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Topic: Critical drivers for ocean salinity science and applications and the future need for high-resolution technologies

Title: Estimating Regional and Pan-Arctic Freshwater Content Variability from Satellite Sea Surface Salinity

Abstract: Freshwater content (FWC) plays a central role in Arctic stratification, circulation, and sea-ice evolution, yet sustained basin-scale observations remain sparse due to limited in situ sampling. Satellite L-band sea surface salinity (SSS) products now provide multi-year surface coverage across much of the ice-free Arctic, offering new opportunities to infer vertically integrated freshwater variability. In this study, conducted within the framework of the ARCFRESH initiative, we quantify statistical relationships between upper-ocean FWC and satellite-derived SSS using the latest ESA Climate Change Initiative (CCI) Level-4 weekly SSS product in combination with an extensive archive of hydrographic profiles (CTDs, Argo and ice-capable floats, moorings, and gliders) from 2010 onward. These relationships are used to estimate spatially continuous FWC variability at both regional and pan-Arctic scales. Results show robust coupling between surface salinity and upper-ocean freshwater storage across large portions of the Arctic, with regional differences linked to stratification regimes and circulation pathways. The reconstruction captures coherent interannual variability and highlights dynamically active regions where freshwater trends are amplified relative to surface salinity changes. This approach demonstrates the potential of satellite SSS, when constrained by in situ observations, to extend freshwater monitoring capabilities and support improved understanding of Arctic hydrographic change.

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