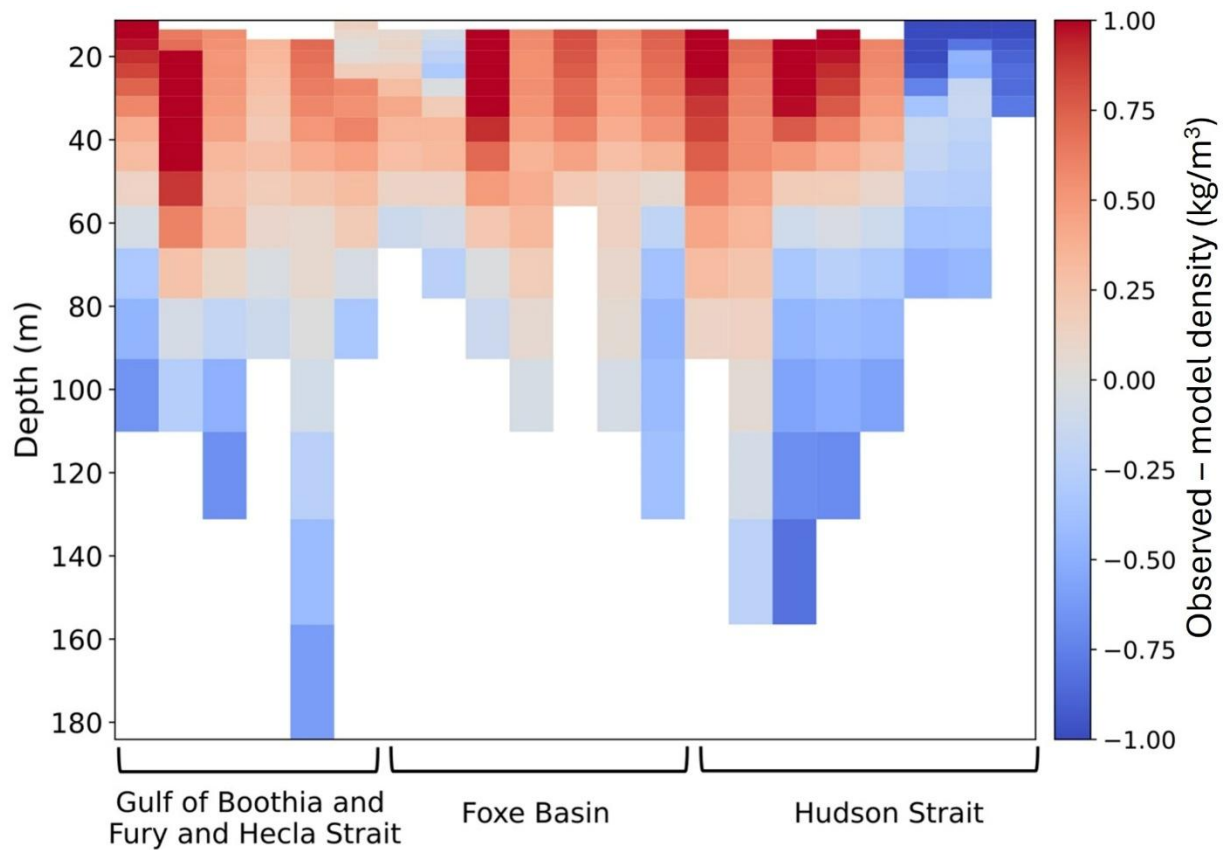


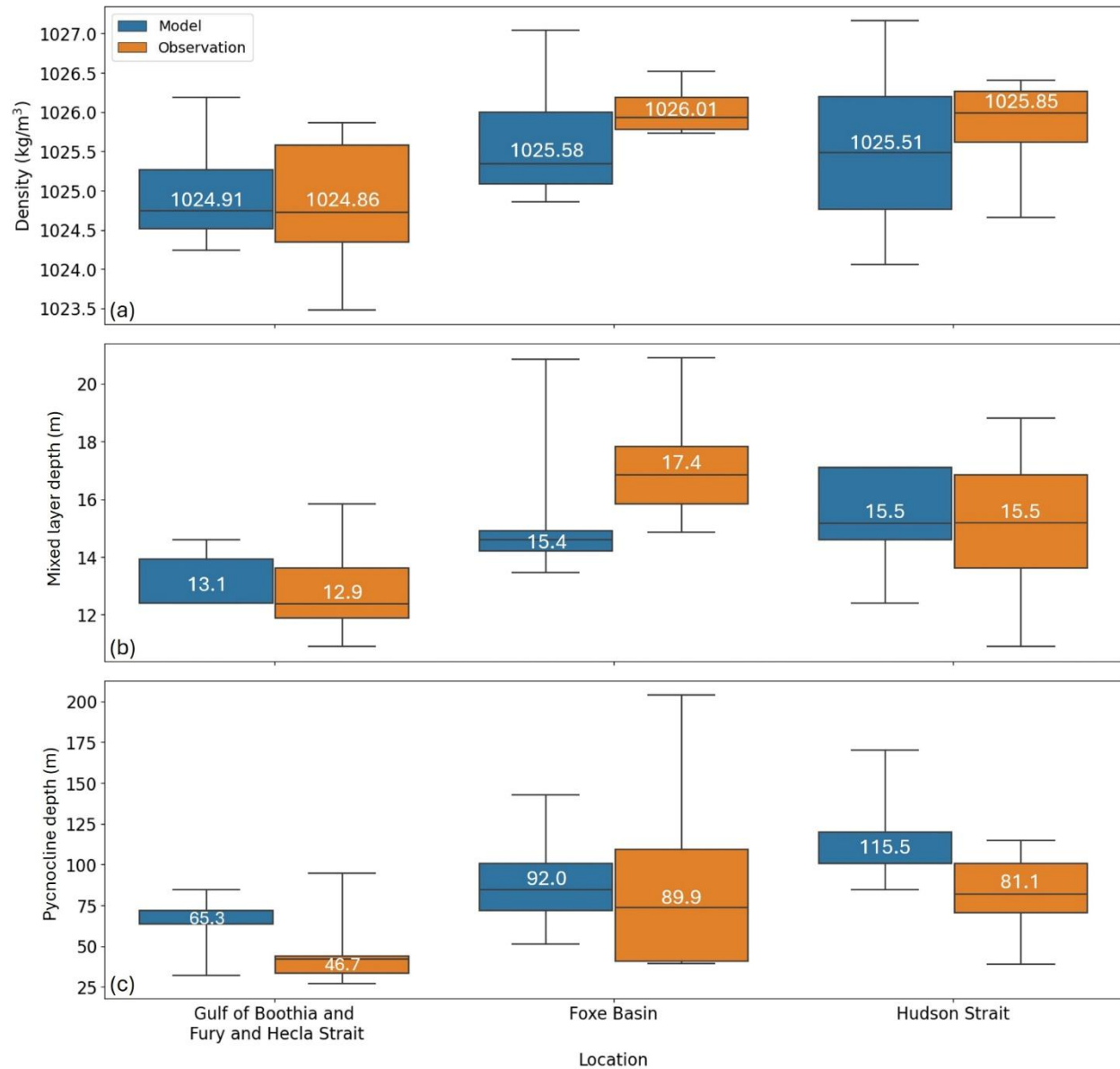
Supplementary material for: Rust R.L., Myers P.G. & Tortell P.D. 2026. The imprint of physical mixing on surface water N₂O and CH₄ concentrations in the eastern Canadian Arctic Ocean. *Polar Research* 45. Correspondence: Rebecca L. Rust, 120 Trustee Road Rochester, NY 14620, USA. E-mail: rrust@eoas.ubc.ca

Model evaluation and results

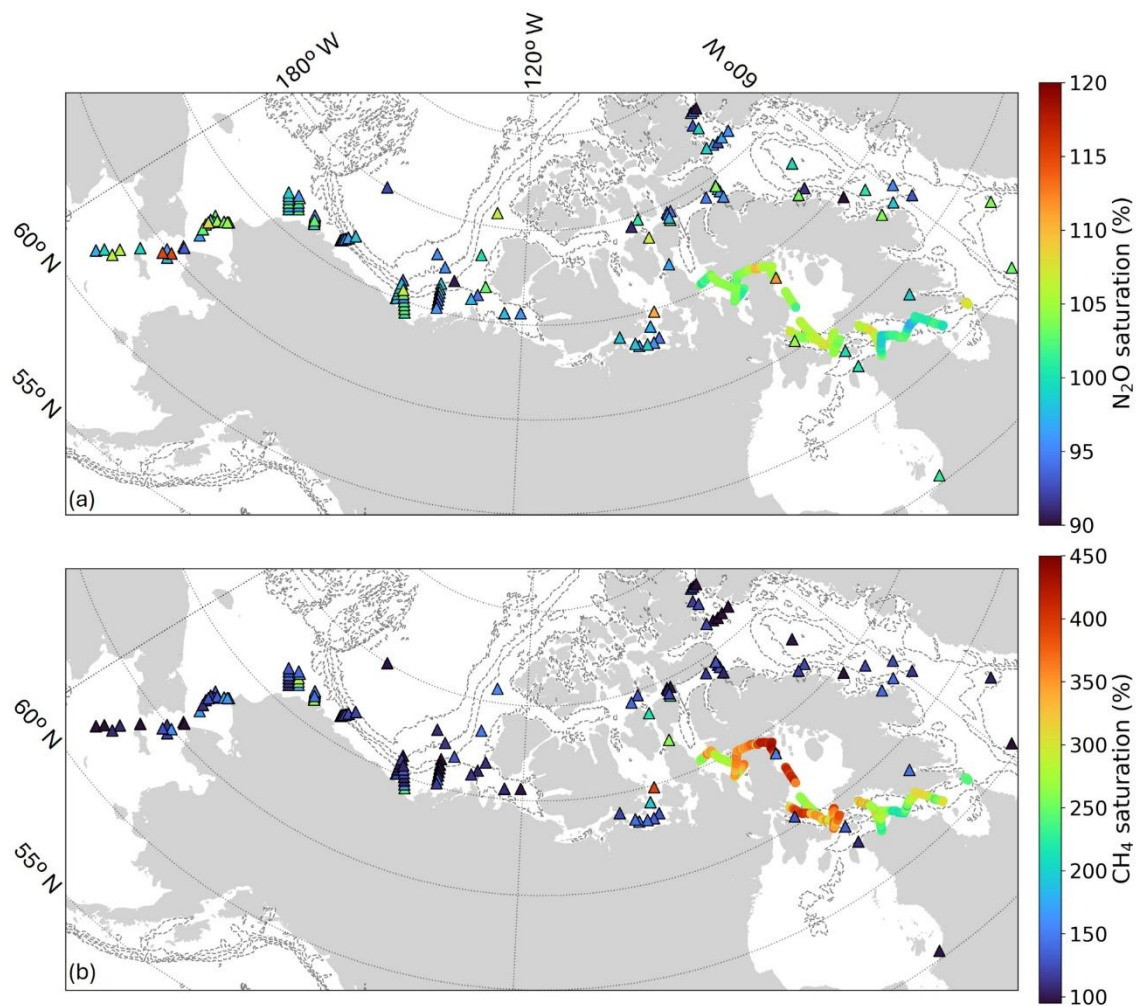
Across the study region, the numerical model showed variable skill in representing water column density, mixed layer depth and pycnocline depth compared to observations. The model tended to underestimate seawater density in shallow waters, while overestimating density at depth. Supplementary Fig. S1 shows the differences between modelled and observed seawater density, averaged between the model-derived mixed layer and pycnocline depths. Across the entire study region, the model showed the best performance in the Gulf of Boothia and Fury and Hecla Strait (RMSE of 0.57 kg m⁻³), with slightly larger density differences and higher RMSE values in Foxe Basin and Hudson Strait (0.62 kg m⁻³; Supplementary Fig. S1). Mixed layer depths were determined using density difference criterion of $\Delta\sigma = 0.03$ with respect to a 10 m reference depth, while the depth of the pycnocline was defined as the maximum depth below the mixed layer depth where the density gradient was less than 0.01 kg m⁻³ (Chu & Fan 2023). Mixed layer depths were generally well captured in the model, although the model underpredicted the full range of mixed layer variability observed in the Gulf of Boothia, Fury and Hecla Strait and Hudson Strait. The model reproduced mixed layer depths most accurately in Hudson Strait (RMSE of 1.4 m), with only slightly worse performance in the other subregions (Foxe Basin RMSE of 3.6 m, Gulf of Boothia and Fury and Hecla Strait RMSE of 2.5 m). Hudson Strait showed the poorest agreement of the three basins between modelled and observed pycnocline depths (RMSE of 51.0 m), with model-derived values over-estimated by up to 80.9 m. This rather large discrepancy may reflect the challenges of representing strong tidal currents in the model. The model also tended to overestimate pycnocline depths in the Gulf of Boothia and Fury and Hecla Strait, although the over-estimates were generally smaller than those seen in Hudson Strait. In contrast, model-derived pycnocline depths in Foxe Basin, were slightly underestimated relative to observations (Supplementary Fig. S2). Despite the differences in density predictions, model performance in Foxe Basin and the Gulf of Boothia and Fury and Hecla Strait was similar (RMSE of 39.1 m and RMSE of 37.2 m, respectively; Supplementary Fig. S1).



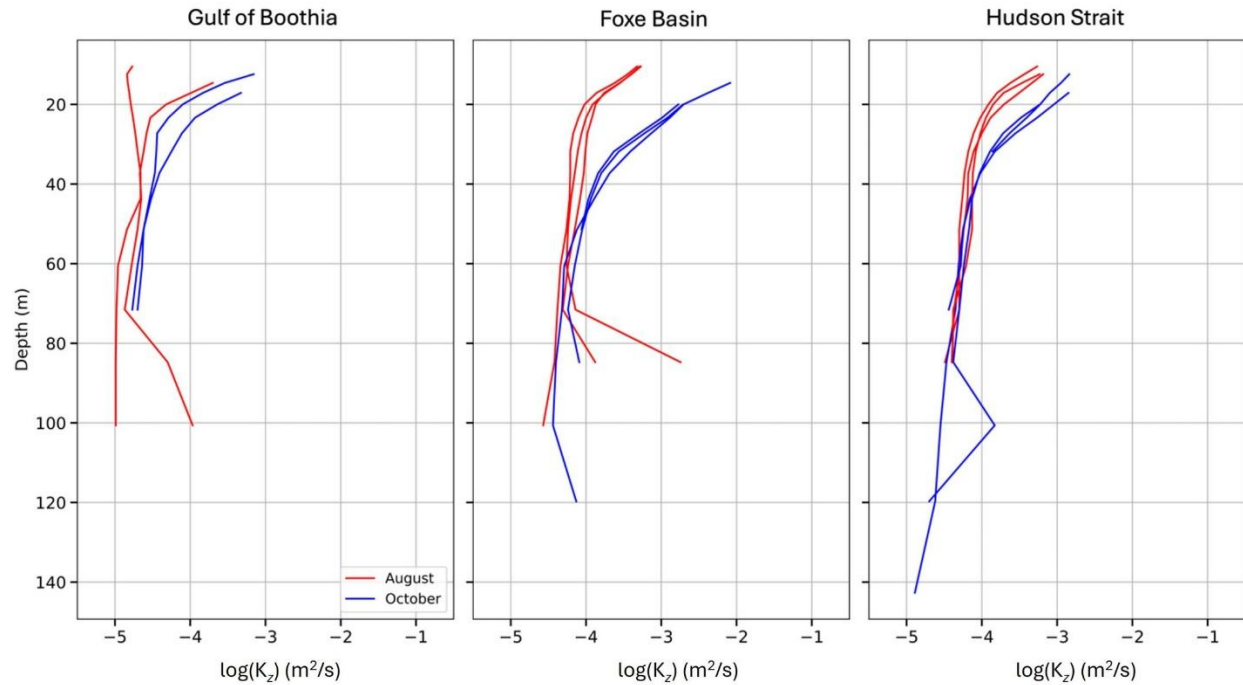
Supplementary Fig. S1. Depth profiles of seawater density differences between observed values and model output. For this comparison, density values were averaged between the modelled mixed layer depth and pycnocline depth. Blue values indicate model overestimation, while red values indicate model underestimates. The x axis denotes the station order, with the station on the farthest left sampled first and the farthest right sampled last.



Supplementary Fig. S2. Box plots of measured and model-derived physical parameters in the Gulf of Boothia, Fury and Hecla Strait, Foxe Basin and Hudson Strait, with values averaged for each sub-region and mean values labelled on each plot. Density in panel a represents the mean density computed between the model-derived mixed layer and pycnocline depths.



Supplementary Fig. S3. Comparison of surface water (a) N₂O and (b) CH₄ saturation measured in this study (dots) and by Manning et al. (2022; triangles).



Supplementary Fig. S4. Depth profiles of model-derived vertical eddy diffusivity coefficients ($\log(K_z)$) at selected station locations from August 2023 (red) and October 2023 (blue) for three sub-regions along the cruise track.

References

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- Manning C.C.M., Zheng Z., Fenwick L., McCulloch R.D., Damm E., Izett R.W., Williams W.J., Zimmermann S., Vagle S. & Tortell P.D. 2022. Interannual variability in methane and nitrous oxide concentrations and sea–air fluxes across the North American Arctic Ocean (2015–2019). *Global Biogeochemical Cycles* 36, e2021GB007185, doi: 10.1029/2021GB007185.