Abstract

Reconstructions of topography and surface uplift histories of orogens over geological time help constrain the geodynamic evolution of collisional domains and improve our understanding of the interactions between climate, tectonics, and surface processes. Stable isotope paleoaltimetry is a powerful tool to estimate past surface elevations. However, recent studies suggest that knowledge of climate conditions is needed to accurately interpret the isotopic composition of water recorded in geologic archives. Furthermore, the geodynamic history of the European Alps is hypothesized to have experienced diachronous surface uplift in response to geodynamic processes such as slab breakoff and slab migration. Our aim is to quantify if these changes in surface uplift histories are detectable using stable isotope paleoaltimetry. We use high-resolution isotope tracking ECHAM5-wiso General Circulation Model (GCM) to simulate the paleoclimate and water isotopes in meteoric water for different surface uplift histories of the Alps. Our emphasis is on understanding the climate and topographic signals preserved in the isotopic composition of precipitation ($\delta^{18}O_p$) which would eventually be recorded in paleosol carbonates. More specifically, we test the hypothesis that different topographic configurations for the Eastern and Western Alps result in significantly different regional climates and spatial distributions of $\delta^{18}O_p$. We perform sensitivity experiments with two free parameters: the height of the West-Central Alps and the height of the Eastern Alps. Moreover, since the Alps reach their maximum elevation during the Miocene period, we perform realistic paleoclimate simulations (e.g. Miocene Climate Optimum and Miocene Climate Transition) with plausible topography configurations to determine the synergistic influence of both climate and topography on the isotopic signal. We focus our analysis on the impact of the surface uplift scenarios on the regional climate (i.e. precipitation, temperature, atmospheric circulation), isotopic lapse rate, and $\delta^{18}O_p$. Our simulated response would help the interpretation of the reconstructions from geologic archives using stable isotope paleoaltimetry.