

Interannual stratification changes affect tides in the Gulf of Maine

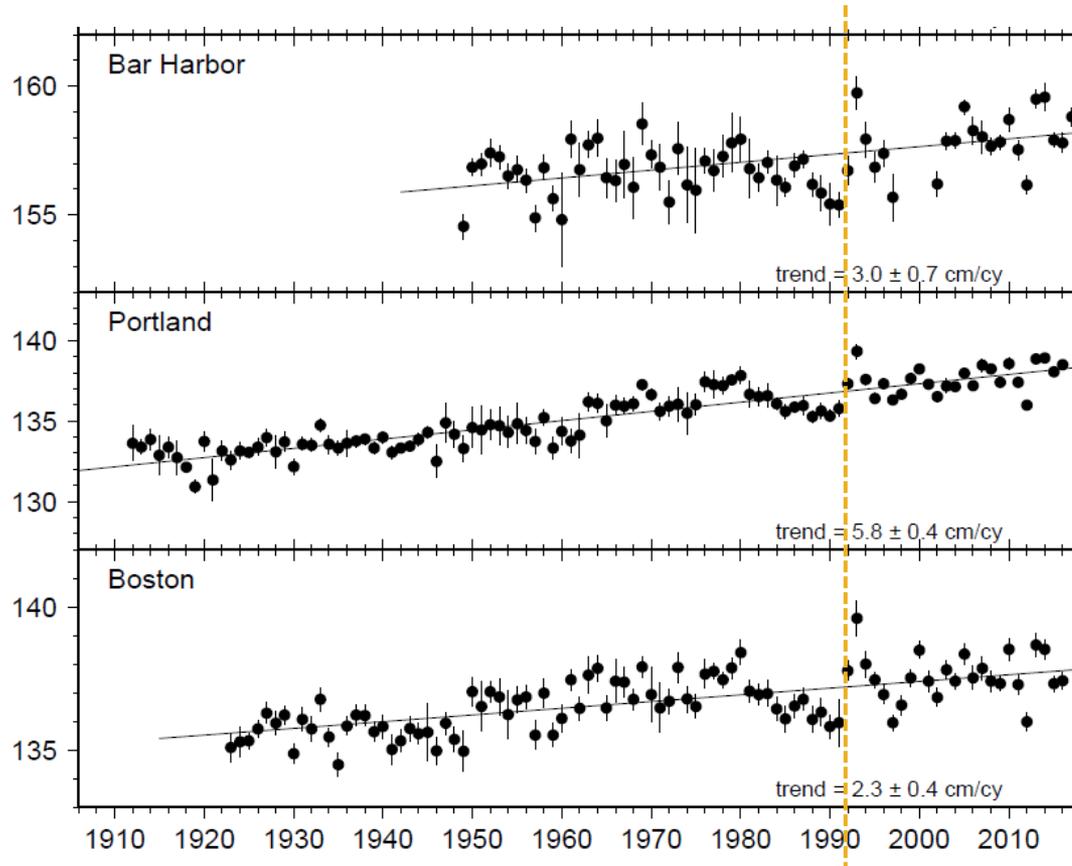
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Tides in the Gulf of Maine are changing ...



M₂ amplitude (cm), Ray and Talke (2019)

- Large secular trends
- Interannual variability also $\sim 1 - 4$ cm
- Causes are unknown

Research Question:

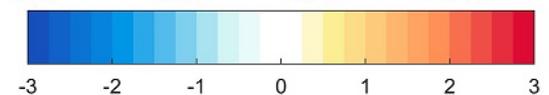
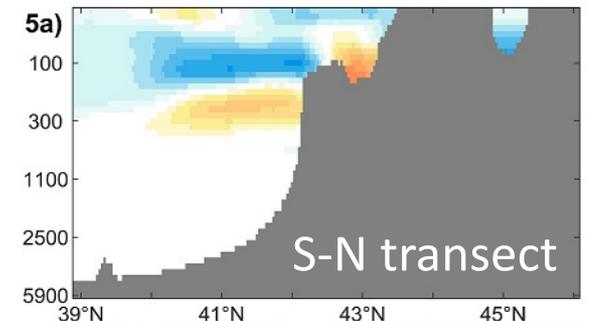
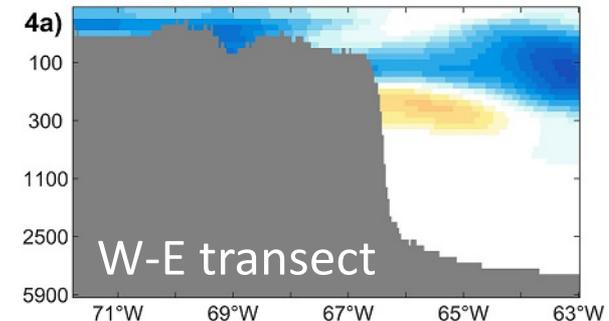
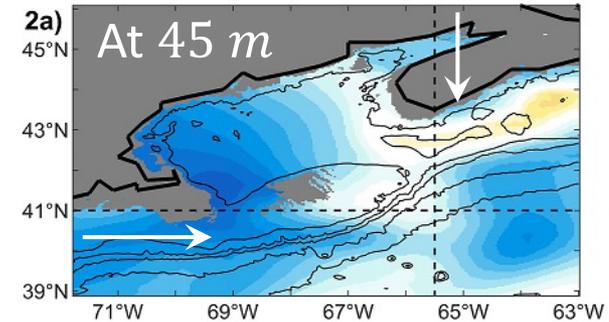
Can M₂ variability from 1990s onward be linked to changes in the regional density structure?

Modeling approach



Regional MITgcm setup:

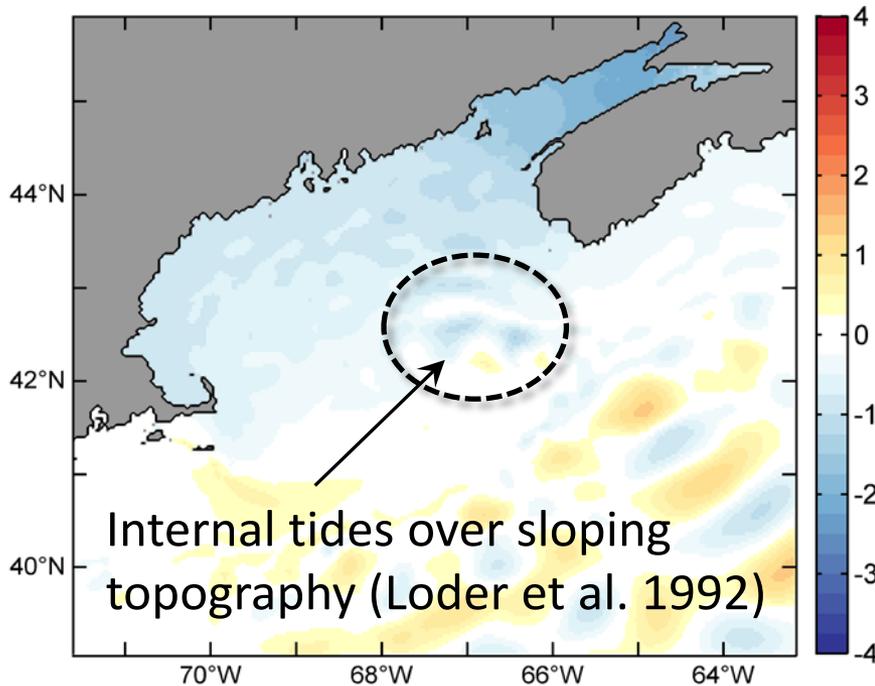
- $1/30^\circ$ lat-lon grid, z -coordinate
- 50 vertical layers, shallowest 10 m
- One 20-day simulation per year (1992, 1993, ..., 2012, 2013)
- **No atmospheric forcing**, tidal velocities at open boundaries are the same for each run
- But **background hydrography is exchanged** on a year-to-year basis:
 - Annual (θ, S) fields from ECCOv5



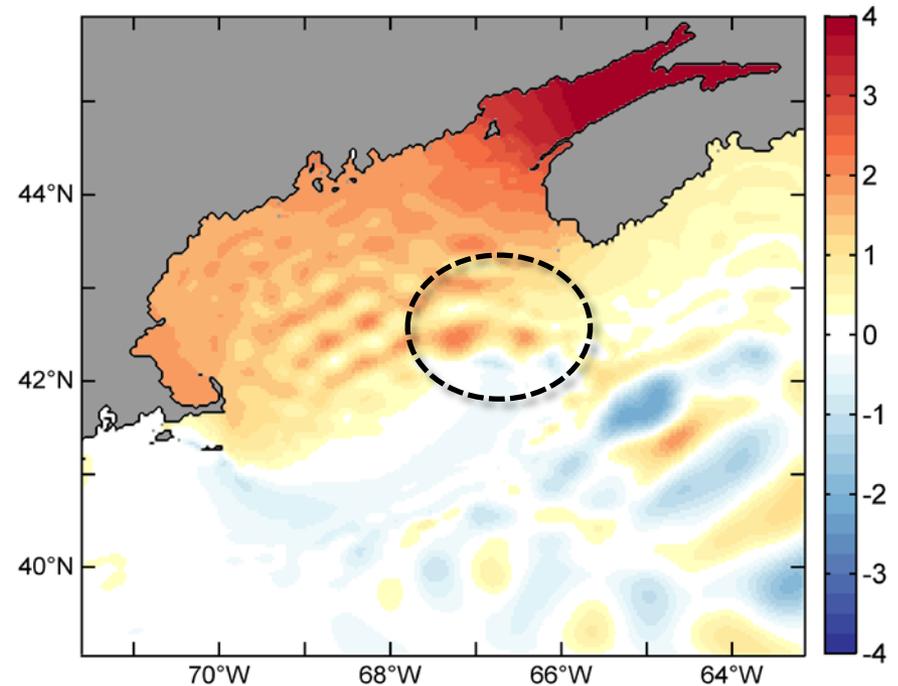
Differences in θ ($^\circ\text{C}$) 2003 minus 2002

Simulated changes in M_2 amplitude (cm):

1996–1994



2003–2001



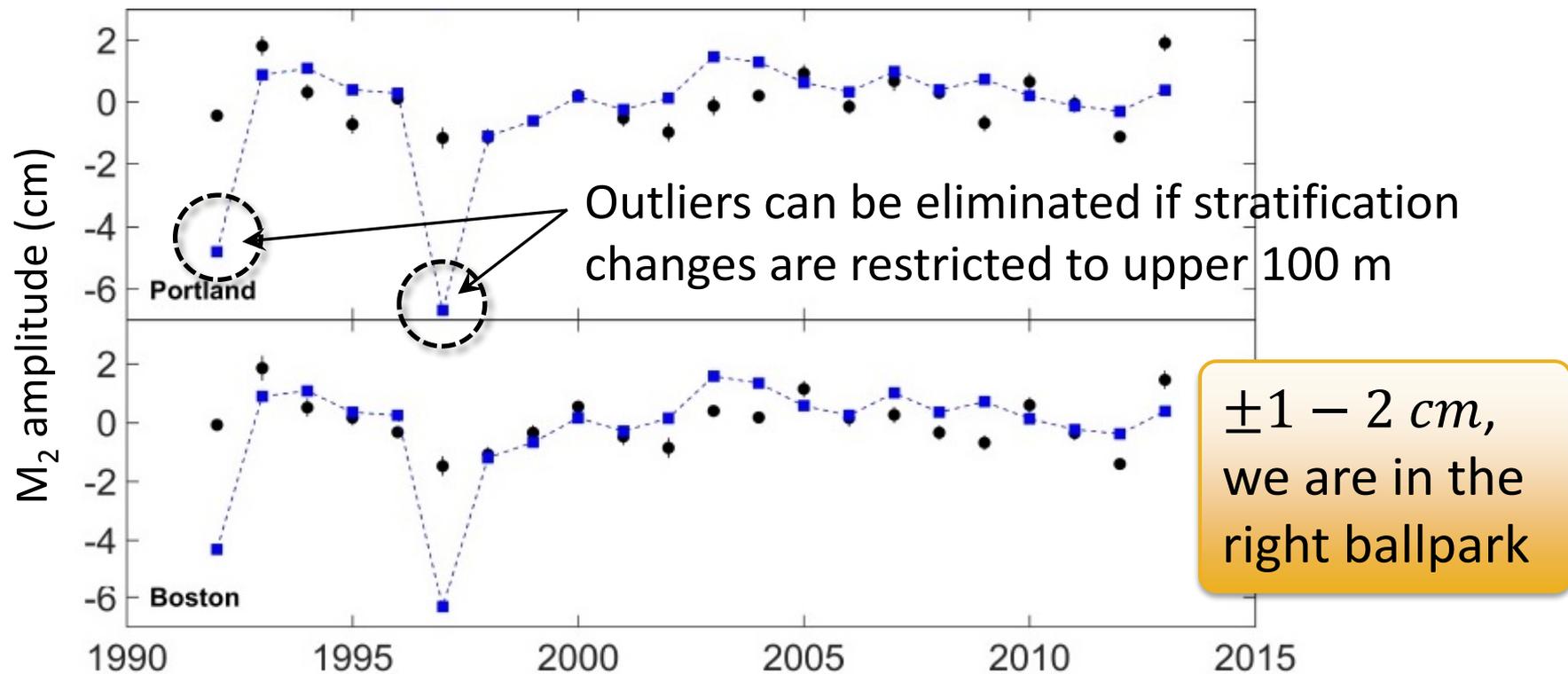
Spatially coherent changes in the Gulf's interior → possibly driven by stratification changes at **Northern Georges Bank**

Results



Comparison with tide gauge data (selection):

- Observed vs. **modeled** annual M_2 amplitude changes



Main take-away message:

The Gulf of Maine tide is sensitive to stratification changes at Georges Bank on interannual time scales

- Assessment of MITgcm simulations:
 - The sign of the modeled M_2 changes is often correct, but there are differences in terms of the magnitude
 - @Boston over 1993–2013: correlation is 0.5, explained var. 20%
 - Model improvement is needed (mixing scheme, vertical layers, ...)
- Is sea-level rise (SLR) another suspect?
 - No ... SLR ~ 1 m is required to get M_2 changes of similar size