SEASONAL VARIABILITY OF PLANT WAX AEROSOL HYDROGEN ISOTOPE VALUES IN DIFFERENT ENVIRONMENTS IN SWITZERLAND

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Introduction

Winds transport plant waxes over long distances (Bendle et al., 2007; Yamamoto et al., 2011), which can result in the deposition of these compounds in climate settings that are dissimilar to those where the waxes originated. Much like riverine transport, winds can mobilize recently produced biologically fresh material, as well as waxes from long-dead leaves through soil erosion (Rogge et al., 1993). Plant waxes are also introduced to the atmosphere through the burning of fossil fuels (Rogge et al., 1993). Although plant waxes have long been recognized as common components of atmospheric dust (Simoneit et al., 1977), efforts to understand the hydrogen isotope values of these compounds in the air have been limited (Gao et al., 2014; Nelson et al., 2017; Yamamoto and Kawamura, 2011). Consequently, little is known about how aerosolized plant wax hydrogen isotope values vary over time and space, and the extent to which they influence sedimentary records.

We present hydrogen isotope data from plant wax aerosols that were collected from three different environments in Switzerland that lie within a 60 km radius. Continuous sampling was conducted from June 2014 to March 2016 at an intensively managed grassland site at the ETH Research Station at Chamau, and above and below the canopy of a mixed deciduous and evergreen forest at the Swiss Canopy Crane Site at Hofstetten. Samples were also collected during the summer months at the high altitude Sphinx Observatory at the Jungfraujoch (3466 meters above sea level). We sought to identify whether the hydrogen isotopic composition of common vascular plant *n*-alkane biomarkers varied over time and by sampling location, and to improve constraints on their possible source regions. Deposition rates were also calculated using wet- and dry-deposition models based on measured atmospheric concentrations, and local meteorological data.

Results

Plant wax aerosol δ^2H values from all sites showed a pronounced seasonal pattern and were highly consistent between years (Figure 1). The amplitude of this seasonal cycle varied by site, and was smallest in the forest, but in all cases δ^2H values were lowest in the late spring and highest in winter. The amplitude also generally increased with increasing *n*-alkane chain length, and was larger for odd carbon-number compounds than for even carbon-number compounds. Deposition-weighted average δ^2H values of plant wax aerosols showed large differences by chain length, but were consistent between the grassland and forest sites. While even chain length *n*-alkane deposition was consistent at approximately -125‰ for all compounds, δ^2H values decreased from approximately -130‰ to -190‰ in odd chain length *n*-alkanes as carbon number increased from *n*-C_{23} to *n*-C_{31}.

Conclusions

The magnitude of the seasonal range of aerosol plant wax *n*-alkane δ^2H values observed at all sites exceeds what is typically observed for individual plants growing in a single location, and therefore suggests that these patterns are at least partially controlled by mixing of multiple sources. Despite the differences in the amplitude of hydrogen isotope variability between sites, the overall patterns are similar. This suggests that processes that exceed the spatial extent of the targeted region may be dominant in determining plant wax aerosol δ^2H values in Switzerland.

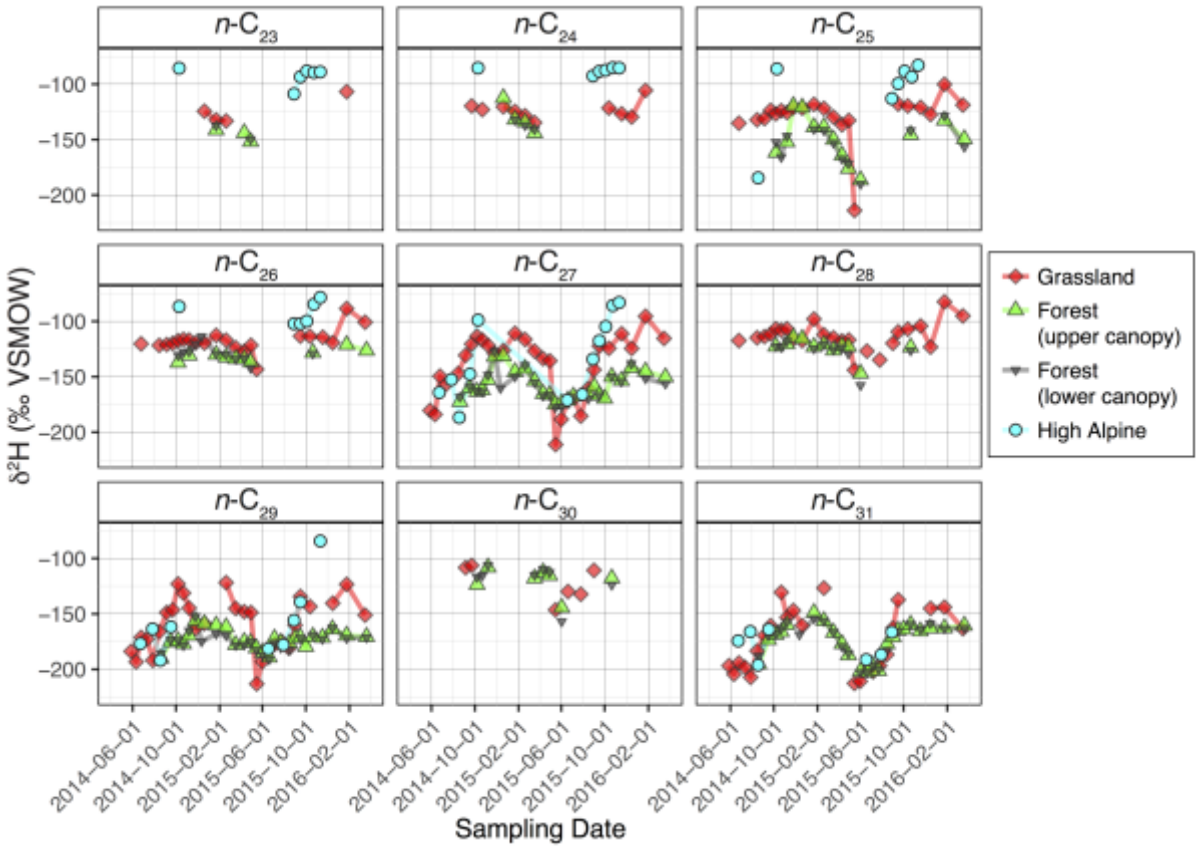

Figure 1: *Summary of aerosol n-alkane δ^2H data from samples collected over approximately two-years at grassland (ETH Grassland Site, Chamau), forest (Swiss Canopy Crane, Hofstetten), and high alpine (Sphinx Observatory, Jungfraujoch, 3466 m a.s.l.) field sites.*

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