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Quantification of the role of orbital and millennial timescale processes on δ18O and 17Δ signals

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The triple isotope composition of atmospheric oxygen (δ18O, 17Δ) integrates the signature of various processes, both on orbital and millennial timescales: changes in global seawater, hydrological cycle, relative humidity, vegetation distribution and C3/C4 plants partition. At the orbital timescale, tropospheric δ18O bears a strong orbital precession signal with a minimum in δ18O shifted by 6 ka relatively to the minimum of precession while at the millennial timescale, δ18O depicts a clear decrease in phase with Greenland InterStadial events. 17Δ (ln(δ17O+1)-λ*ln(δ18O+1)) is more directly related to variations in the global biospheric productivity with a main variability associated with the glacial – interglacial changes.
Here we make use of a global model integrating changes in climate, biosphere productivity, water isotopic composition to quantify the contribution of the different processes to δ18O and 17Δ signals. The model accounts for the latest fractionation ratios between 18O /16O and 17O/16O associated with oxygen respiration processes and leaf transpiration, oceanic net primary production (simulated by PISCES model), the spatial and temporal variation of vegetation distribution (simulated by ORCHIDEE model), climatic conditions and isotopic composition of meteoric water and water vapor (LMDZ global circulation model). The model is applied at relevant orbital periods (snapshots of pre-industrial period, Last Glacial Maximum (LGM), Heinrich event and Eemian interglacial) and allow us to further explore the role of orbital and millennial timescale processes on δ18O and 17Δ signals.