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Dr. Ghassem Asrar
EOS Program Scientist
Code Y
Office of Mission to Planet Earth
NASA Headquarters
Washington, DC 20546

Dear Ghassem:

At our IDS site review in April, we discussed the possibility of implementing an automatic MODIS thermal/SO_2 alarm which would detect erupting volcanoes using near real-time data. Concerns were raised that the alarm would have prohibitive costs in terms of money and man-hours. After having discussed the problem of an alarm with Al Fleig at NASA Goddard, we ask that you consider the option described in this letter before making a final decision.

A thermal/SO_2 alarm would alert us to new eruptions and may give us enough advanced warning to target other EOS (ASTER, MISR: high-res mode, and TES) and non-EOS instruments (e.g., Landsat, SPOT, ERS-2 and Envisat's ASAR) to areas of interest. In addition, advance warning from an alarm would make it more likely that critical ground-based measurements (COSPEC, temperature measurements, eruption observations etc.) would be made in the early stages of an eruption, especially at well-staffed volcano observatories. Without real-time alarms in place, the possibility of acquiring high-resolution satellite data of explosive eruptions or other short-lived events will remain non-existent. A MODIS thermal/SO_2 alarm is an absolute necessity for us to even have the opportunity of catching the initial stages of explosive eruptions when gases and aerosols are injected into the stratosphere. Thus, the ability to study the impact of volcanic plumes on the global environment depends on being able to obtain high-resolution data for plume models, which in turn depends on the existence of a real-time alarm.

Even as recently as the IDS Site Review, we thought that the implementation of an appropriate MODIS alarm would require additional money and/or man-power within the EOS program. Our previous concerns were two-fold: 1) the DAAC's ability to provide us with the thermal and SO_2 alarms themselves within ~8 hours of the

acquisition of MODIS data, and 2) the ability of the DAAC's to provide us with images of these anomalies within the same timeframe so that we can assess whether we are indeed looking at an eruption instead of, for instance, a forest fire. From discussions with Al Fleig at NASA/Goddard SFC, we have concluded that the MODIS data stream can be automatically searched on an orbit-by-orbit basis for radiance values at a few specific wavelengths and the site-specific anomaly information (geographic coordinates accurate to within a few kilometers) placed on a computer network so that a remote site can periodically search for new events.

The need to have images within a few hours of an event is not required because the "validity" of the eruption can be checked at the remote site by checking the geographic location and spatial extent of the anomaly. If you recall, it is only the larger eruptions that we wish to retarget ASTER etc., and so the task of identifying an eruption is quite simple from the radiance values and geographic location. At this stage, it is likely that the thermal alarm algorithm will consist of above DN a specific value "X" in channel 20 (3.75 μm) and above DN "Y" in channel 31 (11.03 μm) means an alarm. The SO_2 alarm will consist of thresholds for differences between DN's for MODIS channels 27 (6.72 μm), 28 (7.33 μm), 31 (11.03 μm) and 36 (14.24 μm).

The second problem that we considered at the Site Review is the timeframe and the "level-of-success" in detecting all eruptions that the IDS team will accept. We are <u>not</u> attempting to build an operational capability, and so can live with the situation where, say, eruption alarms are only generated ~50 — 70% of the time, and that we sometimes get the information within 8 hours and sometimes not for 12 — 24 hours. At this stage of our analysis of volcanic eruptions, simply having the capability of <u>sometimes</u> observing the early stages of an eruption is a significant step forward compared to the current situation. A component of this would require the ground stations to make an effort to send MODIS data forward more quickly than is currently planned; we would suggest that the data are available on an orbit-by-orbit basis rather than every 24 hours as is now the intent. Within the EOS Volcanology IDS Team, we would work towards the prototype of an algorithm for separating eruptions from forest fires, and we have the plan to use AVHRR data to assess the magnitude of this problem. The implementation of the alarm as described above would be very helpful for our community's research needs, and might really be a good PR tool between NASA and countries with volcano hazards, and NASA and the volcanology community. Indeed, volcanologists would most likely find this near-real-time archived database of alarms as one of the most useful aspects of EOS because it alerts them to the initial stages of activity. I should add that in discussions with the ASF DAAC, we are hoping to work with the volcanologists there to develop just this type of eruption alarm for studying the Alaskan volcanoes using direct-broadcast MODIS data.

To conclude, we believe that a MODIS alarm can be implemented that does not stress the existing system in terms of resources or manpower. This alarm would not be an operational capability, since there will not be rigid performance criteria place on the MODIS team to detect an alarm every time within any specific timeframe. However, we do wish to operate an alarm within the current operational specifications of the MODIS data collection and archiving system. As the representatives of the volcanological community within the EOS and larger NASA communities, we believe

that the benefits of a real-time thermal/SO_2 alarm are enormous in that advance warning of increased or unexpected activity could allow field centers to react appropriately and put observers in the field if necessary. The same alarm announcement two days after the fact will not be nearly as useful, since many explosive episodes (such as Mt. Pinatubo) and some basaltic eruptions on Kilauea have started, reached a peak, and declined or ceased altogether within a 48 hour time period. By creating an updated bulletin of volcanoes which we know are active, and making the bulletin accessible to a broad segment of the volcanological community, we can help ensure that the broadest range of scientists in the community take advantage of the unique capabilities of the EOS sensors.

On behalf of the EOS IDS Volcanology Team, I therefore ask that you consider the inclusion of a simple alarm in the MODIS data stream, and encourage the MODIS Team to include this alarm in their baseline performance plans.

Sincerely,

Peter J. Mouginis-Mark
Team Leader, EOS Volcanology IDS Team

cc: V. Salomonson
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