Support to Aviation Control Service

Volcanic eruptions can eject large amounts of ash (aerosols) and trace gases such as sulphur dioxide (SO_2) into the atmosphere which can have considerable impact on air traffic safety and on human health. Ground-based monitoring is carried out at only a limited number of volcanoes and, in fact, most volcanoes, especially those which are remotely located, are not monitored on a regular basis.

Observations of SO_2 and aerosols derived from satellite measurements in near-real time may therefore provide useful complementary information to assess, on a global level, possible impacts of volcanic eruptions on air traffic control and public safety. The Support to Aviation Control Service (SACS) of PROMOTE focuses on the timely delivery of SO_2 data derived from different satellite instruments such as SCIAMACHY, OMI and GOME-2. This allows for monitoring the occurrence and extension of volcanic eruptions and plumes.

On the basis of selection criteria of exceptional SO_2 emissions, SACS sends notifications by e-mail to interested parties with a reference to specific pages at the website. In addition to this, high-resolution images taken with a 15-minute scan cycle by the SEVIRI instrument will provide information to trace and track volcanic ash plumes over Europe and Africa by way of a volcanic aerosol indicator.

In the event of the detection of exceptionally high SO_2 concentrations, the location of the SO_2 peak value will be used to start backward and forward trajectories on the basis of meteorological data (wind, temperature, pressure, etc.). These trajectories will facilitate the interpretation of the satellite observations, provide an indication of the location of the source of the SO_2 and of the height of the plume, and can aid in the forecast of its motion.

Hazards to Aviation

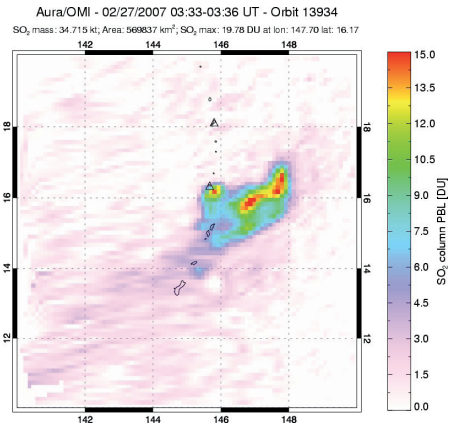
Volcanic eruptions can emit large quantities of rock fragments and fine particles (ash) into the atmosphere, as well as several gases, such as carbon monoxide (CO), SO_2, bromine monoxide (BrO), and water vapour. The rock fragments usually fall quickly back to Earth. However the ash and the gases can rise high up into the troposphere and even reach the lower stratosphere, up to 15 or even 20 km. The elevation reached by the material depends on the strength of the volcanic eruption, which in turn depends on the kind of volcano that erupts.

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, possibly causing the engines to fail.

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 of altitude. The ash emitted during the eruption of the Pinatubo volcano (1991) damaged aircraft as far as 1000 km away from the volcano.

Of the gases emitted during a volcano eruption, SO_2 is in and of itself a haz-

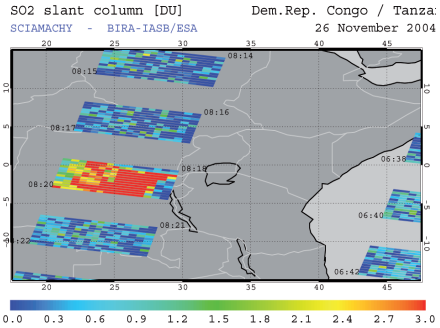
Ash cloud of the Grimsvötn Vulcano eruption on Iceland, November 2004
Source: Matthew Roberts, http://hraun.vedur.is



SO_2 concentrations near Antahan volcano (bottom triangle) on the Mariana Islands as derived from OMI observations on 27 February 2007.
Source: Simon Carn, University of Maryland/OMI

ard to aircraft, as it reacts with water vapour to form sulphuric acid (H_2SO_4), which is corrosive and can therefore scratch the paint and the windows of the aircraft and can create sulphate deposits in the engines. Depending on the kind of eruption, the SO_2 may be inside the ash cloud, but may also be above or below the ash cloud. In general, the ash falls faster than the SO_2 so that some distance away from the volcano the ash and SO_2 clouds may be separated.

Every year there are about 60 volcanic eruptions and, on average, the ash cloud of ten eruptions reaches flight level along major aircraft 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 of people being injured..



SO_2 slant column densities in Dobson Units over part of the Democratic Republic of Congo, as derived from SCIAMACHY observations on 26 November 2004. The SO_2 is related to an eruption of the Nyiragongo volcano, which started on November 22nd

Users of SACS

The Volcanic Ash Advisory Centres (VAACs) are the official organisations charged with gathering information on volcanic ash clouds and, on the basis of that, issuing advice and alerts to airline and air traffic control organisations on the possible danger of volcanic clouds.

The VAACs are part of an international system called the International Airways Volcano Watch (IAVW) and was set up in 1995 by the International Civil Aviation Organization (ICAO). VAAC responsibilities to aviation users include:
(i) Utilisation of satellite data, pilot reports, and other sources of information to detect and track ash clouds
(ii) Use of trajectory/dispersion models to forecast ash plumes.

The core users of SACS data 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 too small for validation of the Service, and other regions in the world may be of interest to future users.

More information on SACS can be found on the web at:
http://sacs.aeronomie.be