Holocene changes in eastern equatorial Atlantic salinity as estimated by water isotopologues

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The isotopic composition of surface seawater is widely used to infer past changes in sea surface salinity using paired foraminiferal Mg/Ca and $\delta^{18}O$ from marine sediments. At low latitudes, paleosalinity reconstructions using this method have largely been used to document changes in the hydrological cycle. This method usually assumes that the modern seawater $\delta^{18}O$ ($\delta^{18}O_{sw}$) / salinity relationship remained constant through time. Modelling studies have shown that such assumptions may not be valid because large-scale atmospheric circulation patterns linked to global climate changes can alter the seawater $\delta^{18}O_{sw}$ / salinity relationship locally. Such processes have not been evidenced by paleo-data so far because there is presently no way to reconstruct past changes in the seawater $\delta^{18}O_{sw}$ / salinity relationship.

We have addressed this issue by applying a multi-proxy salinity reconstruction from a marine sediment core collected in the Gulf of Guinea. We measured hydrogen isotopes in $C_{37:2}$ alkenones (δD_a) to estimate changes in seawater δD. We find a smooth, long-term increase of ~10‰ in δD_a between 10 and 3 kyr BP, followed by a rapid decrease of ~10‰ in δD_a between 3 kyr BP and core top to values slightly lighter than during the early Holocene. Those features are inconsistent with published salinity estimations based on $\delta^{18}O_{sw}$ and foraminiferal Ba/Ca, as well as nearby continental rainfall history derived from pollen analysis. We combined δD_a and $\delta^{18}O_{sw}$ values to reconstruct a Holocene record of salinity and compared it to a Ba/Ca-derived salinity record from the same sedimentary sequence. This combined method provides salinity trends that are in better agreement with both the Ba/Ca-derived salinity and the regional precipitation changes as inferred from pollen records. Our results illustrate that changes in atmospheric circulation can trigger changes in precipitation isotopes in a counter-intuitive manner that ultimately impacts surface salinity estimates based on seawater isotopic values. Our data suggest that the trends in Holocene rainfall isotopic values at low latitudes may not uniquely result from changes in local precipitation associated with the amount effect.