Validating wildfire smoke transport within a coupled fire-atmosphere model using a novel high-density instrumentation network

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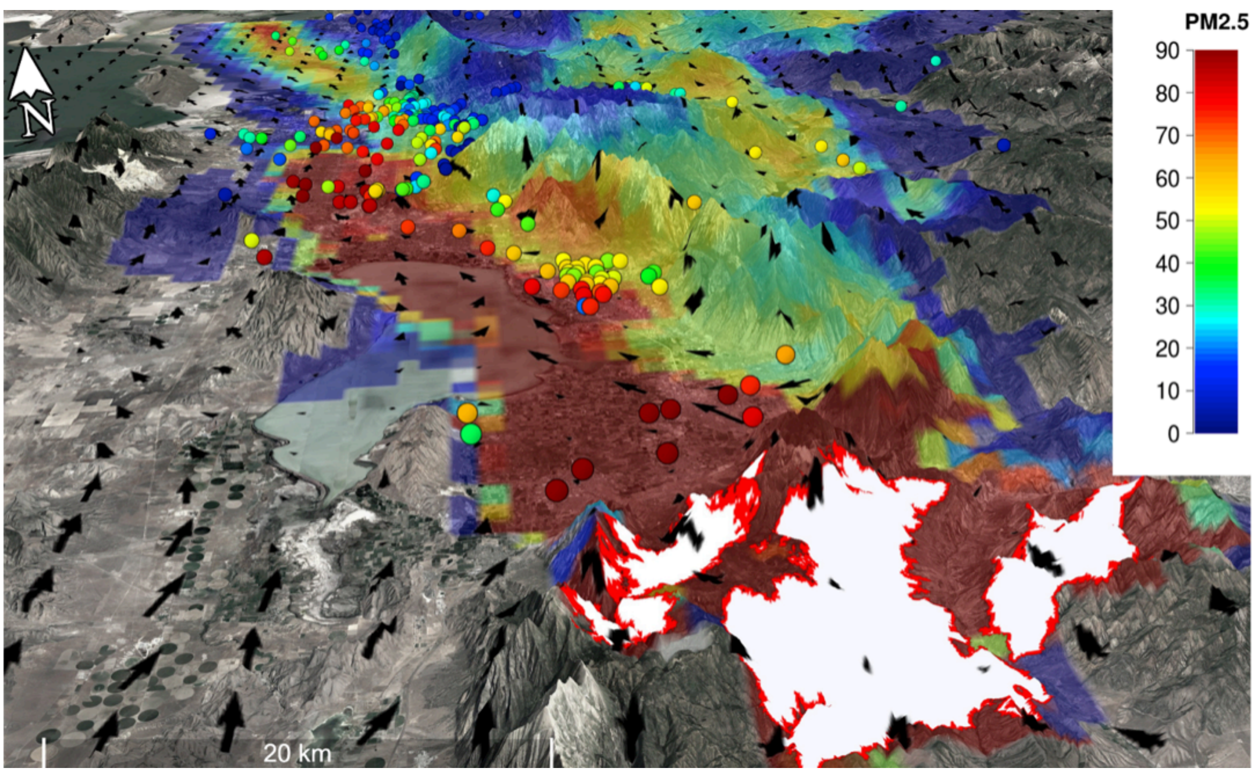

Model simulation (filled contours) and AQ&U observations (circles) of $PM_{2.5}$ concentrations [μg m^{-3}] during the Pole Creek and Bald Mountain smoke event on the morning of September 15th 2018 (9:00 LST). Wind vectors denote model winds while the white polygons show the location of the Pole Creek and Bald Mountain fires.

Abstract:

Wildfire smoke poses a significant hazard to communities and fire managers, as it can reduce visibility while also degrading air quality across areas downwind of the fire. Although many smoke modeling tools exist, accurately simulating smoke production and dispersion is difficult, especially in regions with complex terrain. One of the fundamental problems associated with smoke modeling is the availability of the observational data needed for model validation. The limited density of traditional air quality monitoring networks makes validating wildfire smoke transport challenging, particularly over regions where smoke plumes exhibit significant spatiotemporal variability. In this study, we analyze $PM_{2.5}$ simulations for the Pole Creek Fire, which burned adjacent to the Wasatch Front during the summer of 2018. Here, smoke simulations were generated from a coupled fire-atmosphere model (WRF-SFIRE-CHEM), which can simultaneously render fire growth, fire emissions, smoke dispersion, and fire-atmosphere interaction. The smoke simulations were validated using a novel, high-density air quality network, which consisted of measurements from the University of Utah's AQ&U low-cost sensor network and a $PM_{2.5}$ instrument mounted on a light-rail train (TRAX). Initial results from our case study suggest that low-cost sensor networks and mobile measurements can provide key constraints that can help resolve the spatial heterogeneity of smoke plumes while also serving as a useful data set for validating smoke transport models. Furthermore, results presented here suggest that coupled fire-atmosphere models such as WRF-SFIRE-CHEM can resolve local drainage flow, interbasin exchanges, and the downwind dispersion of wildfire smoke plumes in regions of significant topographic relief.