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Can stable isotopes ride out the storms? The role of convection for water isotopes in models, records, and paleoaltimetry studies in the central Andes

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Globally, changes in stable isotope ratios of oxygen and hydrogen (δ18O and δD) in the meteoric water cycle result from distillation and evaporation processes. Isotope fractionation occurs when air masses rise in elevation, cool, and reduce their water-vapor holding capacity with decreasing temperature. As such, d18O and dD values from a variety of sedimentary archives are often used to reconstruct changes in continental paleohydrology as well as paleoaltimetry of mountain ranges. Based on 234 stream-water samples, we demonstrate that areas experiencing deep convective storms in the eastern south-central Andes (22 - 28° S) do not show the commonly observed relationship between δ18O and δD with elevation. These convective storms arise from intermontane basins, where diurnal heating forces warm air masses upward, resulting in cloudbursts and raindrop evaporation. Especially at the boundary between the tropical and extra-tropical atmospheric circulation regimes where deep-convective storms are very common ($\sim$ 26° to 32° N and S), the impact of such storms may yield non-systematic stable isotope-elevation relationships as convection dominates over adiabatic lifting of air masses. Because convective storms can reduce or mask the depletion of heavy isotopes in precipitation as a function of elevation, linking modern or past topography to patterns of stable isotope proxy records can be compromised in mountainous regions, and atmospheric circulation models attempting to predict stable isotope patterns must have sufficiently high spatial resolution to capture the fractionation dynamics of convective cells.

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