Visualizing Oceanic Climate Change from the Global Scale to the Estuary Scale

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Introduction

Except for the Arctic Ocean, no ocean region on Earth has warmed as much as the coastal northwestern Atlantic. This project investigates how climate is changing on global to estuary scales using output from global climate simulations and a local ocean model for Narragansett Bay.

Narragansett Bay
- Geographic and cultural center of Rhode Island
- Temperate estuary
- Home to diverse assemblage of aquatic organisms

Science Question: How does oceanic climate change differ from the scale of the globe to scales of small estuaries unresolved by global climate models?
Objectives: Visualize climate change on various scales.

Method

A local ocean model of Narragansett Bay and nearby waters (OSOM) was forced with global climate historical simulations and future projections based on RCP 8.5 from the International Laboratory for High-Resolution Earth System Prediction (iHESP). The results from iHESP and OSOM were visualized using appropriate map projections.

Data

Global and regional scale data comes from iHESP. OSOM simulation runs come from my thesis project.

Results

Seas Surface Temperature Changes

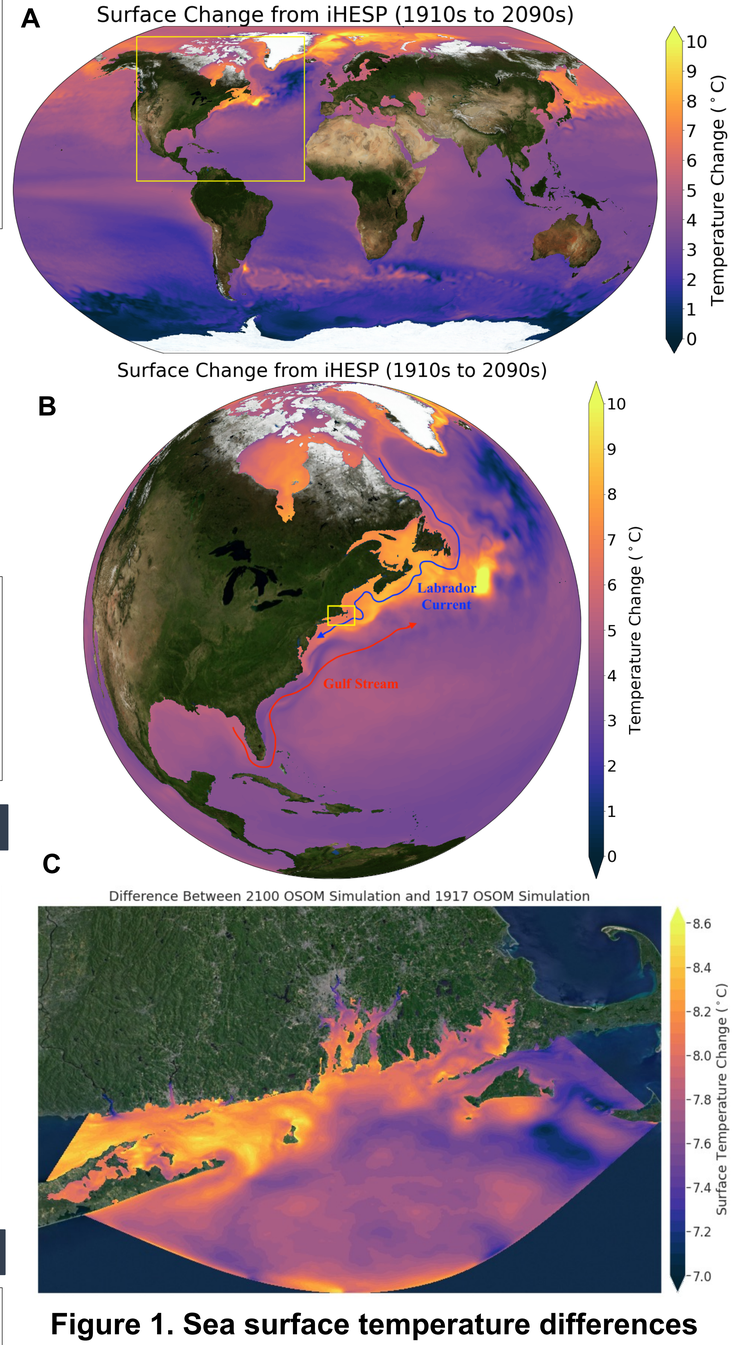

Figure 1. Sea surface temperature differences between the 1910s and 2090s from iHESP (A,B) and OSOM forced by iHESP (C).

Seas Surface Salinity Changes

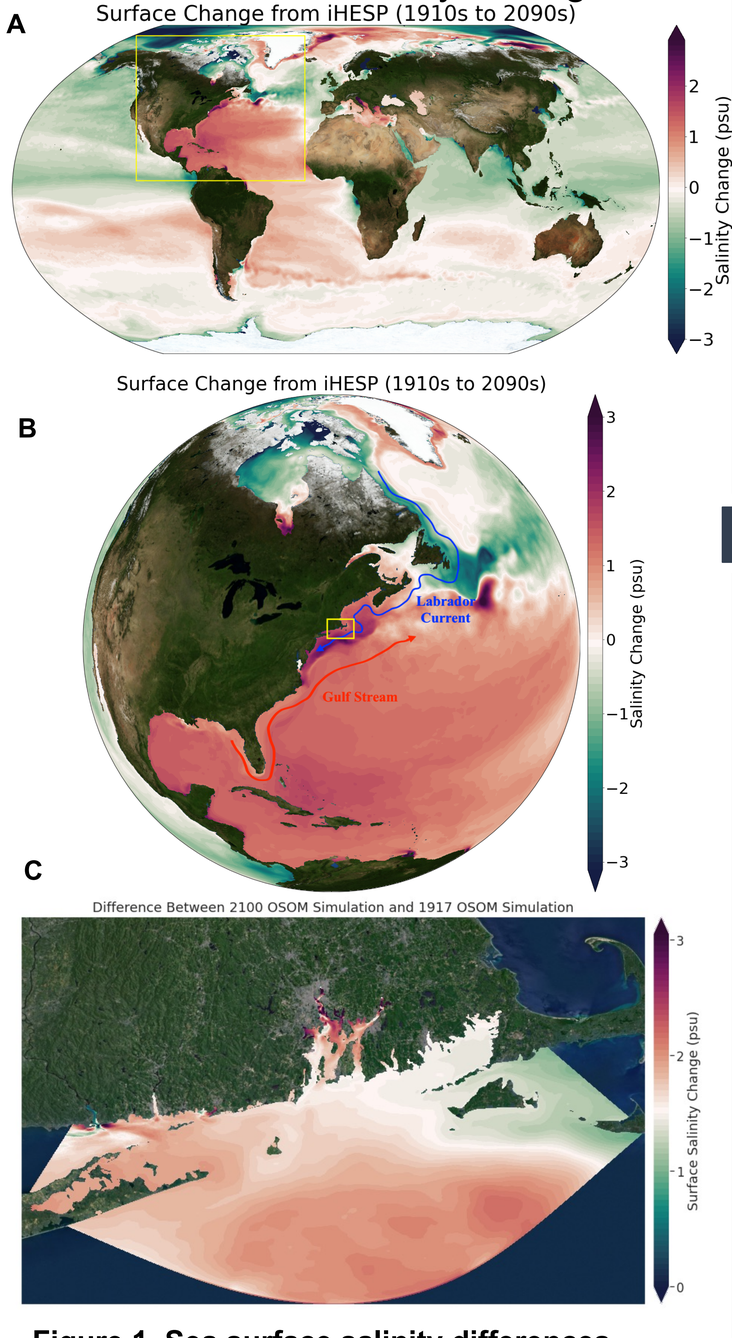

Figure 1. Sea surface salinity differences between the 1910s and 2090s from iHESP (A,B) and OSOM forced by iHESP (C).

Findings

- The northwestern Atlantic is warming faster than 99% of other ocean regions
- Salinity is changing here more than 98% of other ocean regions.
- Global and estuary scale climate simulations indicate that climate change is heterogeneous on local to global scales.
- Mid-coastal regions warm the fastest near Narragansett Bay
- Salinity change near Narragansett Bay is greatest in the freshest regions, further up the estuary and near rivers.

Conclusions & Future

According to global climate simulations, the northwest Atlantic region near the coast of New England is subject to the greatest amount of oceanic climate change in terms of temperature and salinity changes in the world except for the Arctic Ocean. These changes can be explained by changes in the Gulf Stream and Labrador Current.

Changes to ocean temperature and salinity are important environmental controls on ecosystem and organismal functioning. In addition, they govern how the physics of ocean systems behave. Increasing temperature and greater salinity stratification means that Narragansett Bay is becoming more susceptible to hypoxia under climate change due to lower mixing rates. Future work should look at how stratification specifically varies on global to estuarine scales.

Acknowledgements

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References: iHESP. (2021). CESM-HIGHRESMIP. Retrieved May 3, 2022, from https://ihesp.github.io/archive/products/ds_archive/CESM-HRMIP.html.