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Disentangling the contribution of moisture source change to isotopic proxy signatures: Deuterium tracing with WRF-Hydro-iso-tag and application to Southern African Holocene sediment archives

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It is well accepted that global circulation models equipped with stable water isotopologues help to better understand the relationships between atmospheric circulation changes and isotope records in paleoclimate archives. Still, isotope-enabled models do not allow to precisely understand the processes affecting precipitation isotopic compositions, such as changes in precipitation amounts or moisture sources. Furthermore, the relevance of this model-oriented approach relies on the realism of modeled isotope results, that would support the interpretation of the records in terms of modeled climate changes. In order to alleviate these limitations, the newly developed WRF-Hydro-iso-tag, that is the version of the isotope-enabled regional coupled model WRF-Hydro-iso enhanced with an isotope tracing procedure, is presented. Physics-based WRF-Hydro-iso-tag ensembles are used to regionally downscale the isotope-enabled Community Earth System Model for Southern Africa, for two 10-year slices of mid-Holocene and pre-industrial times. The isotope tracing procedure is tailored in order to assess the origin of the hydrogen-isotope deuterium contained in Southern African precipitation, between two moisture sources that are the Atlantic and Indian Oceans. In comparison to the global model, WRF-Hydro-iso-tag simulates lower precipitation amounts with more regional details, and mid-Holocene-to-pre-industrial changes in precipitation isotopic compositions that better match plant-wax deuterium records from two marine sediment cores off the Orange and Limpopo River basins. Linear relationships between mid-Holocene-to-pre-industrial changes in temperature, precipitation amount, moisture source and precipitation deuterium compositions are derived from the ensembles results.