Long-term records of latitudinal climate gradients in the central Andes from stable isotopes in fossil and sedimentary carbonates

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The modern climate of the Andean plateau between 14°S and 24°S shows a strong gradient in amount of rainfall, ranging from $\sim$1 m/yr north of 18°S to $<$25 cm/yr south of 20°S. North of 30°S, rainfall in the Altiplano is sourced predominantly from the Atlantic Ocean. Rain-out from Atlantic-derived vapor masses causes the gradual depletion of ^{18}O and D in water vapor in the Amazon basin, which is buffered by evapotranspiration. As air masses ascend the eastern flank of the Andes, adiabatic cooling causes condensation and rain-out that results in a dramatic decrease in δ^{18}O and δD with increasing altitude. In addition to altitudinal gradients observed in stable isotopes of rainfall, a strong correlation between rainfall amount and the isotopic composition of precipitation is observed in monthly precipitation data, with more negative δ^{18}O and δD values corresponding with greater rainfall amount. We use these general observations of stable isotopes in the modern climate system to assess latitudinal trends in paleoclimate over middle to late Miocene time in both the Subandean foreland and the Altiplano. Isotopic records from the Subandes, based on fossil bivalves and pedogenic carbonates, are used as a baseline for the isotopic composition of rainfall before it ascends the eastern flank of the Andes. High altitude records of mammal tooth fossils and pedogenic carbonates collected between 17°S and 24°S are used to reconstruct latitudinal gradients in isotopic composition of paleo-surface waters. Both Subandes and Altiplano records are compared to modern rainfall compositions to evaluate climate trends over time that are potentially related to rainfall amount and altitude.