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Reconstruction of late Quaternary relative humidity changes on the southern slopes of Mt. Kilimanjaro, East Africa, using a coupled δ^2H-δ^{18}O biomarker paleohygrometer

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Our understanding of African paleoclimate/-hydrological history is decisively based on lake level and lake sediment studies. It furthermore improved remarkably during the last decade thanks to emerging stable isotope techniques such as compound-specific deuterium analysis of sedimentary leaf wax biomarkers ($\delta^2H_{leaf\ wax}$). Here we present results from a multi-proxy biomarker study carried out on a ~100 ka paleosol sequence developed in the Maundi crater at ~2780 m a.s.l. on the southeastern slopes of Mt. Kilimanjaro in equatorial East Africa. The Maundi stable isotope records established for hemicellulose-derived sugars, lignin- and pectin-derived methoxyl groups and leaf wax-derived fatty acid and n-alkane biomarkers ($\delta^{18}O_{sugars}$, $\delta^2H_{methoxyl\ groups}$, $\delta^2H_{fatty\ acids}$ and $\delta^2H_{n-alkanes}$) reveal differences but also similar patterns. Maxima characterize the period from 70 to 60 ka, the last glacial maximum (LGM) and the Younger Dryas (YD), whereas minima occur during the Holocene. The application of a 'coupled $\delta^2H_{n-alkane}$-$\delta^{18}O_{sugar}$ paleohygrometer' allows the reconstruction of the Late Quaternary relative humidity (RH) history of the Maundi study site. Accordingly, the reconstructed RH changes are well in agreement with the Maundi pollen results. Apart from the overall regional moisture availability, the intensification versus weakening of the trade wind inversion, which affects the diurnal montane atmospheric circulation on the slopes of Mt. Kilimanjaro, is suggested as local second important factor controlling the RH history at Maundi. Furthermore, the Maundi results of the coupled $\delta^2H_{n-alkane}$-$\delta^{18}O_{sugar}$ approach caution against interpreting $\delta^2H_{leaf\ wax}$ (as well as $\delta^{18}O_{sugar}$) records straight forwards in terms of reflecting δ2Hprec, because variably and primarily RH-dependent isotopic evapotranspirative enrichment of leaf water can mask δ^2H_{prec} changes. Concerning the biomarker-based reconstructed Maundi $\delta^2H/\delta^{18}O_{prec}$ record, the comparison with the reconstructed RH history reveals an 'anti-amount effect'. This suggests that we do not yet fully understand the controlling factors for $\delta^2H/\delta^{18}O_{prec}$ over East Africa and in low latitudes in general as good as we may think and that respective further research is needed.