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River mixing in the Amazon as a driver of concentration-discharge relationships

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Large hydrological systems such as continental-scale river basins aggregate water from compositionally different tributaries. Here we explore how such aggregation can affect solute concentration-discharge (C-Q) relationships and thus obscure the message carried by these relationships in terms of weathering properties of the Critical Zone. We compute 10 day-frequency time series of Q and major solute (Si, Ca2+, Mg2+, K+, Na+, Cl-, SO42-) C and fluxes (F) for 13 gauging stations of the SNO-HYBAM Monitoring Program (Geodynamical, hydrological and Biogeochemical control of erosion/weathering and material transport in the Amazon, Orinoco and Congo basins) located throughout the Amazon basin, the largest river basin in the world.

Concentration-discharge relationships vary in a systematic manner, shifting for most solutes from a nearly "chemostatic" behavior (constant C) at the Andean mountain front to a more "dilutional" pattern (negative C-Q relationship) towards the system mouth. Associated to this shift in trend is a shift in shape: C-Q hysteresis becomes more prominent at the most downstream stations. A simple model of tributary mixing allows us to identify the important parameters controlling C-Q trends and shapes in the mixture, and we show that for the Amazon case, the model results are in qualitative agreement with the observations. Altogether, this study suggests that mixing of water and solutes between different flowpaths leads to altered C-Q relationships.