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StalFire Consortium: Defining the paleoclimate-fire relationship in California across temporal and spatial scales

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Global climate change is projected to lead to an expansion of wildfire-prone regions coupled with increase in fire frequency and intensity. In the Western US the characteristic fire season has changed considerably in recent years. Notably, there has been an observed doubling of autumn fire activity, an increase in the occurrence and duration of extreme fire weather conditions, and an intensification of wildfire severity. This trend is expected to persist and intensify with increased warming. For California (CA), climate models predict minimal changes to mean annual precipitation, but a substantial increase in climate volatility on the decadal and sub-centennial scale. This volatility manifests as persistent droughts interrupted by pluvial episodes, creating what is referred to as a 'whiplash climate.' However, predicting how the wildfire regime in CA will evolve with increased climate volatility remains a challenging task.

StalFire is multi-lab collaborative framework (consortium) established to facilitate research focused on utilizing paleoclimate data archived in stalagmites. The primary goal is to provide new insights into paleo-wildfires, with a specific emphasis on assessing the paleoclimate-wildfire relationship in CA across multiple timescales and under different climate states. Drawing upon over a decade of monitoring and stalagmite record development in CA caves exposed to significant fires, this consortium project is guided four research objectives: (1) Monitoring tracer evolution across karst systems to improve conventional proxies and expand the understanding and application of promising new qualitative hydroclimate proxies and fire tracers. (2) Developing aquantified representation — a forward proxy system model — of the conditions and processes that govern the different proxy signals of past hydroclimate and fire behavior in stalagmites. (3) Expanding and improving existing CA multi-proxy records for stalagmites representing transects of the north-south climate dipole extending from coastal to Sierra Nevada regions. 4) Conducting site-specific to regional proxy-model comparisons and providing quantitative reconstructions of hydroclimate and fire activity in CA over the past 70,000 years.

We provide a summary of initial results of the StalFire Consortium that focus on developing a 'surface-to-stalagmite' understanding of hydroclimate and fire tracers through monitoring coupled with proxy development ($d^{44}Ca$, fluid inclusion water isotopes, dual clumped isotope, and plant/microbial biomarkers, biomass burning-derived organic molecules like anhydrosugars and polycyclic aromatic hydrocarbons). Finally, we aim for this presentation to encourage discussion among researchers, labs, and work groups involved in paleo-fire coupled with hydroclimate research, from method development to paleorecord analysis.