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Satellite Detection of Atmospheric CO_2 Emissions from Volcanoes

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Quiescent volcanic emissions of carbon dioxide (CO_2) -much alike anthropogenic point-source emissions- vary spatially at the 0.1-10 kilometer-scale and are useful to track to detect phases of unrest, including pre-eruptive emission pulses which may indicate magma movement, or to document source strengths. CO_2 emissions create short-range broad plumes which may diverge in their dispersion behavior from sulfur dioxide (SO_2) from the same source, due to the largely unreactive diffusion-dominated behavior of CO_2 in the atmosphere. Plumes may be discernible from space within their spatial context but the characteristics of aging plumes may pose additional challenges to quantification and attribution.

We will compare the different space-borne assets potentially useful to volcanic CO_2 detections and monitoring applications, and discuss results recently published (Schwandner et al. 2017, Science) that showed the first volcanic CO_2 detections from space-borne sensors: Space-borne measurements by NASA's Orbiting Carbon Observatory-2 (OCO-2) have exposed distinct structures of atmospheric CO_2 on kilometer scales over known anthropogenic and volcanic point sources. However, the 16-day repeat cycle of OCO-2 was not optimized to meaningfully track the temporal evolution of these emissions. The Japanese Greenhouse Gas Observing SATellite (GOSAT) has little option for spatial context, but a faster 3 days repeat cycle. Future observations by the OCO-3 instrument, to be launched and installed on the International Space Station, will have pointing optics and will provide better opportunities to track CO_2 emissions from individual volcanoes at meaningful spatial and temporal modes. NASA's scheduled GeoCARB mission will in the longer term provide additional opportunities to quantify CO_2 emissions from geostationary orbit.

Schwandner, F.M., et al. (2017). Space-Borne Detection of Localized Carbon Dioxide Sources. SCIENCE, October 13, 2017, 358 (6360), eaam5782, p. 192, DOI: 10.1126/science.aam5782.