The Extent and Impact of the 2025 Canadian Wildfires Through Aerosol and Sediment Analysis

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The 2025 Canadian wildfires were the second worst on record in the nation's history, starting in May and involving numerous waves that ended in late August, with plumes of smoke that reached as far as Europe. Wildfire smoke is composed primarily of $PM_{2.5}$, particulate matter 2.5 microns or smaller, and has numerous environmental impacts and harms to human health. This study characterizes the chemical composition of wildfire biomass and documents how it travels over space and time. We collected aerosol and sediment samples from the Labrador Sea aboard the R/V Roger Revelle during cruise RR2504 between June and July 2025, at the height of the summer wildfires. Utilizing aerosol sample mass, $PM_{2.5}$ equivalent values were calculated to ground truth satellite reanalysis data. The observed data followed similar trends to satellite data, but moderately underestimated the amount of $PM_{2.5}$ in the atmosphere. Aerosol samples were investigated using XRF (X-Ray Fluorescence) to characterize bulk elemental composition and SRX (Sub-micron X-Ray Fluorescence) for particle-level analysis. Aerosol samples from the Labrador Shelf, open ocean, and Greenland Shelf all showed consistently high levels of Ti, S, K, and Cr, implying contributions from multiple sources, including continental dust, anthropogenic combustion, and wildfire biomass. Samples from the Greenland Shelf had the highest markers of biomass burning, with 20–30% K by mass, demonstrating a transport of approximately 4,000 km. Particle-level analysis shows more diversity in element aggregates at coastal sites compared to open ocean sites. Aerosol particulate loading rates were also compared to ^{230}Th-normalized ^{232}Th flux in co-located core-top (0–1 cm) sediment samples as a proxy for background lithogenic input into modern (past ~1-5 yrs) ocean sediment. As the intensity of the summer Canadian wildfires increases in both frequency and magnitude, these findings suggest wildfires will continue to spread hazardous particulates across land and sea and impact Arctic communities.