Sources and Ages of Lipids in a Temperate Estuary: Delaware Bay

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Characterizing and constraining the composition, fluxes, and residence times of organic matter (OM) at the land-ocean interface is important for understanding biogeochemical processes and predicting oceanic responses to changes in atmospheric CO_2. Previous ^{14}C studies of biochemical classes of DOC and POC have generally shown that carbohydrate and protein derive from CO_2 that has been recently fixed (i.e., modern in age), while the lipid fraction is the most highly aged ($\sim 10^3$-10^4 yrs BP) component. To better understand the highly aged signatures of lipid, we examined the lipid composition and ^{14}C age of lipids associated with particulate OM (POM, > 0.7 μm) and ultrafiltered dissolved OM (UDOM, 1kDa – 0.1 μm) along the salinity gradient of a representative temperate estuary, Delaware River and Bay.

Overall, $\Delta^{14}C$ values for neutral total lipid extracts (TLE) were more depleted (i.e., had "older" radiocarbon ages) than polar TLE. Radiocarbon ages for neutral TLE_{POM} were younger than neutral TLE_{UDOM} by approximately 10,000 YB while polar TLE_{POM} and polar TLE_{UDOM} were similar in age. Along the estuary, radiocarbon ages of TLE indicate two regions where "aged" lipid enters the Delaware system: (1) the Delaware River and (2) a location downstream of the ETM and upstream of the chl max region. An isotopic mixing model for $\delta^{13}C$ and $\Delta^{14}C$ values for POC suggests that "young" POC may be removed in the ETM through respiration or burial, or that "older" carbon is added in this region of the estuary. Compound specific radiocarbon analysis of fatty acids (FA) showed that the ages of terrestrial and aquatic FA change along the estuary with long-chain FA (soils, vascular plants) getting older and short-chain FA (microbial sources) becoming younger down the estuary.

This study showed different environmental factors influenced the source and age composition of lipid with the Delaware estuary. However, within-estuary processes could not explain the highly aged signatures of lipid suggesting that external sources from the watershed are the likely control.