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Impact of Tibetan Plateau uplift on Asian climate and stable oxygen isotopes in precipitation

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Surface elevation provides crucial information for understanding both geodynamic mechanisms of Earth's interior and influence of mountains growth on climate. Stable oxygen isotopes paleoaltimetry is considered to be a very efficient technic for reconstruction of the elevation history of mountains belts, including Tibetan Plateau and the Himalayas. This method relies on the difference between δ^{18}O of paleo-precipitation reconstructed using the natural archives, and modern measured values for the point of interest. However, stable-isotope paleoaltimetry is potentially hampered by the fact that the presumed constancy of altitude-δ^{18}O relationships through time might not be valid and climate changes affects δ^{18}O in precipitation.
We use the isotope-equipped atmospheric general circulation model LMDZ-iso for modeling Asia climate variations and associated δ^{18}O in precipitation linked with Himalayas and Tibetan Plateau uplift. Experiments with reduced height over the Tibetan Plateau and the Himalayas have been designed. For the purpose of understanding where and how simulated complex climatic changes linked with the growth of mountains affect δ^{18}O in precipitation we develop a theoretical expression for the precipitation composition.
Our results show that modifying Tibetan Plateau height alters large-scale atmospheric dynamics including monsoon circulation and subsidence and associated climate variables, namely temperature, precipitation, relative humidity and cloud cover. In turn, δ^{18}O signal decomposition results show that the isotopic signature of rainfall is very sensitive to climate changes related with the growth of the Himalayas and Tibetan Plateau, notably changes in relative humidity and precipitation amount. Topography appears to be the main controlling factor for only 40% of the sites where previous paleoelevation studies have been performed. Change of moisture sources linked with Asian topography uplift is shown to be not sufficient to yield a strong offset of δ^{18}O values. However, the relative contribution of δ^{18}O controlling factors and their magnitude differ depending on the uplift stage and the region considered. We highlight that future paleoaltimetry studies should take into account constraints on climatic factors to avoid misestimating ancient altitudes.