THE 2000 ERUPTION OF BEZYMIANNY VOLCANO CAPTURED WITH ASTER: A PROPOSAL TO INTEGRATE HIGH-RESOLUTION REMOTE SENSING DATA INTO REAL-TIME ERUPTION MONITORING AT AVO

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Activity increased significantly at Bezymianny Volcano in the last half of 2000, with the activity first seen by way of thermal anomalies detected in Advanced Very High Resolution Radiometer (AVHRR) images in mid-May of that year. Both plumes and new dome formation were detected and the Kamchatka Volcanic Eruption Response Team (KVERT) issued its highest alert warning *[GVN, 2000]*. Numerous AVHRR thermal anomalies, pyroclastic flows (PF's), and 10-20 km plumes were observed. At this time a request was made to increase the observational frequency of Bezymianny using the new ASTER instrument. For the next six months, ASTER collected over 30 scenes, which have been used to monitor the eruption, make comparisons to the AVHRR data, and produce vesicularity maps of the dome *[Ramsey and Dehn, 2001]*. Thermal anomalies covering tens to hundreds of pixels were present from June 2000 to January 2001 *(much longer than either AVHRR or Landsat ETM+ data have shown).* The data are clearly highlighting the non-eruptive thermal state of the volcano and show movement of anomalies with a concentration along a fissure prior to larger eruptions of late October. This eruption was detected by AVHRR and resulted in the formation of a hot flow deposit seen in the December ASTER images (Figure 1).

As the only high spatial resolution instrument onboard the Terra spacecraft, ASTER data are proving extremely valuable for volcano monitoring because of this spatial coverage and increased spectral resolution (four and two times better than current Landsat images, respectively). ASTER has a nominal repeat time of 16 days for any location on Earth *[Yamaguchi et al., 1998]*. This can be reduced to as little as 5 days through the instrument's unique ability to point off nadir. With the high spatial resolution (15-90 meters/pixel), multi-spectral coverage (VNIR to TIR wavelengths), tunable gain settings (for monitoring hot targets without saturation), and the ability to generate along-track digital elevation models (DEMs), ASTER should be the premiere instrument for active volcanic studies and hazard mitigation. However, it suffers from some important logistical drawbacks that limit the data availability and usefulness. The most critical of which is the scheduling, processing, and data delivery pathway. This can take up to two weeks and therefore is not ideal for near real-time data collection. ASTER has several global data acquisition goals including perhaps the most ambitious: volcanic eruption monitoring of over 1500 of the world's active volcanoes.

The aforementioned specifications are critical for volcanic studies in that they allow for the discrimination of smaller thermal, textural, and compositional anomalies on the surfaces of lava flows and domes *[Ramsey and Dehn, 2002; Ramsey and Fink, 1999]*. However, even during eruptions where ASTER is in an increased acquisition mode, the repeat time is not sufficient for its use strictly as a monitoring tool. The current volcano monitoring program at the Alaska Volcano Observatory (AVO) uses geostationary and polar orbiting satellite data to monitor the northern Pacific volcanoes. AVHRR acquires data which are processed in real-time by ground receiving stations. However, these data fail to capture any of the small-scale eruption activity or the nominal non-eruptive character of these remote volcanoes. In a recent NASA Solid Earth and Natural Hazards proposal, the authors proposed to augment the AVO satellite monitoring with ASTER data to further extend the science and provide a complete framework of an eruption. To do this, the proposed research will rely on the current satellite monitoring program of AVO to continue locate and target future eruptions. AVHRR thermal alerts would be directed through the ASTER emergency request procedure, thereby eliminating the delay in data reception (Figure 2). This will lead to a cooperative infrastructure between the ASTER science team and the AVO's research scientists.

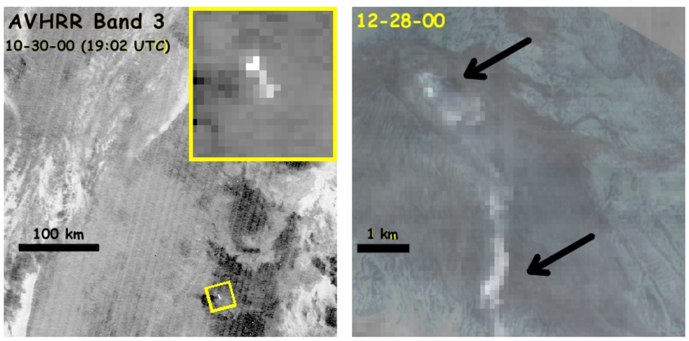

Figure 1. Comparison of AVHRR and ASTER TIR thermal anomaly detection at Bezymianny Volcano. Shown are two dates within the 2000 eruptive time series. ASTER collected 30 scenes over 7 months and detected thermal anomalies on the dome as well as on flow units following large eruptive events *(see arrows)*. Also shown is one AVHRR scene for comparison of spatial resolution *(note scale bar)*. AVHRR detected "alert-triggering" thermal anomalies only during the large eruption of late October 2000, whereas ASTER detected activity throughout the last half of 2000.

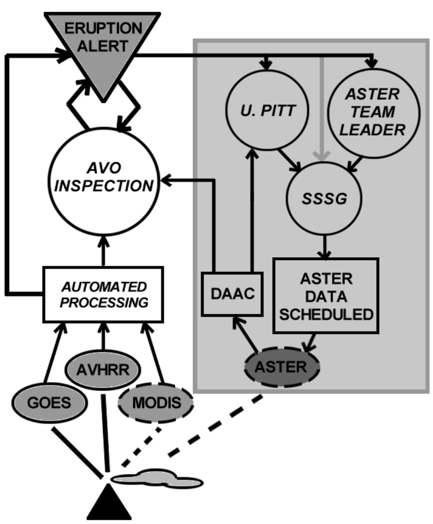

Figure 2. Proposed system flow diagram for volcanic eruption monitoring from space at the Alaska Volcano Observatory (AVO). Data from the high-temporal, low-spatial resolution instruments are received at AVO and processed. Thermal and/or ash advisory alerts can be issued after human inspection of the data or automatically triggered by the processing software. The proposed work seeks to integrate ASTER data *(shown in the gray box)*. As envisioned, AVO alerts would also trigger emails to various ASTER scientists and an emergency request would then be scheduled for the next possible satellite overpass, with the data processed at the Distributed Active Archive Center (DAAC) and delivered to AVO within hours of data acquisition.

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