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Catchment-alluvial fan systems record >200 ka of millennial-scale climate changes in the subtropical Andes

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During the Pleistocene and Holocene, the Central Andes repeatedly experienced high-amplitude fluctuations in climate. These fluctuations are often attributed to changes in the intensity and geographic extent of atmospheric circulation systems, including the South Atlantic Convergence Zone and the South American Monsoon System, which transport moisture to the eastern side of the south Central Andes. However, it remains unclear how far south and westward moisture related to these systems has penetrated in the past, and what effects their fluctuating intensities have had on the tectonically-active landscapes of the Andes. Here, we approach these questions by examining small (∼10 km long) catchment-alluvial fan systems in the Sierra Aconquija, NW Argentina. This 5 km high range is located at ∼27°S, which is approximately the southernmost limit of monsoonal moisture flux today and a climatically-sensitive location.

First, we determined exposure ages of 4 glacial moraines in the (currently unglaciated) Sierra Aconquija, based on in situ 10Be cosmogenic radionuclide (CRN) concentrations of 20 boulders. This is presently the southernmost record of moraine ages from the Central Andes, and we identify advances at 12-13 ka, 19 ka, and 40 ka. These age clusters coincide with dated moraines and paleo-lake highstands farther north, and as glaciation on the range is moisture-limited they confirm that precipitation rates have varied significantly at 27°S in the tropical Andes, often changing abruptly over millennial timescales.

Second, we test whether the coupled catchment-alluvial fan systems of the Sierra Aconquija are capable of preserving signals of such rapid climate shifts. We mapped and dated 7 alluvial fans surrounding the range using radiocarbon and 10Be CRN exposure dating. We identified distinct depositional units that can be correlated across all fans and span the last ∼260 ka, concurrent with rapid climatic fluctuations in the parent catchments. We compare the stratigraphy of the fans with the glacial chronology from the catchments to demonstrate that the fans consistently aggrade during dry intervals and incise during wet intervals. Our results confirm the sensitivity of these small sediment transport systems to millennial-scale climate variability in subtropical South America.