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Can satellite-based monitoring techniques be used to quantify volcanic CO_2 emissions?

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Since 2010, we investigate and improve possible methods to regularly target volcanic centers from space in order to detect volcanic carbon dioxide (CO_2) point source anomalies, using the Japanese *Greenhouse gas Observing SATellite* (GOSAT). Our long-term goals are: (a) better spatial and temporal coverage of volcano monitoring techniques; (b) improvement of the currently highly uncertain global CO_2 emission inventory for volcanoes, and (c) use of volcanic CO_2 emissions for high altitude, strong point source emission and dispersion studies in atmospheric science. The difficulties posed by strong relief, orogenic clouds, and aerosols are minimized by a small field of view, enhanced spectral resolving power, by employing repeat target mode observation strategies, and by comparison to continuous ground based sensor network validation data.

GOSAT is a single-instrument Earth observing greenhouse gas mission aboard JAXA's IBUKI satellite in sun-synchronous polar orbit. GOSAT's Fourier-Transform Spectrometer (TANSO-FTS) has been producing total column XCO_2 data since January 2009, at a repeat cycle of 3 days, offering great opportunities for temporal monitoring of point sources. GOSAT's 10 km field of view can spatially integrate entire volcanic edifices within one "shot" in precise target mode. While it doesn't have any spatial scanning or mapping capability, it does have strong spectral resolving power and agile pointing capability to focus on several targets of interest per orbit. Sufficient uncertainty reduction is achieved through comprehensive in-flight vicarious calibration, in close collaboration between NASA and JAXA. Challenges with the on-board pointing mirror system have been compensated for employing custom observation planning strategies, including repeat sacrificial upstream reference points to control pointing mirror motion, empirical individualized target offset compensation, observation pattern simulations to minimize view angle azimuth.

Since summer 2010 we have conducted repeated target mode observations of now almost 40 persistently active global volcanoes and other point sources, including Etna (Italy), Mayon (Philippines), Hawaii (USA), Popocatepetl (Mexico), and Ambrym (Vanuatu), using GOSAT FTS SWIR data. In this presentation we will summarize results from over three years of measurements and progress toward understanding detectability with this method. In emerging collaboration with the *Deep Carbon Observatory*'s DECADE program, the *World Organization of Volcano Observatories* (WOVO) global database of volcanic unrest (WOVOdat), and country specific observatories and agencies we see a growing potential for ground based validation synergies. Complementing the ongoing GOSAT mission, NASA is on schedule to launch its OCO-2 satellite in July 2014, which will provide higher spatial but lower temporal resolution. Further orbiting and geostationary satellite sensors are in planning at JAXA, NASA, and ESA.