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New insights into volcanic processes from satellite observations of SO_2 emissions

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Although observations of volcanic gas emissions from space may never achieve the sensitivity and specificity of ground-based techniques, the great strength of satellite data lies in global coverage and consistency of measurement over years to decades. These attributes are critical for advancing our understanding of volcano behavior on decadal or longer timescales. Here, we report ongoing efforts to quantify the global flux of sulfur dioxide (SO_2) emitted by passive volcanic degassing; a key parameter that constrains the fluxes of other volcanic gases (e.g., CO_2) and trace metals (e.g., mercury), and which is also a required input for atmospheric chemistry and climate models that include sulfate aerosol. We recently produced the first volcanic SO_2 emissions inventory derived from global satellite measurements, made by the Ozone Monitoring Instrument (OMI) on NASA's Aura satellite since 2005. The OMI measurements permit estimation of SO_2 emissions from over 90 volcanoes, including new constraints on fluxes from poorly monitored volcanoes in regions such as Indonesia, Papua New Guinea, the Aleutian Islands, the Kuril Islands and Kamchatka. On average over the past decade, the volcanic SO_2 sources consistently detected from space have discharged a total of $\sim$63 kt/day SO_2 during passive degassing, or $\sim$23+/-2 Tg/yr. Beyond these improved constraints on volcanic emissions, we also explore other novel applications of the global satellite SO_2 measurements. These include analysis of the effects of large earthquakes on volcanic degassing, and investigation of the incidence and timescales of increased SO_2 emissions prior to volcanic eruptions. This putative 'pre-eruptive' degassing is often the main justification for volcanic gas monitoring, but there have been few comprehensive studies of its occurrence.