Support to Aviation Control Service

Volcanic eruptions can emit large quantities of rock fragments and fine particles (ash) into the atmosphere, as well as several trace gases, such as carbon monoxide (CO), sulphur dioxide (SO_2), bromine monoxide (BrO), and water vapour. These volcanic ejecta can have a considerable impact on air traffic safety and on human health.

Groundbased monitoring is only carried out at a limited number of volcanoes and, in fact, most volcanoes are not monitored on a regular basis. Satellite observations of sulfur dioxide (SO_2) and aerosols may therefore provide useful complementary information to assess, on a global level, the possible impact of volcanic eruptions on air traffic control and on public safety.

The Support to Aviation Control Service (SACS) of PROMOTE focuses on the timely delivery of SO_2 data derived from different satellite-based instruments such as SCIAMACHY, OMI and GOME-2. This allows for monitoring the occurrence of volcanic eruptions, and the extent and motion of volcanic plumes. In the case of large SO2 concentrations SACS sends notifications by e-mail to interested parties with a reference to a dedicated webpage. This weboage shows information and maps of the event.

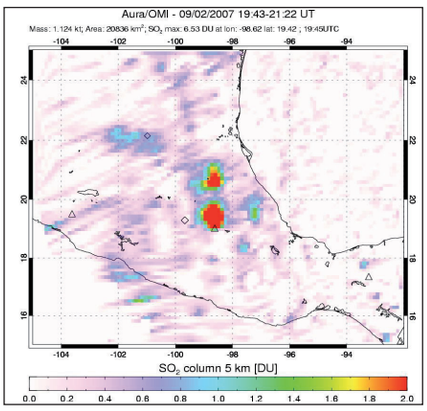
The location of the SO_2 peak value will be used to start the calculation of backward and forward trajectories on the basis of meteorological information (wind, temperature, pressure, etc.). These trajectories will facilitate the interpretation of satellite observations, providing an indication of the location of the SO_2 source, the height of the plume, and its motion.
In addition to SO_2 data, high-resolution images taken with a 15-minute scan cycle by the SEVIRI instrument will provide information on volcanic ash (aerosols), in order to trace and track volcanic ash plumes related to eruptions specifically in Europe and Africa.

Ash cloud of Mount St. Helens Vulcano eruption in the pacific northwest of the United States, 18 May 1980.
Source: USGS/Cascades Volcano Observatory

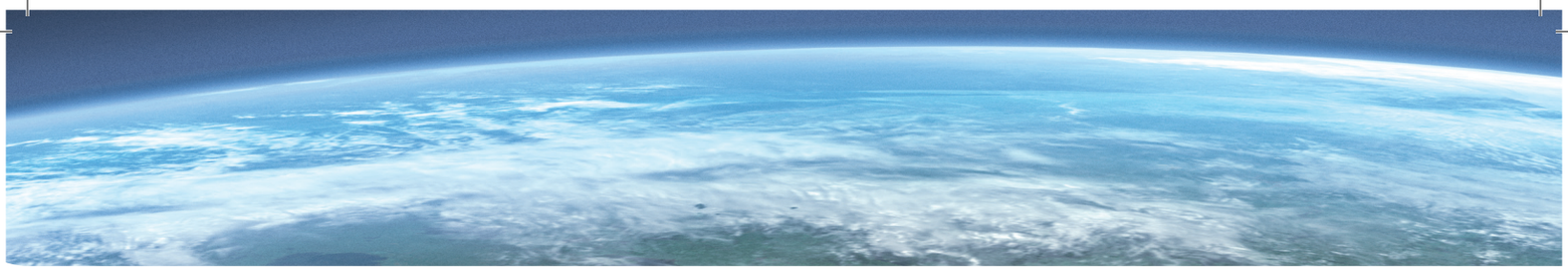
Hazards to Aviation

Of the volcanic ejecta, the larger rock fragments usually fall back to Earth close to the volcano. The lighter ash and the gases, however, can rise high into the troposphere and even reach the lower stratosphere, up to 15 or 20 km, depending on the type of volcano erupting.

The ash emitted by volcanic eruptions is a major hazard to aviation. The ash can, for example, severely damage the material of the aircraft, clog its sensors, limit the view of its pilots, and severely scratch („sandblast“) the windows of the aircraft. If it enters the aircraft engines, the ash can melt, which may cause the engines to fail.



SO_2 concentration map based on OMI data of 2 September 2007 (20:30 GMT). The area shown is about 1350 by 1100 km. The triangle in the middle is Popocatépetl, the diamond to the left of that is Mexico City. The triangle to the far left is Colima.
Source: Simon Carn, University of Maryland/OMI



Worldwirde over 90 aircraft have sustained damage after flying through volcanic ash clouds. In at least seven cases this resulted in temporary loss of power to one or more of the engines during flight. In three cases, a Boeing 747 lost all four engines (1982 and 1989); fortunately the engines could be restarted once outside the ash cloud but in the meantime the aircraft had lost several kilometres altitude.

Of the gases emitted during a volcanic eruption, SO_2 is a possible hazard to an aircraft: it reacts with water vapour to form sulphuric acid (H_2SO_4), which is corrosive, can scratch the paint and the windows of the aircraft and, it can create sulphate deposits in the engines.

Once in the stratosphere, both ash and SO_2 can travel large distances. The ash emitted during the eruption of the Pinatubo volcano (1991), for example, is known to have damaged aircraft as far as 1000 km away from the mountain.

Approximately 60 volcanic eruptions occur each year and, on average, the ash cloud of ten eruptions reaches flight level along major aviation routes. The total cost of the damage sustained by aircraft due to volcanic ash clouds in the period 1982-2000 is estimated at 250 million US dollars. Fortunately, none of the incidents so far have resulted in fatal accidents or in people being injured.

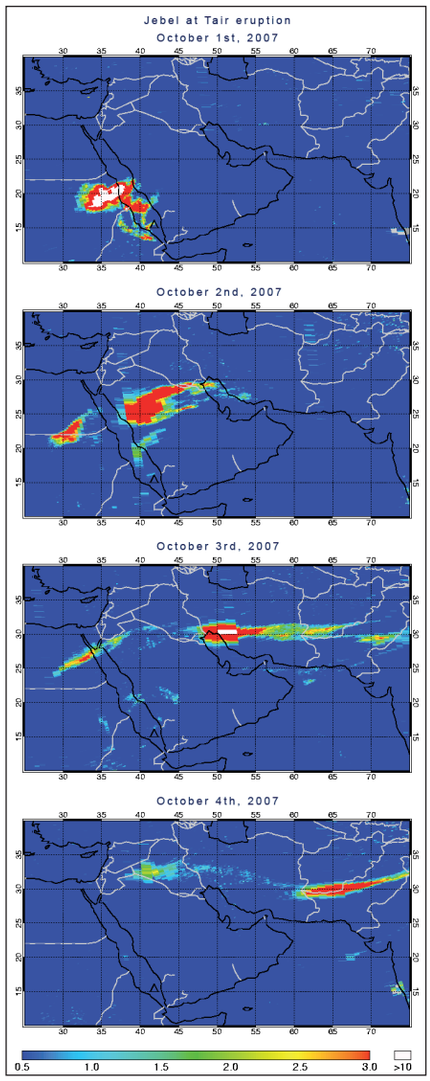
From all these considerations it is clear that the safest procedure for an aircraft is to stay clear of volcanic clouds. Pilots cannot always see an ash cloud (e.g. at night) and the ash does not show up on the radar. And SO_2 and H_2SO_4 are colourless gases, and therefore invisible. So they have to rely on external information to know in advance where volcanic clouds are and what elevation they reach.

Users of SACS

The Volcanic Ash Advisory Centres (VAACs) – set up in 1995 by the International Civil Aviation Organization (ICAO) – are the official organisations charged with gathering information on volcanic ash clouds. On the basis of this, the VAACs issue advises and alerts to airline and air traffic control organisations on the possible danger of volcanic clouds, and they forecast the motion of the clouds.

The core users of SACS are the London and Toulouse VAACs, which cover Europe and Africa. The data and information from PROMOTE will, however, not be restricted to these areas because the number of active volcanoes in Europe and Africa is not large enough for validation of the Service, and because other regions in the world may be of interest to future users.

For more information on SACS see http://sacs.aeronomie.be/



Motion of SO_2 emitted during the eruption of the Jebel at Tair volcano (triangle) on a Yemen island in the Red Sea. Eruption started on 30 September, 2007 late in the evening. Measurements based on OMI data, covering an area of about 5200 by 3300 km. Source: BIRA-IASB

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The aim of the PROMOTE project is to deliver a sustainable and reliable operational portfolio of services to support informed decisions on atmospheric policy issues such as those related to stratospheric ozone depletion, surface UV exposure, air quality and climate change.

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