FACT SHEET

GOES-R Aviation Products
Volcanic Ash Detection

Why is volcanic ash an important safety issue?

Airborne volcanic ash is a major aviation, health and infrastructure hazard. When ingested into aircraft engines, volcanic ash can lead to engine damage or failure. For example, in December 1989, a 747 jetliner carrying 231 passengers encountered an ash cloud during an eruption of the Mount Redoubt volcano, located southwest of Anchorage, Alaska. Within 60 seconds of encountering the heavy ash cloud, all four engines of the aircraft had stalled. Fortunately, the pilot was able to restart the engines, narrowly avoiding a crash. Volcanic ash is extremely abrasive and even small concentrations can cause severe damage to the exterior of aircraft. In addition, ash falls pose significant health and infrastructure threats to those on the ground. Breathing volcanic ash can result in serious illness or death and ash falls can also pollute water supplies and damage or destroy buildings.

Image of the December 1989 Mt. Redoubt eruption (upper) demonstrates that a large quantity of volcanic ash can be rapidly injected to aircraft cruising level. Heavy ash fall from this eruption also caused significant engine damage to a KLM passenger jet (lower).

How will GOES-R address this hazard?

Current GOES operational volcanic cloud products are qualitative, primarily due to sensor limitations. Improved spatial resolution and a large selection of spectral channels will enable the GOES-R Advanced Baseline Imager (ABI) to generate more advanced quantitative volcanic cloud products. The GOES-R series **Volcanic Ash Detection** product will provide objective estimates of ash cloud coverage, height, mass and particle size which are necessary to issue Significant Meteorological Information (SIGMET) advisories for aircraft and accurately forecast the dispersion of ash clouds.

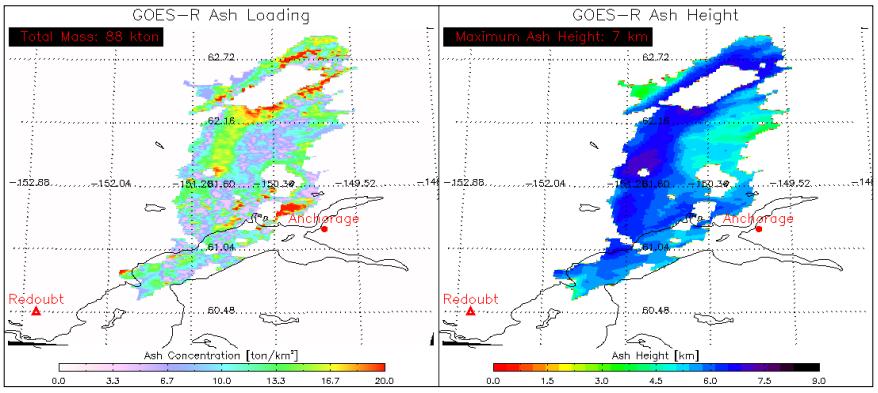
A thick layer of ash covers the roof a house surrounded by broken branches and trees without foliage due to volcanic ash fall from the eruption of Mount Pinatubo on June 15, 1991.

How does the Volcanic Ash Detection Product work?

The GOES-R **Volcanic Ash Detection** product is generated from infrared radiances, which are day/night independent. ABI channels centered at 8.5, 11, 12 and 13.3 μm are used in the algorithms. The 8.5, 11 and 12 μm channels provide information on cloud particle size and composition the 13.3 μm channel detects ash cloud height. These algorithms are unique because they account for background conditions such as surface temperature, surface emissivity, atmospheric temperature and water vapor on a pixel-by-pixel basis. Consideration of background conditions results in greater sensitivity to thin ash and consistent algorithm performance from the tropics to high latitudes.

The **Volcanic Ash Detection** algorithms were developed and tested using the Spinning Enhanced Visible and Infrared Imager (SEVIRI) on board the European Meteosat Second Generation (MSG) satellites and the NASA Moderate Resolution Imaging Spectroradiometer (MODIS), providing proxy data for the ABI. The **Volcanic Ash Detection** product is validated by using spaceborne lidar and high spectral resolution ultraviolet measurements provided by instruments on NASA research satellites.

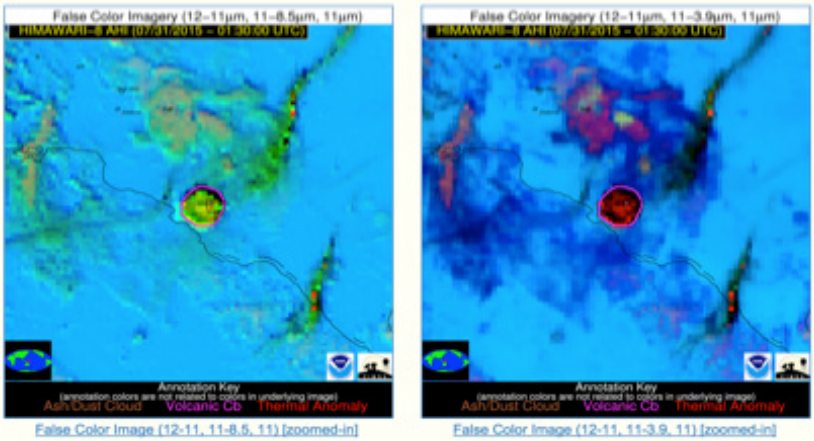
In addition to the baseline products, several experimental GOES-R tools have been developed for volcanic ash applications. The collection of experimental tools, referred to as the **Volcanic Cloud Analysis Toolkit (VOLCAT)**, are currently utilized by Volcanic Ash Advisory Centers (VAACs). **VOLCAT** utilizes geostationary or low Earth orbit satellite data to automatically alert users when a volcano enters a state of unrest or erupts, tracks and characterizes volcanic ash clouds, and provides the information needed to initialize and validate models that forecast the future location of airborne volcanic ash in the wake of an eruption. **VOLCAT** is designed to take full advantage of GOES-R capabilities, thereby allowing for far more timely detection of volcanic eruptions and more accurate ash cloud characterization, and hence forecasting, than is possible from the legacy GOES system.



*GOES-R-like **Volcanic Ash Loading** and **Height** products are shown for ash clouds produced by eruptions of Mount Redoubt on March 23, 2009.*

What are the benefits?

On average, more than 50 volcanic eruptions occur each year, many of which are within or downwind of the region viewed by the GOES satellites. More than 80,000 large aircraft per year and 30,000 people per day are in the airspace near and potentially downwind of the 90 active volcanoes in Alaska. The International Civil Aviation Organization has designated 24/7 volcanic cloud monitoring duties to nine VAACs around the world. The VAACs are responsible for issuing Volcanic Ash Advisories, which alert aviation interests to the presence of volcanic ash clouds. The National Weather Service is responsible for operating the Anchorage, Alaska, and the Washington, D.C., VAACs.



An example volcanic eruption alert produced by the Volcanic Cloud Analysis Toolkit for the Manam Volcano eruption on July 31, 2015. The eruption was automatically detected using Himawari-8 satellite imagery, which is very similar to what GOES-R will provide. GOES-R will allow for more timely and accurate detection of volcanic eruptions.

Volcanic ash clouds can have serious economic impacts. For instance, Alaska Airlines was forced to cancel 295 flights (stranding over 20,000 passengers) in March and April of 2009 due to ash clouds produced by Mount Redoubt. The cost of the eruption to the aviation industry alone was $101 million.

As airborne volcanic ash has significant aviation, health, infrastructure and economic effects, frequent observation of volcanic regions and prompt identification of ash clouds are necessary to minimize risk. The advanced spectral, spatial and temporal resolution of the GOES-R ABI will be utilized to generate a complete set of volcanic cloud detection and monitoring products and tools, resulting in improved air and ground safety as well as economic savings. The GOES-R products will also be used to improve the modeling of volcanic ash clouds, which will allow for more accurate ash cloud dispersion and ash fall forecasts.

On the web

- www.ssd.noaa.gov/VAAC/vaac.html