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Using drones to sample volcanic plumes.

Laura Wainman^{1†}

¹School of Earth and Environment, University of Leeds, Leeds, UK.

[†]email: eelrw@leeds.ac.uk

Volcanic plumes consist of gases and particulate matter (PM) that are produced during volcanic eruptions. Locally, plumes influence the composition of the troposphere and, owing to their buoyancy, can rise high into the stratosphere, potentially influencing the Earth's climate. Understanding the composition of volcanic plumes provides insights into below-ground magmatic processes, as well as the reactions that occur within plumes and how they interact with the atmosphere. However, volcanic eruptions are inherently dangerous, which makes ground-based plume sampling challenging, if not impossible.

Drone sampling capabilities have accelerated since 2015, with increased drone payloads and flight times providing new approaches for sampling the composition and dynamics of volcanic eruption plumes. Fixed-wing drones have been used to sample ash-rich volcanic plumes at higher altitudes (up to 2km vertical ascent) whilst rotary style drones are used more routinely to sample at lower-altitudes during gas-rich eruptions. Increased payload capacity means that drones can simultaneously be mounted with multiple sensors and apparatus to collect samples. Drones can hover in-place and collect discrete field samples or transect plumes to obtain continuous time series, at ranges of up to several km from the operator. These capabilities allow drones to perform measurements of the dispersion of gases and environmentally reactive trace elements (such as As, Pb, Cd, Zn) with higher temporal and spatial resolution than previously achieved using ground-based approaches.

Drones are being used extensively during the ongoing eruptions on the Reykjanes Peninsula, Iceland, to sample emissions from the active fissures and craters. Drone-based observations can also be used to rapidly assess the risk of human exposure to air pollution associated with volcanic emissions. For example, drone-based measurements during the Litli-Hrútur eruption 2023, revealed differences in the composition and morphology of PM depending on if it originated from wildfires, ignited by lava flows, or volcanic sources.

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Competing interests

The authors declare no competing interests.

Credit:

Editor's summary:

Laura Wainman explains how drones can be used to sample the composition and dynamics of volcanic plumes.

