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Evaluating the transport of trace metals and other inorganics in $PM_{2.5}$ attributed to specific fires in the United States

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Wildfires are increasing in activity and severity in the continental United States with serious socio-economic, health, and environmental impacts. Smoke from wildfires has recently been demonstrated as the principal culprit in reversing or stagnating improvements in air quality that were gained under policies such as the Clean Air Act. Further, estimated future increases in fine particle concentrations (size < 2.5 μm; i.e., $PM_{2.5}$) due to wildfire smoke threaten to jeopardize public health gains seen under otherwise improving air quality conditions (in the absence of wildfire). To date, it is unclear what the physical toxicological mechanisms of wildfire smoke are—and to what extent they vary across different fires, space, and time (if indeed they vary at all). Here, we investigate 15 years of speciated air quality data in the United States (2006 - 2020) from the EPA CSN and IMPROVE air monitoring networks and leverage recent advancements in satellite imaging, atmospheric transport modeling, and wildfire $PM_{2.5}$ data to attribute changes in trace metals / inorganics associated with $PM_{2.5}$ directly to wildfire. Results suggest that the trace metal / inorganic character of $PM_{2.5}$ in wildfire smoke is fundamentally different than the composition of baseline $PM_{2.5}$ on nonsmoke days. Further, we assess the propensity for long-range transport of trace metals / inorganics associated with $PM_{2.5}$ and demonstrate—at the elemental level—how specific fires introduce a plausible toxic threat to air quality in the continental United States.