THERMAL INFRARED SPACE-BASED SO2 DETECTION: A NEW TECHNIQUE FOR THE ALASKA VOLCANO OBSERVATORY

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Since the launch of NASA’s Terra and Aqua platforms (1999 and 2002, respectively), the Alaska Volcano Observatory (AVO) has been receiving near-real time Moderate Resolution Infrared Spectroradiometer (MODIS) data. MODIS provides high thermal infrared (TIR) spectral resolution data with a temporal resolution up to two passes per day and a TIR spatial resolution of 1 km at nadir. Utilizing the 8.6µm SO2 absorption feature, total SO2 emissions during an eruption are now possible using MODIS in conjunction with the algorithm MAP_SO2 (Realmuto, 1994, 1997).

Due to the spatial resolution of MODIS, the detection of passive degassing at subduction related volcanoes is limited; however its 2330 km swath width allows the detection of large eruptive episodes. The algorithm MAP_SO2 provides a means to create SO2 concentration maps based on modelled radiance values. These maps provide a total SO2 tonnage emitted along with a further understanding of the internal plume structure. Since MAP_SO2 was initially developed to detect passive degassing using the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), which has a higher spatial resolution, the attenuation of the signal by ash within the TIR was not accounted for. Therefore, the total SO2 tonnage determined is an overestimate of the actual SO2 emitted (Watson et al, 2004). Although the estimation may exceed the actual amount, it does provide an upper limit of emitted SO2.

In the last four years, several eruptions in NOPAC have been detected by MODIS, including the recent eruption of Bezymianny. On 13 January 2004, Bezymianny volcano located on the Kamchatka peninsula erupted, sending gas and ash up to 12 km into the atmosphere. The detection of the eruption by both Terra and Aqua provided a MODIS time series approximately 12 hours after the eruption began. Analysis of this data set indicates approximately 4 kt or SO2 was emitted by 0025 UTC on 14 January 2004, increasing to 40 kt by 0210 UTC.

The use of MODIS to determine a total SO2 tonnage during an eruptive episode by AVO is a new research tool for the observatory. Using detected events at Bezymianny, Klyuchevskoi and Sheveluch, MAP_SO2, in conjunction with MODIS and ASTER, has been tested in order to determine its abilities within the NOPAC. During an eruption, the volcano of interest is added to the ASTER emergency response list. This increases the probability of acquiring an ASTER scene over the volcano of interest, allowing AVO to detect lower levels of degassing throughout the episode. Due to the reliability of incoming MODIS data, the emergency response ASTER list and the successful retrieval of SO2 tonnages, MAP_SO2 is now a part of AVO’s response during an eruption.

References