Isotopic Expression of Volcanic Climate Signatures

Samantha Stevenson (UC Santa Barbara), Bette Otto-Bliesner (NCAR), Esther Brady (NCAR), Jesse Nusbaumer (Columbia University), Clay Tabor (University of Connecticut), Robert Tomas (NCAR), David Noone (Oregon State University), Zhengyu Liu (The Ohio State University)

Explosive volcanic eruptions are one of the largest natural climate perturbations, but few observational constraints exist on either the climate responses to eruptions or the properties (size, hemispheric aerosol distribution, etc.) of the eruptions themselves. Paleoclimate records are thus important sources of information on past eruptions, often through the measurement of oxygen isotopic ratios ($\delta^{18}O$) in natural archives. However, since many processes affect $\delta^{18}O$, the dynamical interpretation of these records can be quite complex. Here we present results from new, isotope-enabled members of the Community Earth System Model Last Millennium Ensemble (CESM LME), documenting eruption-induced $\delta^{18}O$ variations throughout the climate system. Eruptions create significant perturbations in the $\delta^{18}O$ of precipitation and soil moisture in central/eastern North America, via excitation of the Atlantic Multidecadal Oscillation (AMO). Monsoon Asia and Australia also exhibit strong precipitation and soil $\delta^{18}O$ anomalies; in these cases, $\delta^{18}O$ may reflect changes to ENSO phase following eruptions. Salinity and seawater $\delta^{18}O$ patterns demonstrate the importance of both local hydrologic shifts and the phasing of the ENSO response, both along the equator and in the subtropics. In all cases, the responses are highly sensitive to eruption latitude, which points to the utility of isotopic records in constraining aerosol distribution patterns associated with past eruptions. This is most effective using precipitation $\delta^{18}O$, and in iCESM, the most robust identification can be achieved for Southern Hemisphere eruptions. This work thus serves as a starting point for new, quantitative uses of isotopic records for constraining the dynamics of volcanic impacts on climate.