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Transient simulation using the iLOVECLIM-CARAIB coupled model equipped with oxygen isotopes and comparison with ice core δ18Oatm data

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The δ18Oatm (i.e. δ18O of atmospheric O_2) combines past variations of the low latitude water cycle and of the biosphere productivity. Over the last 800 ka, the δ18Oatm measured in EPICA Dome C (EDC) ice core shows orbital and millennial variations which are similar to the low latitude hydrological cycle variations observed in the δ18Ocalcite of the East Asian speleothems. The δ18Oatm is also a precious tool for ice core dating and chronology construction. However, the uncertainty associated with the use of this proxy as chronological constraint is high (6 ka) because of the lack of quantitative interpretation of the δ18Oatm including past evolution of oxygen fluxes and associated isotopic fractionation.

This study presents a modelling approach for a quantitative interpretation of the δ18Oatm through the estimation of the oxygen fluxes and fractionation factors over several glacial-interglacial cycles. This approach combines (1) the coupling between the intermediate complexity climate model iLOVECLIM and the vegetation model CARAIB, (2) an estimation of the oxygen fluxes associated with photosynthesis and respiration processes, (3) an estimation of the isotopic composition of the oxygen in leaf water (δ18Oleaf) and (4) an estimation of the oxygen fractionation during oxygen uptake. This method associates the climatic parameters and water isotopes simulated by iLOVECLIM with the changes in vegetation distribution and terrestrial biosphere productivity obtained by CARAIB for 26 PFTs (Plant Functional Types) instead of the 2 PFTs previously used in iLOVECLIM.

We present here the results of this new coupled model over several glacial-interglacial cycles and discuss the spatial distribution of the vegetation and δ18Oleaf, as well as the carbon and oxygen fluxes linked to the continental biosphere productivity. A focus on the Last Glacial Maximum can also allow a direct comparison with previous "offline" simulations with General Circulation Models. The δ18Oleaf corresponding to the terrestrial contribution of the δ18Oatm, our results can be compared, as a first approximation, to the isotopic δ18Oatm data measured in EDC ice core.