Seasonal and Interannual Salinity Variability on the Northeast U.S. Continental Shelf: Insights from Satellite Sea Surface Salinity and Implications for Stratification

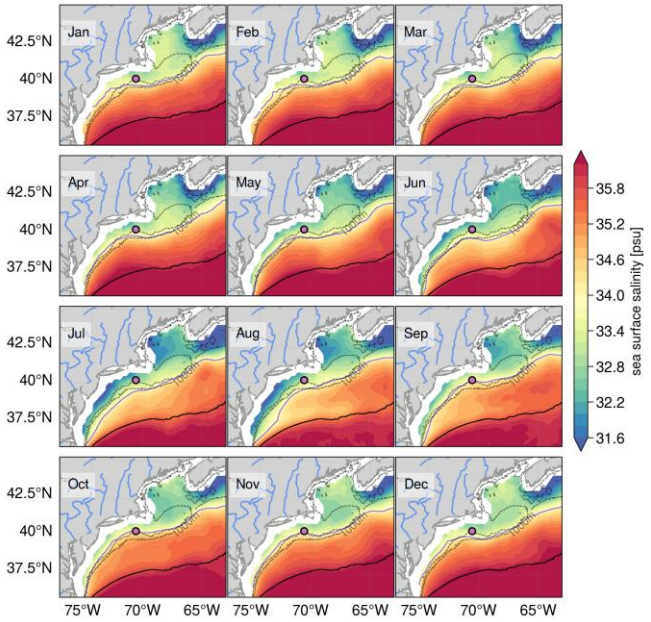


Figure 1: Mean seasonal cycle (2016–2022) of sea surface salinity (SMAP). Dashed contour denotes the 100 m isobath and purple contour represents the 34 isohaline. The mean Gulf Stream path is shown as black contour and the magenta dot marks the position of the Pioneer array inshore mooring located at the 95 m isobath.

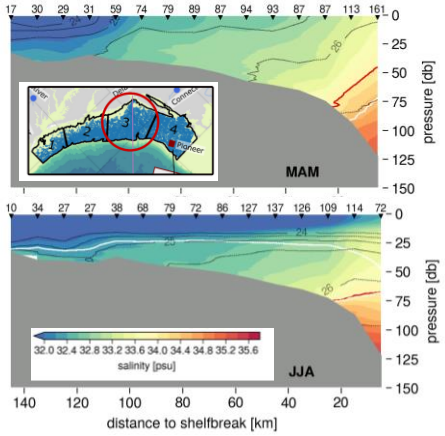


Figure 2: Mean cross-shelf sections of salinity for March, April May (MAM) and June, July, August (JJA) constructed from EcoMon profiles in box 3. Gray isolines denote potential density, red isoline re-presents the 34 isohaline, indicative of the shelf break front. Black triangles mark the bins (10 km) used for constructing the sections and numbers above indi-cate number of profiles in each bin.

Motivation: The Northeast U.S. continental shelf is a highly productive and economically important region that has undergone substantial changes in recent years, with warming rates exceeding the global average. Cold and fresh, nutrient-rich waters of Arctic origin flow southward via the Scotian Shelf and Labrador Current, adjacent to the warm and salty Slope Sea Water which is a derivative of Gulf Stream waters. Monitoring the interactions between both water masses, as well as local freshwater input, is key to understanding the regional ocean variability from seasonal to interannual to decadal time scales with important implications for fisheries and coastal ecosystem management. Yet, the high complexity of processes at play and lack of continuous long-term observations pose large challenges.

Data: Three gridded L3/L4 *sea surface salinity products*: SMAP V5.0 (produced by Remote Sensing Systems), SMOS V8.0 and OISSS v2.0. *Mooring data* from the Ocean Observatory Initiative Coastal Pioneer Array (mooring data) and *hydrographic profiles* from the NEFSC Ecosystem Monitoring (EcoMon) program.

Results:

- Local river discharge drives decreasing salinities not only in spring and summer on the shelf but also in the Slope Sea ***(Figure 1).*** In spring, fresher water aids the build-up of stratification and a low salinity surface layer extends to the shelf break above the pycnocline by the beginning of summer ***(Figure 2)***.
- An observed salinification in the fall is linked to offshore forcing over the slope associated with the presence of mesoscale eddies shedding from the Gulf Stream (Warm Core Rings).
- Coherent low-frequency salinity variability is found over the slope and shelf, with maximum salinities in 2015 associated with a northerly position of the Gulf Stream, highlighting that shelf conditions are significantly impacted by offshore variability, particularly the position and stability of the Gulf Stream ***(Figure 3)***.
- A freshening between 2015 and 2021 is in agreement with increased river cumulative discharge as well as lower offshore salinities. Overall, salinity serves as a valuable additional tracer of these multi-variate processes.

Implications: Coastal ocean dynamics regulate the heat and material budgets of highly productive and economically important regions of the world's oceans. Due to the strong lateral salinity gradients from fresh coastal to very saline offshore waters, salinity is a better tracer of ocean processes than temperature in many ways. As demonstrated, satellite SSS data can provide valuable spatio-temporal insights into the region's variability, despite existing caveats in spatial resolution and data acquisition near the coast.

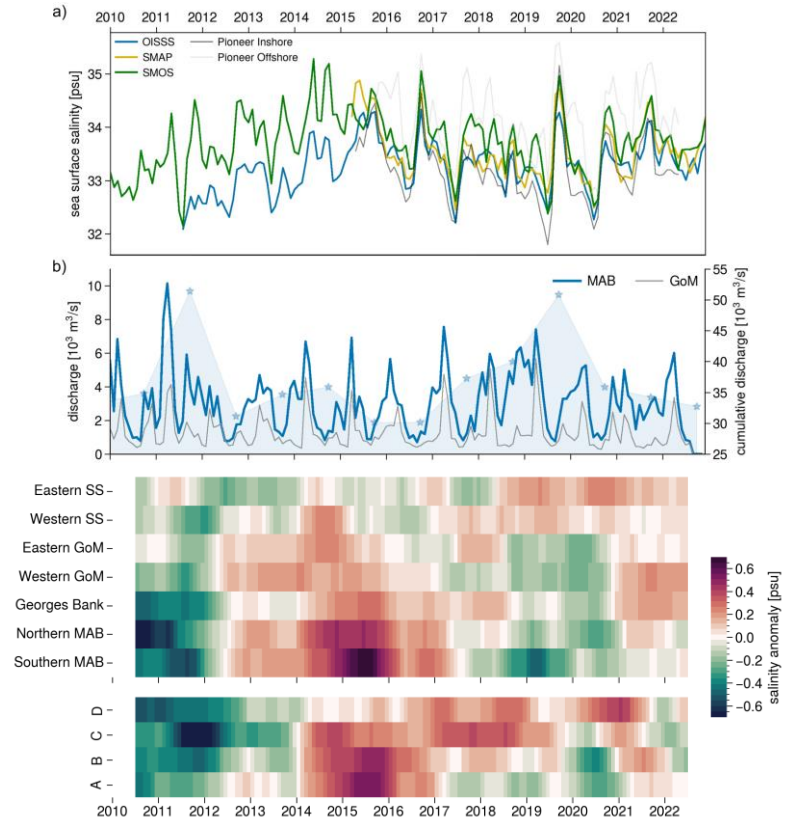
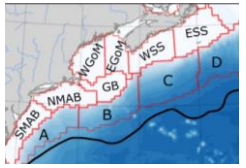


Figure 3: (a) Sea surface salinity from three satellite products (colored lines) extracted at the Coastal Pioneer Inshore mooring location (see Figure 1), as well as salinity from two Pioneer surface moorings (3 m depth; gray colors). (b) Monthly river discharge compiled for the Mid-Atlantic Bight (MAB) and the Gulf of Maine (GoM) and cumulative discharge (wateryear) for the MAB (blue shading). (c) Low-frequency variability of satellite SSS (SMOS) additive model applied to regional averages over ecoregions (map)



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