IHWTC process design

Results:

- Contract terminated before completion



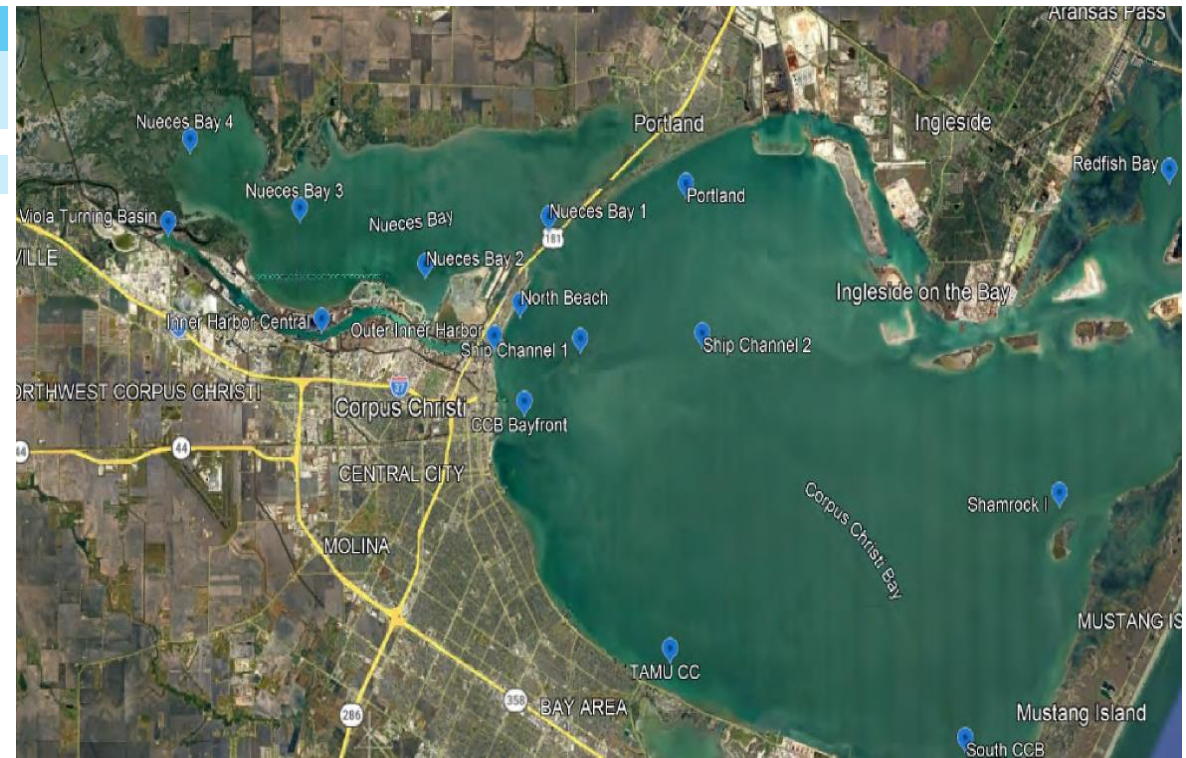
Current Far Field Assessment

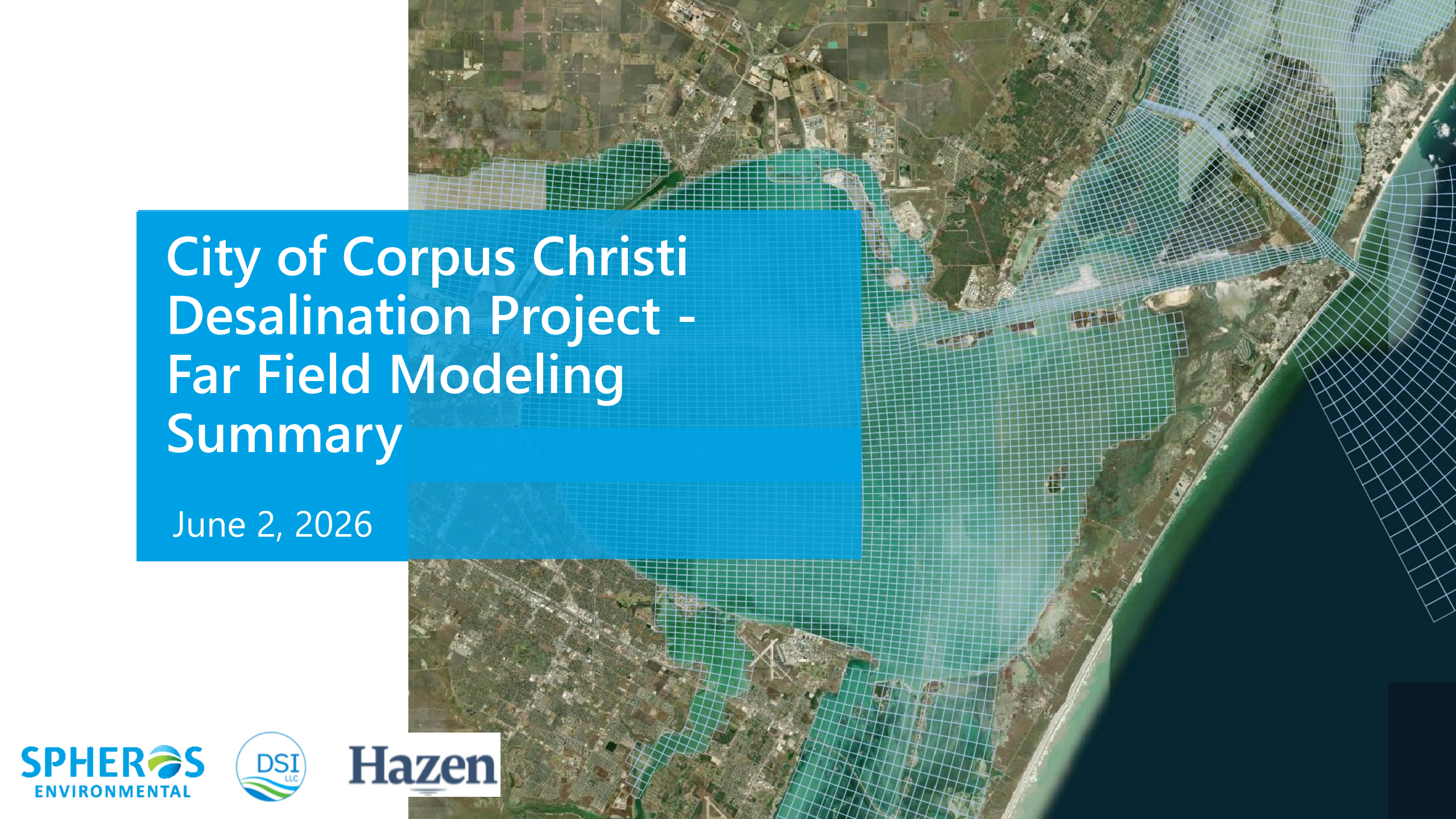
Far Field Assessment # 5

EFDC+ Model (2026) – Spheros Environmental
Commissioned by the City of Corpus Christi

Included discharge scenarios with:

- 30MGD Corpus Christi Inner Harbor
- 30MGD POCCA La Quinta
- 50MGD POCCA Harbor Island
- CC Polymers
- Barney Davis
- Flint Hills
- Citgo
- GCGV
- Nueces Bay Power Station
- Valero
- US Dept of the Navy
- Cheniere





City of Corpus Christi Desalination Project - Far Field Modeling Summary

June 2, 2026

Agenda

- Study Objectives
- Modeling Team
- Estuarine Hydrodynamics
- Far Field Model Development
- Far Field Model Application
- Summary of findings

Study Objectives

- Develop a hydrodynamic model of Corpus Christi Bay to reasonably represent observations of
 - Water levels
 - Salinity
 - Temperature
- Apply the model to evaluate potential changes to salinity within Inner Harbor, Corpus Christi Bay, and Nueces Bay that could result from brine discharges from the proposed desalination plant

Specific Modeling Tasks in the Scope of Work

- Develop a baseline simulation
 - Incorporate recent bathymetry and improve model resolution in the Inner Harbor (Mod #1)
 - Extend model inputs to recent years (Mod #4)
- Process enhancements
 - Dynamic mixing of desalination plant intake and return to assess recirculation effects in the Inner Harbor (Mod #2)
 - Ship traffic – simulate effects of large ship traffic on brine mixing (Mod #3)

Modeling Team



& Far Field Advisory Committee



Pradeep Mugunthan,
PhD, PE

Lead Modeler, Project
Manager, Spheros



Binglei Gong, MSC
Hydrodynamic
Modeling Support



**Shahab
Karimifard, PhD**
Modeling &
Water Resources
Management



**Amir
Sedaghatdoost, PhD**
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Modeling Support



Brennan Richardson
Field Data Collection
Specialist



Alex Smith, PhD
Coastal Ecosystem
Dynamics



Wally Darling, PG
Field Data Collection
& Dashboard
Development



Paul Craig, PE



Tran Duc Kien, PhD



Szu-Ting Lee, PE



**Mehrzad
Shahidzadehasadi**

DSI, Inc. Support Staff



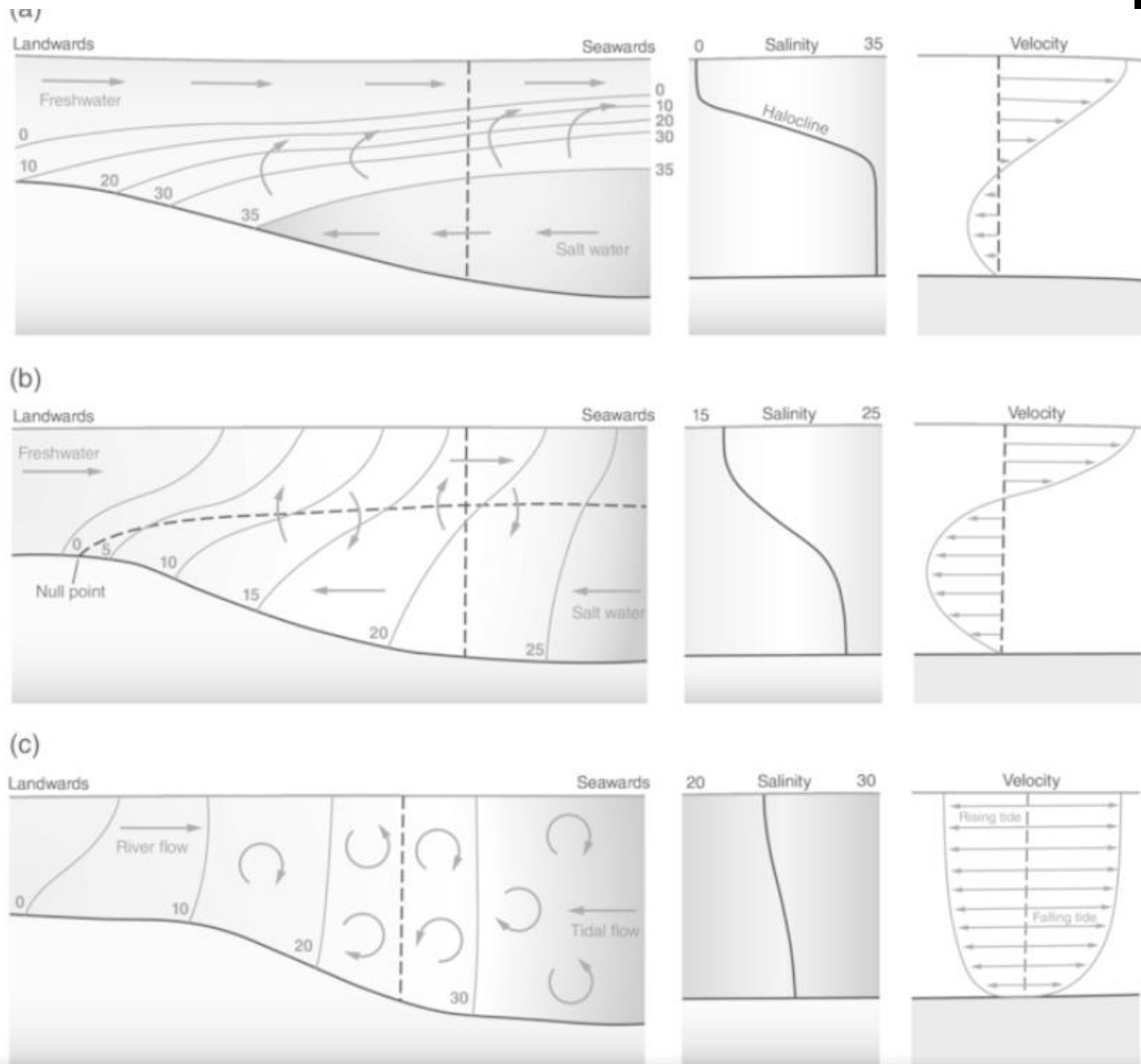
Tim Osting, PE,
DWRE, CFM



Amin Kiaghadi,
PhD, PE

Hazen and Sawyer

Estuarine and Coastal Hydrodynamics



Salt-wedge – strongly stratified – typically bottom to surface salinity differences > 30 ppt, or bottom to surface density differences > 20 kg/m³

Partially mixed – moderately stratified - typically bottom to surface salinity differences 3 – 30 ppt, or density differences are between 2 – 20 kg/m³

Well mixed – weakly stratified - typically bottom to surface salinity differences < 3 ppt, or density differences < 2 kg/m³

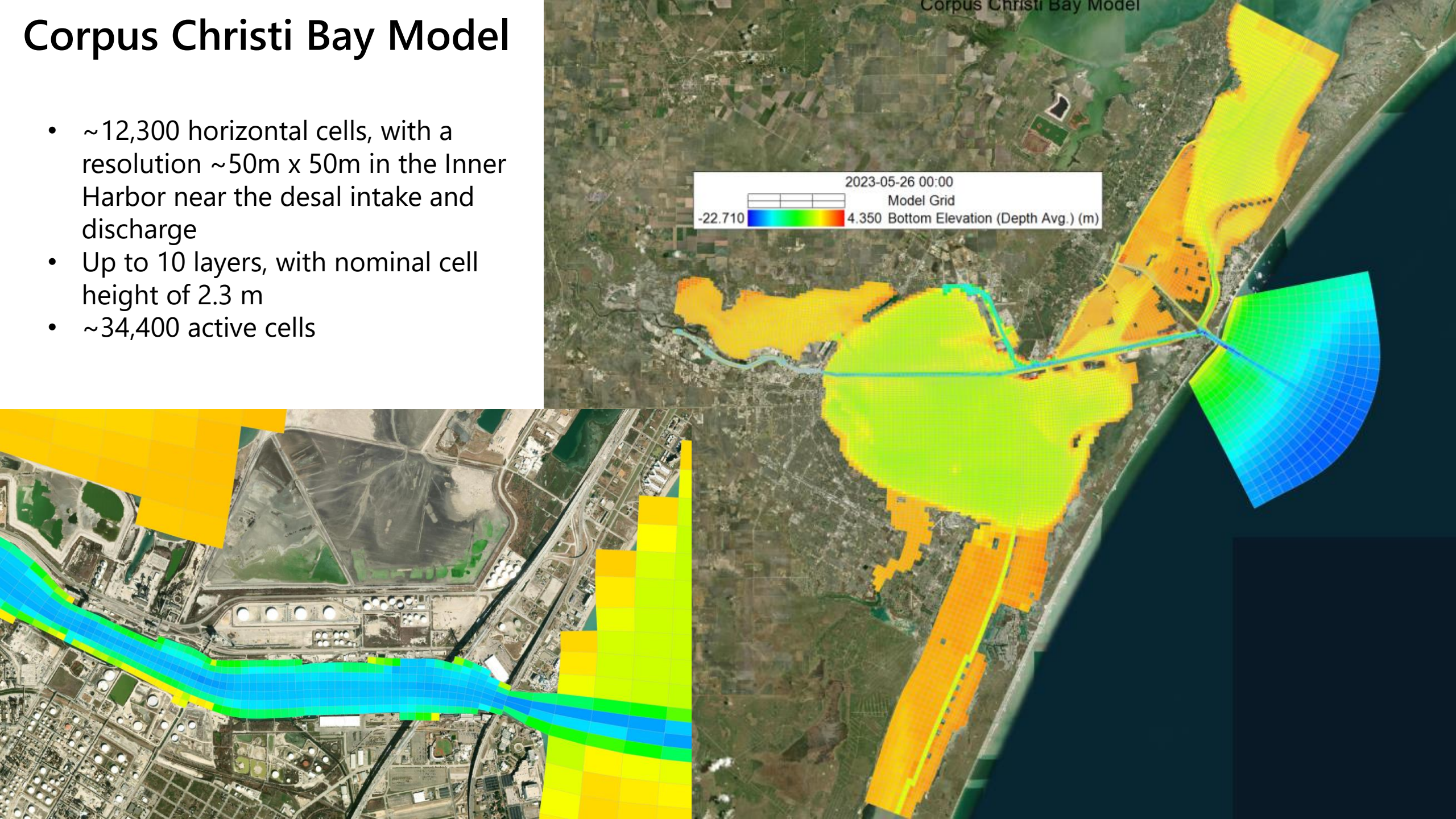
Image Source: The Urban Ocean by Blumberg and Bruno (2018)

What Does a Hydrodynamic Model Do?

- Applies fundamental scientific principles of energy, momentum and mass conservation to predict
 - Water movement and water levels
 - Transport of heat and salinity
- Models provide a prediction of reality at discrete points in space and time
 - It cannot replicate nature exactly
- Models are constrained by field measurements
 - A good model will reproduce field measurements reasonably well
- Model is a tool, when constrained and applied correctly can provide insights on effects of perturbations to a system (in this case the effect of desalination plant operation in Corpus Christi Inner Harbor)

Corpus Christi Bay Model

- ~12,300 horizontal cells, with a resolution ~50m x 50m in the Inner Harbor near the desal intake and discharge
- Up to 10 layers, with nominal cell height of 2.3 m
- ~34,400 active cells

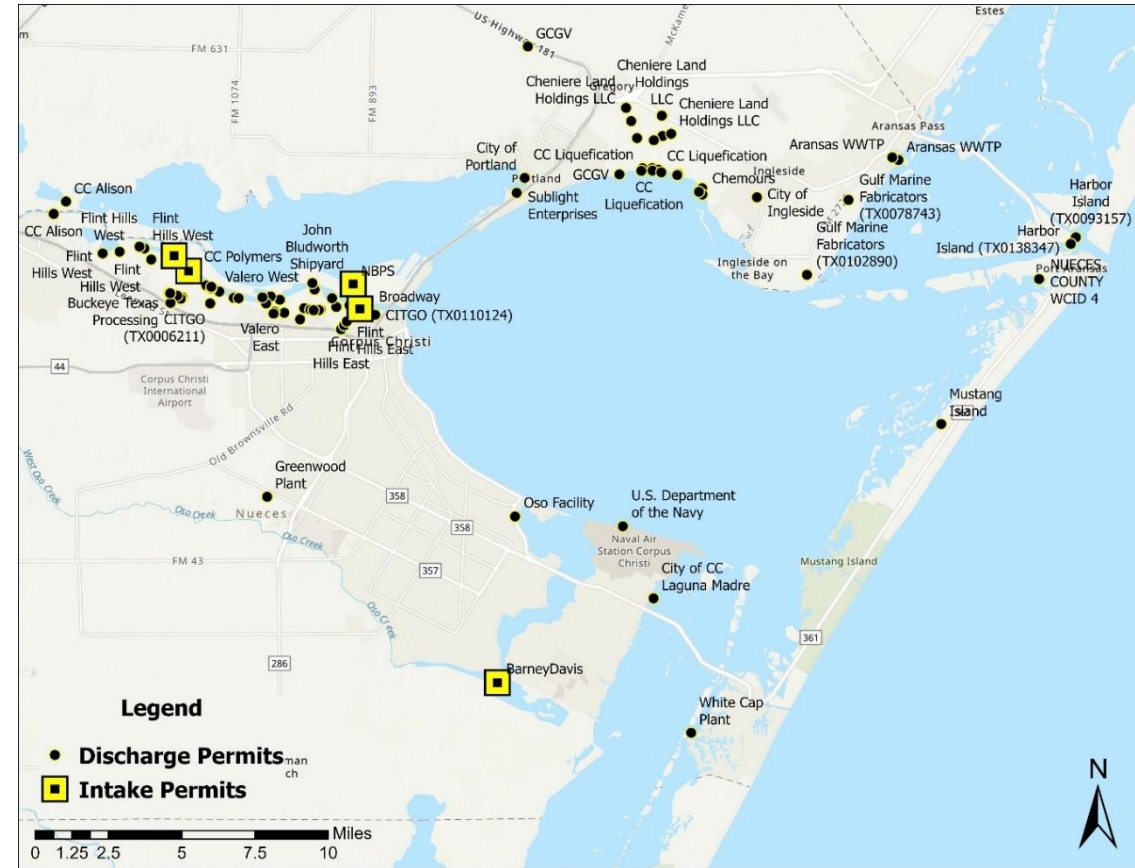


Overall Modeling Approach

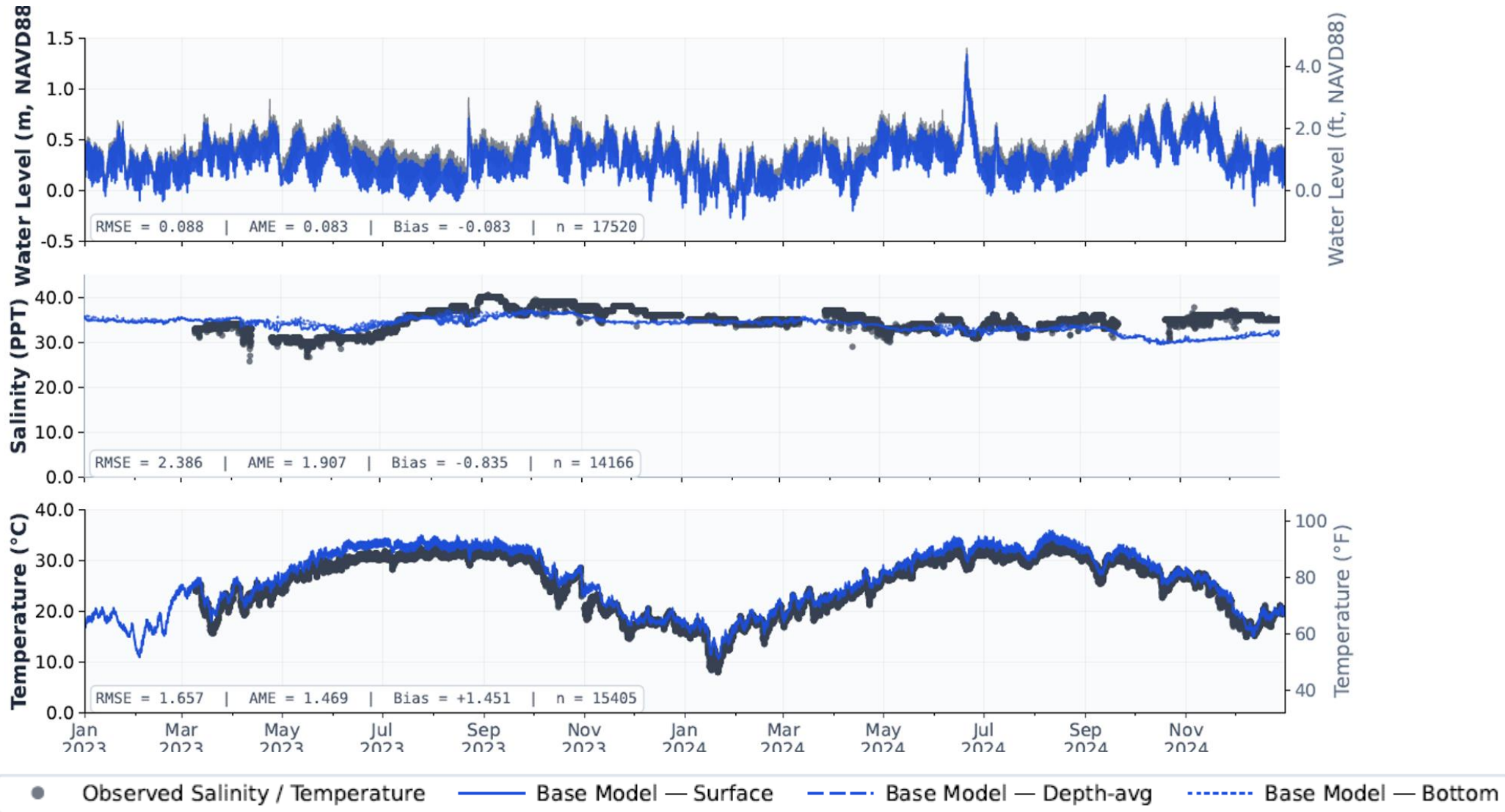
- Develop and validate model for 2023-2024 conditions
- Apply model with desalination intake and discharge
 - Existing conditions without ship traffic
 - Hypothetical future conditions
 - Assess potential mixing from ship traffic

Information Sources for Model Development

- **Bathymetry** - NOAA BlueTopo (compiles latest bathymetry data from various sources)
- **Water levels** – NOAA, CBI
- **Salinity** – USGS, CBI, TWDB, TCEQ
- **Temperature** – NOAA, CBI, USGS
- **Point sources/withdrawals**
 - TCEQ discharge permits and DMRs
 - Water rights permits

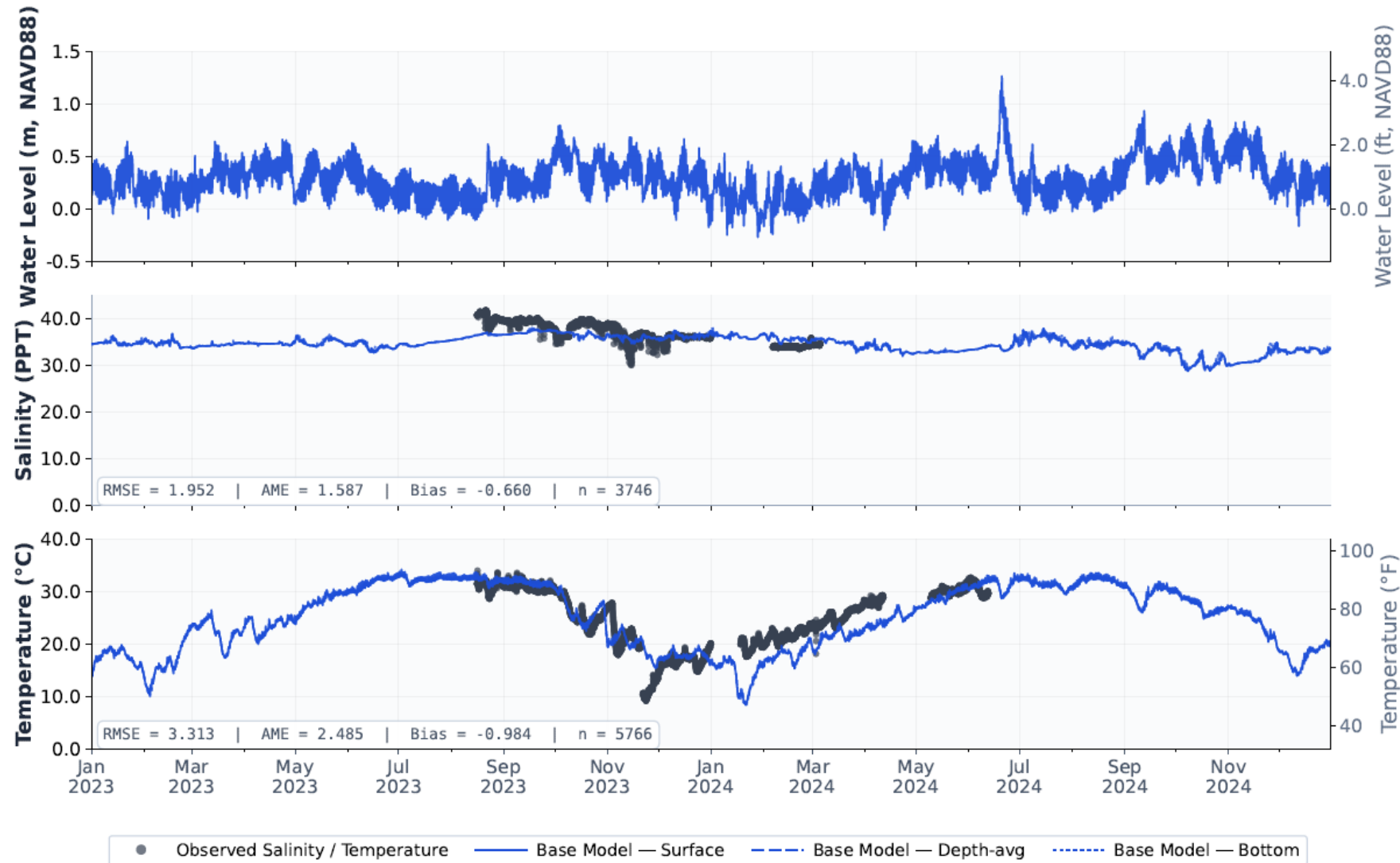


Model Performance at the Inner Harbor Mouth



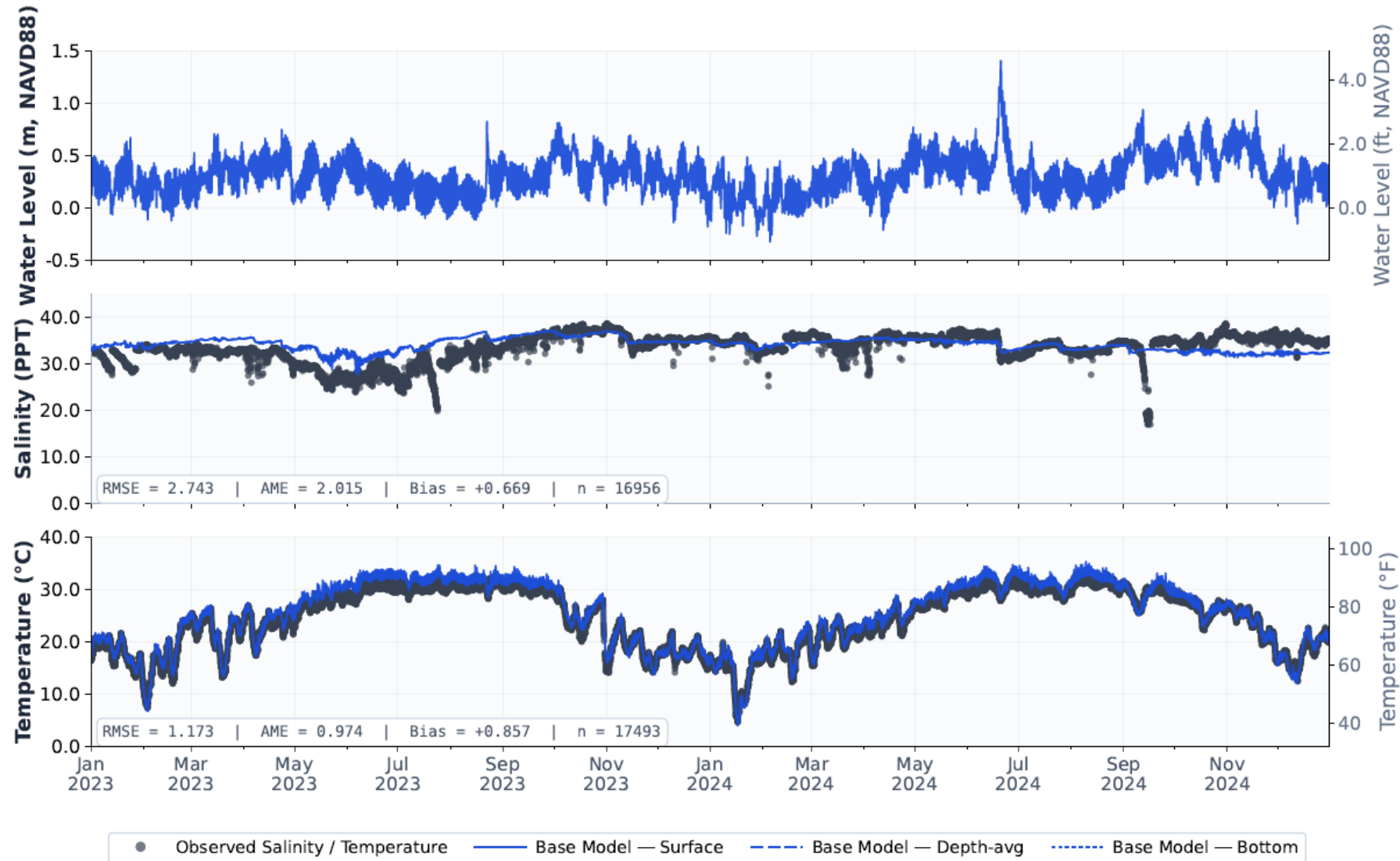
Notes: Water levels and temperature at NOAA USS Lexington Station. Salinity is at USGS CC Bay Station. Model predicted salinity is in parts per thousand (PPT), while salinity measurements are in practical salinity units (PSU). Differences between these two units are negligible for normal ocean salinity ranges and are assumed to be equivalent for model-data comparisons.

Model Performance in Corpus Christi Bay



Notes: Model predicted salinity is in parts per thousand (PPT), while salinity measurements are in practical salinity units (PSU). Differences between these two units are negligible for normal ocean salinity ranges and are assumed to be equivalent for model-data comparisons.

Model Performance within Nueces Bay

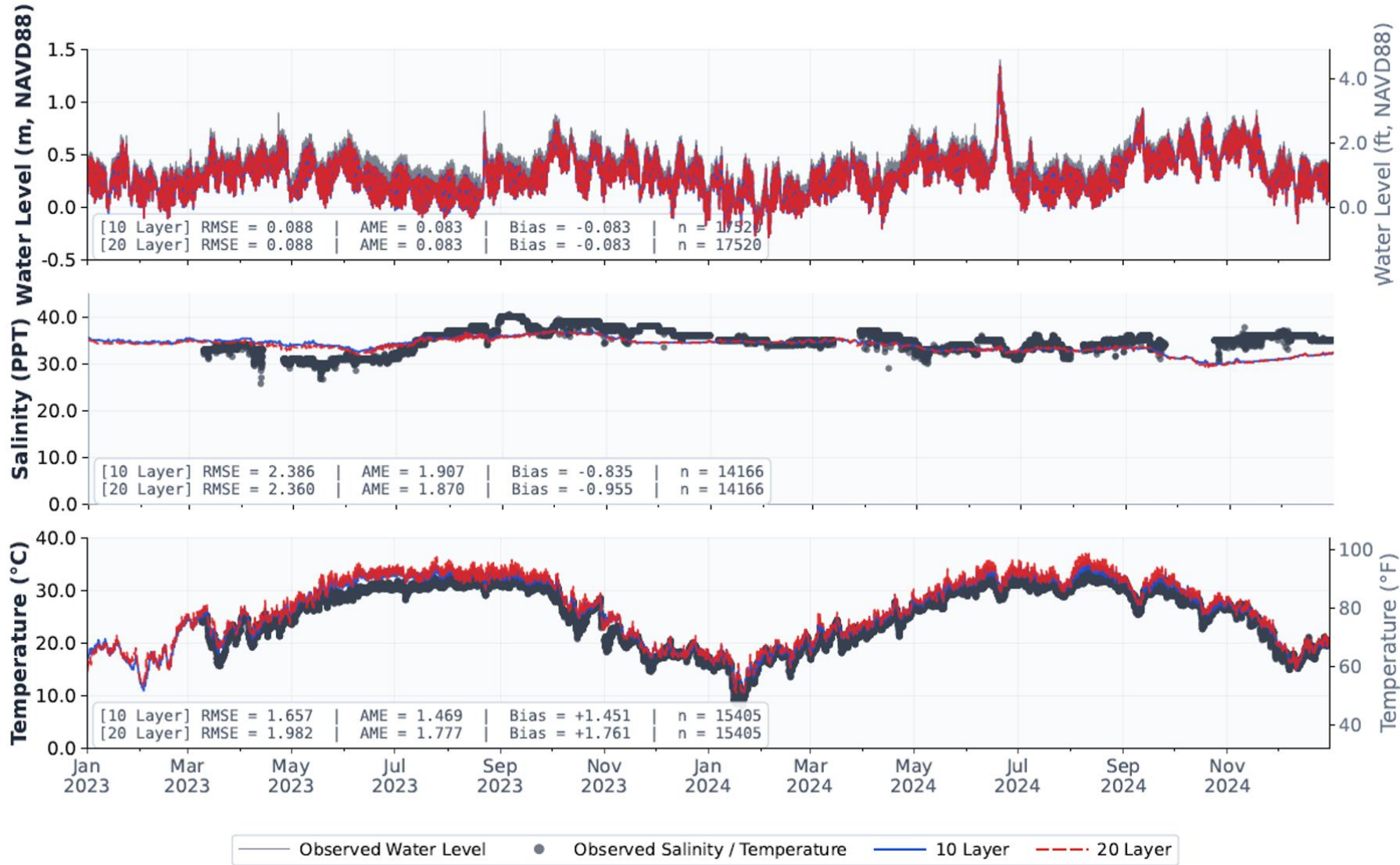


Notes: Model predicted salinity is in parts per thousand (PPT), while salinity measurements are in practical salinity units (PSU). Differences between these two units are negligible for normal ocean salinity ranges and are assumed to be equivalent for model-data comparisons.

Sensitivity to Vertical Resolution

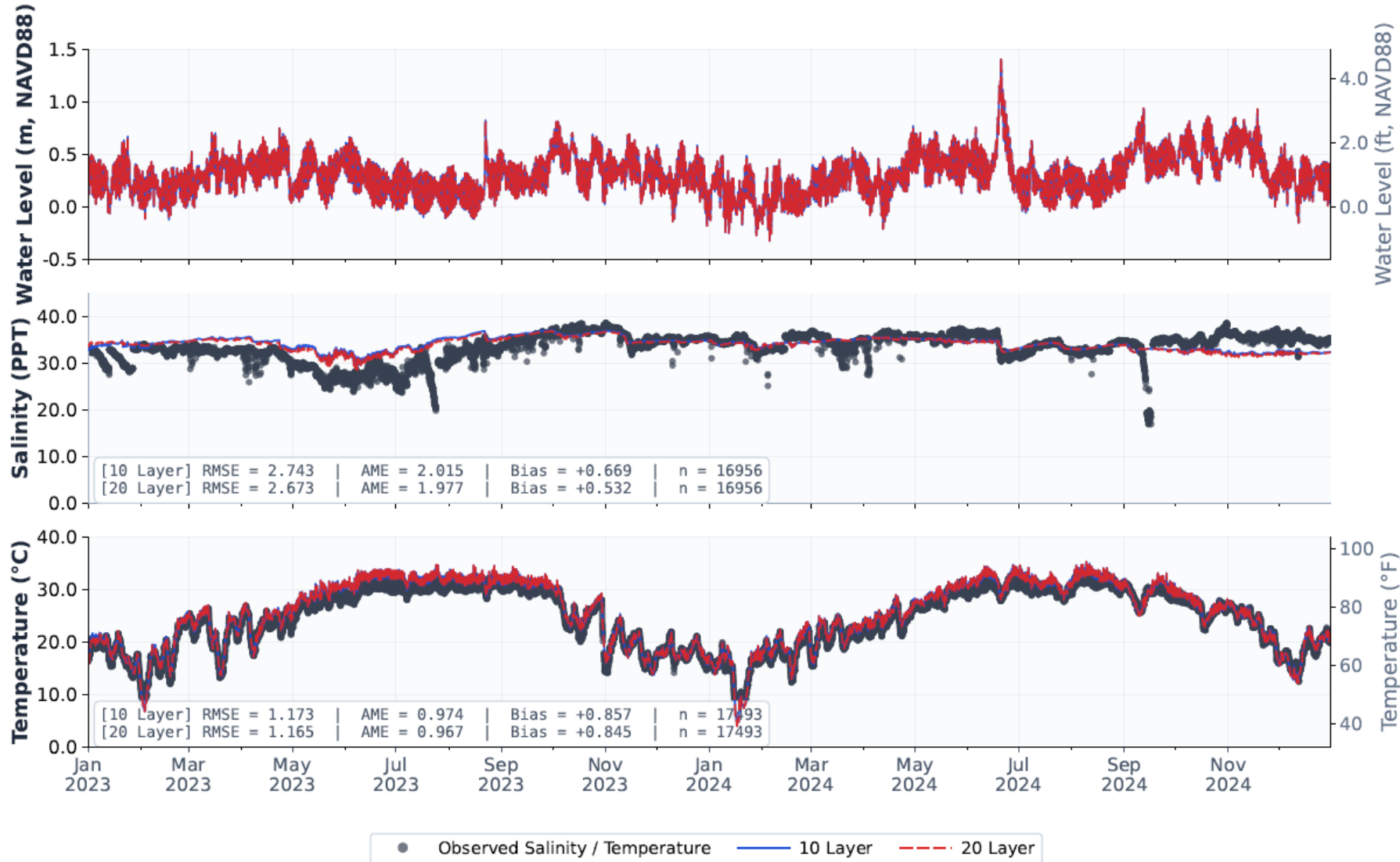
- Tested a 20-layer model to assess sensitivity to vertical resolution
- Up to 20 sigma-zed layers vs up to 10 layers in base model
- 1.1 m nominal vertical resolution in 20 L model vs. 2.3 m nominal vertical resolution in base model
- Total number of active cells ~ 61,400 (base model has ~34,400 active cells)
- The performance of the 20-layer model was compared relative to the 10-layer model both for existing conditions as well as in simulating the effects of brine discharge

Performance near Inner Harbor: NOAA USS/USGS



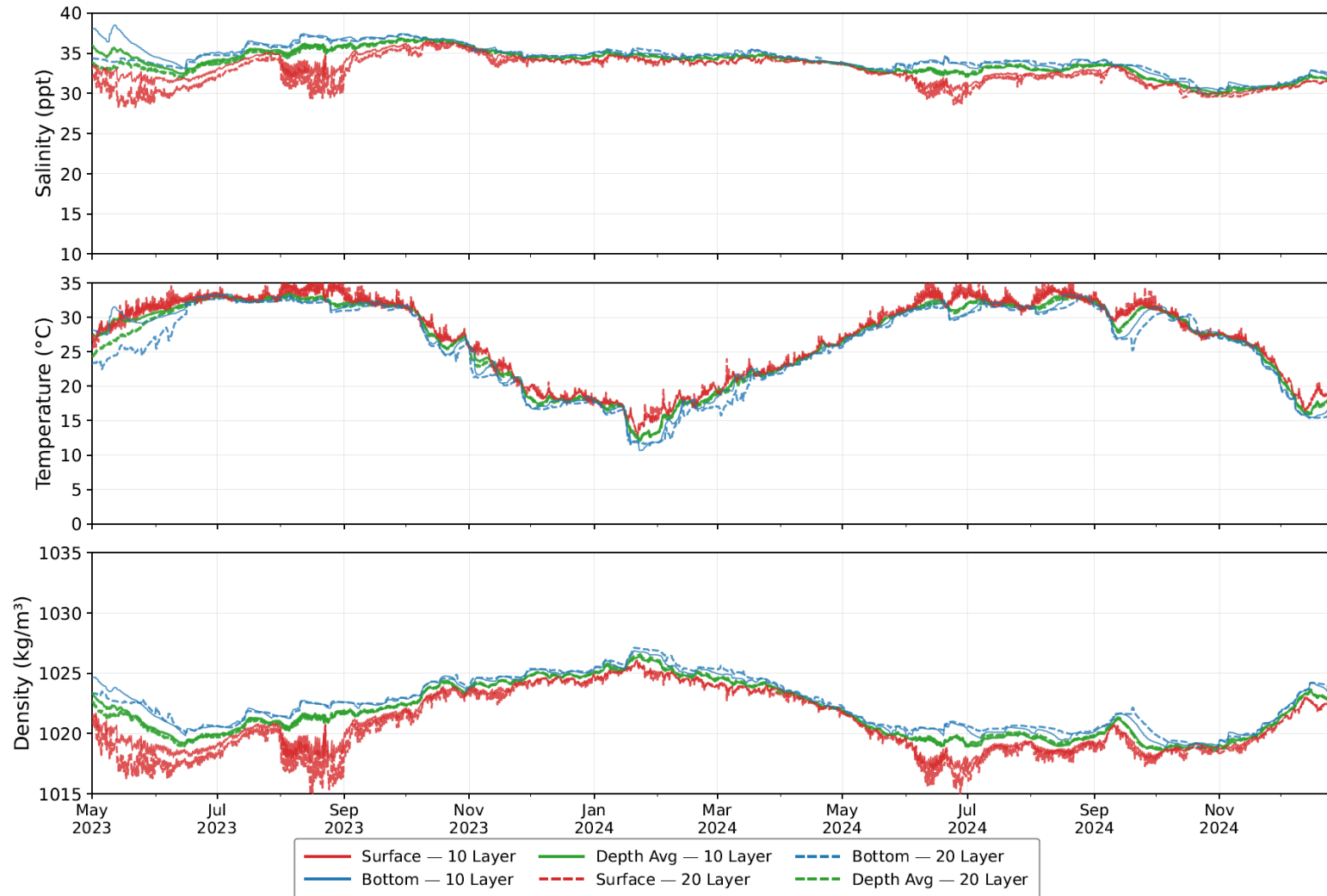
Notes: Water levels and temperature at NOAA USS Lexington Station. Salinity is at USGS CC Bay Station. Model predicted salinity is in parts per thousand (PPT), while salinity measurements are in practical salinity units (PSU). Differences between these two units are negligible for normal ocean salinity ranges and are assumed to be equivalent for model-data comparisons.

Performance within Nueces Bay

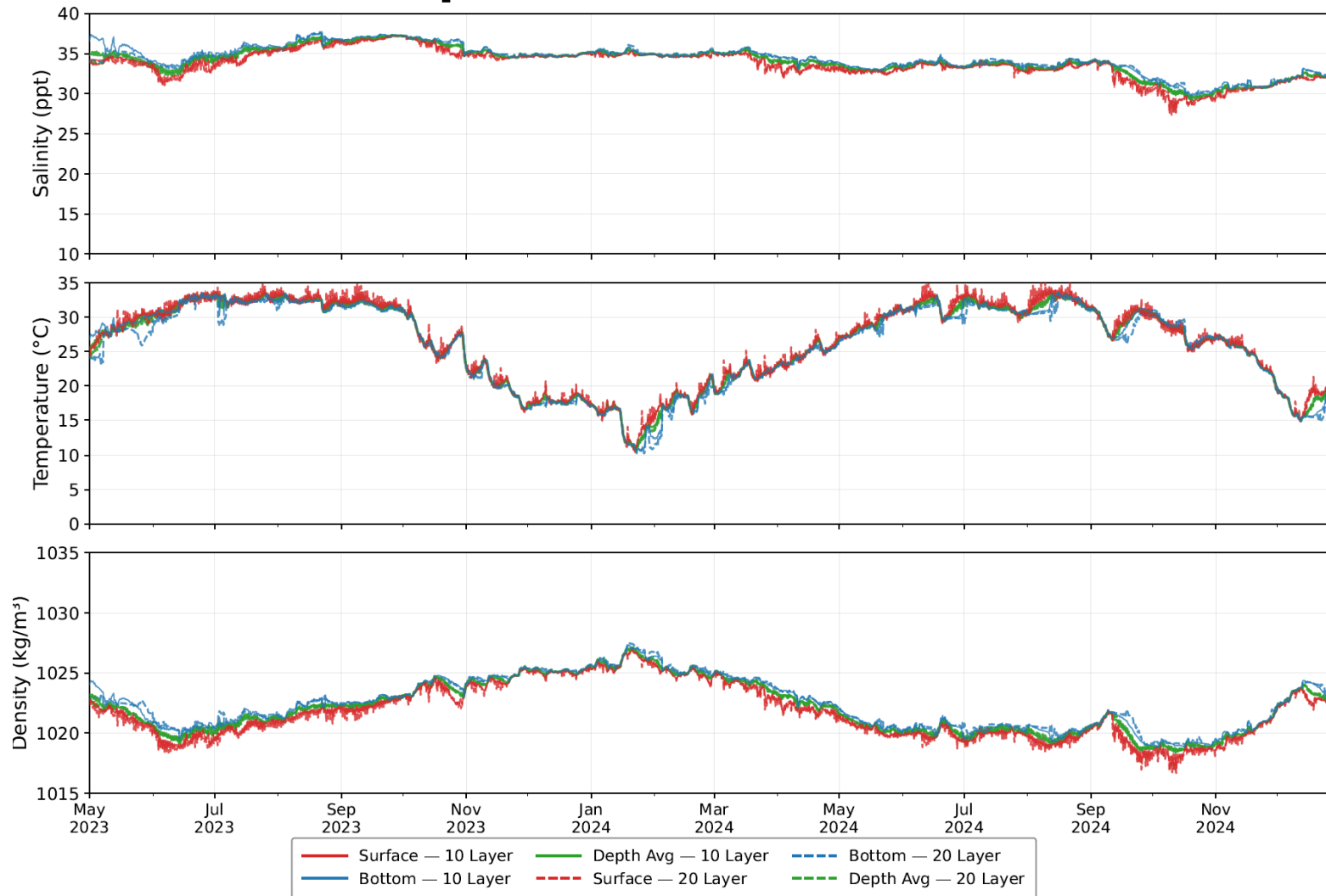


Notes: Model predicted salinity is in parts per thousand (PPT), while salinity measurements are in practical salinity units (PSU). Differences between these two units are negligible for normal ocean salinity ranges and are assumed to be equivalent for model-data comparisons.

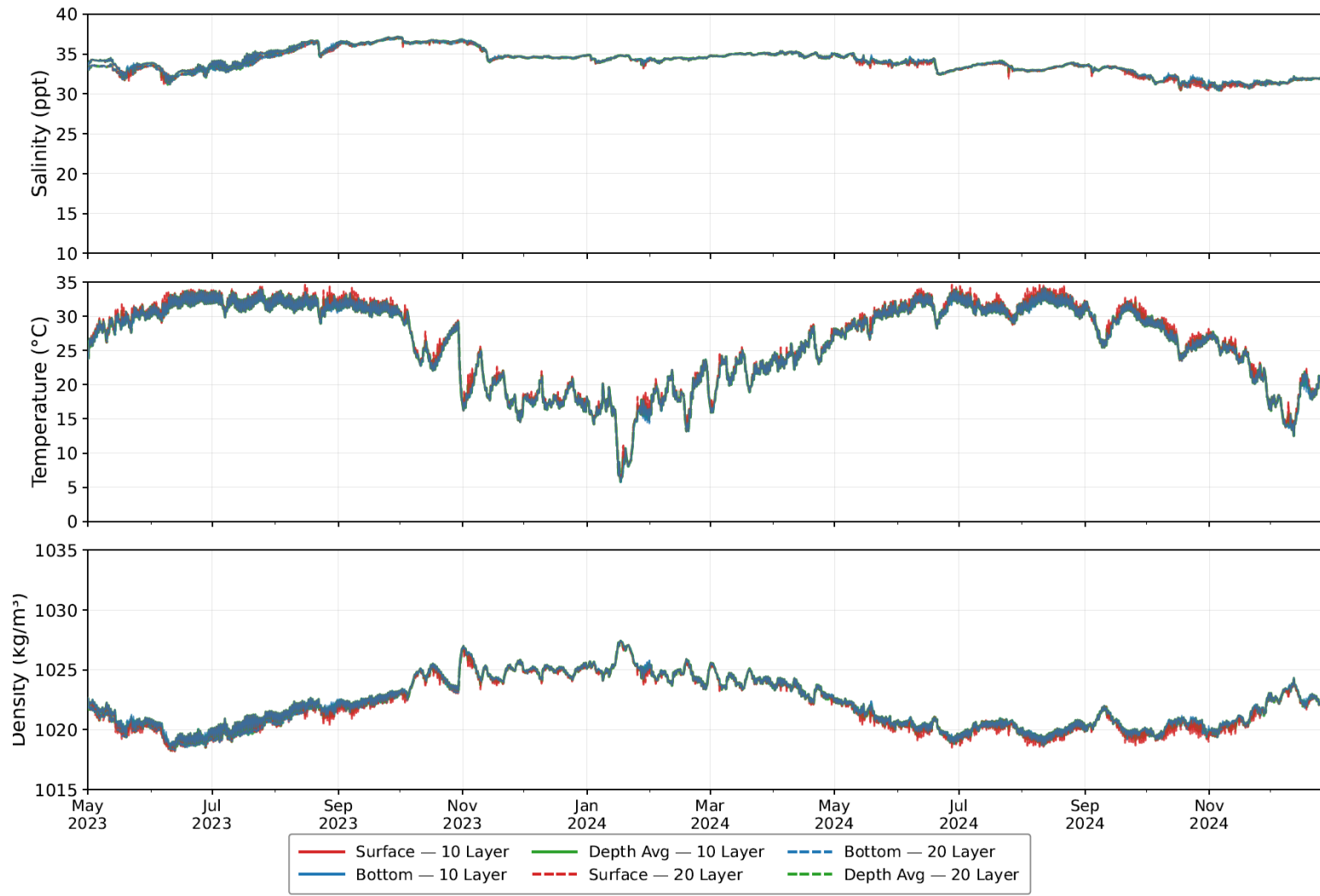
20-layer vs 10-layer - Predicted Surface and Bottom Salinities, Temperature and Density: Inner Harbor



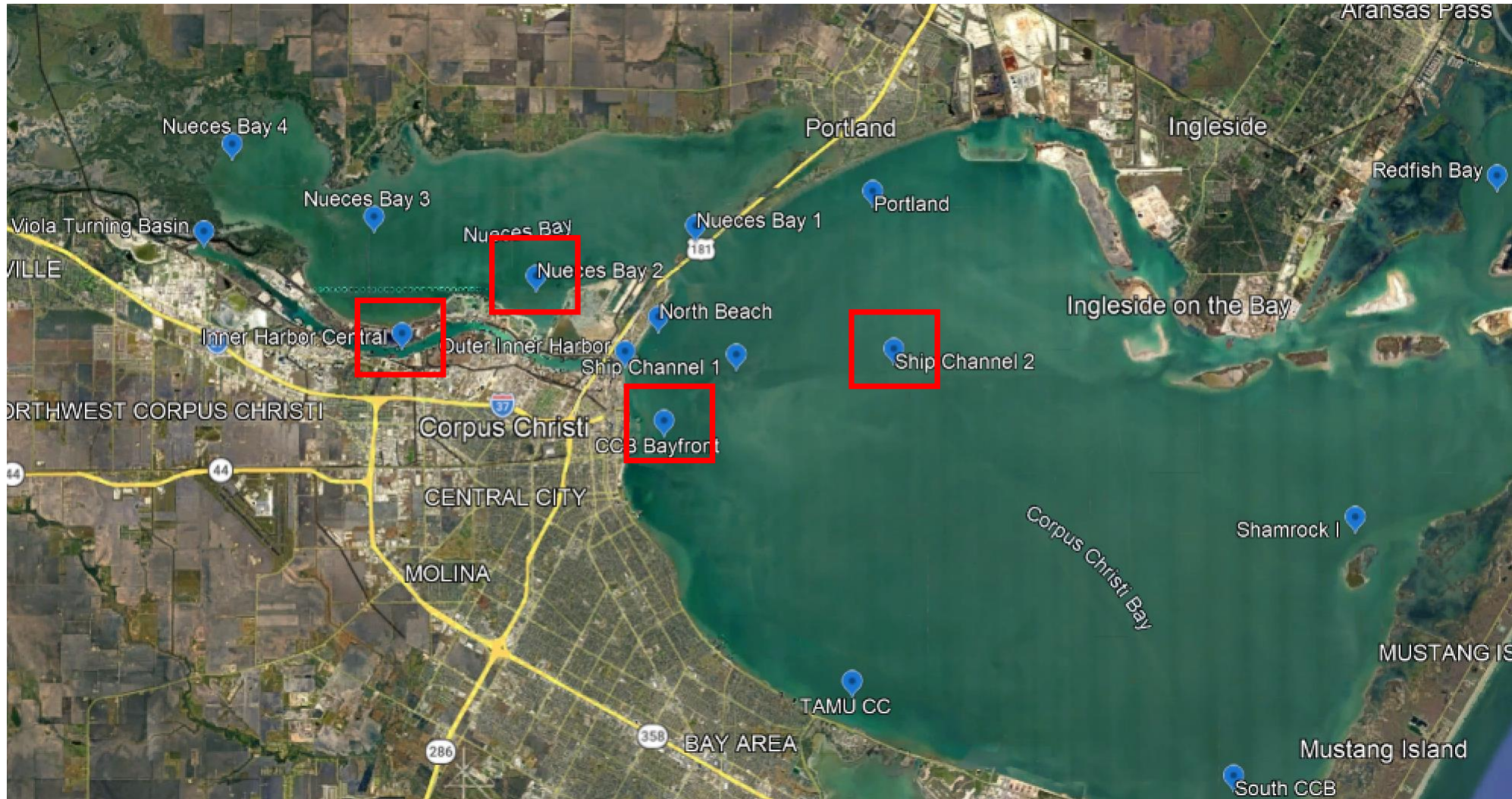
20-layer vs 10-layer - Predicted Differences in Salinities: Ship Channel



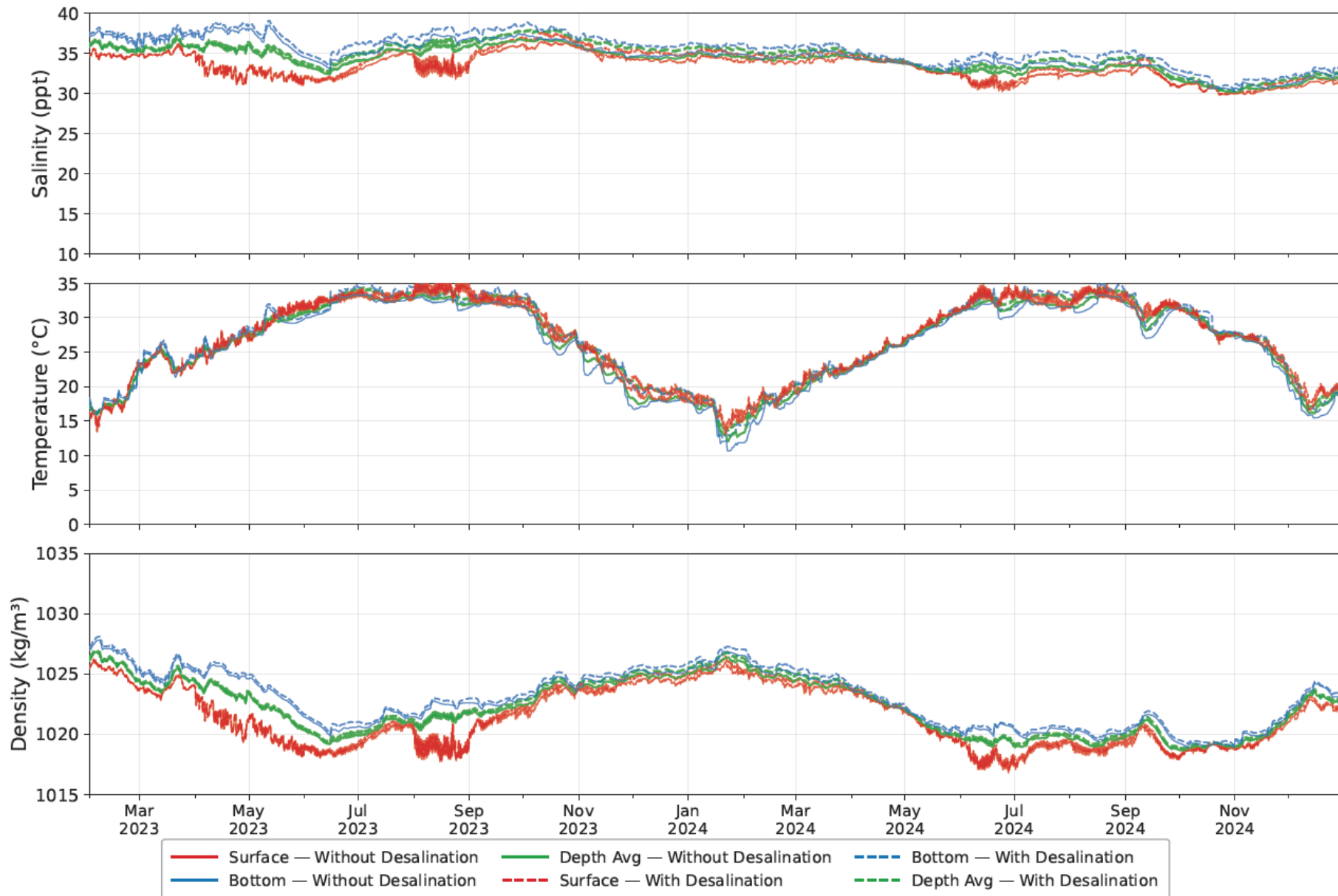
20-layer vs 10-layer - Predicted Differences in Salinities: Nueces Bay



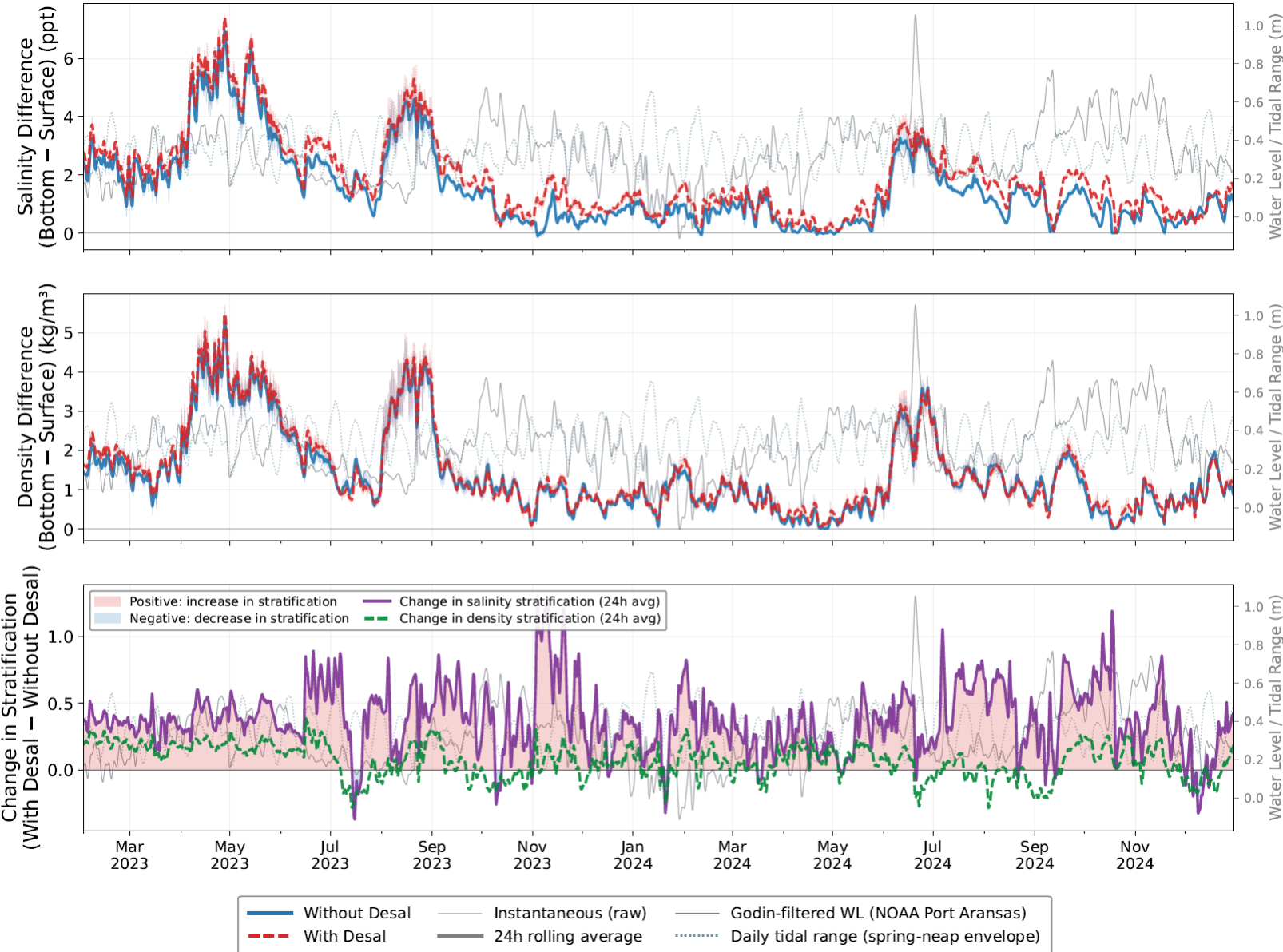
Location Map for Scenarios



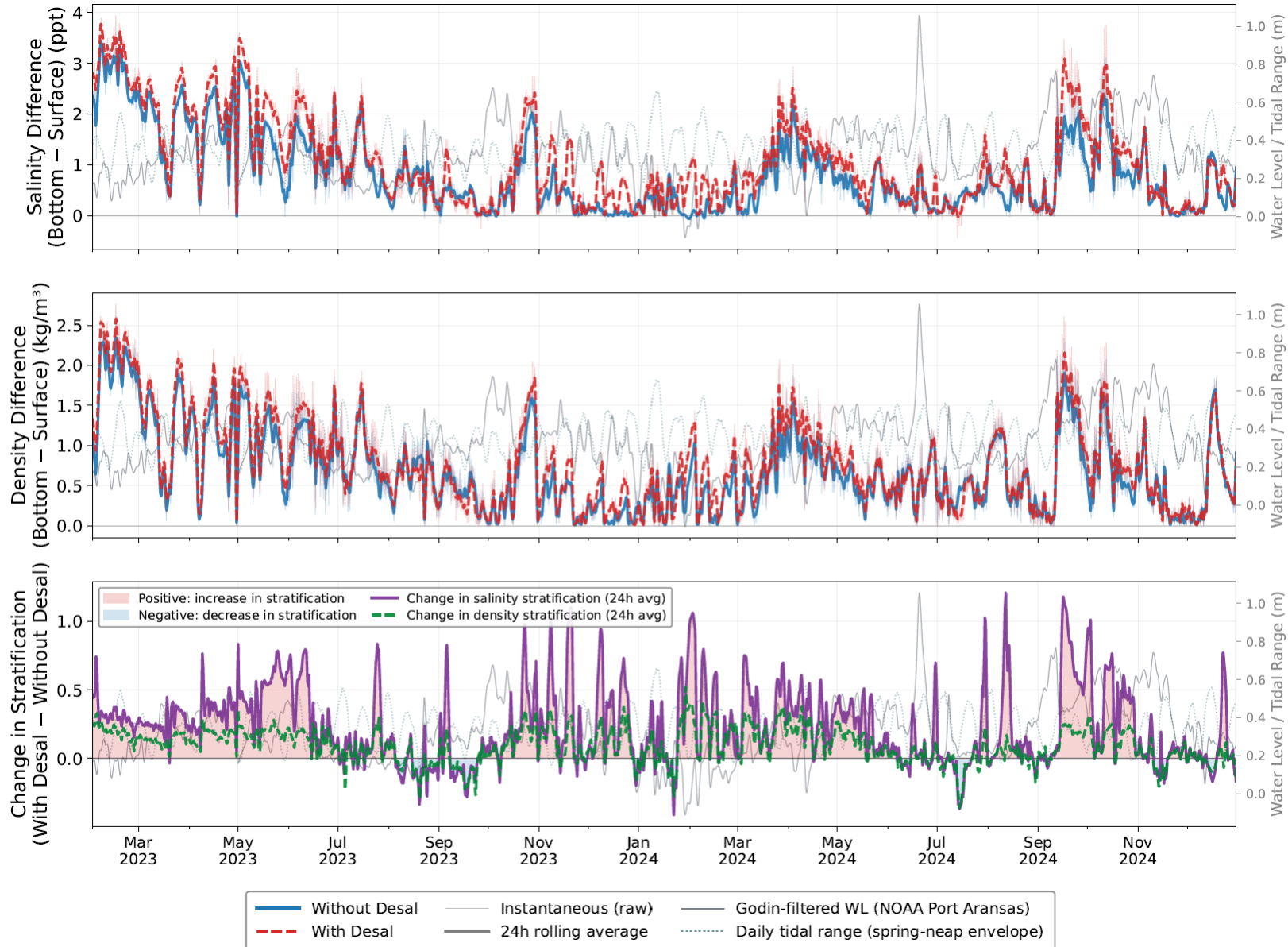
Simulation of Brine Discharge under Existing Conditions: Predicted Changes in Inner Harbor



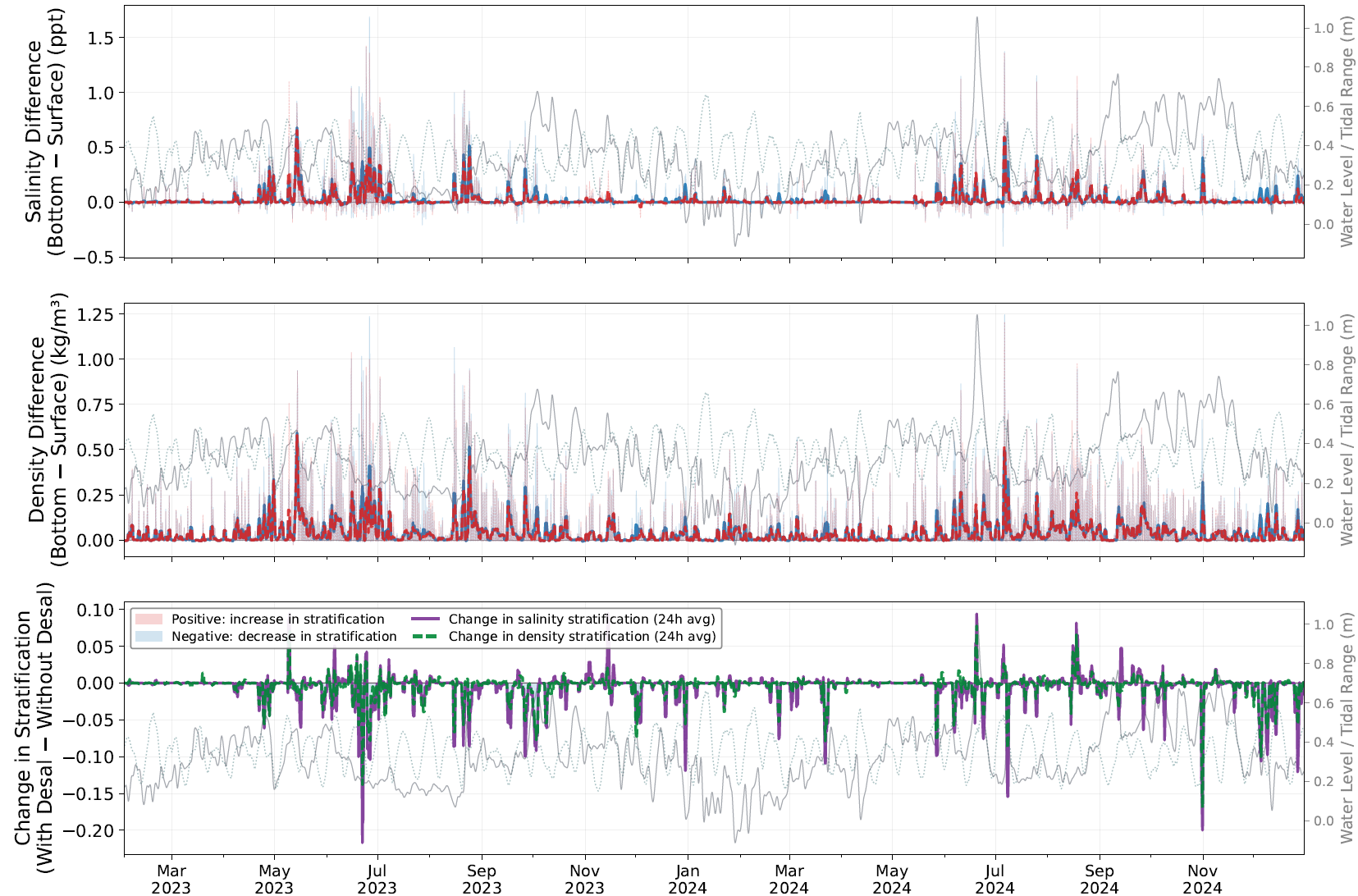
Simulation of Brine Discharge under Existing Conditions: Predicted Changes in Inner Harbor



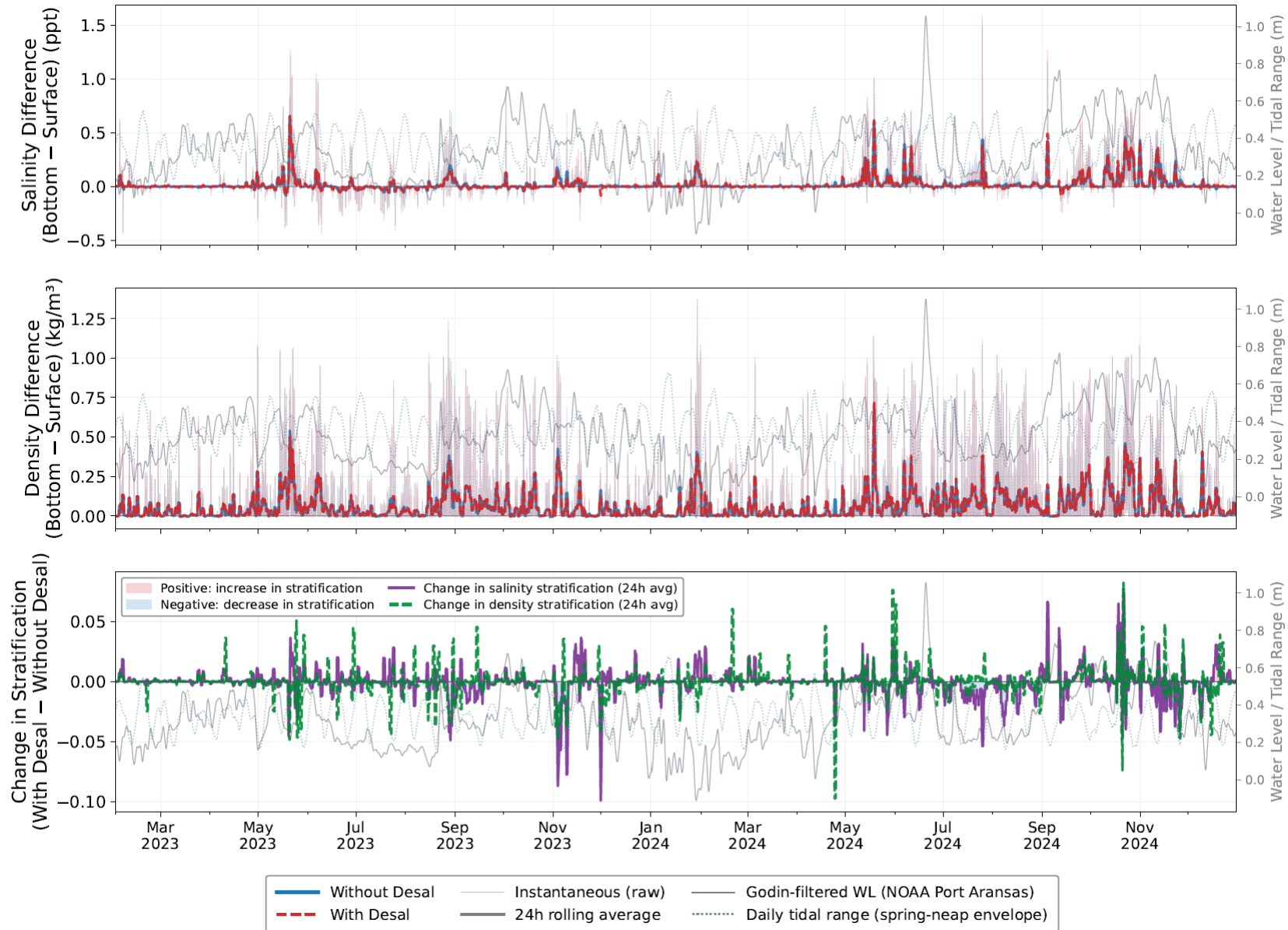
Simulation of Brine Discharge under Existing Conditions: Predicted Changes in Corpus Christi Ship Channel



Simulation of Brine Discharge: Predicted Changes at Corpus Christi Bayfront



Simulation of Brine Discharge: Predicted Changes within Nueces Bay



Existing Conditions Simulations: Overall Changes to Salinity

Time-Mean Surface Salinity Difference [With Desal - Without Desal] (ppt)



Time-Mean Bottom Salinity Difference [With Desal - Without Desal] (ppt)



Overall Changes to Salinity - Within Inner Harbor

Time-Mean Surface Salinity Difference [With Desal - Without Desal] (ppt)



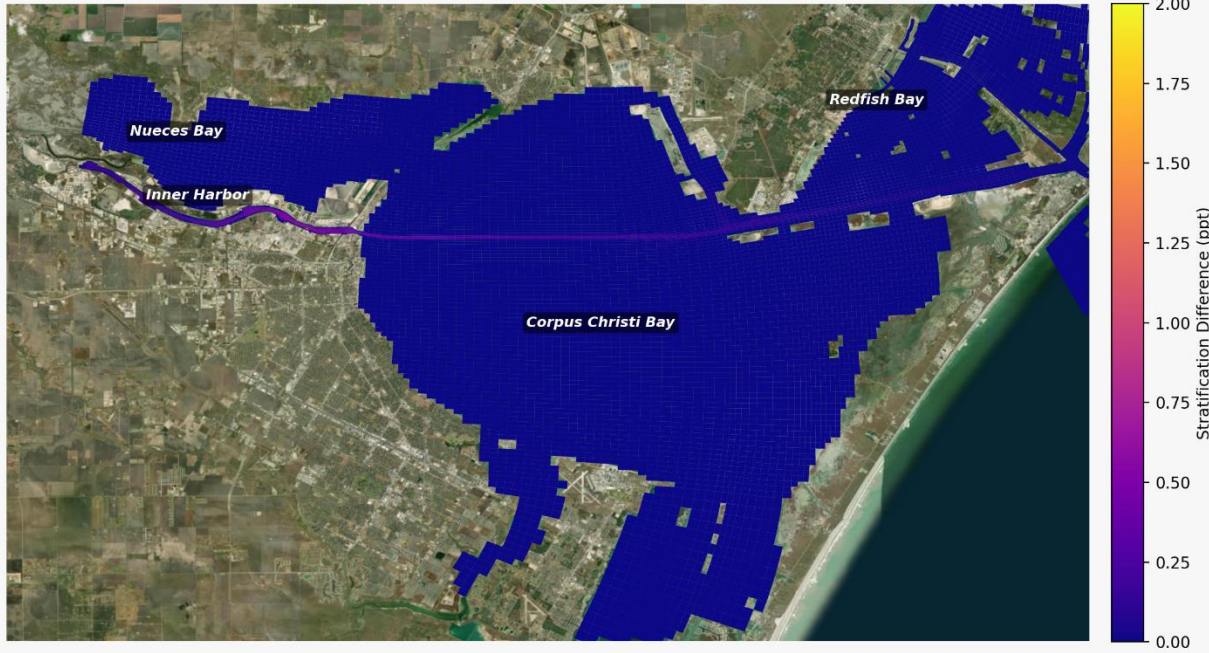
Time-Mean Bottom Salinity Difference [With Desal - Without Desal] (ppt)



Stratification Changes: Areal Extent and Duration



Time-Average Stratification Difference [With Desal - Without Desal] (ppt)

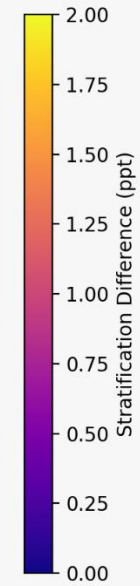


% of time Stratification Difference > 1 ppt

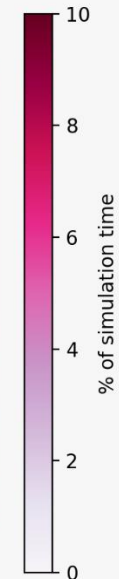
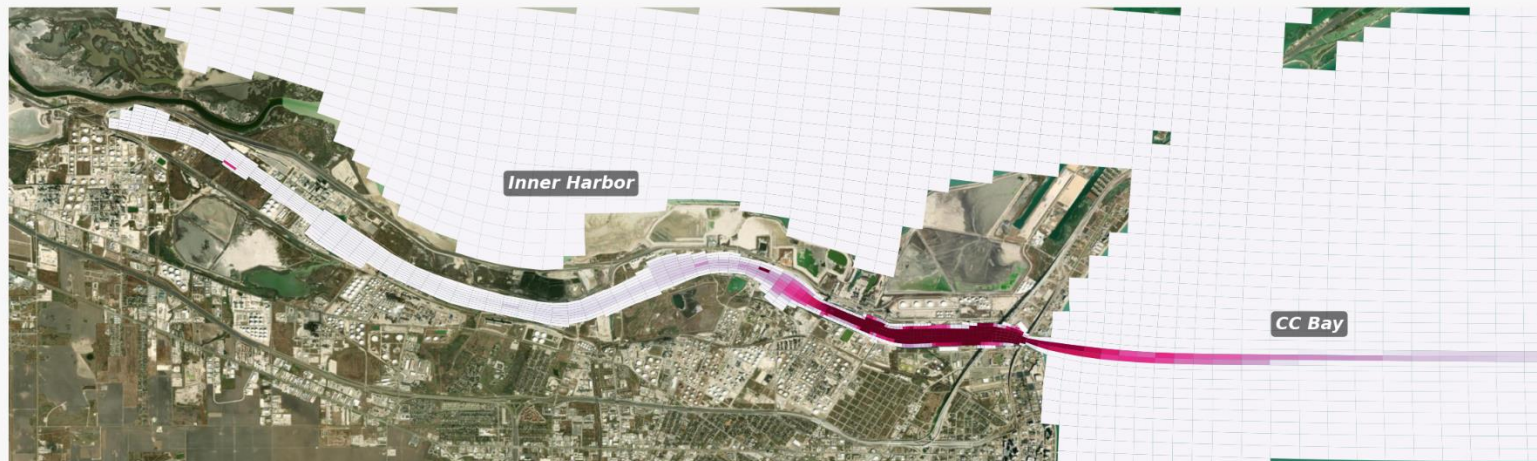


Stratification Changes: Areal Extent and Duration – Inner Harbor

Time-Average Stratification Difference [With Desal - Without Desal] (ppt)



% of time Stratification Difference > 1 ppt

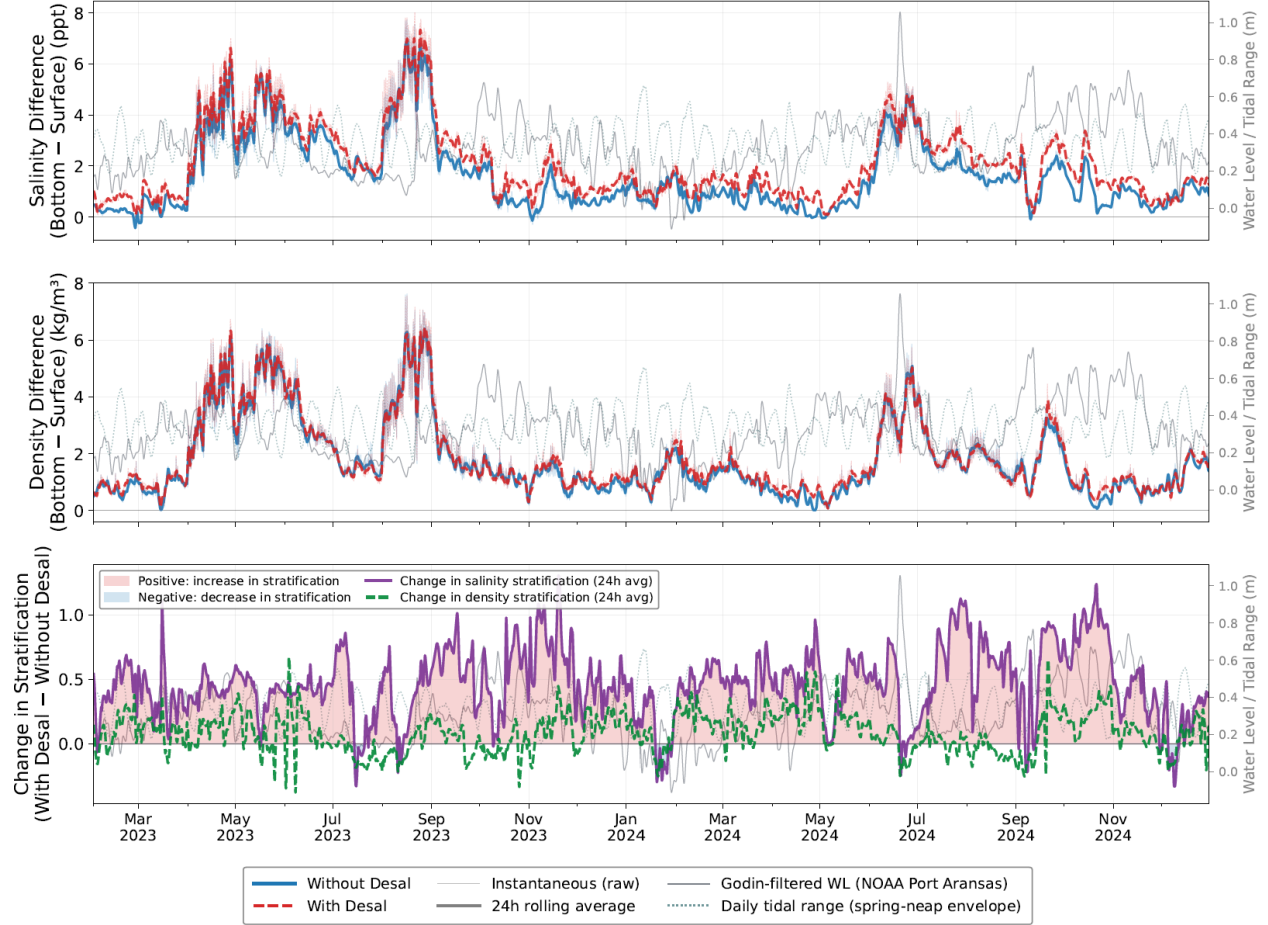
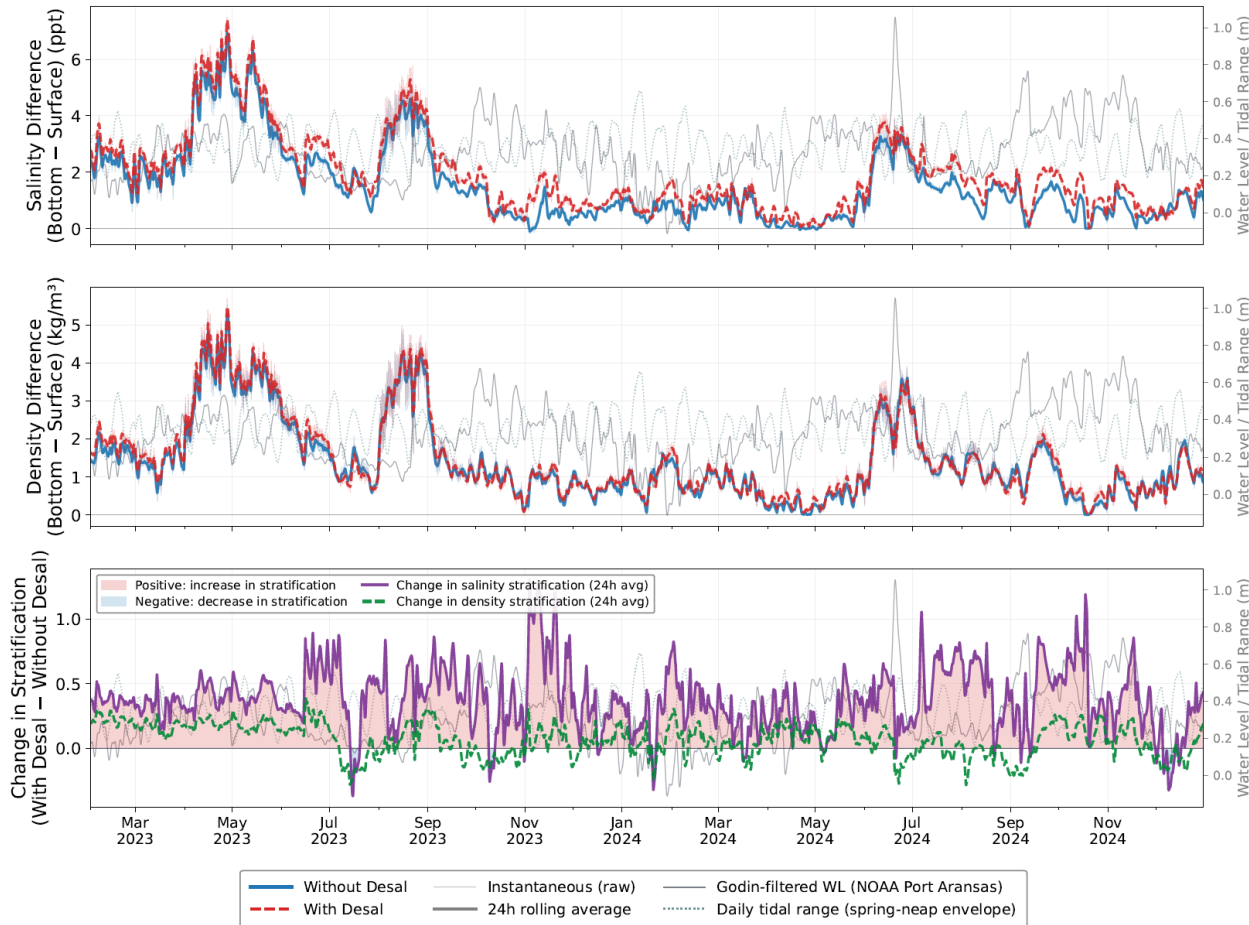


Simulation of Brine Discharge – 10 L vs 20L: Predicted Changes within Inner Harbor



10 Layer Model

20 Layer Model

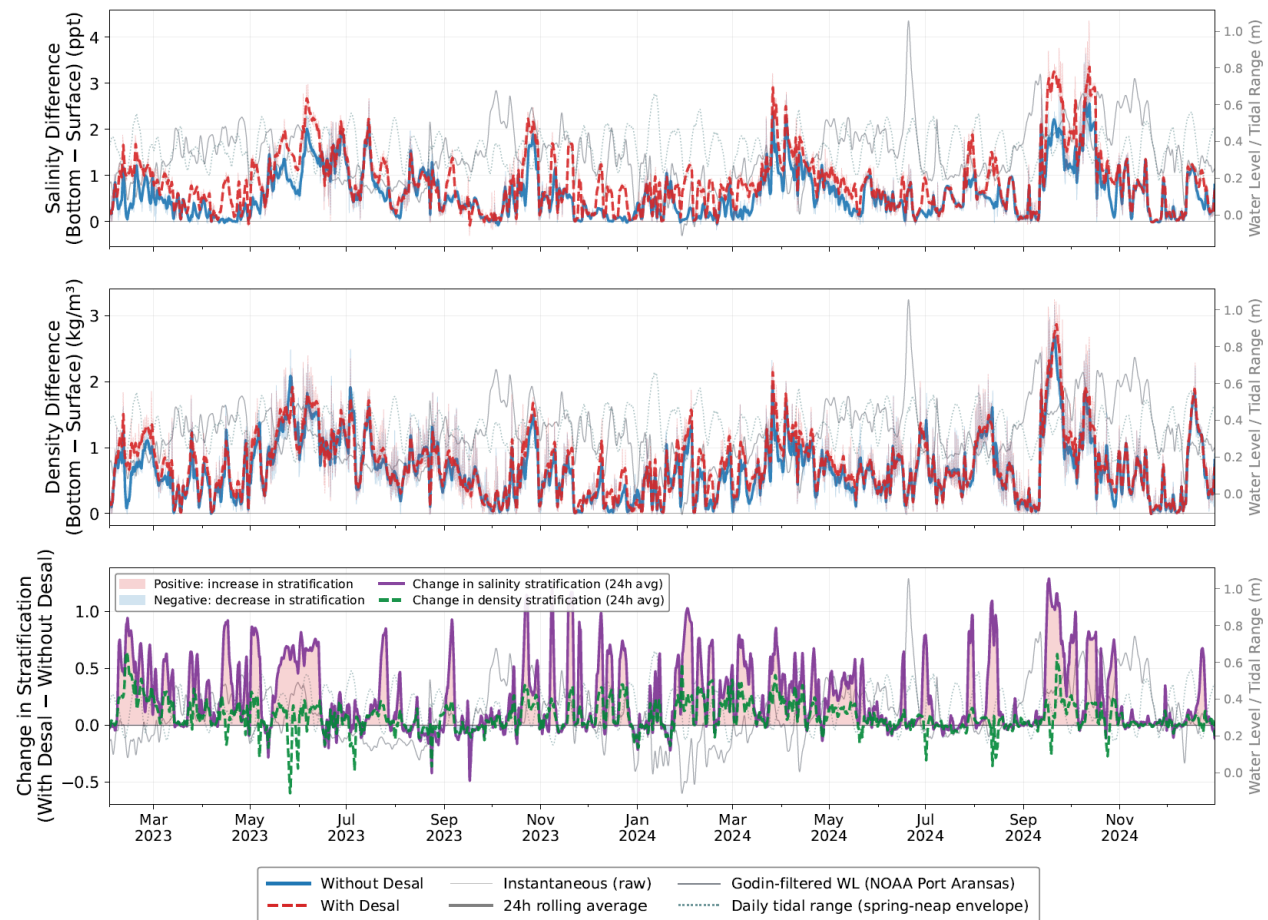
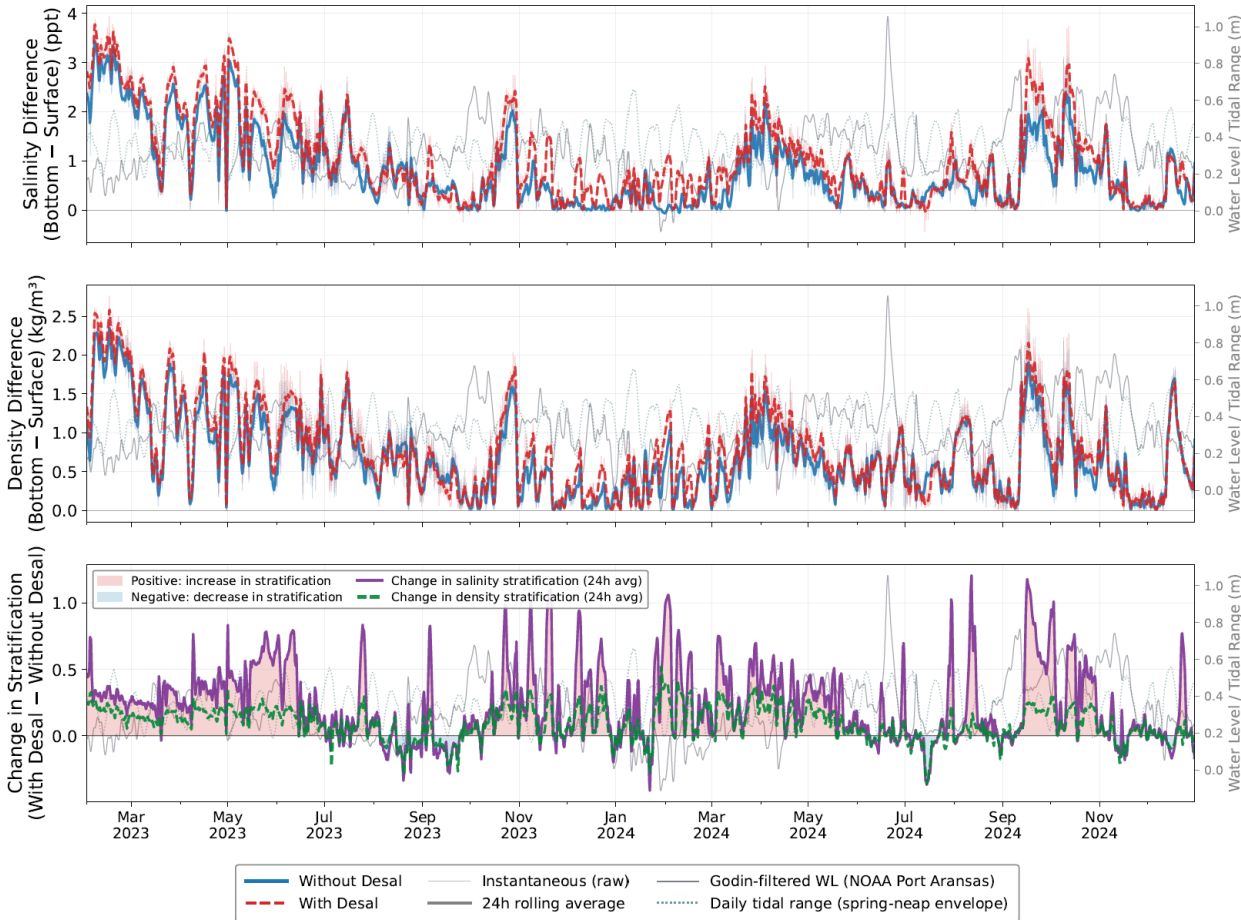


Simulation of Brine Discharge – 10 L vs 20L: Predicted Changes within Ship Channel



10 Layer Model

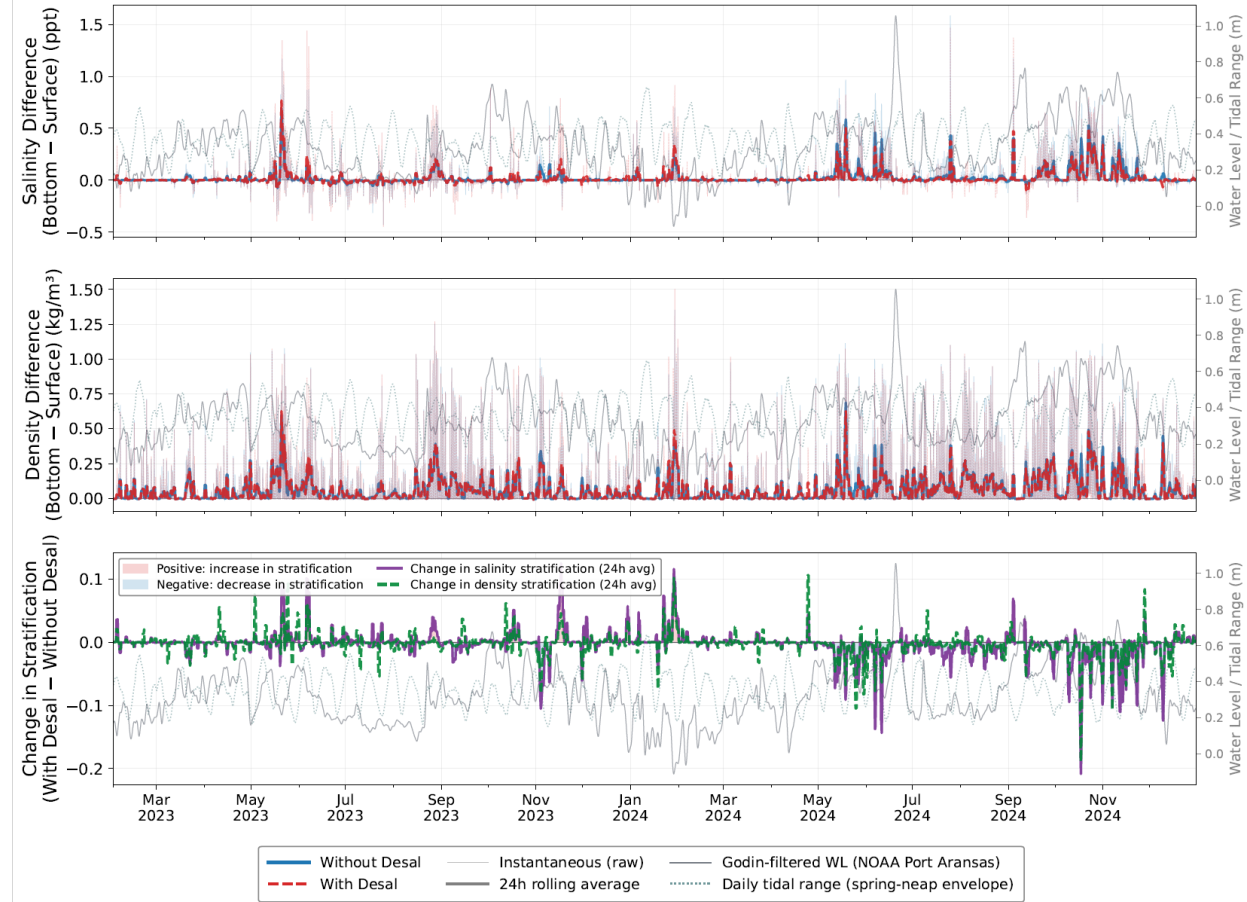
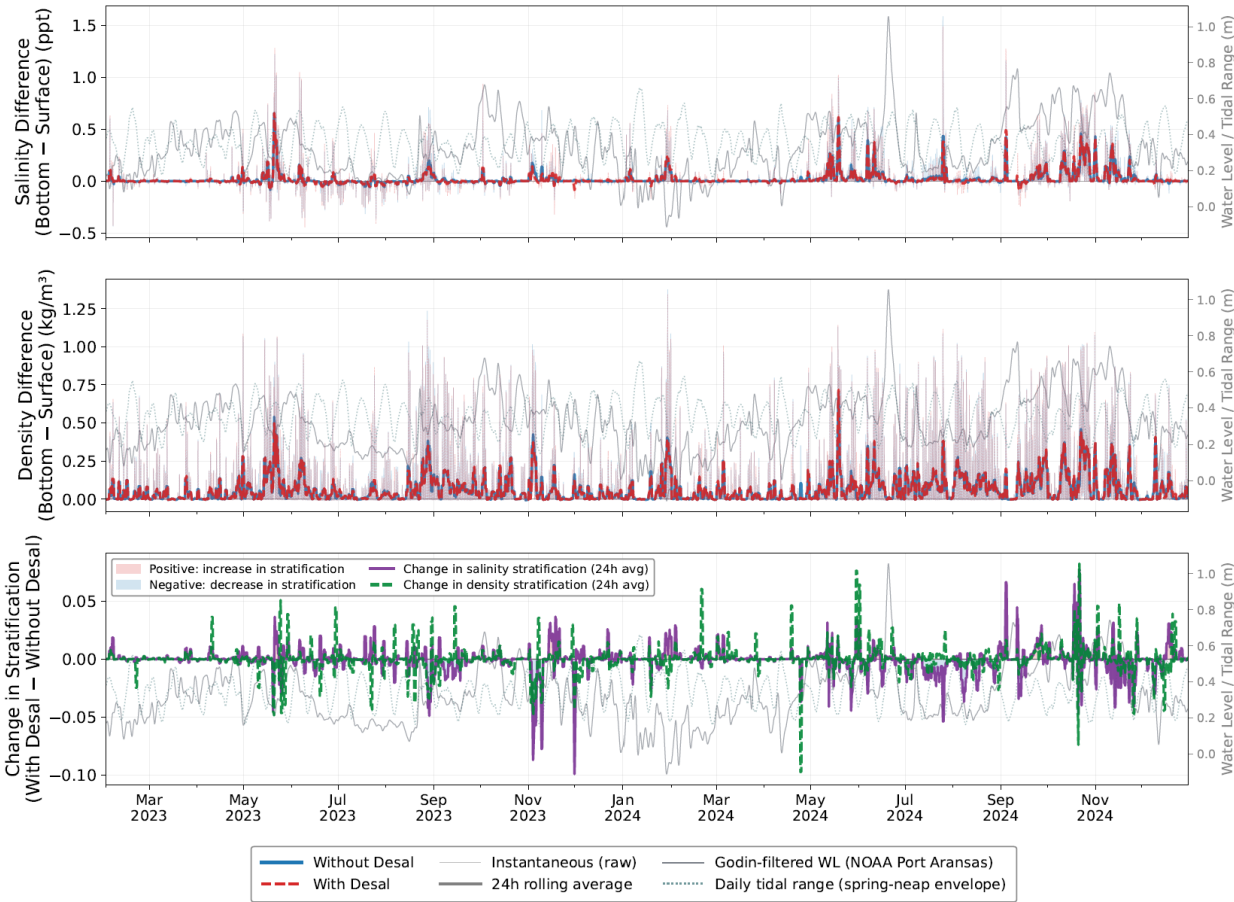
20 Layer Model



Simulation of Brine Discharge – 10 L vs 20 L: Predicted Changes within Nueces Bay

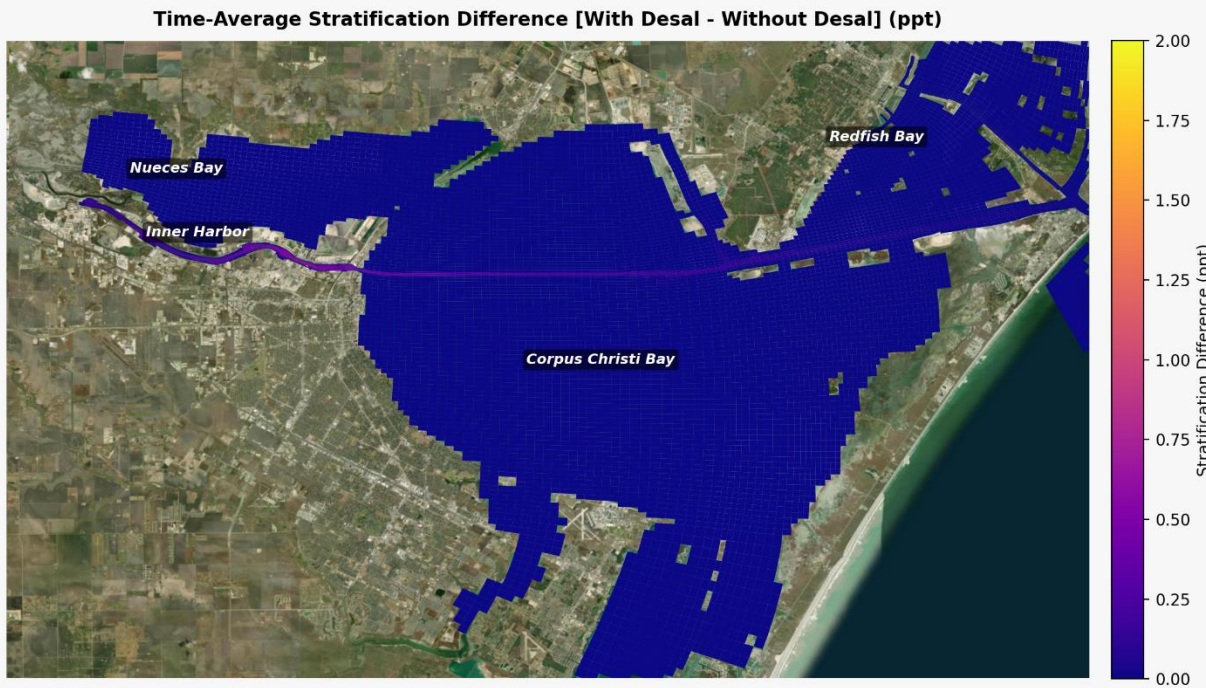
10 Layer Model

20 Layer Model

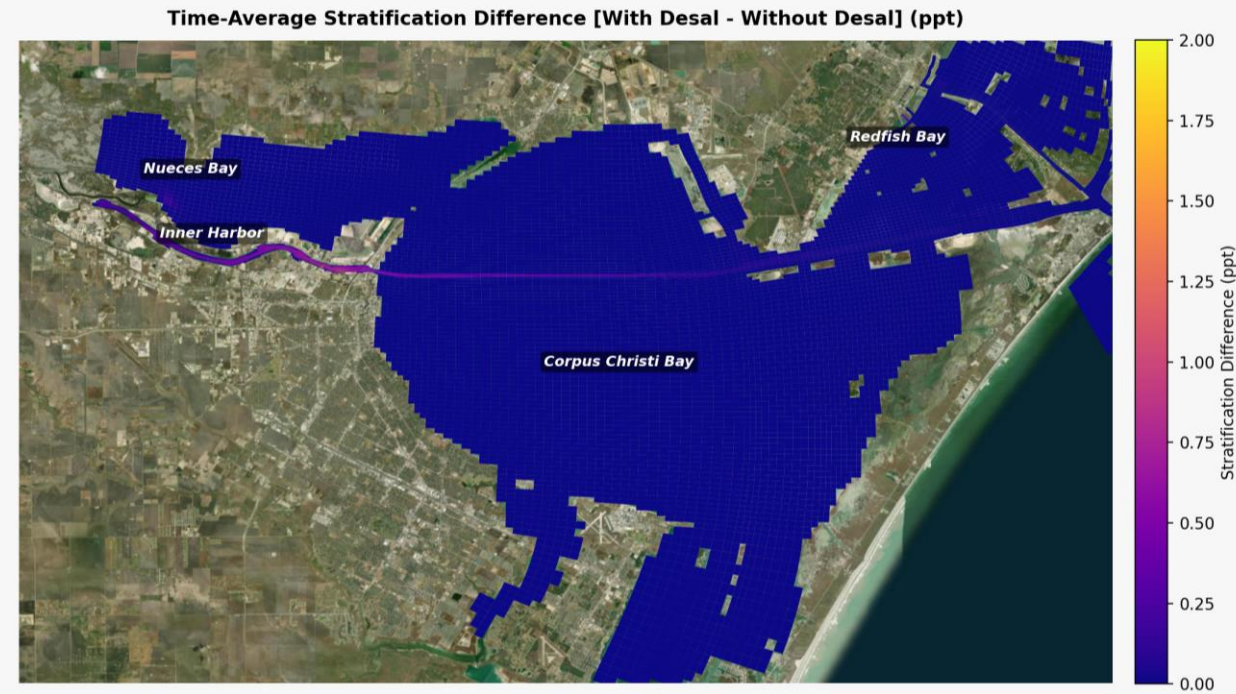


Stratification Changes Areal Extent: 10 L vs 20 L

10 Layer Model



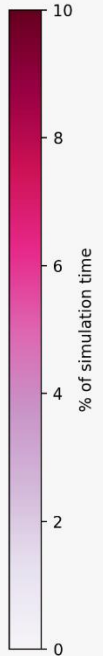
20 Layer Model



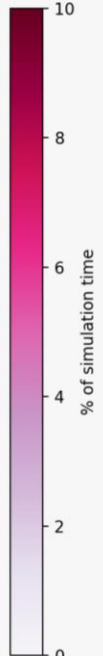
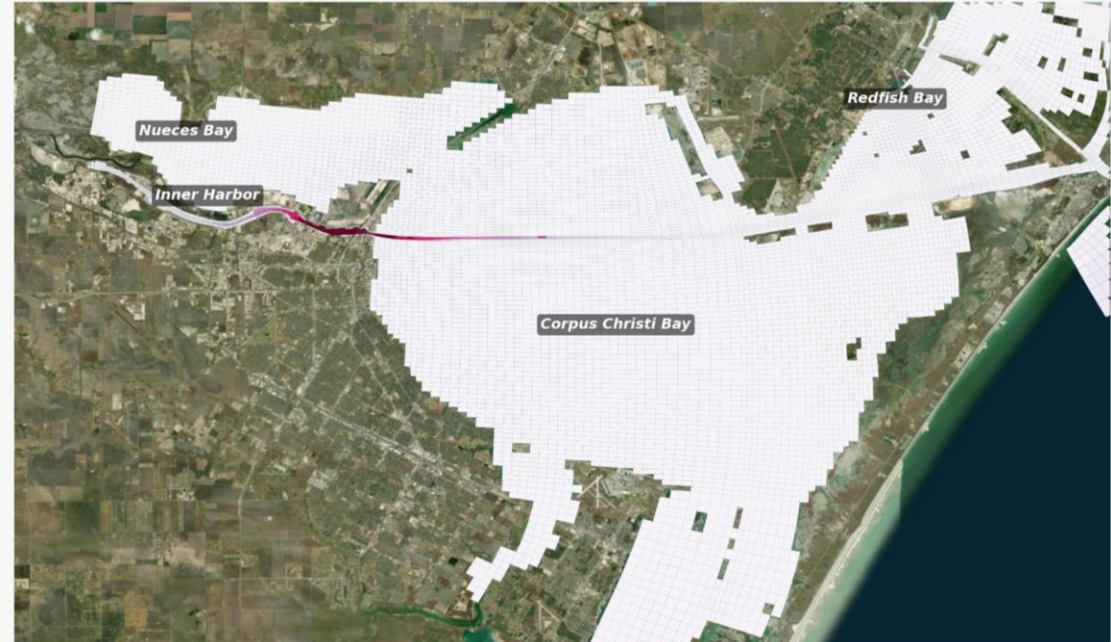
Stratification Changes Duration: 10 L vs 20 L



% of time Stratification Difference > 1 ppt



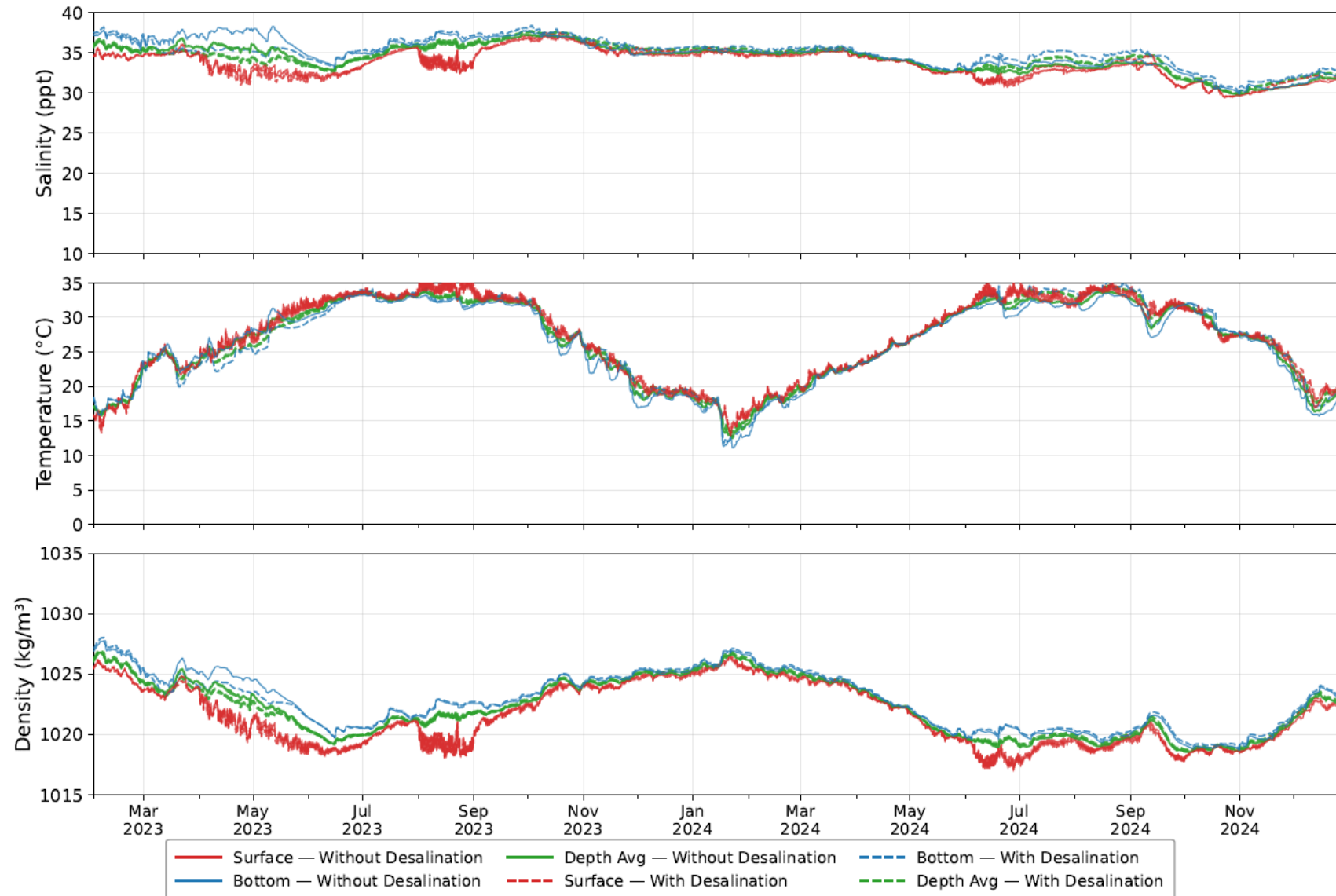
% of time Stratification Difference > 1 ppt



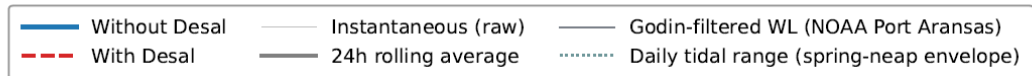
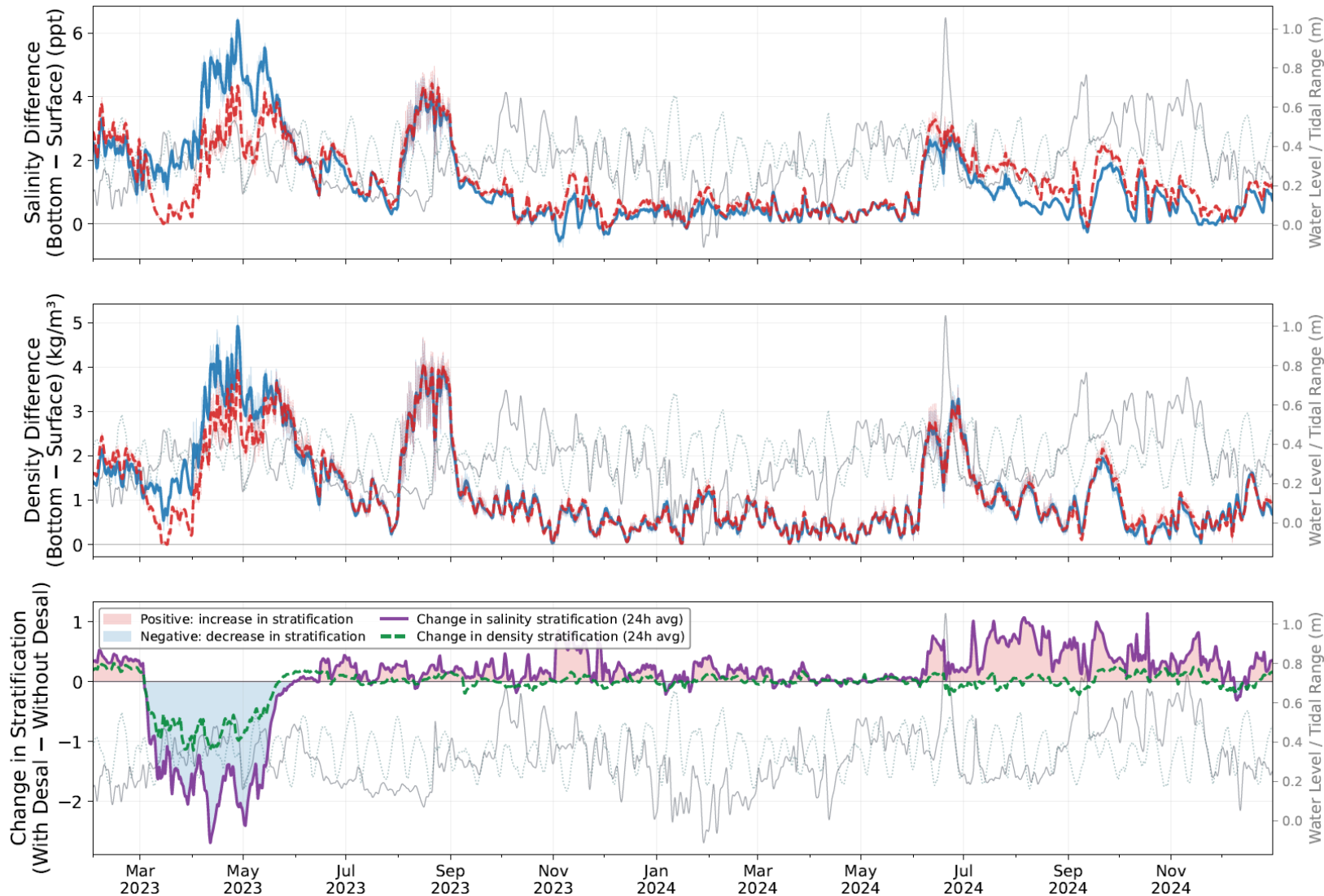
Hypothetical Worst Case

- FFAC recommendation to include in scenarios
- Climate change projections - 1.2°C water temperature increase and 120 mm sea level rise
- Zeroed out freshwater inflow from Nueces River
- Added CC Polymer desalination discharge – assumed intake will be as per water right permit, and 50% consumptive use for freshwater production
- Removed Oso Facility and Allison Facility discharges

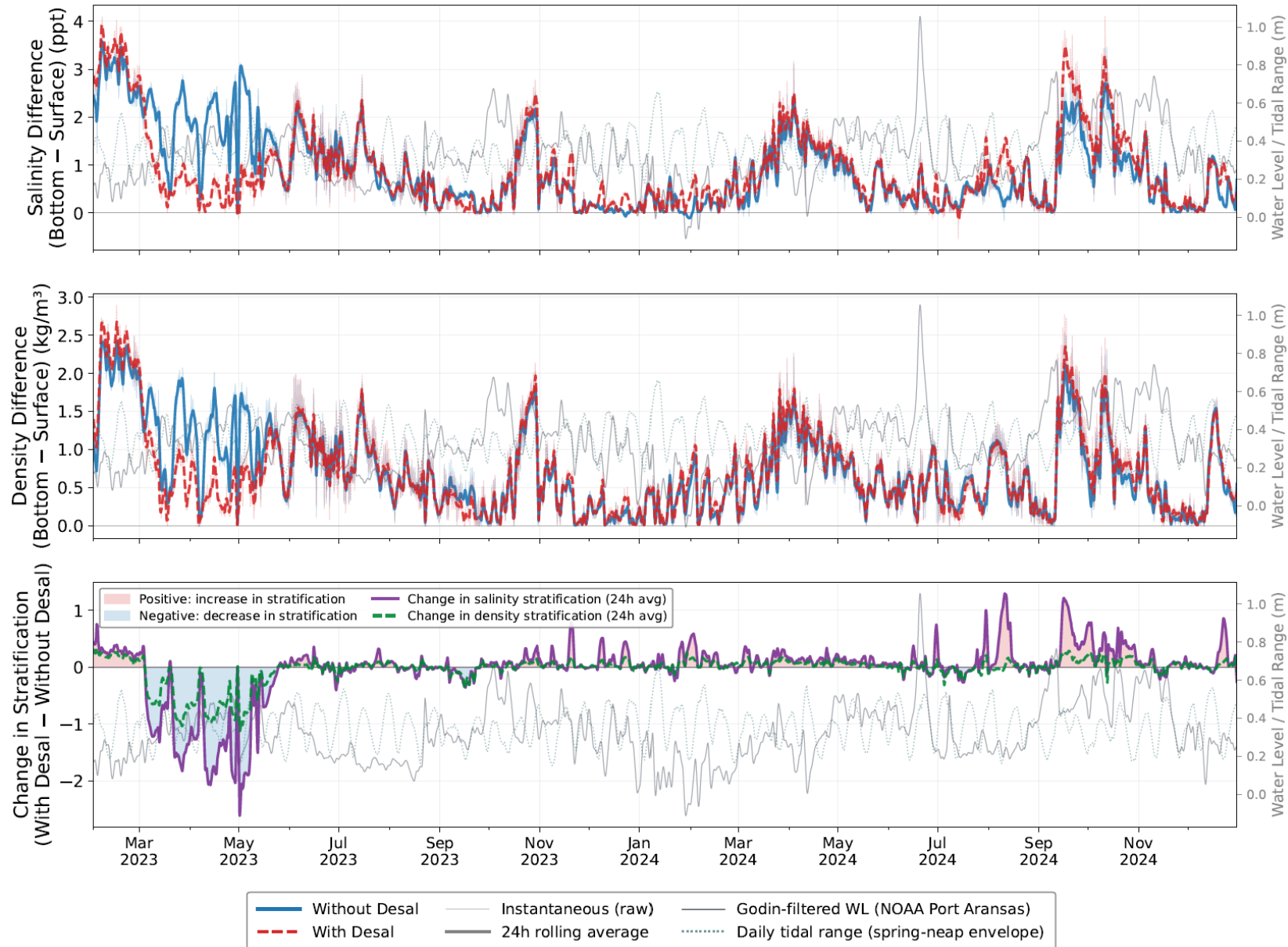
Simulation of Brine Discharge under Hypothetical Worst Case: Predicted Changes in Inner Harbor



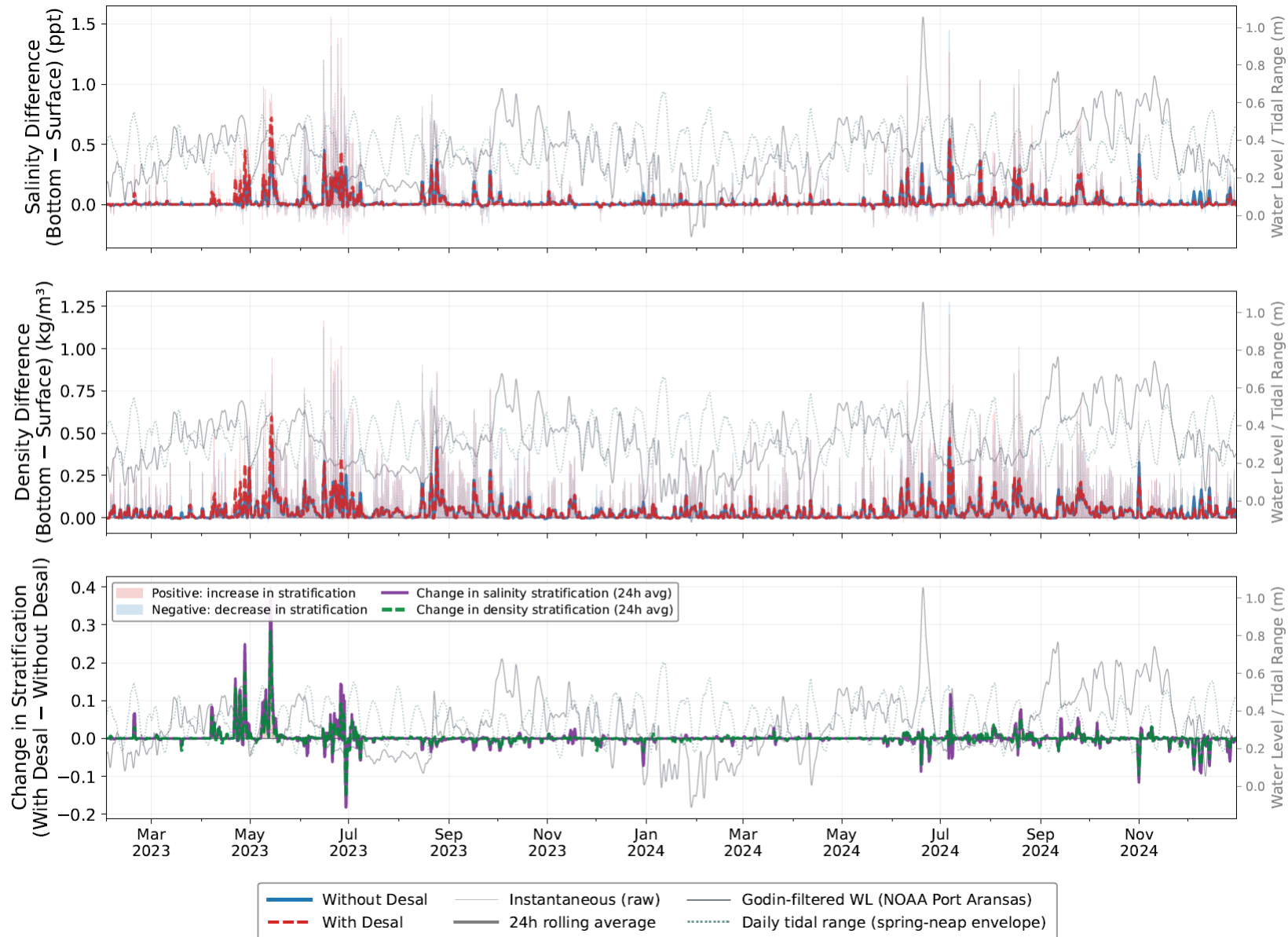
Simulation of Brine Discharge under Hypothetical Worst Case: Predicted Changes in Inner Harbor



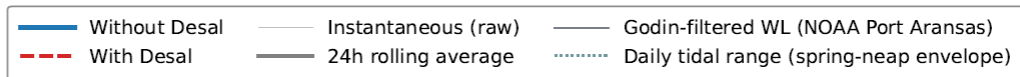
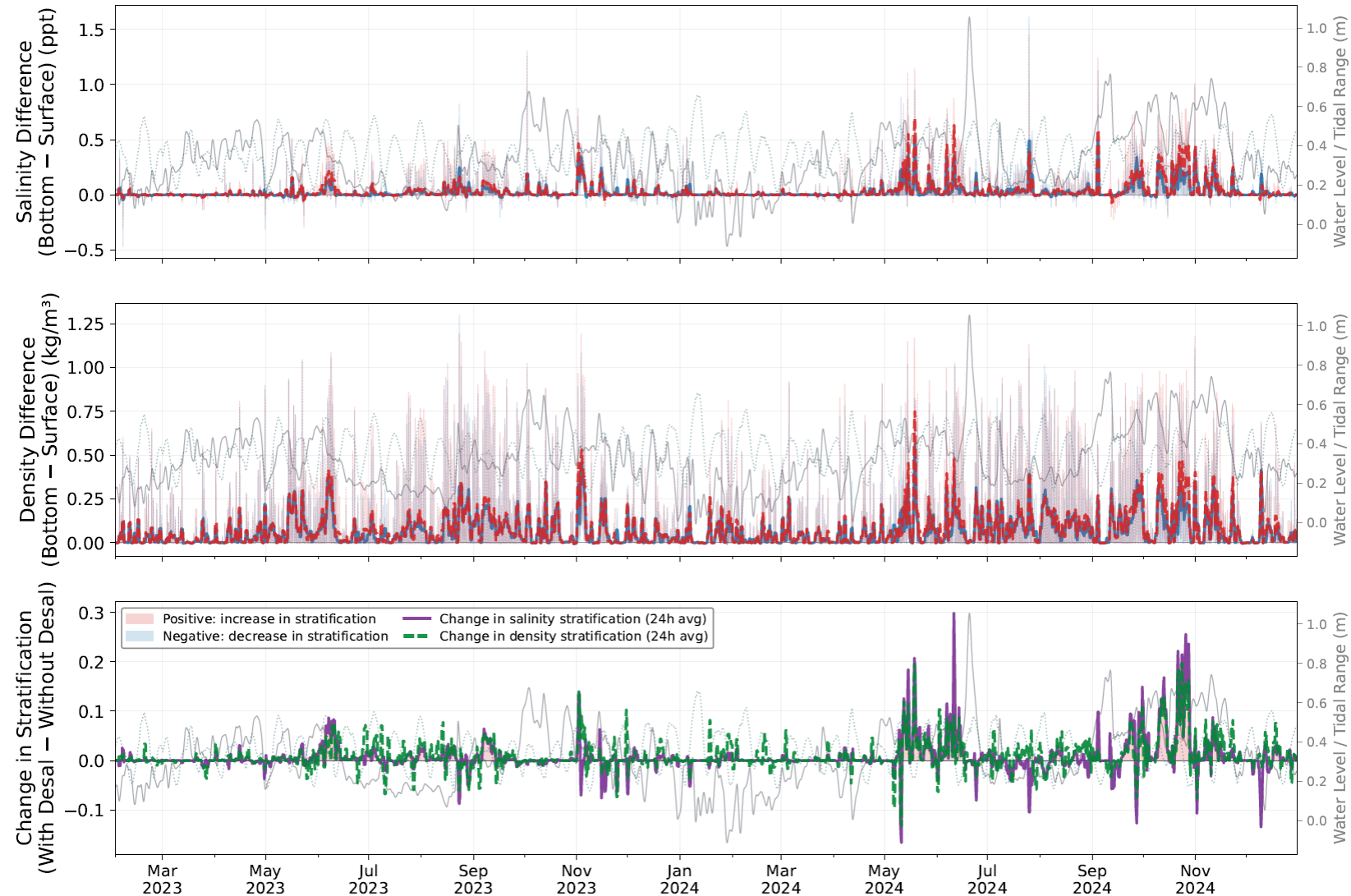
Simulation of Brine Discharge under Hypothetical Worst Case: Predicted Changes in Corpus Christi Ship Channel



Simulation of Brine Discharge under Hypothetical Worst Case: Predicted Changes at Corpus Christi Bayfront



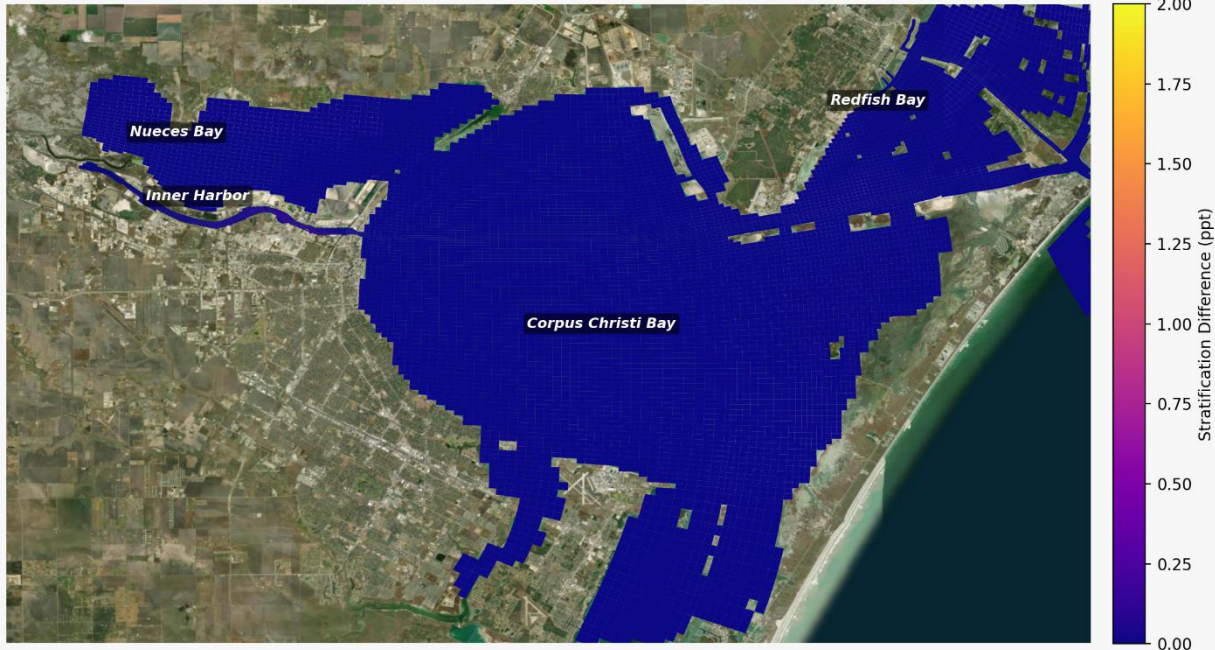
Simulation of Brine Discharge under Hypothetical Worst Case: Predicted Changes within Nueces Bay



Stratification Changes: Hypothetical Worst Case



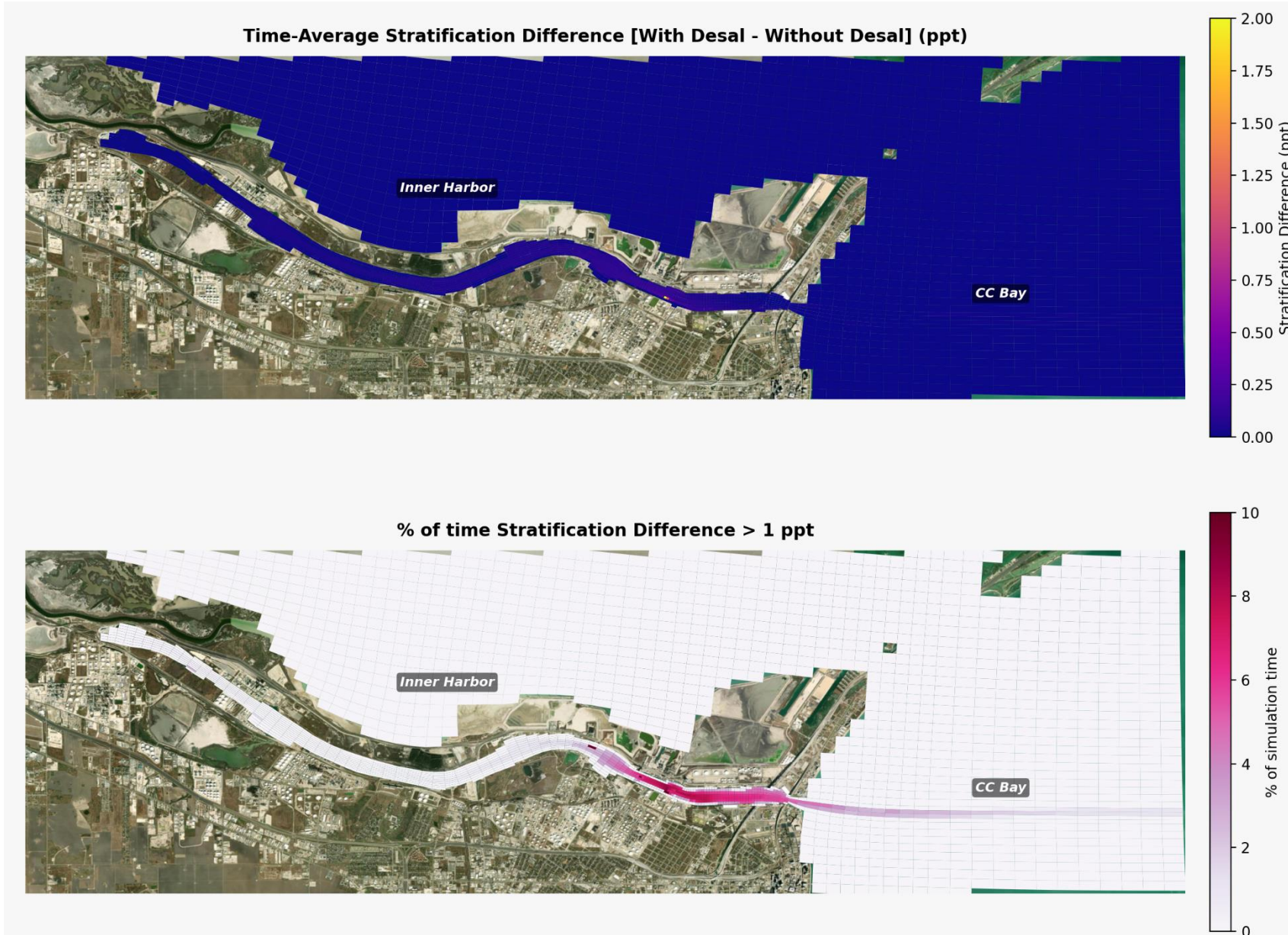
Time-Average Stratification Difference [With Desal - Without Desal] (ppt)



% of time Stratification Difference > 1 ppt

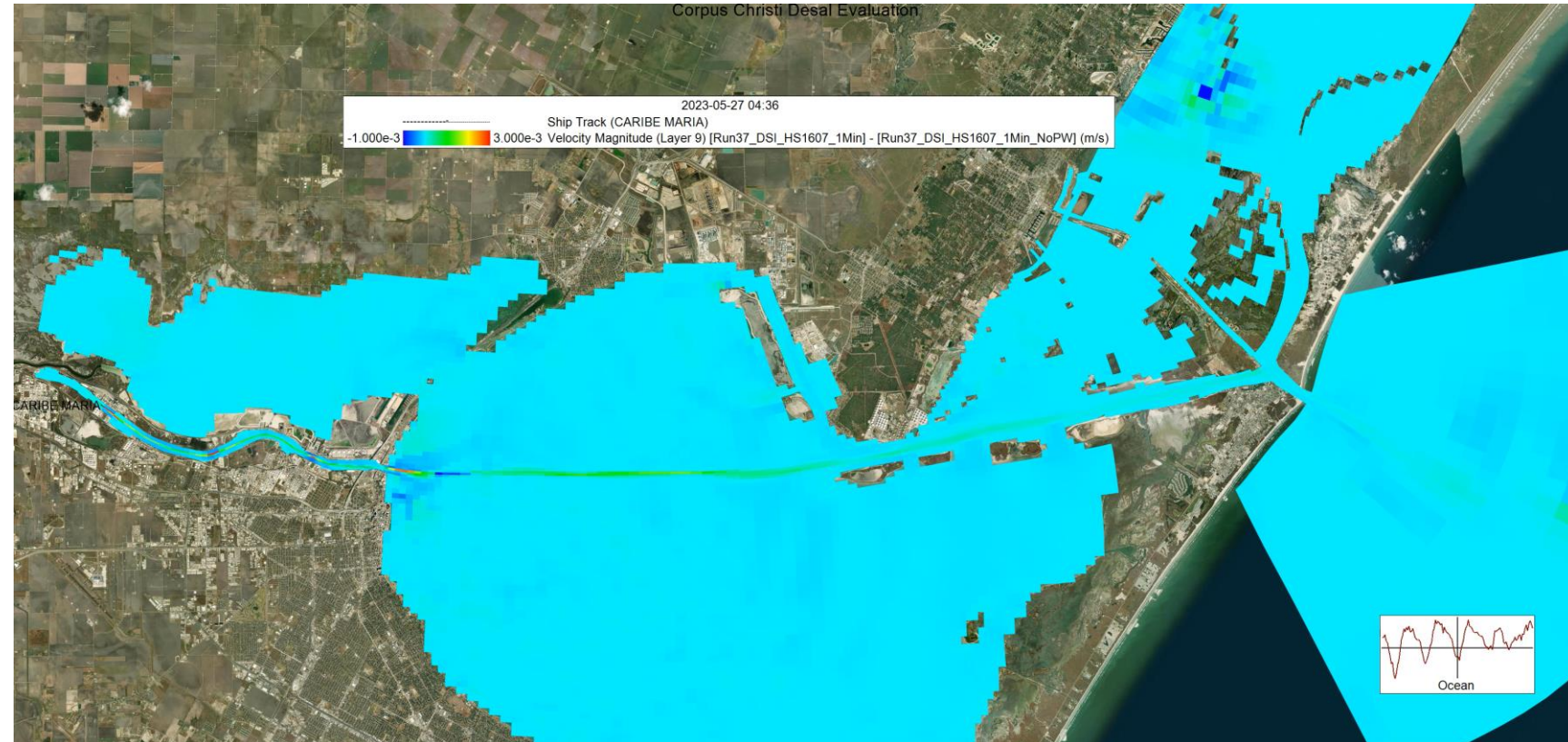


Stratification Changes: Hypothetical Worst Case – Inner Harbor



Findings from Ship Traffic Simulations

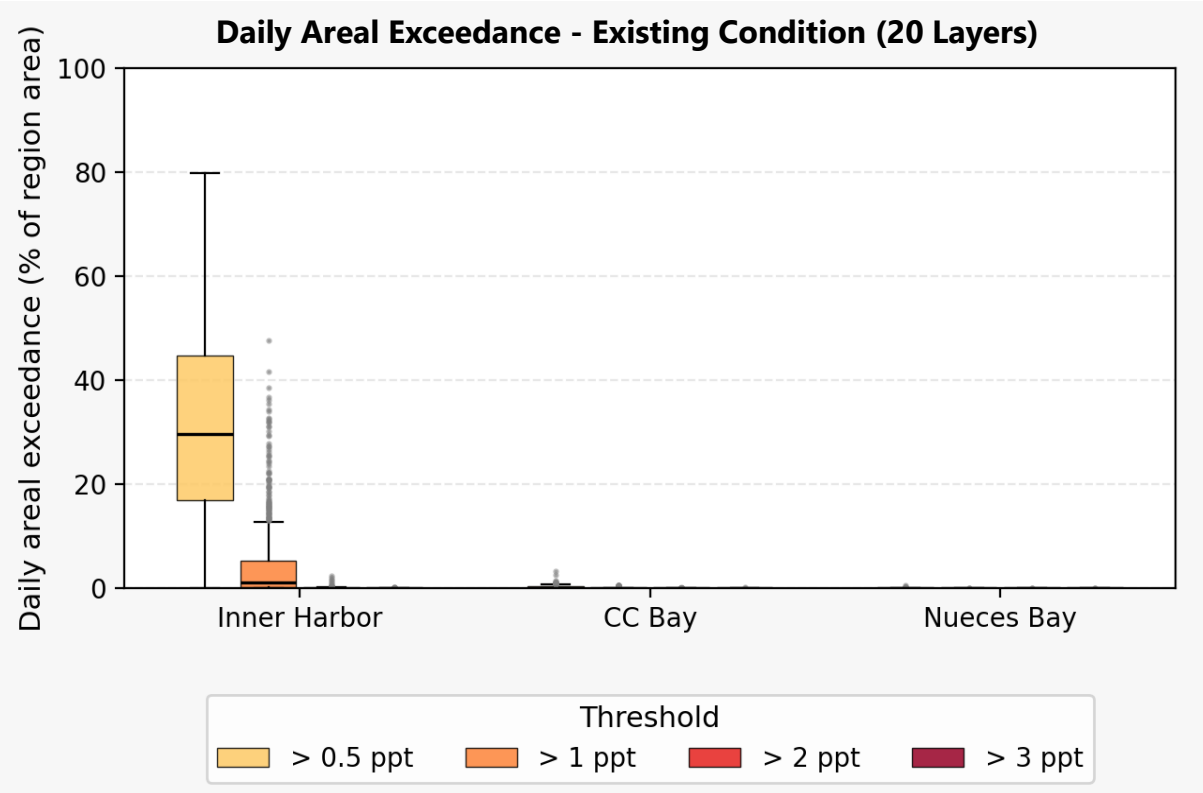
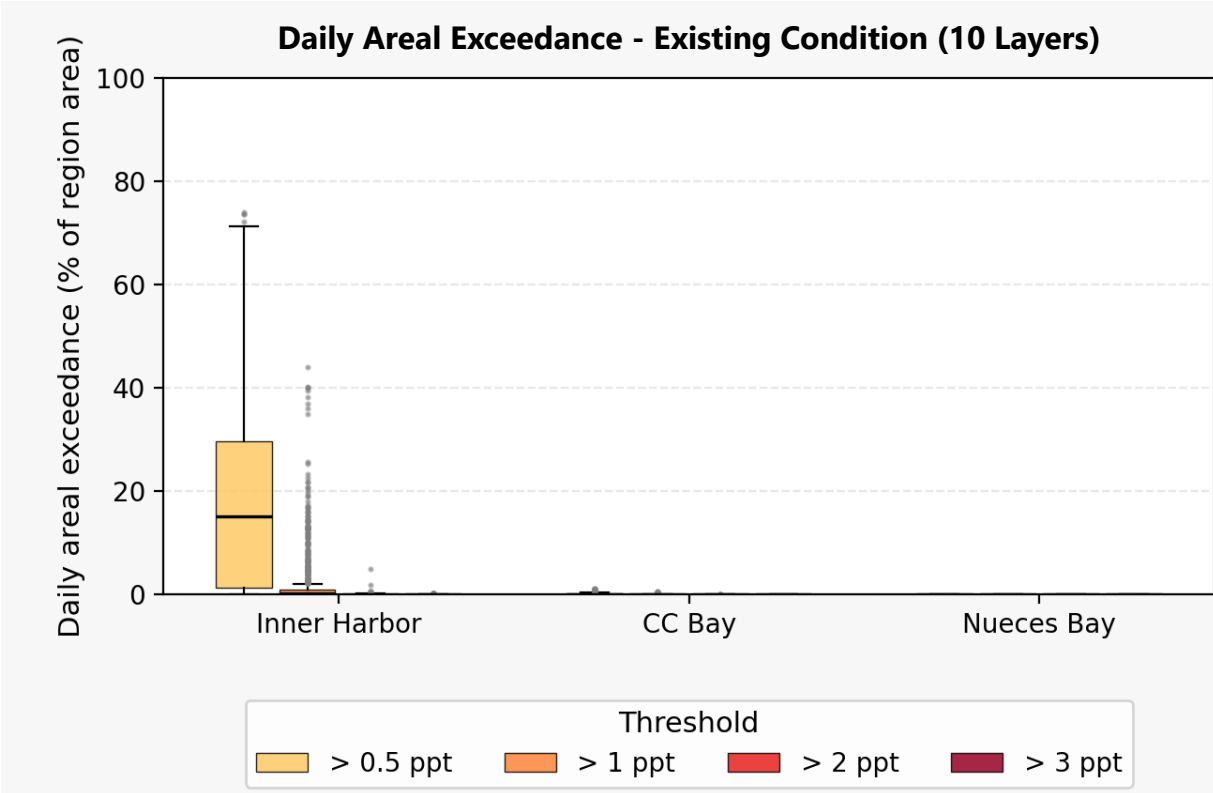
- Predicted changes in velocities are small
- Salinities are comparable with and without ship traffic
 - Mixing effect not apparent
 - Probably an artifact of the assumptions used (one ship in and out)



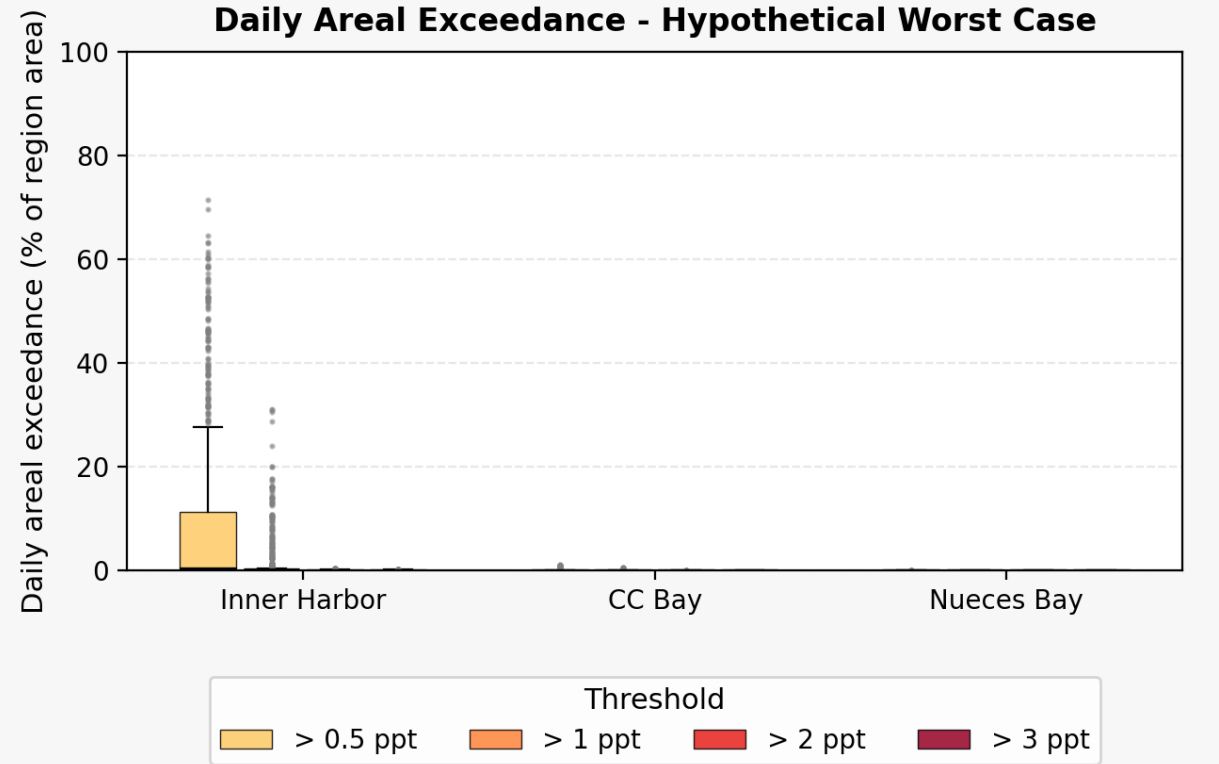
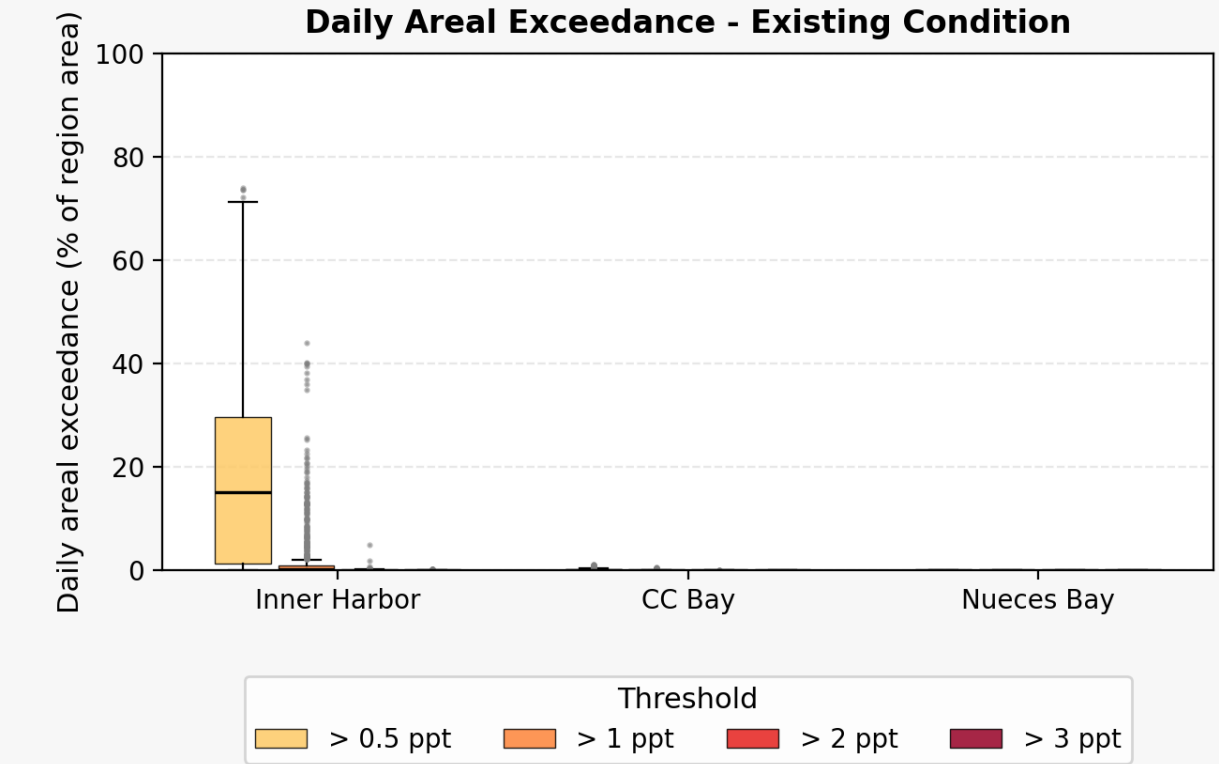
Findings Summary

- 3D far-field modeling shows that introduction of desalination discharge into the Inner Harbor may increase daily stratification locally by up to 2 ppt
 - Changes to stratification events dissipate due to tides and other environmental conditions over time scales of 2 weeks to 1 month
- Outside of Inner Harbor and Corpus Christi Channel stratification changes are generally less than 0.5 ppt
- DO was not modeled in this study – however, these findings suggest risk of desalination discharge exacerbating DO deficits in areas outside of the Corpus Christi Channel and Inner Harbor appear to be minimal

Findings Do Not Change with Increased Vertical Resolution



Findings Do Not Change under Hypothetical Worst Case Scenario



Thank you

- Spheros Environmental appreciates the opportunity to support the City and collaborate with the Far Field Advisory Committee on this important project



CITY OF CORPUS CHRISTI
**CORPUS CHRISTI
WATER**