TESTING AND APPLYING LEVOGLUCOSAN AS A BIOMASS BURNING MARKER IN MARINE SEDIMENTS

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Modern biomass burning events impact biogeochemical cycling, vegetation dynamics and climate. However, interactions between these components of system Earth are not well understood and therefore recent studies have focused on reconstructing fire and vegetation history under different climatic conditions using sedimentary archives[1]. Most of these studies used microscopic charcoal or soot particles or polycyclic aromatic hydrocarbons as proxies for biomass burning, but application of these tracers in sedimentary archives can be problematic as they rely on visual identification under the microscope or are not specific to burning of vegetation, respectively. Therefore, we focus on the analysis of levoglucosan, a compound generated only during burning of vegetation[2]. Although photochemical reactions can degrade levoglucosan during long range atmospheric transport[3], typically it remains stable for several days under most conditions[4]. To date, the analysis of levoglucosan in lacustrine sediments is more common[5] than that of marine sediments. However, marine sediments have a high potential to reconstruct more long term variations in biomass burning and cover a wider geographical region. Indeed, levoglucosan has been found in marine sediments up to 130 ka[6], illustrating the potential of this compound as a biomass burning proxy. However, relatively little is known about the fate of levoglucosan in the marine water column. Therefore, we analysed sinking particulate matter in the tropical North Atlantic Ocean using a novel UHPLC-high resolution-MS method developed for rapid and quantitative analysis of levoglucosan[7]. This material was collected over a year with four sediment traps, three at 1200 m water depth and one at 3500 m water depth, on a 12°N transect with increasing distance from the African coast. Furthermore, surface sediments from the same transect were analysed to assess the fate of levoglucosan in marine sediments.

In the sediment trap at 23°W, closest to the African coast, a peak in levoglucosan flux was detected during February/March, coinciding with a peak in fire occurrence south of the Sahara desert. In the open ocean sediment trap at 37°W, levoglucosan flux was lower and the same seasonal peak was detected, although less pronounced, as expected because of its more remote location, further away from the source. In the sediment trap at 49°W, closer to the South American coast, levoglucosan flux was overall higher than in both other sediment traps, with a shift in the peak flux to June. This sediment trap may be under the influence of the Amazon River plume, with its peak in eastward transport in summer, potentially transporting levoglucosan from the Amazon into the tropical Atlantic Ocean. Surprisingly, the levoglucosan flux in the open ocean sediment trap is higher in the lower trap than in the upper trap, possibly related to the bigger catchment area of the lower trap, collecting material integrated over a larger geographical area. Also, the bottom of the ocean at this location is more than 1000 m down from the lower sediment trap, making it unlikely that reworked sediment from the seafloor was caught in any of the traps. Importantly, the upper and lower trap have similar

seasonal levoglucosan trends, indicating that the seasonal signal recorded at 1200 m water depth is still preserved at 3500 m water depth and that degradation of levoglucosan in the water column does not play a major role. Levoglucosan was detected in all the surface sediments from the same transect, with an average concentration of 0.4 ng/g, about 30-fold lower than in the sediment traps, indicating that degradation of levoglucosan mainly takes place in the sediment. Nevertheless, the readily detectable quantities of levoglucosan in open ocean surface sediments at great water depths (up to 5 km) clearly reveals the high potential for levoglucosan as a biomass burning proxy in marine sediments.

To further investigate this potential we analysed levoglucosan in sediment core GeoB9528-3 retrieved from the Guinea Plateau Margin, spanning the last 192 ka. This site receives dust from central North Africa near the boundary of the Sahara with the Sahel and was studied for past vegetation- and hydrology changes in the Sahara/Sahel region[8]. Levoglucosan was detected throughout the record (Fig. 1), and the initial low resolution study suggests that its abundance varies with $\delta^{13}C$ of higher plant wax *n*-alkanes (Fig. 1), which provides clues on vegetation type (C3 vs. C4 plants). This indicates that the extent of biomass burning and vegetation composition/aridity in this region may be coupled. We are currently increasing the resolution of the levoglucosan record to confirm this observation and constrain potential leads and lags between vegetation/aridity and biomass burning.

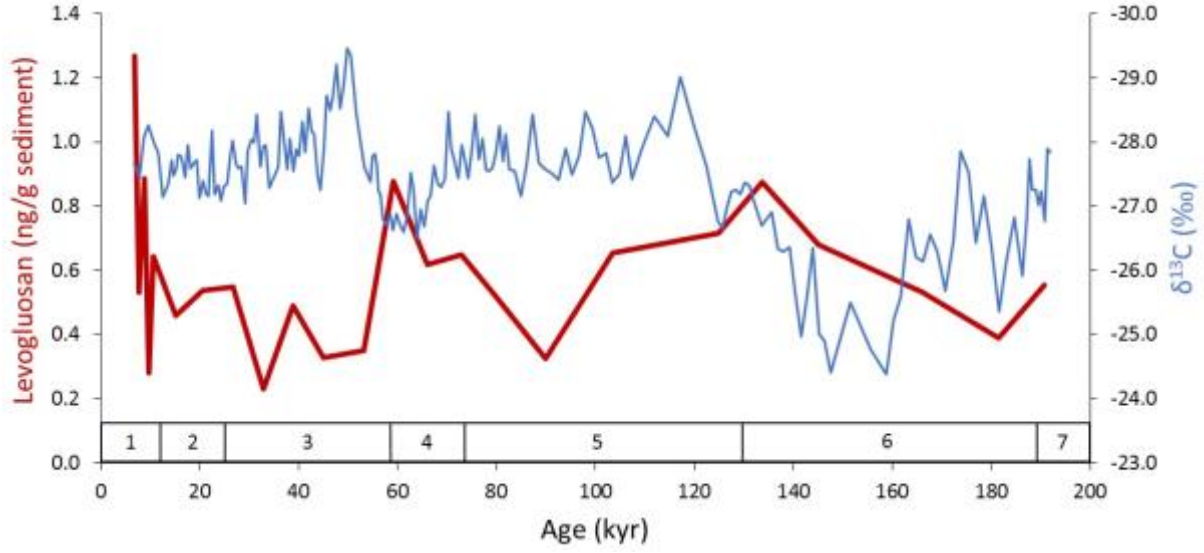

Figure 1 *In blue the $\delta^{13}C$ values of the C_{29} n-alkane is shown, reported in standard delta notation (‰) against the VPDB standard. In red levoglucosan concentration is shown, in nanograms per gram of sediment. The bar at the bottom indicates Marine Isotope Stages 1-7.*

References

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