Multi-Source Autonomous Response for Targeting and Monitoring of Volcanic Activity

This concept has great relevance to Earth science and future planetary exploration.

NASA's Jet Propulsion Laboratory, Pasadena, California

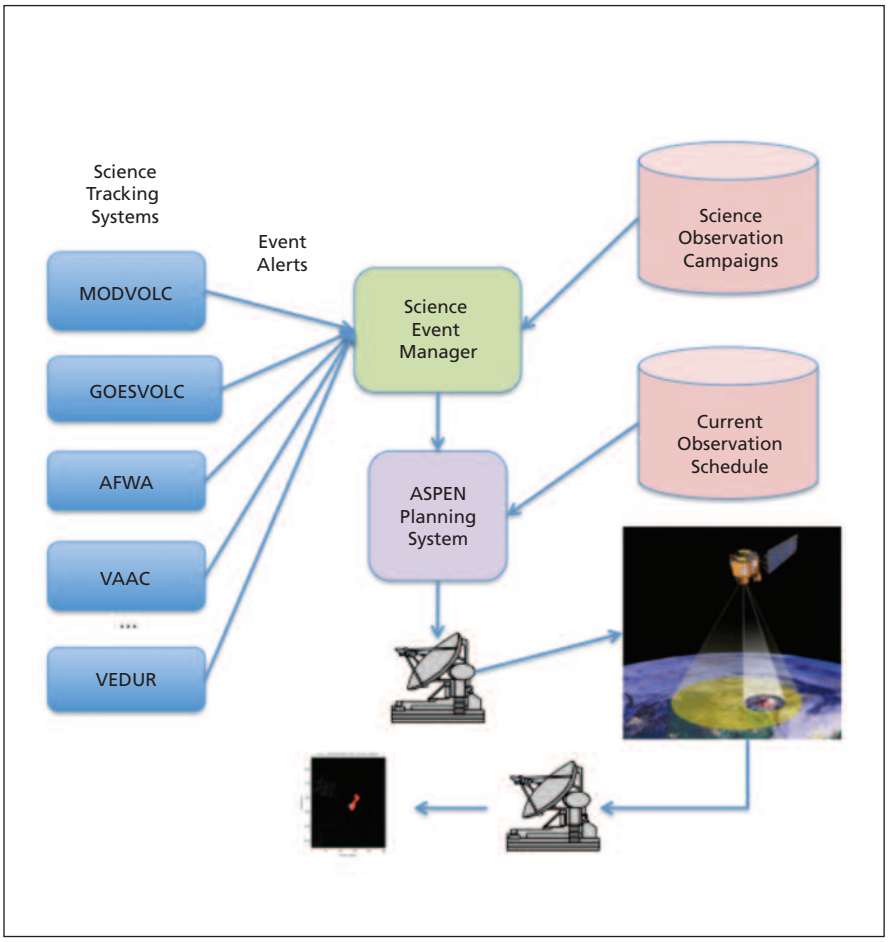
The study of volcanoes is important for both purely scientific and human survival reasons. From a scientific standpoint, volcanic gas and ash emissions contribute significantly to the terrestrial atmosphere. Ash depositions and lava flows can also greatly affect local environments. From a human survival standpoint, many people live within the reach of active volcanoes, and therefore can be endangered by both atmospheric (ash, debris) toxicity and lava flow.

There are many potential information sources that can be used to determine how to best monitor volcanic activity worldwide. These are of varying temporal frequency, spatial regard, method of access, and reliability. The problem is how to incorporate all of these inputs in a general framework to assign/task/reconfigure assets to monitor events in a timely fashion.

In situ sensing can provide a valuable range of complementary information such as seismographic, discharge, acoustic, and other data. However, many volcanoes are not instrumented with *in situ* sensors, and those that have sensor networks are restricted to a relatively small numbers of point sensors. Consequently, ideal volcanic study synergistically combines space and *in situ* measurements.

This work demonstrates an effort to integrate spaceborne sensing from MODIS (Terra and Aqua), ALI (EO-1), Worldview-2, and *in situ* sensing in an automated scheme to improve global volcano monitoring. Specifically, it is a "sensor web" concept in which a number of volcano monitoring systems are linked together to monitor volcanic activity more accurately, and this activity measurement automatically tasks space assets to acquire further satellite imagery of ongoing volcanic activity.

A general framework was developed for evidence combination that accounts for multiple information sources in a scientist-directed fashion to weigh inputs and allocate observations based on the confidence of an events occurrence, rarity of the event at that location, and other scientists' inputs. The software framework uses multiple source languages and is a general framework for combining inputs and incrementally submitting observation requests/reconfigurations, accounting for prior requests.



The dataflow of the **Sensor Web System** uses alert systems to task volcano observations automatically based on scientist-specified observation campaigns.

The autonomous aspect of operations is unique, especially in the context of the wide range of inputs that includes manually inputted electronic reports (such as the Air Force Weather Advisories), automated satellite-based detection methods (such as MODVOLC and GOESVOLC), and *in situ* sensor networks.

This work was done by Ashley G. Davies, Joshua R. Doubleday, and Daniel Q. Tran of Caltech for NASA's Jet Propulsion Laboratory. EO-1 is managed by Goddard Space Flight Center. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-48148.