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# Biomass burning in the Sahara/Sahel region in Northwest Africa and interaction with climate, vegetation and humans

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Fire impacts global ecosystem patterns and processes, and it affects regional and global biogeochemical cycling, vegetation dynamics, climate, air quality and human health. Nevertheless, large gaps remain in our understanding of the complex interactions between fire and other components of the Earth system. Therefore, fires have been studied at a wide range of temporal and spatial scales using satellites, historical data and dendrochronological data for investigating the relation between climate, environment and fire, both at present as well as in the recent past. Over longer (geological) time scales, sedimentary records enable longer-term fire history reconstructions. Earlier studies use charcoal or polycyclic aromatic hydrocarbons (PAHs) as proxies for fire activity. However, application of these proxies in the sedimentary archive can sometimes be limited as charcoal gives a rather local signal, while PAHs are not specific for biomass burning.

Here, we focus on the analysis of levoglucosan, a thermal product of cellulose generated only during vegetation burning, which provides a regional to global proxy for biomass burning. We reconstructed fire history for Northwest Africa over the last 192 ka by analyzing levoglucosan in a marine sediment core retrieved from the Guinea Plateau, which receives atmospheric particles originating from central North Africa near the boundary of the Sahara with the Sahel. Levoglucosan was detected throughout the record, and its accumulation rate increased from $\sim$1 to $\sim$3 ng/cm$^2$/kyr at 85 ka, followed by a decrease to $\sim$2 ng/cm$^2$/kyr at 15 ka. Most intriguingly, there are two distinct peaks in levoglucosan accumulation of 14 and 17 ng/cm$^2$/kyr at 50 and 55 ka, respectively. These peaks are not visible in the higher plant wax $n$-alkane accumulation rate, which rules out the possibility of overall increased terrestrial input during these times, and argues for an increase in biomass burning at 50 at 55 ka.

The trends and distinct peaks in levoglucosan accumulation did not correlate with changes in North Atlantic sea surface temperature or AMOC variability or global climate over the past 192 ka, which implies that biomass burning in the Sahara/Sahel region is not necessarily coupled to glacial/interglacial variability in oceanic and climatic conditions. Furthermore, levoglucosan accumulation does not show a clear relationship with higher plant wax $n$-alkane $\delta^{13}$C, which relates to vegetation type ($C_3$ vs. $C_4$ plants) and aridity. This indicates that the extent of biomass burning and vegetation composition/aridity in this region are also not necessarily coupled. Interestingly, the increase in levoglucosan accumulation at 85 ka could possibly be related to routine domestic use of fire by humans, which began around 50 to 100 kyr ago, and the two distinct fire peaks at 50 and 55 ka occurred during a major dispersal period of hominins out of Africa. Collectively, this illustrates that in the Sahara/Sahel region in Northwest Africa, fire occurrence and human activities might have been coupled and that global climate and vegetation changes have been of lesser influence on fire occurrence.