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Improving Estimates of Arctic Ocean CO_2 Uptake

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The Arctic Ocean covers only 3 % of the Earth's surface but contributes 5 - 14 % of the global ocean carbon sink. Sparse and unevenly distributed observations of the partial pressure of CO_2 (pCO_2) hinder our understanding of the magnitude and the controlling mechanisms of this carbon sink. In order to constrain the magnitude of this flux, we adapt the Self-Organising Map – Feed-Forward neural Network (SOM-FFN) method of Landschützer et al. (2016) to interpolate existing observations and construct a monthly 1 x 1 degree pCO_2 product for the Arctic Ocean from 1991 - 2022. We first divide the Arctic Ocean (i.e., the region ≥ 55° N) into five biogeochemical provinces; four obtained from using the SOM method and a fifth for all grid cells with greater than 85 % ice cover. For each province, we then derive non-linear relationships between pCO and predictor variables (i.e., biogeochemical drivers) using the FFN method. The monthly reconstructed Arctic pCO_2 product is then evaluated against existing observations of surface ocean pCO_2, chiefly from SOCATv2023 and from independent timeseries stations. Our study shows that biogeochemical properties previously selected as predictor variables at the global scale are not well suited to the Arctic Ocean. Limiting the spatial domain from which relationships are derived also improves performance, with less biased $p(CO_2)$ values predicted when excluding the Baltic Sea.