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Combining charcoal sediment and molecular markers to infer a Holocene fire history in the Maya lowlands of Petén, Guatemala

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Holocene vegetation changes in the Maya Lowlands during the Holocene are a result of changing climate conditions, solely anthropogenic activities, or interactions of both factors. As a consequence, it is difficult to assess how tropical ecosystems will cope with projected changes in precipitation and land-use intensification over the next decades. We investigated the role of fire during the Holocene by combining different proxies. We distinguished between three different morphotypes (grass, wood and leaves) in macroscopic charcoal. We also determined the molecular fire proxies levoglucosan, mannosan and galactosan. Combining these different fire proxies allows a more robust understanding of the complex history of fire regimes at different spatial scales during the Holocene. Comparing the two biomass burning proxies may help increase our understanding about advantages and limitations of molecular markers as proxies for past fire reconstruction in lake sediments.
In order to infer changes in past biomass burning, we analysed a lake sediment core from Lake Petén Itzá, Guatemala (17°00'N, 89°50′W, 110 m above sea level), and compared our results with millennial-scale vegetation and climate change data available in this area. Some differences were observed between the two records and we assumed that while macroscopic charcoal represents a local fire signal, the molecular fire proxies records seem to be influenced by regional to supra-regional fire or low temperature fires. During the Holocene we detected three periods of high fire activity: 9500–6000 cal yr BP, 3800 cal yr BP and 2700 cal yr BP. We attributed the first maximum (9500–6000 cal yr BP) to only climate conditions, which corresponds with observations from previous studies in this region. The fast decrease in the relative abundance of woody charcoal to grass charcoal at the 3800 cal yr BP fire maximum may result from human activity, but we cannot exclude that this shift was related to climate conditions during this period. The last maximum (2700 cal yr BP) we attribute to the agricultural activity of the Maya at Lake Petén Itzá.