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Millennial-scale fire dynamics in temperate forest of central Europe

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Fire is considered one of the most important disturbance agents in forested ecosystems, yet there remain gaps in knowledge pertaining to the long-term role of fire and its drivers in central Europe. We applied a high-resolution multi-proxy approach (macro- and micro-charcoal, pollen, plant macrofossils, and charred plant remains) from a spruce and beech dominated mountain forest located in the Šumava Mountains of Czech Republic to understand the long-term role and drivers of fire from central Europe. Our results illustrate that at the regional-to-subcontinental-scale in the early Holocene, climate was the dominant driver of fire responsible for synchronizing biomass burning throughout central Europe. However, vegetation acted as a secondary driver of fire by influencing fuel type. Post 6,500 cal yr BP, human activities became an important driver of fire activity at the local-scale. In the early Holocene, fire adaptive species such as Pinus, Corylus, and Betula thrived under warm and dry conditions, outcompeting fire sensitive species resulting in a fire frequency of roughly 3 fires/1000 years. Norway spruce (Picea abies) established ∼10,000 cal yr BP when biomass burning was the highest of the entire record, suggesting that this fire avoider species may not be as impacted by fire as once previously thought. When climatic conditions became cooler and wetter ∼6,500 cal yr BP, essentially becoming more favorable for more true fire sensitive species such as for beech (Fagus sylvatica), biomass burning only slightly decreased to 2 fires/1000 years. Fire activity peaked ∼2,500 cal yr BP to 6 fires/1000 years in association with an increase in anthropogenic pollen indicators. This points to the role of humans in shaping spruce-beech forests fire regimes in central Europe. Over the past 500 years the decline in Abies, also a fire sensitive species, is attributed to local human activities. As temperate mountain ecosystems from central European become more susceptible to mortality with increasing temperature and drought frequency, mountain ecosystems may also become more vulnerable to the increasing risk of wildfire.