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Tracking interactions of the jet-stream and topography: uplift of the Tian Shan and Altai

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The timing of surface topographic development in northern Central Asia remains poorly constrained. Today, the Tien Shan and Altai accommodate a substantial portion of the shortening accompanying the collision of India and Asia and also delineate sharp climatic boundaries, suggesting that better constraints on surface uplift will yield insights into the coupled evolution of climate and tectonics north of the Tibetan Plateau. We use a multi-proxy approach to place better constraints on the timing of surface topographic growth in the northern Tien Shan and Altai mountains by analyzing and comparing records from both the windward and leeward sides of these orogens. First, we present new meteoric water δ^{18}O data to constrain moisture transport pathways in Mongolia and Kazakhstan. Second, we apply new paleosol carbonate Δ_{47} temperature data to previously published data from the lee of the Altai to independently constrain paleo-water δ^{18}O. We demonstrate that modern waters across the Altai have characteristically low δ^{18}O due to orographically-forced rainout on the windward side of the range. Low meteoric δ^{18}O first appears in the paleosol carbonates in leeward basins in the late Miocene, suggestive of substantial surface topographic development. A shift toward low, leeward δ^{18}O is coincident with a similar shift in the windward Zaysan Basin, which we attribute to a topographically-forced shift in the seasonality of precipitation. Finally, paleosol carbonate δ^{13}C in both leeward and windward basins shifts toward higher values in unison with shifting δ^{18}O, indicating sustained drying. Notably, the shift in δ^{13}C in the leeward basins is greater than in windward basins, indicative of the establishment of the Altai rain shadow. We conclude that the late Miocene uplift of the Tien Shan and Altai likely had lasting impacts on Central Asia climate, including shifting seasonality of rainfall, enlargement of the Gobi Desert, and increasing dust fluxes across Asia.