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Volcanic emissions and air quality during the Kilauea 2018 eruption measured using a low-cost sensor network

Ben Crawford, Jesse Kroll, Colette Heald, and David Hagan

Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, USA

Worldwide, hundreds of millions of people live within potential exposure range of hazardous gases and particulates emitted by active volcanoes. Despite these risks, traditional volcanic emissions monitoring networks are configured primarily to improve understanding of volcanic processes rather than perform air quality assessment for affected communities. Likewise, regulatory air quality monitoring networks operated by local governments may not be designed to measure relevant volcanic atmospheric emissions (e.g. hydrogen sulfide) and expensive, immobile instrumentation restricts spatial coverage and network flexibility. Other observational techniques such satellite-based gas and aerosol measurements offer broad spatial coverage but are limited in terms of resolution (horizontal, vertical, and temporal). Recent improvements in low-cost sensor technology have made it possible to deploy dense sensor networks in a wide range of environments and complement traditional network and satellite observations. Such networks offer several advantages: i) increased spatial resolution and continuous, real-time in situ monitoring, ii) small sensor footprints for rapid deployment and network flexibility during an emergency, and iii) new ways to engage and interact with local communities.

This work highlights results from a low-cost sensor network deployed during the summer 2018 Kilauea eruption on the Island of Hawai'i. Lava from this eruption destroyed hundreds of homes, displaced several thousand people, and created hundreds of hectares of new land. However, the eruption's environmental impacts extended far beyond areas directly affected by lava, with poorest air quality observed hundreds of kilometers downwind. This is a unique case-study demonstrating successful deployment of a low-cost sensor network during an acute air quality event. Challenges, lessons learned, and techniques (e.g. sensor calibration, network evaluation) from this study have potential to be applied to volcano emissions monitoring in other environments. This novel dataset also reveals spatial variability of air pollution exposure and provides insight into meteo-chemical processes underlying sulfur dioxide oxidation and formation of secondary sulfuric acid aerosols.