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Thermal infrared data analysis of volcanic processes: From 15 years of ASTER to new orbital concepts for measuring passive volcanic plumes

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The success of the ASTER instrument for observing active volcanic processes early in the mission gave rise to a funded NASA program designed to increase the number of ASTER observations following an eruption. The urgent request protocol (URP) system grew out of this initial study and has now operated by the University of Pittsburgh in conjunction with and the support of the Universities of Alaska Fairbanks, Hawaii, Turin, Clermont Auvergne, as well as the USGS Land Processes DAAC and the ASTER science team. The data have been used for operational response to new eruptions, longer-term scientific studies such as capturing detailed changes in lava domes/flows, pyroclastic flows and lahars. These data have also been used to infer the emplacement of new lava lobes, detect endogenous dome growth, and interpret hazardous dome collapse events. Now, this long-term archive of volcanic image data is being mined to provide statistics for future high-repeat TIR orbital concepts being considered by NASA. Future TIR instruments will likely get smaller and more numerous using uncooled detectors, such as microbolometers. These instruments are cube-sat compatible and could operate in a sensor-web network for rapid response times to volcanic crises. Once such instrument concept has been proposed to NASA to measure the global inventory of volcanic degassing on a repeated schedule. The mission concept named ICAPE and the instrument it carries called ITHEMIS would acquire high-spatial resolution multispectral thermal infrared (TIR) data specifically tuned to detect SO_2, CO_2, H_2O, and solid phase SiO_2 (ash). With a planned a spatial resolution of $\sim$ 30m/pixel and an SO_2 detection threshold better than 2 g/m2, the data would allow passive degassing and proximal plumes to be studied globally. If launched, ITHEMIS will allow us to quantify the mass and energy flux from these plumes and measure the globally-averaged gas, aerosol and mineral abundance injected by them into the lower atmosphere. Analysis of this potential future dataset has already begun with the development of a ground-based TIR imaging sensor designed to replicate ASTER and ITHEMIS. Data from this camera were acquired of the Kilauea plume and lava flow in 2017 and 2018. The ultimate goal of this ongoing effort is to launch an improved TIR imaging system to improve volcanic monitoring, eruption forecasting, and understanding of the linkage between the aerosol species to the regional to global climate.