Geophysical Research Abstracts
Vol. 13, EGU2011-7644, 2011
EGU General Assembly 2011

Holocene humidity changes in southernmost Chile as implied by hydrogen isotope ratios of higher plant leaf waxes

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Current knowledge suggests that the fractionation of hydrogen isotopes (δD) in plants is relatively constant, such that the δD values of leaf waxes (δDwax) derived from terrestrial plants, which obtain their hydrogen from meteoric water, have the potential to record changes in the isotopic composition of the hydrogen source. This approach has been successfully applied to reconstruct humidity changes at a glacial/interglacial timescale in low latitudes (tropical Africa), where the δD composition of rainfall (δDrain) is mainly function of the so-called "amount effect". Moving towards mid- and high latitudes however, surface air temperature (SAT) is the predominant factor controlling δDrain ("latitudinal rainout effect").

A calibration approach based on 25 surface sediment samples from marine, fjord and lake environments located between 22°S and 54°S shows that in western Chile δDwax is significantly correlated with δDrain, and that both are linearly related to annual mean SAT. We have further measured δDwax on a Holocene sediment core located at 50°S in the center of the westerly winds, where the rainfall amount exceeds 7000mm/year and the annual amplitude of SAT is relatively low ($\sim$5°C). When converting the δDwax record into SAT using the previously established calibration, unrealistic SAT fluctuations (up to 10°C) are obtained for the Holocene, suggesting an important humidity signal in the δDwax record. Using a proxy-based reconstruction of annual mean SAT (MBT/CBT index) and the present-day relationship between SAT and δDrain, we could obtain a reconstructed δDrain that we used in order to correct the δDwax of its temperature component. The results suggest relatively wet conditions in the early to mid-Holocene (with a reversal centered at 8 kyr cal BP) and relatively dry conditions in the late Holocene in close agreement with other records located in southernmost Chile (53°S). Humidity fluctuations are ultimately related to changes in the position and/or strength of the westerly winds during the Holocene.