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Modeling of water stable isotopes in the fully coupled Earth system model MPI-ESM: current status and perspectives

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The hydrological cycle is a fundamental component of the Earth's climate system. Modeling the time response of this cycle and the implied physical processes challenges the general circulation models (GCM) used to study the climate system and to project future climate. Water stable isotopes ($H_2{}^{16}O$, $H_2{}^{18}O$ and $HD^{16}O$) are integrated tracers of climate processes occurring in various branches of the hydrological cycle. Changes of the isotopic composition, which can be measured in various natural climate archives, have been used, for example, to reconstruct past temperatures changes at high resolution or to study the past dynamics of the monsoon. The explicit modeling of these isotopes in GCMs allows to evaluate their performance and to study the past and present-day hydrological cycle evolutions.

We present here the first results, under present-day and Last Glacial Maximum (LGM) conditions, of the ongoing implementation of water stable isotopes in the fully coupled Earth system model MPI-ESM, called hereafter MPI-ESM-wiso. It includes the atmospheric model ECHAM6, the dynamic vegetation module JSBACH and the ocean/sea-ice module MPIOM. In addition to classical variables (temperatures, precipitation amount...), we evaluate the isotopic composition of precipitation, water vapor, ocean, etc. simulated by MPI-ESM-wiso against available observations. Our analyses concentrate also on a detailed comparison to the previous model release, COSMOS-wiso [1], and potential improvements in simulating the water stable isotopes signal (spatial variability, link with the local temperature...) due to overall model enhancements.

This work will be an important contribution to the Paleoclimate Modelling Intercomparison Project. Indeed, the models with an explicit water stable isotope diagnostics make it possible to perform direct comparisons, at different time periods, with environmental records and to reduce the uncertainties resulting from the interpretation of these records in terms of climate signals in model-data comparisons. The project is part of the PalMod initiative ("Paleo Modelling: A national paleo climate modelling initiative"), funded by the German Federal Ministry of Education and Science (BMBF).

[1] Werner et al., 2016, *Geosci. Model Dev.*, **9**, 647-670.