Multi-parameter Volcano Monitoring from Space: Recommendations from the USGS Powell Center Volcano Remote Sensing Working Group and Beyond

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Less than 35% of the volcanoes that have erupted since 1500 CE have continuous ground monitoring. Data from an international constellation of > 50 current satellite instruments provide a cost-effective means of tracking the ~1413 subaerial volcanoes with Holocene eruptions and/or instrumental unrest. These data span the electromagnetic spectrum (Fig. 1) and when combined with ground sensors could address one of the grand challenges in volcanology -- to overcome our biased understanding of the relation between volcanic unrest and eruption, which is currently based on only a few well-studied volcanoes. While the potential of volcano remote sensing has been recognized for decades, there are also well-known hurdles. Recognizing these hurdles, an ad hoc working group for volcano remote sensing was funded by the USGS Powell Center for Analysis and Synthesis and is called PowellVolc. Here, we report on the four main objectives of PowellVolc: 1) Coordinate existing efforts to develop global databases of satellite observations of volcanic degassing, thermal activity and ground deformation; 2) Use these databases to answer a series of fundamental scientific questions; 3) Make recommendations to space agencies about the best strategy for establishing a global volcano observatory; and 4) Facilitate the use and interpretation of satellite data by local volcano observatories. We find that over 374 volcanoes (>57 in the USA) have produced signals of volcanic unrest detected by satellites. Remote sensing data are being used by volcano observatories around the world operationally and synergistically with ground sensors to fill gaps in ground networks, evaluate noise in the ground observations, and decide alert levels. Yet, remote sensing data are not yet fully exploited. There are opportunities for facilities and education/outreach to increase data sharing and develop greater links between research and operational communities.
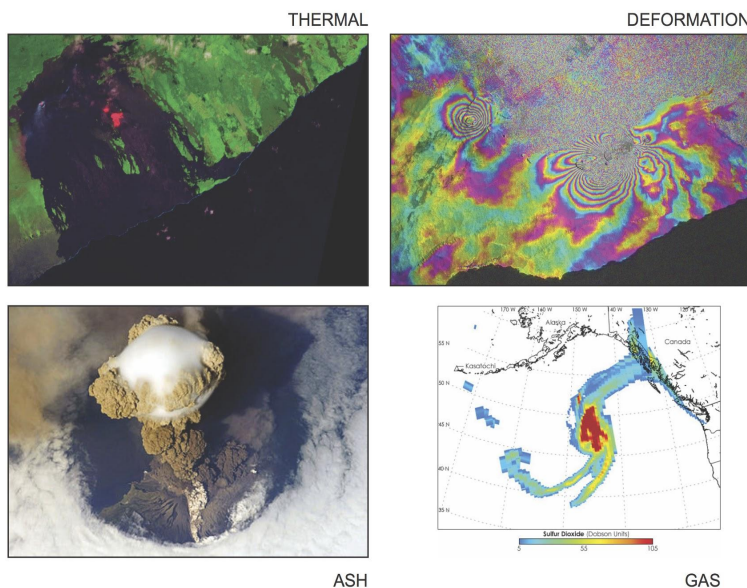

Fig 1. Examples of space-based volcano-monitoring products, which are well equipped to detect thermal anomalies (Kīlauea from ASTER, courtesy Hawaii Volcano Observatory), ash emissions (2009 eruption of Sarychev Peak, Kuril Islands seen by the International Space Station, courtesy NASA), deformation of Earth's surface (Kīlauea interferogram from Cosmo-SkyMed and spanning the March 2011 East Rift Zone intrusion/eruption), and SO_2 emissions (Kasatochi, Alaska eruption in 2008 from OMI).