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Developing Novel Techniques for Reconstructing Past Fire Histories in South-Eastern Australia

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South-eastern Australia is notoriously fire-prone, leaving the landscape vulnerable to extensive erosion as vegetation cover is decimated and soil hydrophobicity is increased. As climate change continues to modify fire regimes at local to national scales, it is forecast that bushfires will increase in severity, intensity and area burned. However, our existing records rely primarily on satellite imagery, which is limited to the last 30-50 years, or charcoal and tree rings analysis, preventing the distinction of fire severity and characteristics. To better defend against the effects of bushfires in the future and determine whether events such as the Black Summer Bushfires of 2019-20 are the new normal standard, there is an urgent need to develop new techniques that can significantly extend our fire record. Boron (B) isotopes and Fourier Transform Infrared (FTIR) spectroscopy lend themselves as potential proxies due to their sensitivity to changes in vegetation cover and chemical bonds, respectively.

The Upper Blue Mountains in New South Wales (NSW) and Namadgi National Park in the Australian Capital Territory (ACT) are subject to frequent and intense fire events. They are therefore used as case studies to test these two techniques. Sites are targeted such that a range of fire return intervals are analysed to determine the resolution that individual fire events can be distinguished. Sediment samples are examined from swamps and large order streams, pairing an age-depth model with results from these two proxies to formulate a hindcast model of future fire events. Analysis of small order creeks produces promising results highlighting an increase in the $\delta^{11}B$ value of the clay fraction with exposure to high severity fire due to input of leaf material in ash which has a higher $\delta^{11}B$ composition. This is accompanied by a shift to higher relative aromatic composition as aliphatic compounds are preferentially removed with heating. If successful over longer timescales, these methods can be applied to fire hotspots globally to improve mitigation, mediation, and recovery efforts in the face of future fire events.