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

Title: Assessment of salinity variability in the Bering Sea from satellite-based observations and a coupled ice-ocean model, with comparison to concurrent work on the Northern California Current System

Abstract: The lateral exchange of salinity between the shelf and interior ocean contributes to seasonal and interannual variability in both environments. But because the flux is often primarily through cross-isobath eddying motions, quantification of the processes is challenging. Here we present an assessment of current observational and modeling capabilities for analyzing shelf-basin salinity exchange and variability in the Bering Sea with particular focus on satellite surface salinity products contextualized with free-running multiyear high resolution coupled ice-ocean model simulations. We then provide a comparative analysis of this relatively high latitude system with our concurrent study of salinity variability in the California Current system (CCS).

Single-platform satellite salinity products from SMAP (RSS v6) and SMOS (CEC, BEC-Arctic) along with products that merge output from both satellites (OISSS, CMEMS) were analyzed over the broad eastern Bering Sea shelf, the narrow Koryak coast and the deep basin for 2015 through 2023. Comparison with each other, with Argo drifters, and summer shelf surveys allow us to frame the uncertainty of these products but do not provide adequate ground-truthing to determine one product as best for assessing seasonal to interannual variability.

A Regional Ocean Modeling System (ROMS) coupled ice-ocean model simulation for 2018 through 2024 was used to obtain a temporally and spatially high-resolution perspective on the dynamics of the system. To the extent that the model reasonably captures the processes that constitute the salinity variability, we compare model to satellite and in situ estimates. Where interannual variability is adequately large, such as in the Gulf of Anadyr in the northwest of the Eastern Bering Sea shelf, the satellite observations and model can be used in conjunction to offer dynamical explanations for observed surface salinity anomalies. In other locations such as along the Koryak coast, model results suggest intriguing shelf basin exchange processes of brine water injection at pycnocline depths that may exhibit surface signatures that will require the next generation of satellite salinity measurements to capture.

Lateral salinity fluxes between shelf and basin are primarily eddy-driven in both the Bering Sea and California Current systems. But differences in geometry and the principal drivers of lateral gradients cause the systems to differ markedly. The narrow shelf of the CCS leads to strong salinity gradients in proximity to the shelf break, both due to high freshwater influx in the north and intense upwelling further south. While freshwater influx to the Bering Sea is nearly as large, it largely occurs over the extremely broad shallow Eastern Bering Sea shelf. Brine injection and freshening from seasonal ice melt can lead to direct exchanges with the basin along the narrow-shelved Kamchatka and Koryak coasts. But the largest near surface salinity flux to the Bering Sea Basin is driven by strong tidal mixing along the Aleutian Island archipelago.

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