Geophysical Research Abstracts
Vol. 21, EGU2019-1142, 2019
EGU General Assembly 2019

Seasonal fluctuations in organic carbon export and stable isotopic signatures in a lowland migrating river of the Andean Foreland

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Over geological timescales, atmospheric CO_2 is regulated by an equilibrium of CO_2 sources and sinks. The burial of terrestrial organic carbon (OC) in depositional basins represents one of these CO_2 sinks to the atmosphere. However, the mechanisms describing the burial and preservation of OC are poorly understood. While many studies have examined seasonal variation in OC oxidation in mountain catchments, sediment exported from mountains often traverse large floodplains where OC can be oxidized and modified before reaching the ocean. Studies examining the seasonal variability in OC flux and composition in lowland river networks are rare, and limiting our ability to predict OC fluxes to the ocean. To address this knowledge gap, we collected weekly suspended sediment samples from March 2016 to March 2018 from the Rio Bermejo, Argentina, a lowland river draining the eastern Andes that travels ∼1000 km along the Chaco Plain with no tributary inputs of sediment and is dominated by C3 vegetation. Our data show channel lateral migration rates and suspended sediment load increase in the high flow season, coincident with a decrease in OC weight percent (from ∼0.6% to ∼0.3% in the low and high flow seasons, respectively), and an increase in stable carbon isotopic signatures (δ13Corg, from ∼-26.5‰ to ∼-24.8‰ in the low and high flow season, respectively), and an increase in OC to nitrogen ratios (OC/N, from ∼3.4 to 4.5 in the high and low flow season, respectively). Sediment size is relatively constant over the year (median grain size between 4-5 μm), suggesting seasonal variations are not due to variations in hydrodynamic sorting. We interpret these seasonal variations in OC to be driven by variation in channel lateral migration, where we observe lateral migration rates increase from approximately 13 to 55 m/yr between low flow and high flow seasons, respectively. During the high flow season, elevated lateral migration rates source OC from the channel banks and adjacent floodplain. This creates higher sediment loads that act to dilute the OC content, resulting in lower OC weight percent in the high flow season (∼0.3%) relative to the low flow season (∼0.6%). These aged floodplain sediments tend to be 13C enriched (∼-23‰, such that their erosion is consistent with the increase in δ13Corg we observe in river sediments. Reduced lateral migration rates in the low flow season limits input of aged floodplain sediment, resulting in a higher representation of fresh organic material in the OC load which tend to be 13C depleted (∼-28‰ and have high OC/N ratios, consistent with the decrease in δ13Corg and increase in OC/N we observe in the Bermejo suspended load. Via exploiting a simple natural system (a lowland river with no tributary inputs and relatively constant vegetation), our study provides the first estimates on how channel-floodplain interactions can modify the OC load and composition in lowland rivers, and will aid in future estimates of predicting OC fluxes to ocean basins.