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Sea surface salinity of the Eocene Arctic Azolla event using innovative isotope modeling

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With the realization that the Eocene Arctic Ocean was covered with enormous quantities of the free floating freshwater fern Azolla, new questions regarding Eocene conditions facilitating these blooms arose. Our present research focuses on constraining the actual salinity of, and water sources for, the Eocene Arctic basin through the application of stable water isotope tracers.

Precipitation pathways potentially strongly affect the final isotopic composition of water entering the Arctic Basin. Therefore we use the Community Atmosphere Model (CAM3), developed by NCAR, combined with a recently developed integrated isotope tracer code to reconstruct the isotopic composition of global Eocene precipitation and run-off patterns. We further addressed the sensitivity of the modeled hydrological cycle to changes in boundary conditions, such as pCO2, sea surface temperatures (SSTs) and sea ice formation. In this way it is possible to assess the effect of uncertainties in proxy estimates of these parameters. Overall, results of all runs with Eocene boundary conditions, including Eocene topography, bathymetry, vegetation patterns, TEX86 derived SSTs and pCO2 estimates, show the presence of an intensified hydrological cycle with precipitation exceeding evaporation in the Arctic region. Enriched, precipitation weighted, isotopic values of around -120%■ are reported for the Arctic region.

Combining new results obtained from compound specific isotope analyses (D) on terrestrially derived n-alkanes extracted from Eocene sediments, and model outcomes make it possible to verify climate reconstructions for the middle Eocene Arctic. Furthermore, recently, characteristic long-chain mid-chain 20 hydroxy wax constituents of Azolla were found in ACEX sediments. D values of these C32 – C36 diols provide insight into the isotopic composition of the Eocene Arctic surface water. As the isotopic signature of the runoff entering the Arctic is modelled, and the final isotopic composition of the surface waters can be deduced from the isotopic composition of the diols, we can calculate the degree of mixing between freshwater (isotopically light) and seawater (isotopically heavy) in the surface waters. This way we quantify Eocene Arctic surface water salinity, which in turn will shed light on the degree of (seasonal) mixing and stratification.