Satellite retrievals and transport modeling of
Volcanic eruption clouds

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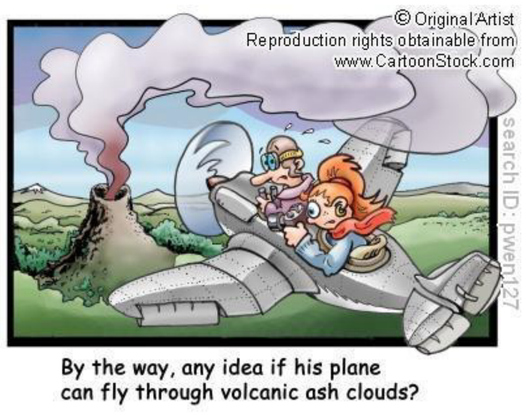
WHAT WE DO

We can retrieve important information about the volcanic eruption column, that is estimate **how much ash and gas is released by the volcanic eruption, and to which heights above the volcano.**

We do this by using satellite observations of the volcanic eruption clouds together with transport simulations of the emissions. The estimation is then performed using an analytical inversion algorithm (Seibert, 1999)

With this height and mass information we can **accurately simulate the transport of the volcanic emission cloud over several days after the eruption**.

These transport simulations can be used to forecast the movement of hazardous volcanic ash clouds, and warn the airline traffic of areas to avoid.



ACKNOWLEDGEMENT

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KASATOCHI ERUPTION 2008

Volcano location:
Aleutian Islands, Alaska

Three explosive eruptions:
- 07 August 2008 22:01 UTC
- 08 August 2008 01:50 UTC
- 08 August 2008 04:35 UTC

Emissions:
Sulphur dioxide: 1.2 - 2.5 Tg
Ash: 0.3 – 0.7 Tg

Emissions reached the stratosphere, top exceeding 15 km.

The ash travelled along with the SO_2 for about 3 days, thus SO_2 may also serve as a proxy for ash

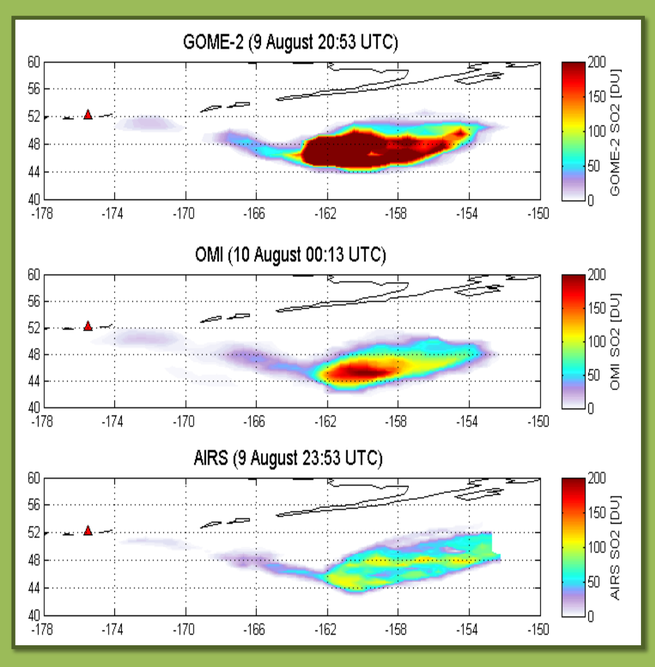

***Figure 1**: SO_2 columns retrieved from ultraviolet (UV) satellite measurements (GOME-2 and OMI) and from infrared (IR) measurements (AIRS). The measurements are from ~2 days after the eruption. The Kasatochi Volcano is marked by a red triangle. The SO_2 cloud was transported into a circular shape due to a low pressure system, and is seen here over the Pacific Ocean approaching the west coast of North America.*

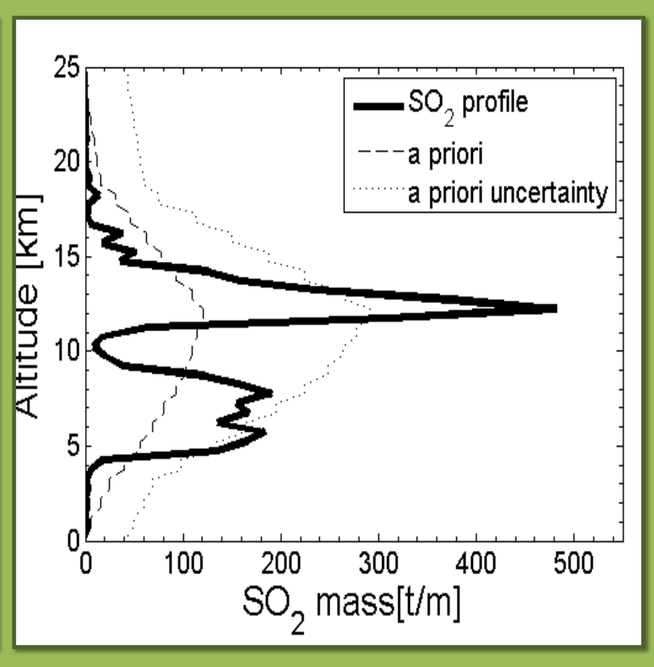

***Figure 2**: Vertical SO_2 profile for the eruption of Kasatochi estimated by an analytical inversion algorithm which is based on comparisons of satellite data (Fig 1) and data from the FLEXPART model. The eruption of Kasatochi resulted in one tropospheric emission peak, and one stratospheric emission peak (above the tropopause at ~10 km a.s.l.). The high altitude emissions were transported around the entire Northern Hemisphere.*

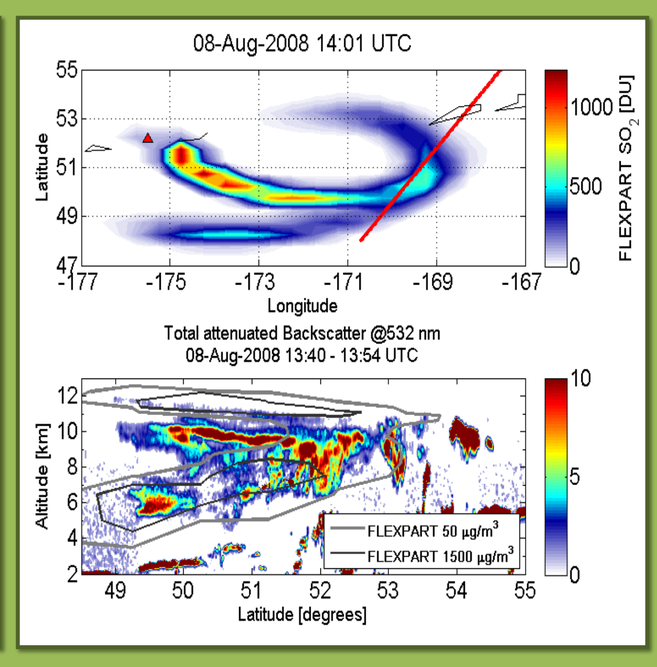

***Figure 3**: Comparison of CALIPSO attenuated backscatter with SO_2 concentrations simulated by FLEXPART on 8 August, 15 hours after the eruption. The upper panel shows total columns of SO_2 simulated by FLEXPART using the emission profile from Figure 2. The red line indicates the location of the CALIPSO nadir track. In the lower panel, the CALIPSO data are shown by the color shading and the FLEXPART results are plotted as isolines.*

EYJAFJALLAJÖKULL ERUPTION 2010 (Preliminary results)

Volcano location:
Iceland

Explosive eruption period:
14 April - 23 May 2010

Continuous emissions of volcanic ash, also some sulphur dioxide (SO_2)

The eruption plume caused closure of airspaces over large parts of Europe.

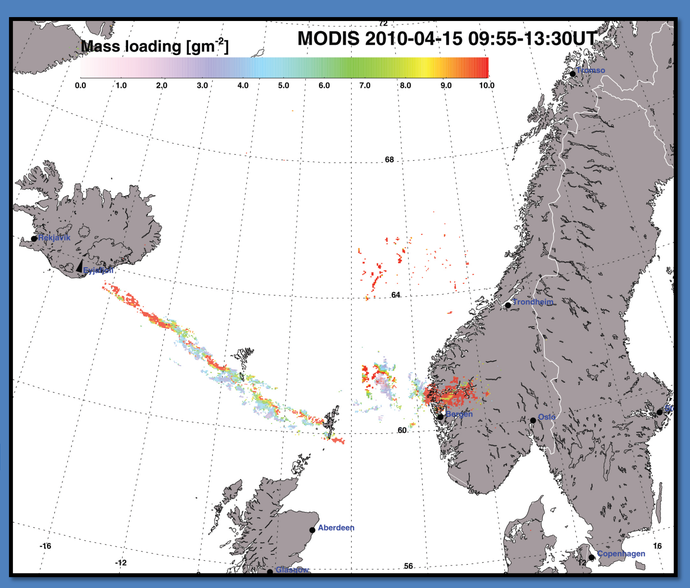

***Figure 4:** Observations of the volcanic ash emissions from Eyjafjallajökull with the MODIS satellite instrument. The figure is an aggregated plot of all 4 MODIS daytime passes on 15th of April 2010. The total mass was about 0.5 Tg (andesite ash).*

The Icelandic Meteorological Office and Institute of Earth Sciences, UoI, reported on the 14th of April that the ash loaded eruption plume rose to more than 8 km height and was deflected to the east by westerly winds.

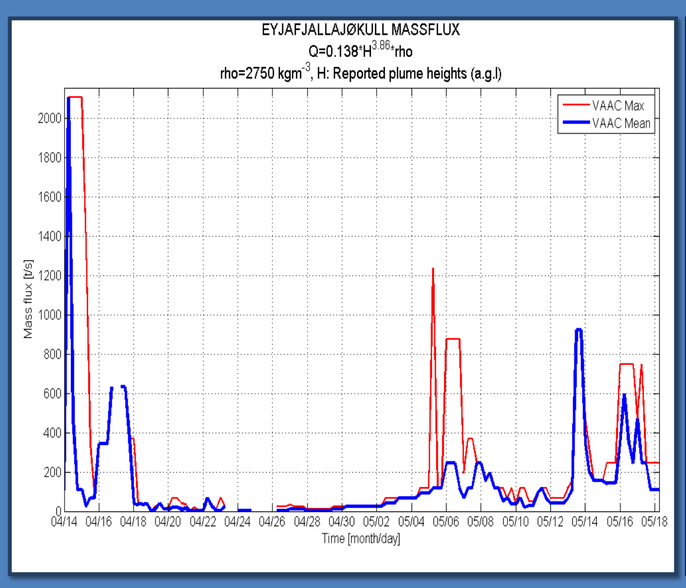

***Figure 5:** Time evolution of the eruption rate (tons pr second) for the Eyjafjallajökull eruption. The mass flux calculation is based on the reported plume height from London VAAC and using the best fit equation of Sparks et al. (1997, Eq. 5.1)*
These results are not retrieved by the inversion algorithm, but only extracted directly from the observations. The inversion method is currently being extended for volcanic ash.

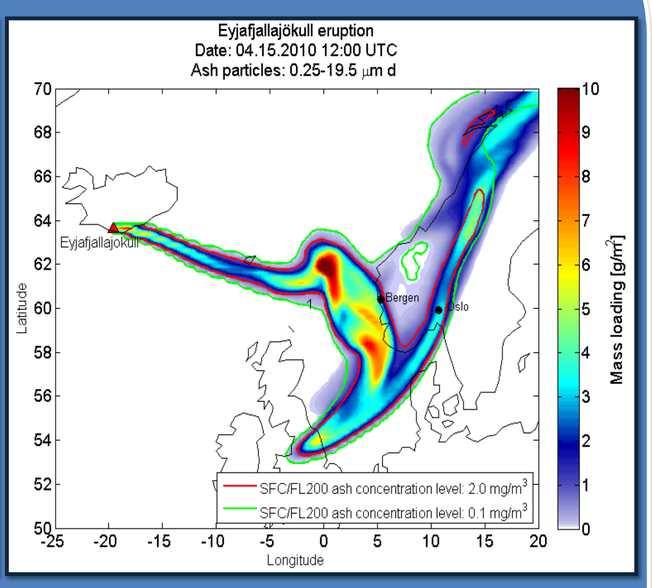

***Figure 6:** FLEXPART model simulation of the volcanic emissions from Eyjafjallajökull. The figure shows the situation about 1 day after the eruption onset (the same time as for Fig. 4 and Fig. 7). The simulation is using emissions according to the mean eruption rate (blue line) shown in Fig. 5, and with ash particles up to 19.5 micrometer diameter. The simulation accounts for turbulence, convection, diffusion, wet- and dry deposition, and is using ECMWF input data with 0.18 degree resolution.*

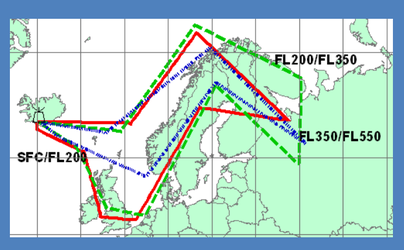

***Figure 7:** Volcanic Ash advisory Issued 20100415/1200Z by the London VAAC*

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