Water mass contributions to oxygen in the North Western Pacific

I've been exploring how we might quantify the contribution of different water masses to the Canadian Pacific, particularly to understand oxygen variability at depth. I started by replicating the linear mixing model used by Thomson and Krassovski (2010), which identifies Pacific Equatorial Water (PEW) and Pacific Subarctic Upper Water (PSUW) based on their characteristic temperature–salinity (T–S) profiles.

A helpful extension beyond what's done in their paper is to project every individual T–S profile collected at stations P4 (off Vancouver Island) and CS01 (off Queen Charlotte Sound) onto these endmember profiles. This involves interpolating each measured profile onto the mixing line defined by PEW and PSUW at constant density (the 26.5 σ_0 isopycnal). Doing so gives us clear, time-resolved estimates of how much each water mass contributes at each station.

These mixing fractions show strong correlations with measured oxygen concentrations. At CS01, for example, the proportion of PEW varies significantly between years—from around 5% to as high as 25%. This variation corresponds closely to large swings (~80 µmol/kg) in observed dissolved oxygen levels.

One step further is to calculate the residual oxygen (O*). This residual represents the portion of oxygen variability that isn't explained simply by changes in water mass mixing. Positive or negative deviations in O* indicate higher or lower oxygen concentrations than expected given the water mass mixture, likely pointing to changes in local respiration rates or ventilation.

Overall, these results suggest that both variability in water mass delivery and local biogeochemical processes (indicated by O*) are key factors controlling oxygen dynamics along our shelf.

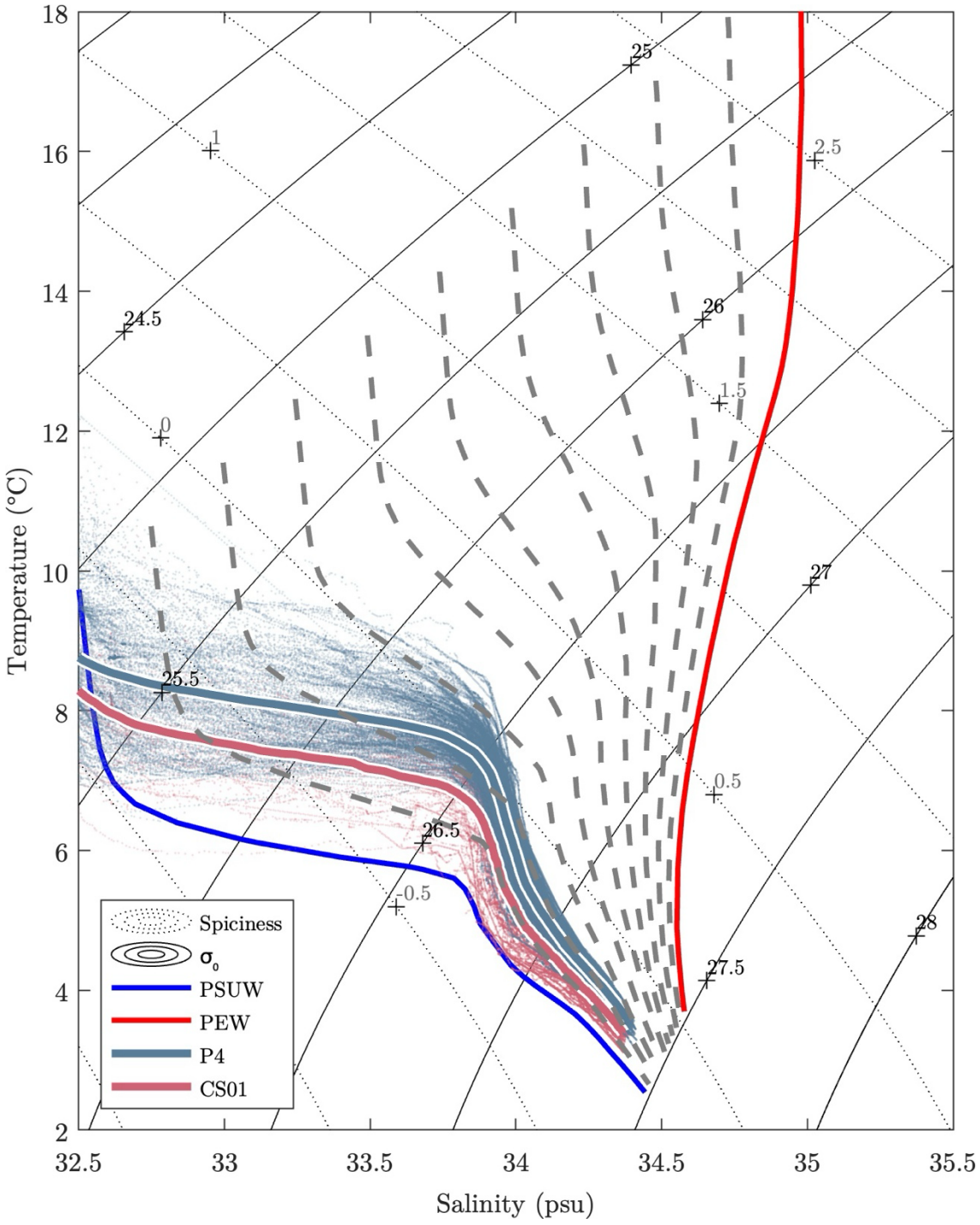

Figure 1: Temperature–salinity diagram showing water mass endmembers (PEW and PSUW, thick lines), mixing lines (dashed), and observed individual profiles from stations P4 (blue) and CS01 (red). Adapted from Figure 1 in Thomson and Krassosvski (2010).

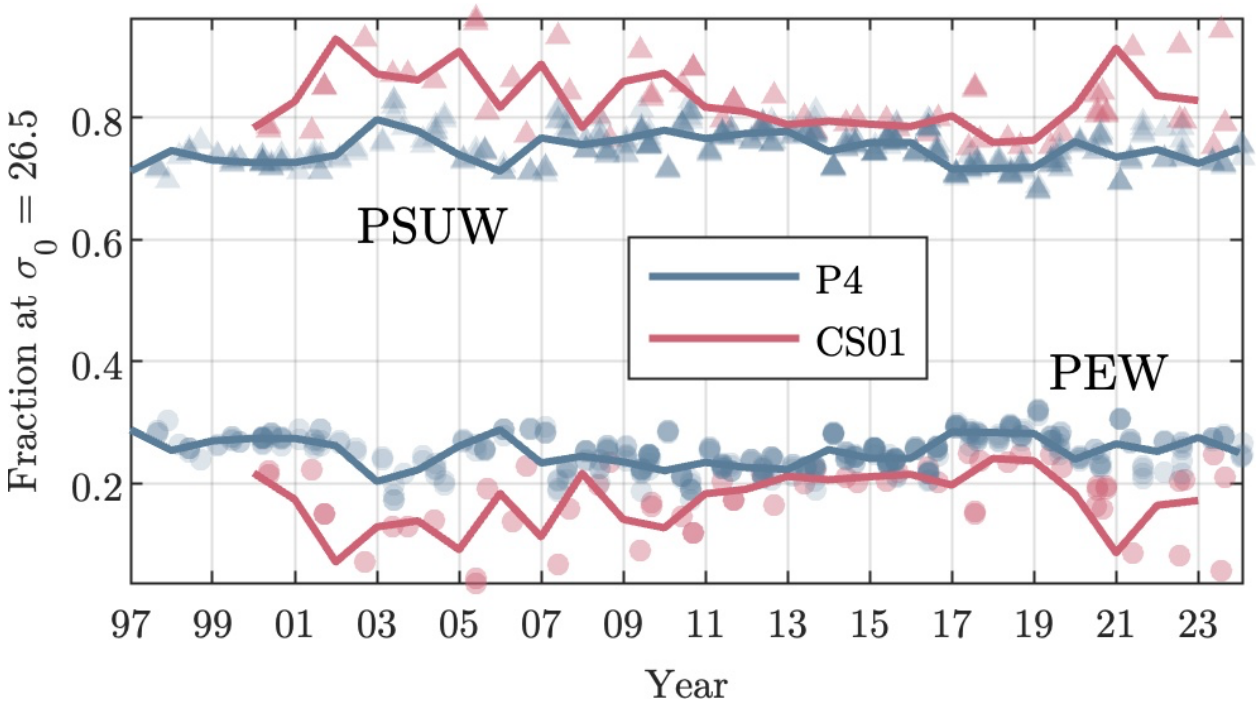

Figure 2: Time series (annual means and individual profiles) of water mass fractions at the 26.5 σ_0 isopycnal for stations P4 (blue) and CS01 (red). Upper series shows Pacific Subarctic Upper Water (PSUW) fractions; lower series shows Pacific Equatorial Water (PEW) fractions.

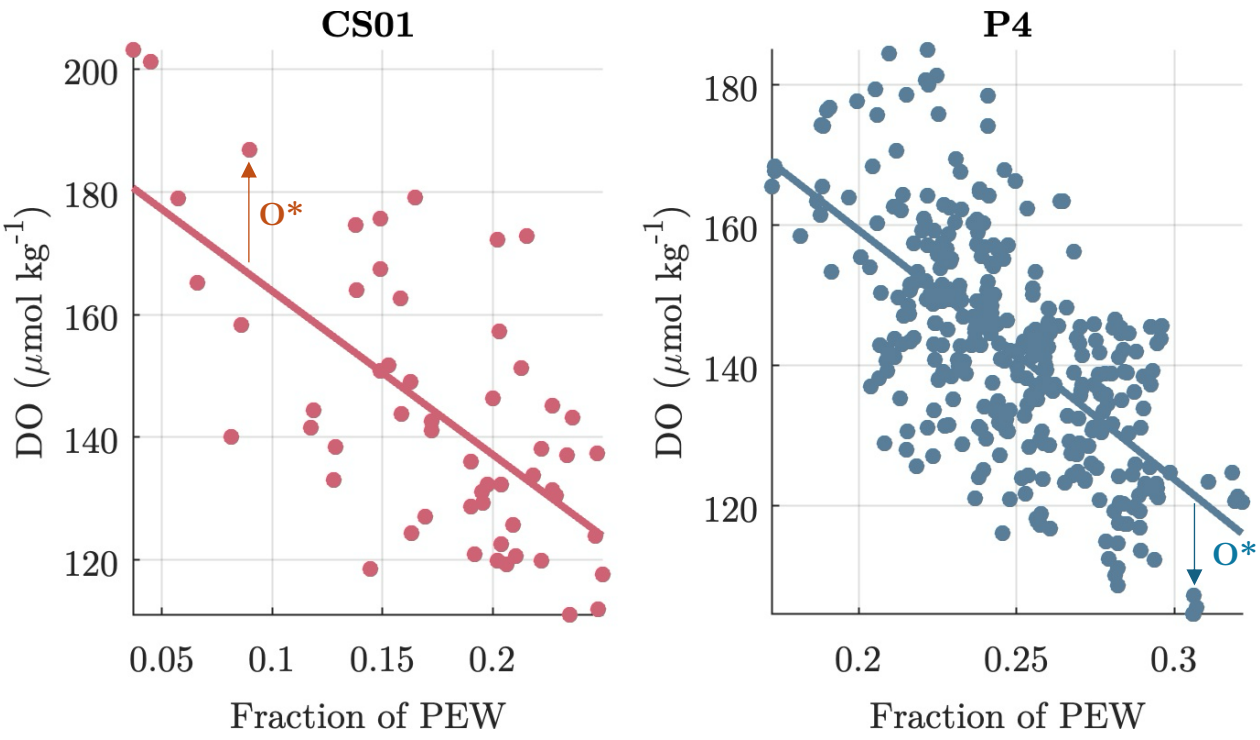

Figure 3: Scatter plots showing the correlation between dissolved oxygen (DO) and Pacific Equatorial Water (PEW) fraction at the 26.5 σ_0 isopycnal for stations CS01 (left, red) and P4 (right, blue). A visual representation of O* is included.

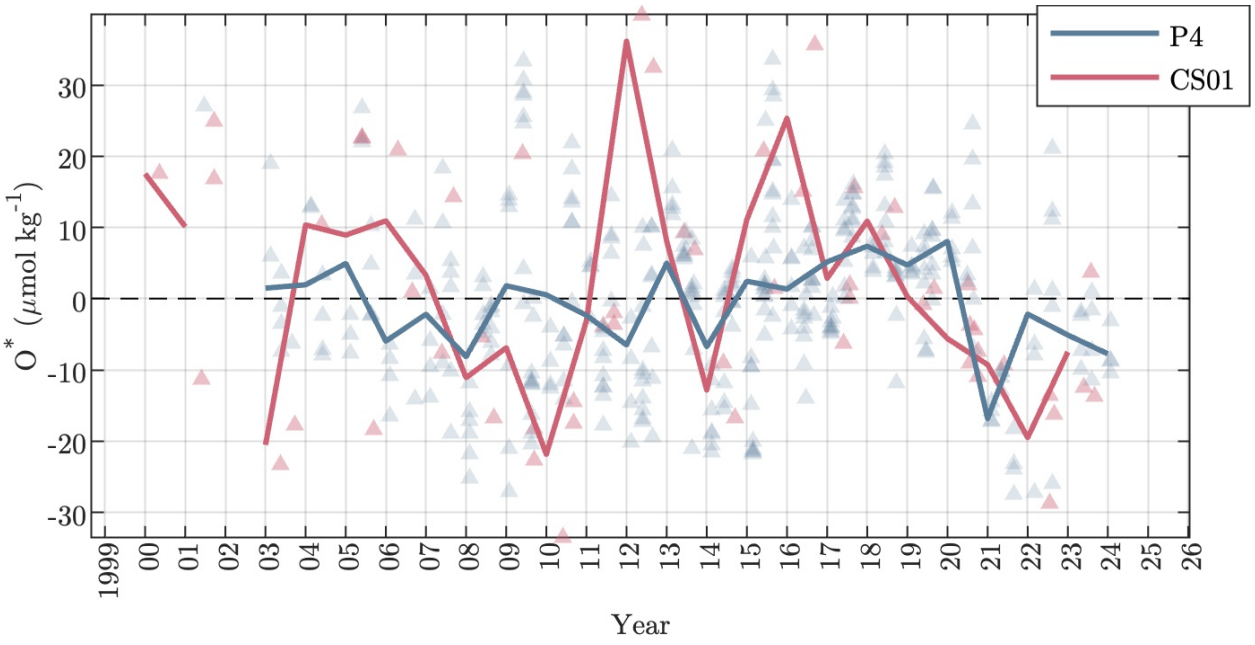

Figure 4: Annual mean and individual measurements of O*, the residual oxygen anomaly at the 26.5 σ_0 isopycnal. Positive values indicate higher-than-expected oxygen concentrations for a given water mass mixture, and negative values indicate oxygen deficits. Station P4 (Vancouver Island slope) in blue, CS01 (Queen Charlotte Sound slope) in red.