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Climate controls on the residence time of terrestrial biospheric carbon in river basins

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Our current understanding of the timescales over which terrestrial biospheric carbon is transferred from source to sedimentary sink, and of the factors that control these timescales, remains limited. Such information is crucial for developing a mechanistic understanding organic matter cycling on the continents and the dynamics of terrestrial carbon delivery to the oceans. Radiocarbon is increasingly being used to examine the "age" of organic constituents in the dissolved and particulate phase. Based on such measurements, there is growing evidence to suggest that land-ocean organic matter transfer via rivers may be rapid (years, decades) or may take place over centuries to millennia. How do these ages relate to drainage basin properties and biospheric carbon dynamics within continental drainage basins?

This presentation seeks to explore the factors that influence radiocarbon ages of specific components of terrestrial biospheric carbon carried and exported by rivers to the ocean. Molecular-level radiocarbon measurements on vascular plant biomarkers (plant leaf waxes and lignin-derived phenols) have been made on particulate matter collected from a range of river systems globally, as well as on sediment cores collected near the mouths of rivers. Additional molecular isotopic (stable carbon and hydrogen isotopes) measurements of the plant wax markers provides complementary information on the provenance of the vegetation signals and on regional environmental conditions. The measurements reveal that two primary controls on apparent storage time of terrestrial biospheric carbon are regional temperature and aridity. The former is most apparent in contrasts between low and high latitude rivers, with colder regional climates resulting in longer residence times. Evidence for aridity as a control on storage times is evident from relationships between the stable carbon isotopic and/or hydrogen isotopic composition of vascular plant markers and their radiocarbon age, with dryer climates promoting protracted storage on biospheric carbon on the continents. These and other factors will be discussed in the context of the movement of carbon within drainage basins and implications for interpretations of sedimentary records of continental vegetation dynamics.