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**Topic:** Recent ocean salinity science advances

**Title:** Seasonal and interannual variability in the ocean surface salinity along the US West Coast

**Abstract:** SMOS and SMAP sea surface salinity (SSS) products, in-situ Argo and glider measurements, and outputs of a high-resolution regional ocean circulation model are used to understand near-surface salinity variability along the US West Coast and in the wider Northeast Pacific (NEP) region. The focus is on the coastal transition zone (CTZ), an interior ocean area adjacent to the shelf where circulation is influenced by the coastal ocean processes such as terrestrial water discharges, seasonal wind-driven upwelling and downwelling, alongshore current instabilities and eddy variability.

As an example, in the CTZ off Vancouver Island (British Columbia, Canada) the annual cycle in SSS is determined by summer freshening due to offshore eddy transport of the terrestrial waters and a winter salinity increase due to vertical mixing by storms. The turbulent salinity flux at the base of the surface mixed layer must counteract the effect of precipitation, which is of comparable order of magnitude. Interannual variability in this CTZ relates to variations in surface eddy kinetic energy and terrestrial discharges. By incorporating the full suite of discharges from the GloFAS hydrological model, we significantly reduce the SSS bias and improve the annual cycle amplitude in the ocean circulation model compared to satellite and in-situ observations, a notable improvement over an earlier benchmark.

On longer time scales, SSS variability in the NEP is associated with known decadal modes of variability (defined by SSH and SST), such as the Pacific Decadal Oscillation (PDO) and the North Pacific Gyre Oscillation (NPGO). Analyses of satellite SSS and Argo reveal a widespread freshening pattern from 2018 to 2024, stretching from California to the Gulf of Alaska, with a detected decrease of up to 0.3 psu over 7 years. Argo profile data confirm that this freshening extends over the 300 m depth. SSS Empirical Orthogonal Function (EOF) analyses explain this event as a combination of negative PDO (signifying north-to-south displacement of water masses along the coast) and negative NPGO (indicating a weakening of the gyre circulation).

Our improved understanding of SSS variability and satellite product quality encouraged us to approach assimilation of the SMOS Level 3 data set into NOAA's West Coast Ocean Forecast System (WCOFS), specifically to constrain the geometry of the summer upwelling front. The immediate challenge is a seasonally changing bias in the salinity product: the satellite salinity is fresher than in-situ glider observations in summers and saltier in winters. This seasonally varying bias, with an amplitude of 0.3–0.5 psu, is comparable to the seasonal variations caused by coastal upwelling-downwelling. Mitigating this bias is the focus of our present research.

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