EGU21-9847
https://doi.org/10.5194/egusphere-egu21-9847
EGU General Assembly 2021

Last Glacial to present-day variability of surface climate from oxygen isotope signatures in speleothems and model simulations

Janica Buehler[1], Nils Weitzel[1], Jean-Philippe Baudouin[1], Martin Werner[2], and Kira Rehfeld[1]
[1]Institute of Environmental Physics, Ruprecht-Karls-Universität Heidelberg, Germany (jbuehler@iup.uni-heidelberg.de)
[2]Alfred Wegener Institute for Polar and Marine Research (AWI), Bremerhaven, Germany

Comparing simulations and data from paleoclimate archives such as speleothems can test the capability of climate models to capture past climate changes. In past, present, and future, the hydrologic response to radiative forcing changes is far less understood and more uncertain than thermal changes.

Speleothems store terrestrial climate information in the form of isotopic oxygen in mineral and are found mostly in the low-to mid-latitudes of the landmasses. Their usually well preserved (semi-)continuous time series of oxygen isotope ratio $\delta^{18}O$ can cover full Glacial-Interglacial cycles and are used for past climate reconstructions. However, the measured $\delta^{18}O$ in the mineral is influenced by multiple climate and cave-related variables and does, therefore, not directly represent past temperature or precipitation.

We assess the capability of the isotope-enabled models HadCM3 and ECHAM5-MPI/OM to simulate decadal to centennial climate variability beyond the instrumental period. In particular, we investigate the relationship between simulated $\delta^{18}O$ and precipitation variability under different background conditions. By comparing simulated $\delta^{18}O$ values at cave locations to the large global speleothem database SISALv2 (Comas-Bru et al. 2020), we also examine the consistency between modeled and archived temporal changes in $\delta^{18}O$ in the mean state and variability. Our strategy involves forward-modeling of cave processes such as temperature-dependent fractionation and transit times to constrain a simple speleothem proxy model for the simulation output. For the late Holocene, we observe a strongly underestimated simulated isotopic variability on decadal to centennial timescales. We further test how much this underestimation depends on the background radiative forcing conditions by comparing the Last Glacial Maximum, the mid-Holocene, and the late Holocene. This provides deeper insight on low to mid-latitude state-dependent climate variability on decadal to centennial time scales.

Reference:

Comas-Bru, L., et. al. SISALv2: a comprehensive speleothem isotope database with multiple age-depth models. Earth System Science Data 12, 2579-2606 (2020) https://essd.copernicus.org/articles/12/2579/2020/