Geophysical Research Abstracts
Vol. 13, EGU2011-8303, 2011
EGU General Assembly 2011

Hydrogen isotope ratios of lacustrine sedimentary n-alkanes as proxies of tropical African hydrology: new insights from a calibration transect across Cameroon

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Hydrogen isotope signatures (δD) of ancient leaf-wax lipids potentially record isotopic properties of ancient plant water, which may indirectly reflect isotopic signatures of plant source water (e.g., rainfall). There is a tight relationship between leaf-wax δD and source-water δD as demonstrated for sedimentary material collected in several mid- and high-latitude lacustrine environments. In contrast, for the tropical realm, where both vegetation and processes associated with isotope fractionation in the hydrologic system strongly differ from those at higher latitudes, calibration studies for this proxy are not yet available. This is despite the fact that leaf-wax lipid δD signatures are increasingly used to reconstruct changes in tropical hydrology. Because of our limited understanding of the factors controlling leaf-wax δD values in tropical ecosystems, any of such reconstructions are only of qualitative nature. Therefore, we investigated surface sediments from eleven lakes in the Cameroon to identify the hydro-climatological factors and plant physiological processes that determine the hydrogen isotopic composition of leaf-wax lipid biomarkers and to develop a robust framework for the quantitative application of compound-specific hydrogen isotopes in tropical Africa. This 10°-long latitudinal transect across Cameroon encompasses a wide range of contrasting vegetation classes and climates that are representative for the whole of tropical Africa. We find that the δD values of the n-C29 alkane correlate with the δD values of precipitation, as has been observed in the higher latitudes, highlighting the robustness of the leaf-wax lipid δD proxy. In contrast, δD values of the n-C31 alkane do not show such a relationship, but instead are correlated with the evaporative lake water δD values. This suggests distinct water sources for both leaf-wax lipids, most likely originating from two different groups of plants. We hypothesize that the plants primarily producing n-C29 alkanes are located uphill in the lake catchment, away from the lake water influence. On the other hand, the plants producing primarily n-C31 alkanes are either located at the lake's shore (e.g., emerged grasses growing in the water), or derive their water from a pool, which evaporates at the same rate than the neighboring lake (e.g., the top soil or leafwater). These new findings have important implications for the interpretation of long-chain n-alkane δD records from ancient lake sediments: we show that a robust interpretation of palaeo-hydrological data requires knowledge of the vegetation in the catchment area, as different plants may tap different water sources. If our findings that the plants producing n-C31 alkanes and using an evaporated water (e.g., lake water) as their hydrogen source prove to be a general feature of tropical vegetation, a new higher plant based evaporation proxy could be developed.