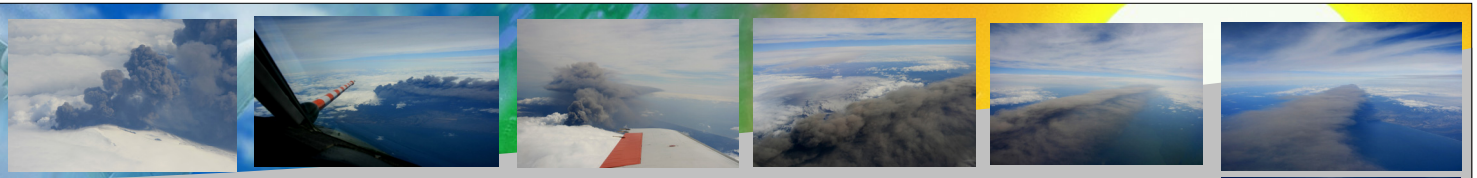
Deutsches Zentrum
für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft
Institut für Physik der Atmosphäre

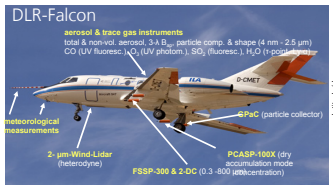


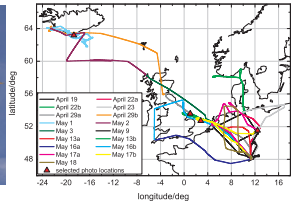
The volcanic ash plume near the Eyjafjallajökull on 1-2 May 2010

U. Schumann, R. Baumann, A. Minikin, O. Reitebuch, Th. Sailer, H. Schlager, Ch. Voigt, and B. Weinzierl

Measurements

Airborne measurements of the volcanic ash plume over Central Europe and close to Iceland's Eyjafjallajökull volcano in April/May 2010 provided an extensive data set on the volcanic ash plume properties. Here, we quantify the plume properties for the period of 1st and 2nd May, 2010, from the volcano in Iceland in more detail.



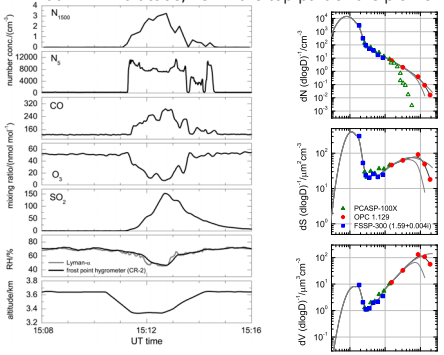


The results of the whole campaign are described in

Schumann, U., B. Weinzierl, O. Reitebuch, H. Schlager, A. Minikin, C. Forster, R. Baumann, T. Sailer, K. Graf, H. Mannstein, C. Voigt, S. Rahm, R. Simmet, M. Scheibe, M. Lichtenstern, P. Stock, H. Rüba, D. Schäuble, A. Tafferner, M. Rautenhaus, T. Gerz, H. Ziereis, M. Krautstrunk, C. Mallaun, J.-F. Gayet, K. Lieke, K. Kandler, M. Ebert, S. Weinbruch, A. Stohl, J. Gasteiger, S. Groß, V. Freudenthaler, M. Wiegner, A. Ansmann, M. Tesche, H. Olafsson, and K. Sturm, ***Airborne observations of the Eyjafjalla volcano ash cloud over Europe during air space closure in April and May 2010***, Atmos. Chem. Phys., 11, 2245–2279, 2011.

In-situ observations, 60°N, 15:00 UTC 2 May 2010

at 3.4 km altitude, i.e. in the top part of the plume



Top left: Time series of aerosol number concentrations N (>1.5 µm and >5 nm), trace gas mixing ratios of CO, O_3, and SO_2, relative humidity RH, and flight altitude versus time (h:min) on 2 May 2010.

Top right: Particle number N, surface S, and volume V per unit size interval and unit ambient volume versus particle diameter *D*.

Blue squares: PCASP data points.

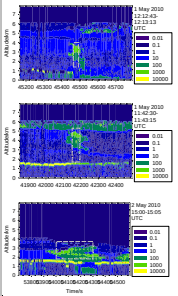
Green triangles: OPC data (open symbols: particle sizes affected by low inlet collection efficiency).

Red circles represent FSSP data.

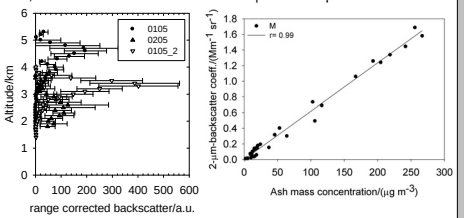
L, M, H analysis for refractive index 1.59 + (0.,0.004, 0.008) i.

Optical Depth at 2 µm derived from Lidar Data

Backscatter (arbitrary units)



computed 2-µm backscatter

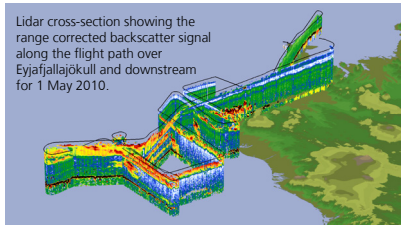


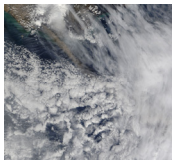
The "shadow technique": Estimation of the optical depth of a transparent ash layer from the observable signal loss – called shadow – of an opaque lower cloud (Ruppersberg and Renger, DLR Forschungsbericht 91-07, 1991).

date	distance	shadow signal loss factor	upper limit for OD	depth of plume	effective radius	mean mass concentration
01/05	200 km	0.1-0.05	1.15-1.5	1.6- 2 km	10 µm	9 – 16 mg/m³ (OD 1-1.5)
02/05	450 km	0.03-0.1	0.5-1.2	1.3 km	4 µm	<6 mg/m³ (OD=1)

Lidar observations and NASA-MODIS data

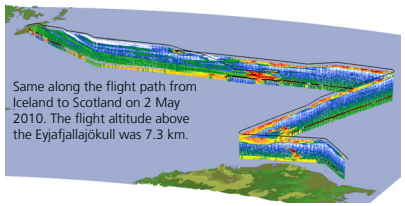
Lidar cross-section showing the range corrected backscatter signal along the flight path over Eyjafjallajökull and downstream for 1 May 2010.

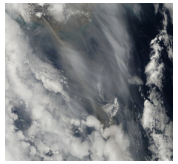




13:15 UTC 1 May 2010 (MODIS, NASA)

Same along the flight path from Iceland to Scotland on 2 May 2010. The flight altitude above the Eyjafjallajökull was 7.3 km.



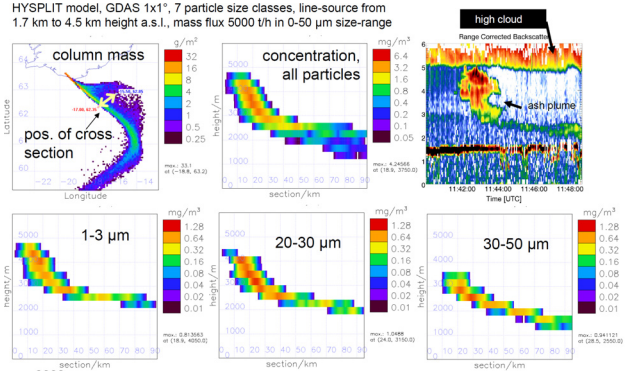


12:20 UTC 2 May 20101 (MODIS, NASA)

(http://rapidfire.sci.gsfc.nasa.gov/gallery/)

Ash plume dispersion 1 May, HYSPLIT and Lidar

HYSPLIT model, GDAS 1x1°, 7 particle size classes, line-source from 1.7 km to 4.5 km height a.s.l., mass flux 5000 t/h in 0-50 µm size-range



for HYSPLIT see: Draxler, R. R., and Hess, G. D.: An overview of the HYSPLIT-4 modeling system of trajectories, dispersion, and deposition, Aust. Meteor. Mag., 47, 295-308, 1998.

Summary

The measurements provide a test case for volcanic ash plume modeling

	Unit	May 1, 11:49 UTC	May 2, 15:12 UTC
Position	degree	62.5°N, 16.5°W	60.17°N, 15.17°W
Distance from Volcano	km	200	450
Plume age, top	h	3-4	7-12
Plume width	km	30-35	61 (56-65)
Plume upper height	km	4.5-4.9	3.8
Plume lower height	km	2.2	1.6
Mean depth	km	1.7 (1.6-2)	1.3 (1.3-2)
Wind speed	m s^{-1}	14	11 (11-14)
Plume top temperature	°C	-20	-7 (-4 - -8)
maximum particle size (diameter)	µm	<50	<30
Plume mean mass concentration	mg/m³	<16	0.5 (0.3–0.8)*)
Maximum SO_2 mixing ratio	10^{-9}		150
Ash optical depth (2 µm)	1	<1.5	<1.2
Volume flux	km³/s	0.8±0.4	1±0.5
Mass flux	kg/s	<16000	500 (240–1600)
SO_2 flux	kg/s		300 (100-1200)

*) in-situ result at 3.4 km altitude

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