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Distribution and stable isotope composition of leaf wax n-alkanes as tracers for organic matter transport along hydrological transects in the NW Argentine Andes

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The burial of organic matter in marine sediments represents the main long-term sink for reduced carbon in the global carbon cycle, with the fluvial system being the predominant transport mechanism. Organic matter deposited in marine and continental sediments contains valuable information on ecological and climatic conditions, and organic proxy data is thus often used in paleoclimate research.

To use sedimentary records to investigate past environmental conditions in the terrestrial realm, processes dictating the transport of organic matter, including spatial and temporal resolution as well as the influence of climatic and tectonic processes, have to be understood. In this study, we test if a lipid biomarker based approach can be used to trace present-day organic matter sources in a fluvial watershed draining two intermontane basins in the southern-central Andes of NW Argentina, a tectonically active region with pronounced topographic, rainfall, and vegetation gradients. We investigated the distribution of long-chain leaf-wax n-alkanes, a terrestrial plant biomarker (and as such representative of terrestrially sourced carbon), in river sediments and coarse particulate organic matter (CPOM) along two altitudinal and hydrological gradients. We used n-alkane abundances and their stable carbon and hydrogen isotopic values as three independent parameters for source discrimination. Additionally, we analyzed the control of environmental parameters on the isotopic signatures in leaf-wax n-alkanes.

The general pattern of n-alkane distribution in river sediments and CPOM samples in our study area suggest that vascular plants are the major source of riverine organic matter. The stable carbon isotopic composition of $n\mathrm{C}_{29}$ alkanes suggests a nearly exclusive input of C3 vegetation. Although C4 plants are present in the lower catchment areas, the total percentage is too low to have a detectable influence on the carbon isotopic composition in river sediment and CPOM samples.

Considering environmental parameters, $n\mathrm{C}_{29}$ alkane $\delta^{13}\mathrm{C}$ values are significantly correlated with mean annual rainfall in the respective catchment area, with less negative $\delta^{13}\mathrm{C}$ values in drier areas (r = – 0.63, $p < 0.01$). The variability in stable hydrogen isotopic composition (δD) of $n\mathrm{C}_{29}$ alkanes is determined mostly by the δD value of the source water and aridity. We find that the apparent fractionation ($?_{app}$), defined as the difference in hydrogen isotopic composition of plant source waters and synthesized leaf-wax n-alkanes, is significantly correlated with aridity (r = -0.65, $p < 0.005$), with a smaller apparent fractionation in drier areas, as well as with mean annual rainfall (r = -0.59, $p < 0.01$), relative humidity (r = -0.56, $p < 0.02$), and actual evapotranspiration (r = -0.53, $p < 0.05$).

Our data indicate that vascular plants are the major source of riverine organic matter, with their stable carbon and hydrogen isotopic compositions influenced by climatic parameters. Thus, on spatial scales covering large gradients in environmental parameters, the analysis of leaf-wax n-alkanes can be used for organic matter source assessment in orogenic settings.