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Fate of lignin in large river systems across different latitudes - Perspectives from compound-specific radiocarbon analysis

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As the second most abundant biopolymer in terrestrial plants, lignin is a key component of organic matter in soils and in sediments delivered to coastal oceans by rivers. The transformation and stabilization of lignin during fluvial transport plays a vital role in its fate in the ocean. However, the timescales over which lignin is delivered from land to the oceans is not well understood. Here we employed compound-specific radiocarbon analysis to investigate the radiocarbon age of lignin-derived phenols in sedimentary particles from several major river systems that span a range of latitudes, extending from Arctic (Mackenzie, Kolyma, Indigirka, Lena, Yenisey, Ob, and Kalix), temperate (Columbia), to tropical regions (Congo and Ganges-Brahmaputra). These drainage basins are each characterized by large fluxes of terrestrial organic carbon and also encompass a variety of climatic and hydrological conditions. Investigating the provenance and transport of lignin in these areas allows for the assessment of environmental, geomorphic and other factors controlling the stabilization of lignin in the river systems. Lignin phenols were isolated by copper oxide oxidation, followed by high pressure liquid chromatography (HPLC), and further purified for compound-specific 14C isotopic analysis. The radiocarbon age of lignin phenols ranged from modern in the tropical (Congo and Ganges-Brahmaputra) rivers to approximately 4000 years in the Arctic (Kolyma and Indigirka), much younger than plant wax lipids isolated from the same sediments. This indicates that lignin is a fast cycling component of the terrestrial organic matter transported by rivers. Moreover, a general correlation was observed between the radiocarbon age of lignin phenols and the latitude of rivers, suggesting climatic control over the preservation of lignin within the river drainage basins. These findings add novel perspectives to our understanding of the fate of lignin during fluvial transport and the parameters controlling the stabilization of terrestrial organic matter in river and marine systems.