Atmospheric Winter-Time Convection in the Gulf of Maine

[1]Collin Beirne, [1,2]Tiago Carrilho Biló, Greg Gerbi[1], Svenja Ryan[3]

1 School of Marine Science, University of Maine, 2 Climate Change Institute, University of Maine
3 Physical Oceanography, Woods Hole Oceanographic Institute

Introduction

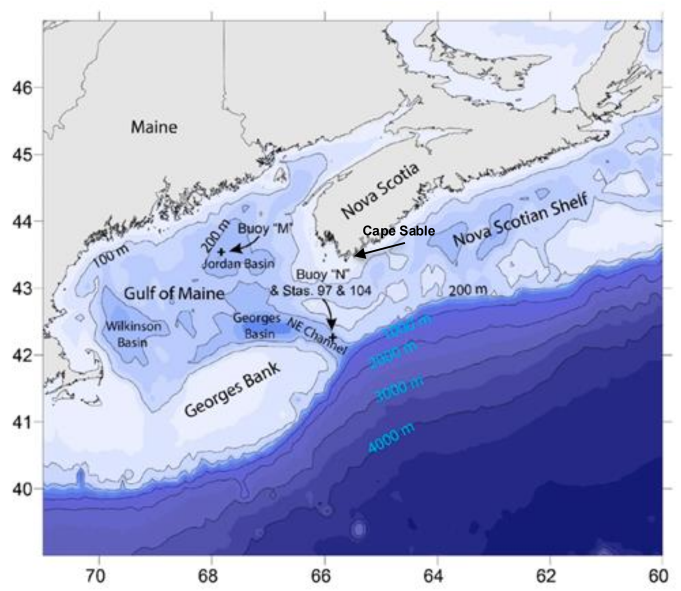
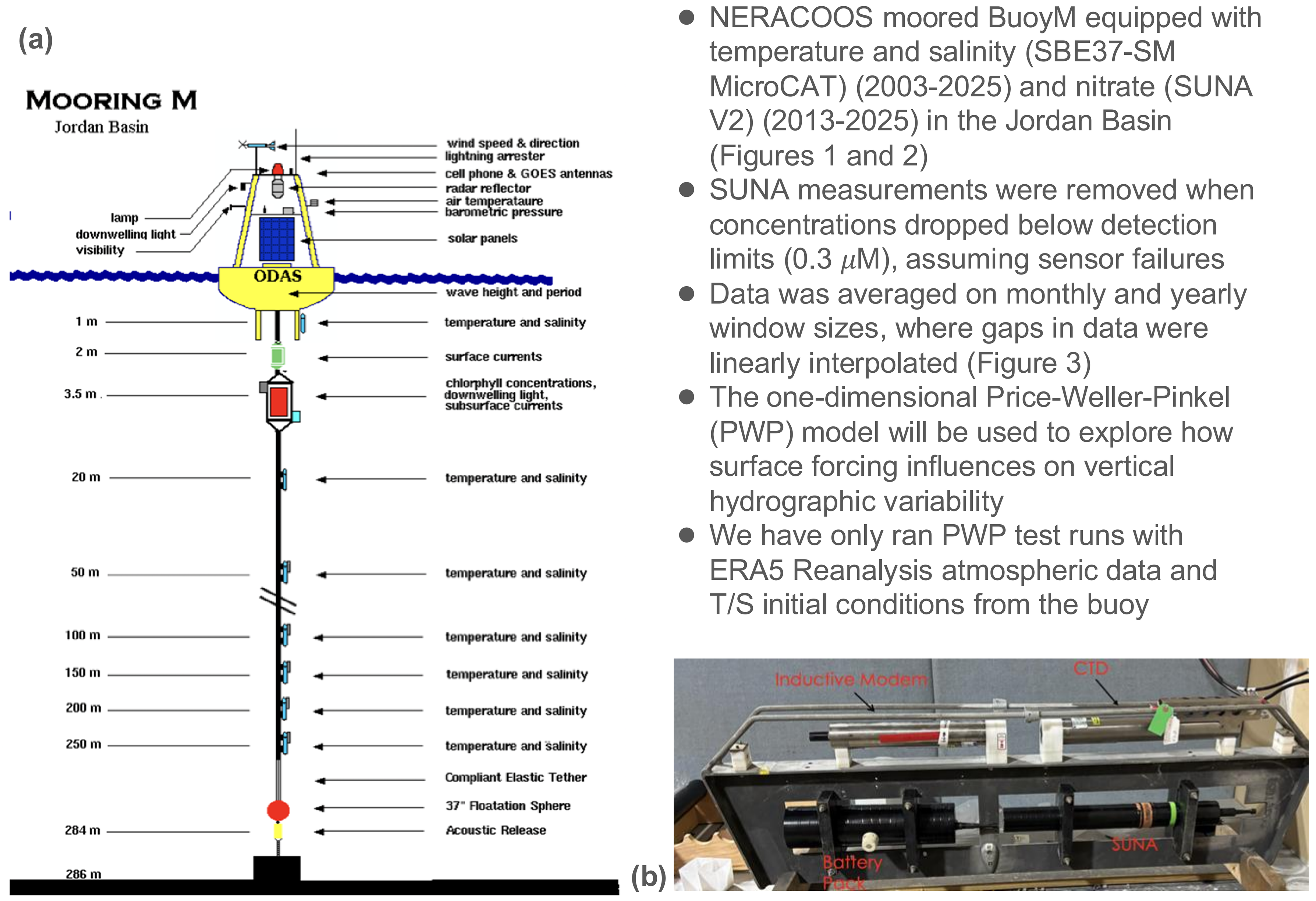


Figure 1. Map of the GoM region depicting the location of Buoy M in the Jordan Basin and surrounding bathymetric features, (longitudinal x-axis, latitudinal y-axis) (Townsend et al., 2023).

- The Gulf of Maine (GoM) is a highly productive, economically vital ecosystem (Townsend et al., 2023).
- The GoM is sourced with cold/fresh waters at the surface around Cape Sable and the Northeast Channel, while warm/salty waters enter the GoM through the Northeast Channel below 50 - 75m (Townsend et al., 2015).
- The Jordan Basin serves as a reservoir of nutrients from slope waters, where localized upwelling allows nutrients to be distributed throughout the GoM (Townsend et al., 2015).
- **The purpose of this study is to bridge the knowledge gap in how local atmospheric forcing affects the temporal variability of hydrographic properties and nutrient concentrations on monthly to interannual timescales.**

Data and Methods



- NERACOOS moored BuoyM equipped with temperature and salinity (SBE37-SM MicroCAT) (2003-2025) and nitrate (SUNA V2) (2013-2025) in the Jordan Basin (Figures 1 and 2)
- SUNA measurements were removed when concentrations dropped below detection limits (0.3 μM), assuming sensor failures
- Data was averaged on monthly and yearly window sizes, where gaps in data were linearly interpolated (Figure 3)
- The one-dimensional Price-Weller-Pinkel (PWP) model will be used to explore how surface forcing influences on vertical hydrographic variability
- We have only ran PWP test runs with ERA5 Reanalysis atmospheric data and T/S initial conditions from the buoy

Figure 2. (a) Diagram of NERACOOS Buoy M payload (UMaine Physical Oceanography Group, 2003), (b) T/S rails modified to accommodate the SUNA (Submersible Ultraviolet Nitrate Analyzer), with a dedicated battery pack and inductive modem for real-time data transmission.

References

Townsend, D. W., Pettigrew, N., Thomas, M., Neary, M., Mcgillicuddy, D., & O'Donnell, J. (2015). Water Masses and Nutrient Sources to the Gulf of Maine. *Journal of Marine Research*, *73*. https://doi.org/10.1357/002224015815848811

Townsend, D. W., Pettigrew, N. R., Thomas, M. A., & Moore, S. (2023). Warming waters of the Gulf of Maine: The role of Shelf, Slope and Gulf Stream Water masses. *Progress in Oceanography*, *215*, 103030. https://doi.org/10.1016/j.pocean.2023.103030

University of Maine Physical Oceanography Group (2003). http://gyre.umeoce.maine.edu/data/gomoos/buoy/html/M01.html

Results

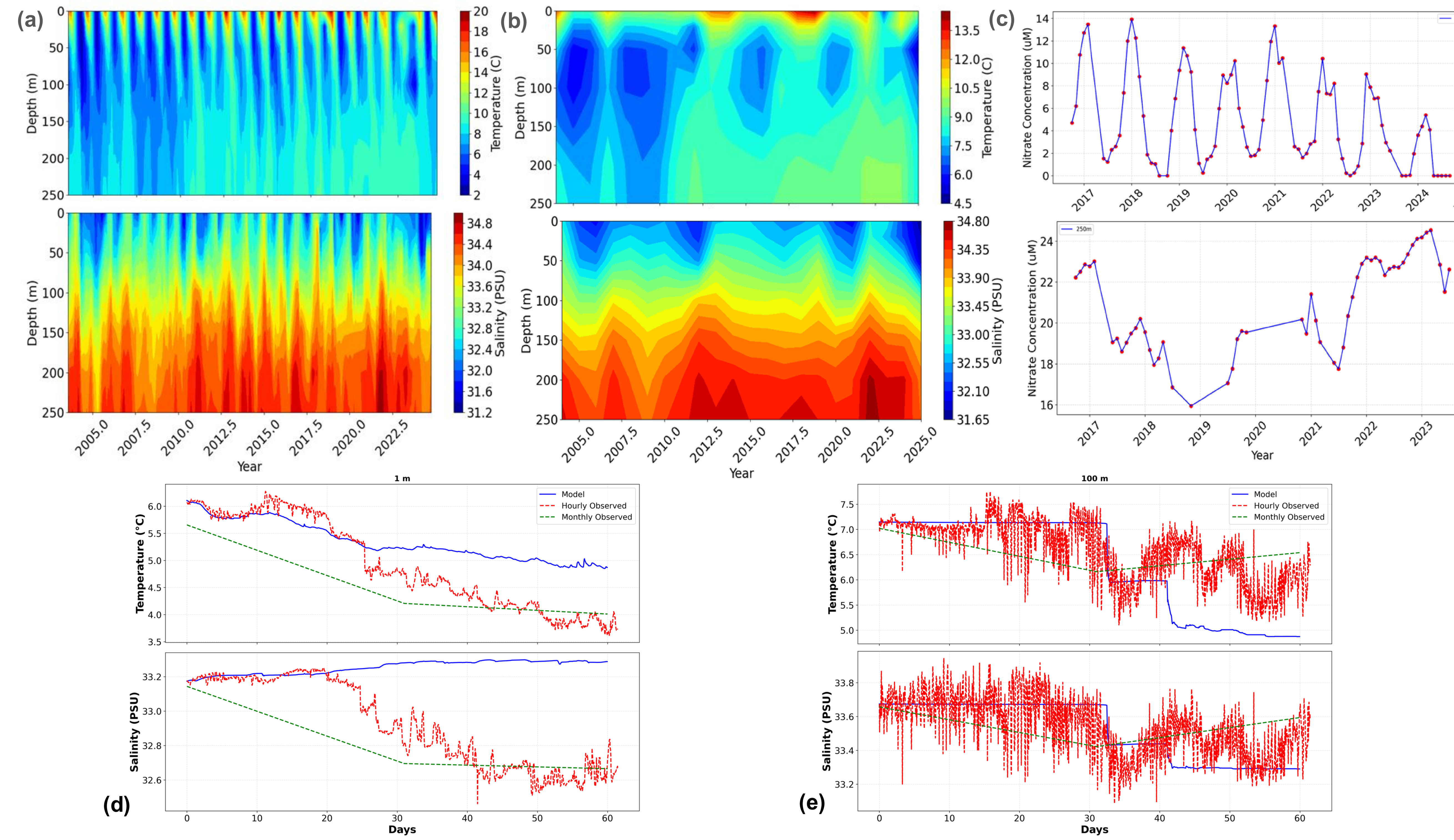


Figure 3. Visual data representation of hydrographic properties and nitrate variability measured from Buoy M in the Jordan Basin. Hovmoller diagrams of **(a)** monthly and **(b)** annual averages for temperature (top panels) and salinity (bottom panels). **(c)** Monthly running averages of nitrate concentrations near the surface (1 m) and ocean bottom (250 m). **(d)** and **(e)** PWP test run comparisons with observed data, from 1 and 100 m. **It seems wintertime convective mixing is driving mixing at depth. Where warm salty waters are trapped at depth when wintertime convective mixing isn't as prevalent. Seemingly leading to accumulation of nitrate concentrations at depth and a depletion at the surface. The PWP test run indicates the model can explain the surface variability up to a few weeks and potentially predict certain vertical mixing events at depth.**

Take Home Messages

- Temperature and salinity were dominated by seasonal cycles
- Strength of seasonality changes changes yearly, where the strength of the wintertime convection seems to dictate interannual variability of temperature and salinity properties. Convection observed to become weaker over the years, leading to warmer and saltier waters at depths below 150m.
- Due to reduced vertical mixing, nitrate seems to be increasing at depth and decreasing at the surface
- Our PWP test run indicates a one-dimensional dynamical framework can explain a significant portion of the temperature and salinity variability over periods of a few weeks at the surface and vertical mixing events at depth. For our experiment, model will be reinitialized after every 10 days, with initial data that was passed through a 72 hour Lanczos filter.

Acknowledgements

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