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Modelling water isotopes for an improved interpretation of various paleorecords

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During the past two decades, several atmospheric and oceanic general circulation models (GCMs) have been enhanced by the capability to explicitly simulate the hydrological cycle of the two stable water isotopes H218O and HDO. A number of previous studies have demonstrated the possibility of an improved interpretation of observed isotope variability in terms of climate change by such isotope GCM simulations. Here, we report new results of the ECHAM5 atmosphere GCM enhanced by explicit water isotope diagnosis (named ECHAM5-wiso hereafter). Several simulations covering climate changes in the range of the last decades up to glacial-interglacial cycles have been performed to evaluate the overall capability of the ECHAM5-wiso model and to enable a more quantitative interpretation of various isotope paleoarchives. All simulations have been performed with a high spatial model resolution of approx. 1° (T106 spectral mode) or finer. It is shown that the refinement of the spatial resolution leads to a substantially better agreement with available present-day observations and isotopic paleorecords, e.g. Antarctic ice core data. Using this new set of paleoclimate simulations, we investigate if and how climate variability is imprinted in the isotopic composition of precipitation on different time scales. Special focus is given to the question how the temperature-isotope relation might has changed in different regions of the Earth on the various time scale. The atmospheric isotope GCM results are complemented by first oceanic isotope GCM simulation results with the MPI-OM model as well as investigations of the influence of paleovegetation changes on the hydrological cycle and its isotopic composition, as simulated by an isotope-enhanced ECHAM5/JSBACH model setup.