

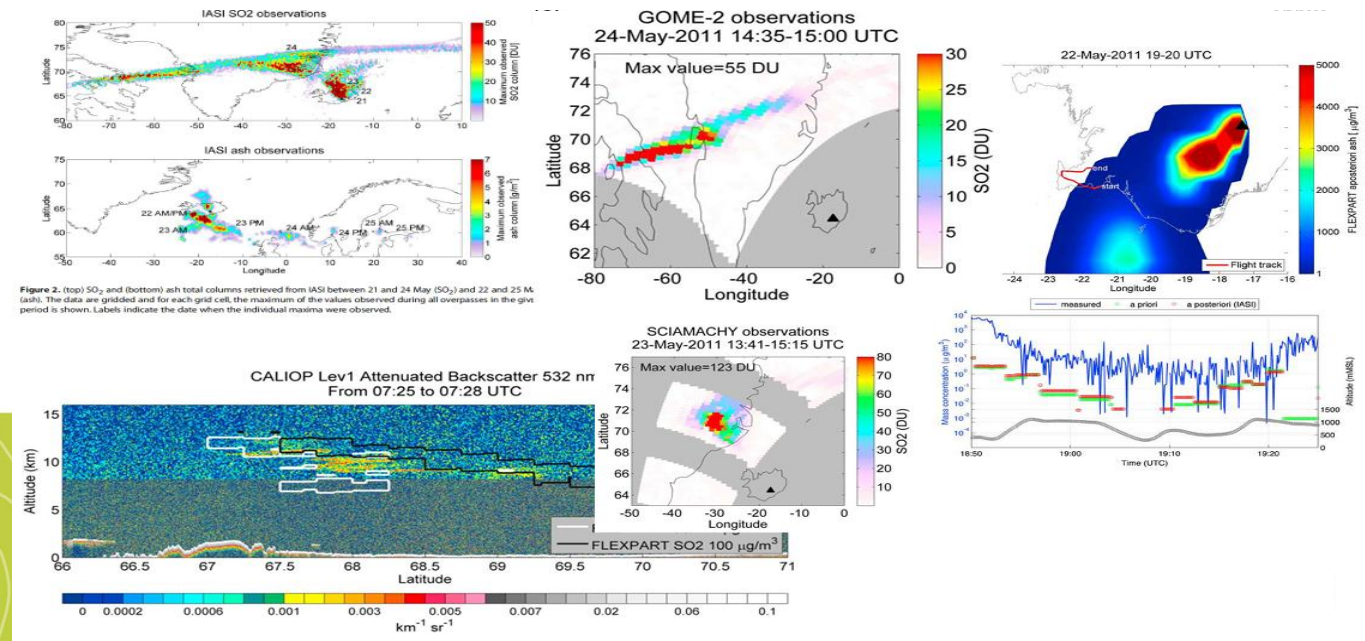
FLEXPART for volcanic applications

CBRN Incident Modeling

Marie Danielle Mulder (Mariëlle)

marie.mulder@geosphere.at [till 30.9.2026]

24. September 2026



Introduction

- Why simulate volcanic plumes?
- VAACS
- Literature

Methods of projects at GeoSphere Austria

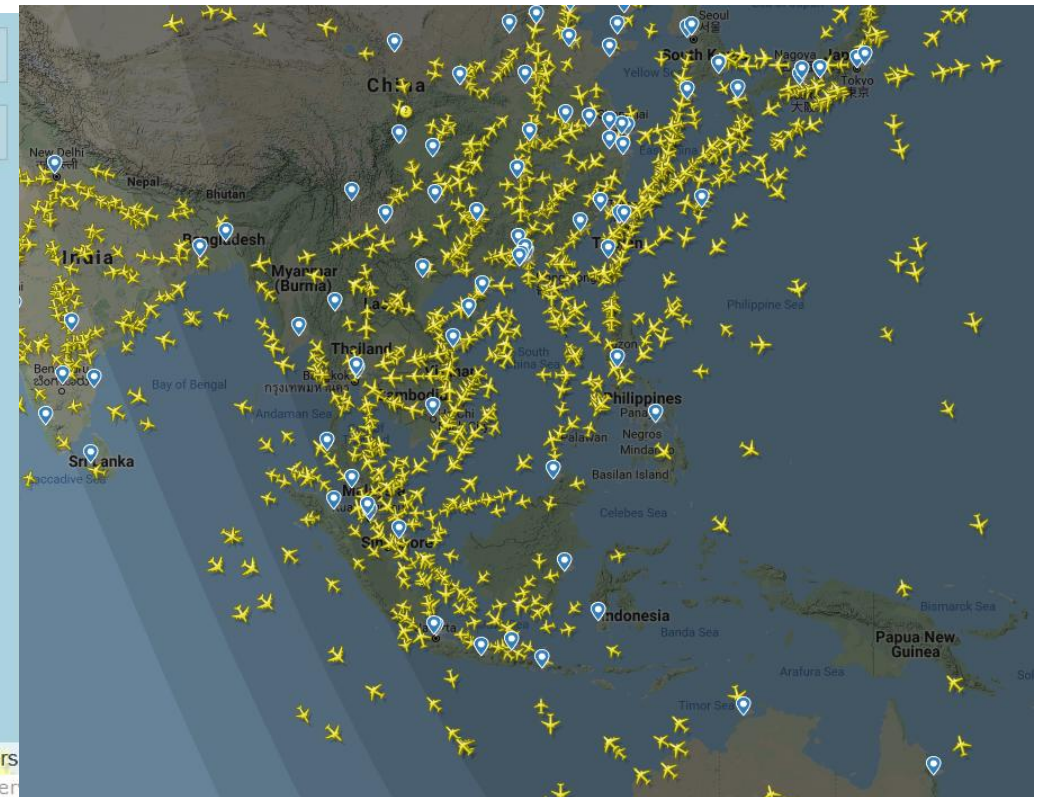
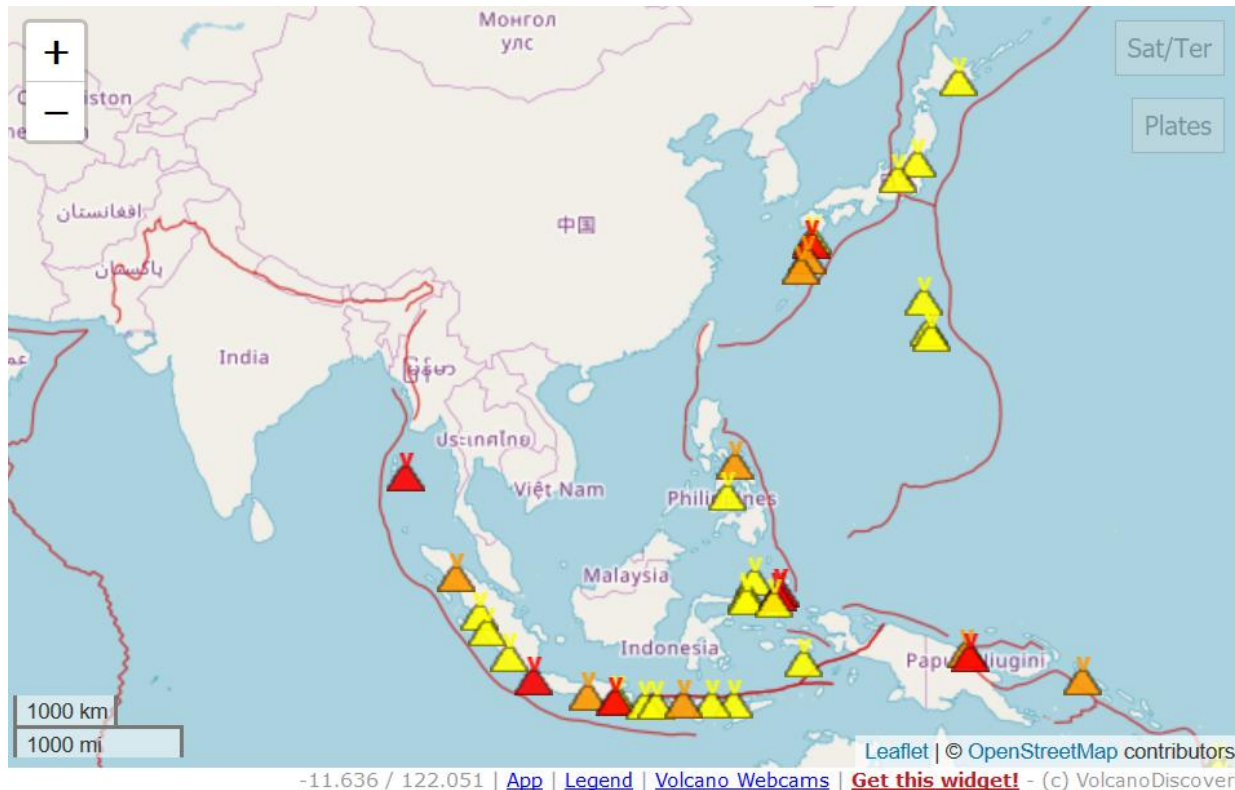
- VAST
- EUNADICS

Exercises

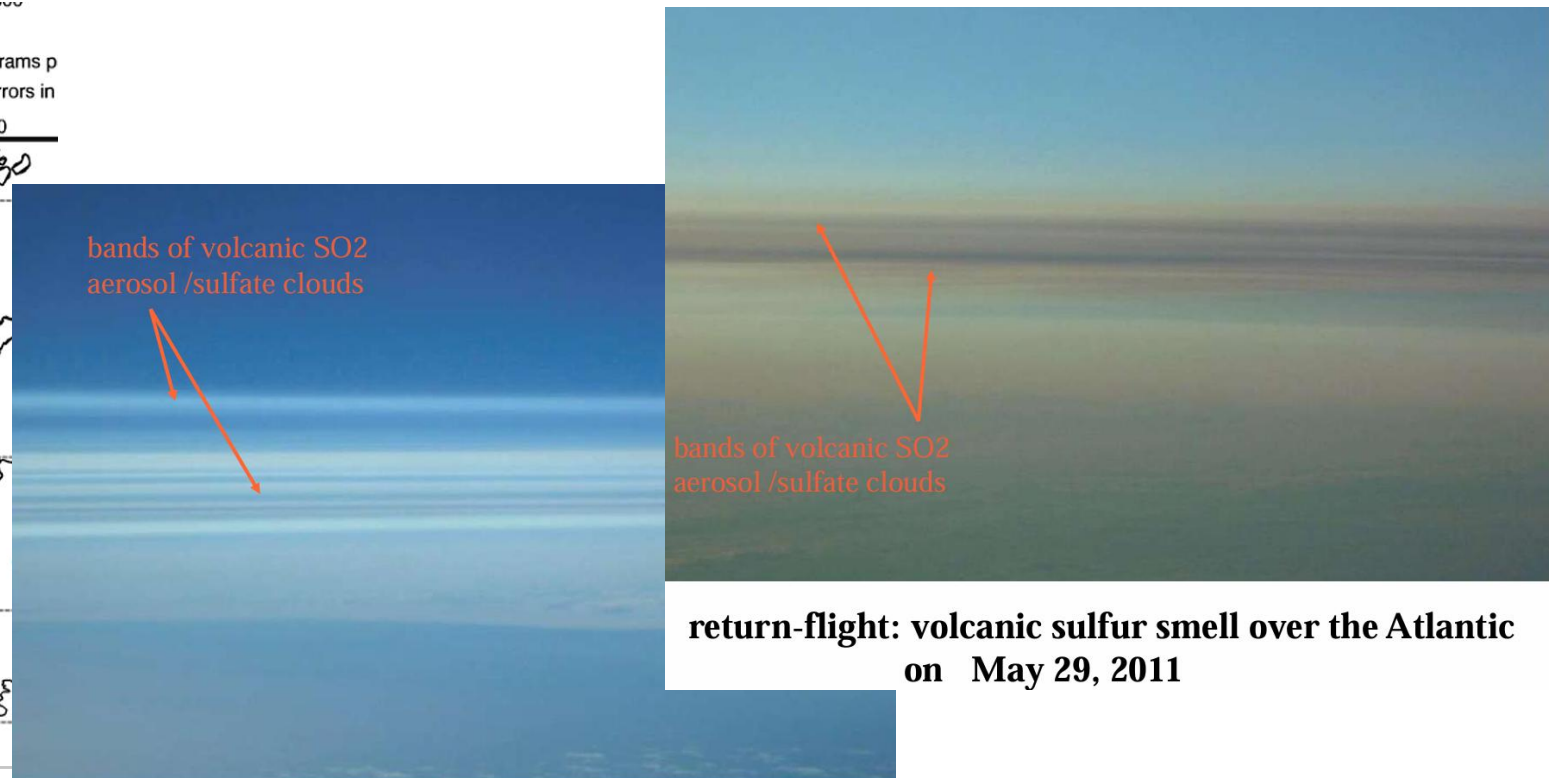
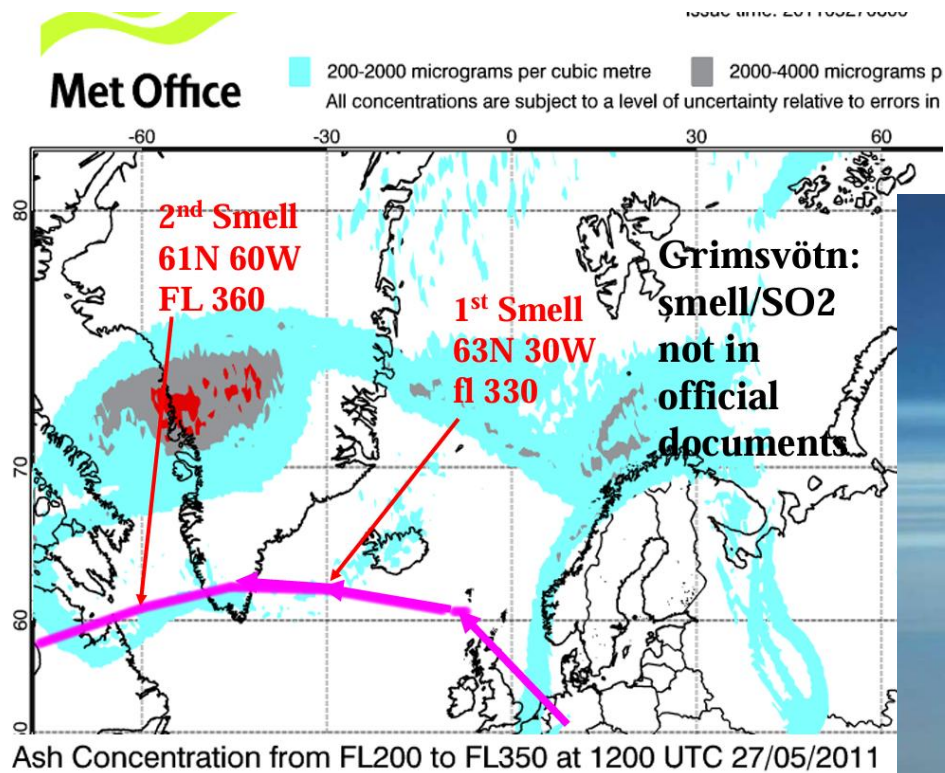
- Simply with a simply RELEASES file
- With a generated RELEASES file
- Make a *a priori* ST file

Introduction: are they important?

Flightradar information 12.12.2018 at 20:30 Local Time



- EUROCONTROL in charge of air traffic management, European Aviation Crisis Coordination Cell (EACCC)
- National aviation authorities in charge of Air Traffic Control ATC - air space closure
- Airlines decide on flight scheduling
- Pilots are in charge of the safety of their particular flight



flying westbound

May 27, 2011

Images from Claus Sievers

The Grimsvotn eruption in 2011: Separation of ash and SO₂



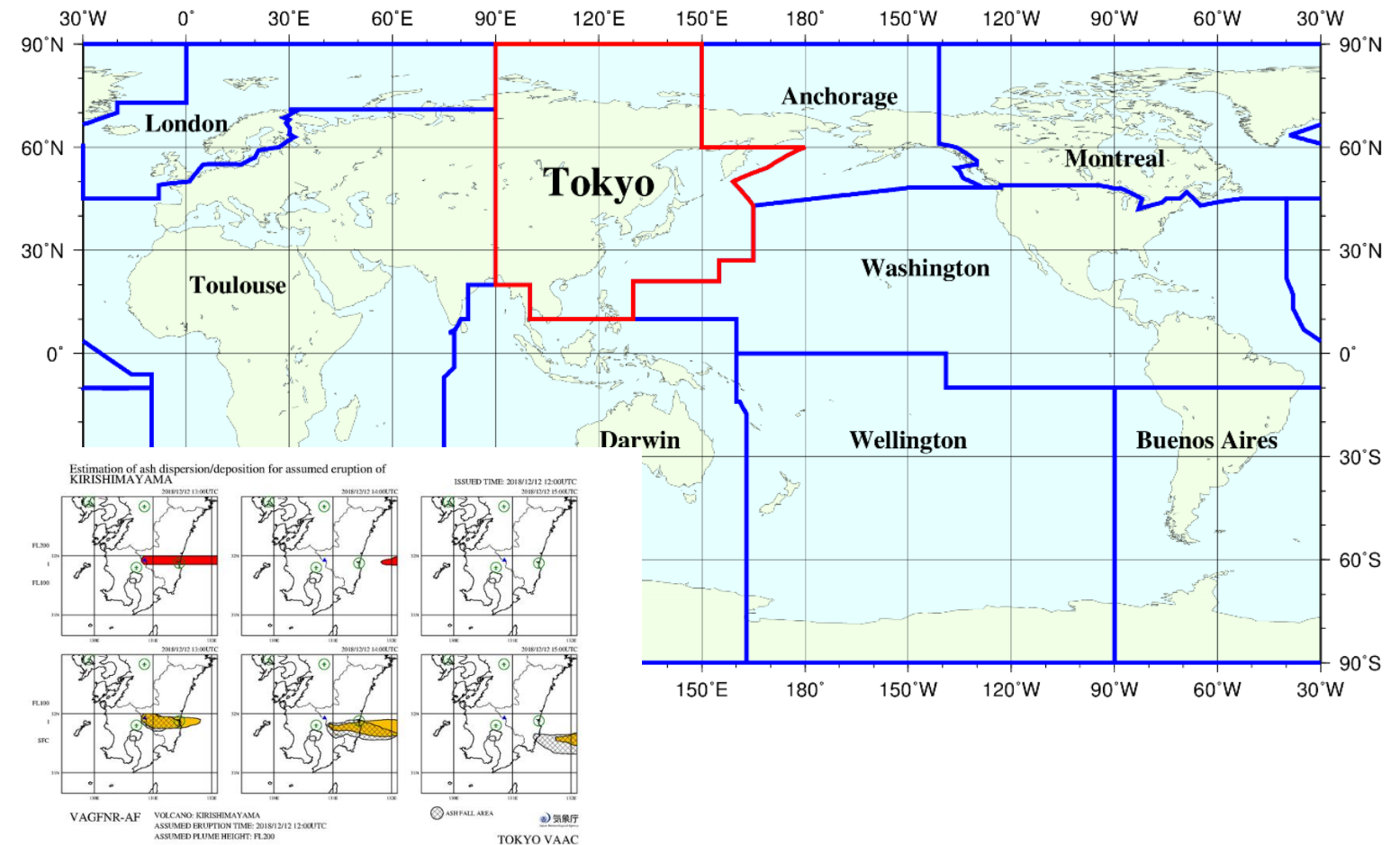
<http://icelandinpictures.com/post/5729133963/grimsvotn-eruption-pictures>



<https://www.wired.com/2011/05/more-information-on-the-may-21-eruption-of-grimsvotn-in-iceland/>

VAACS were established in 1995 to gather information regarding volcanic ash clouds and to assess the possible hazard to aviation set up by the International Civil Aviation Organization (ICAO), an agency of the United Nations

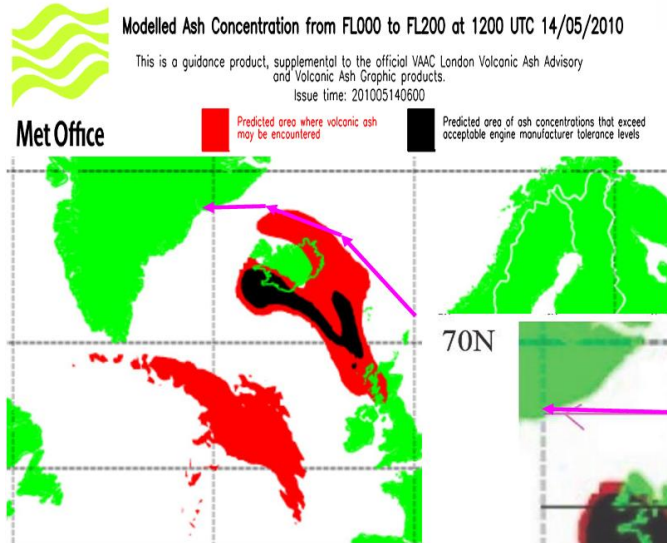
VOLCANIC ASH ADVISORY CENTERS – AREAS OF RESPONSIBILITY



Where were you in 2010?

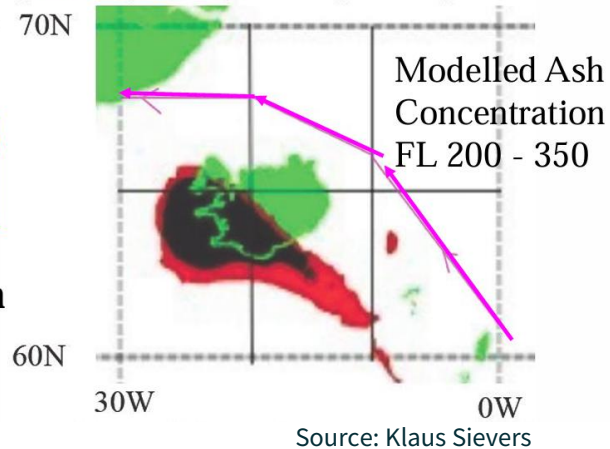


Due to the eruption of the Eyjafjallajökull in 2010, **100 000 flights** were cancelled in total.



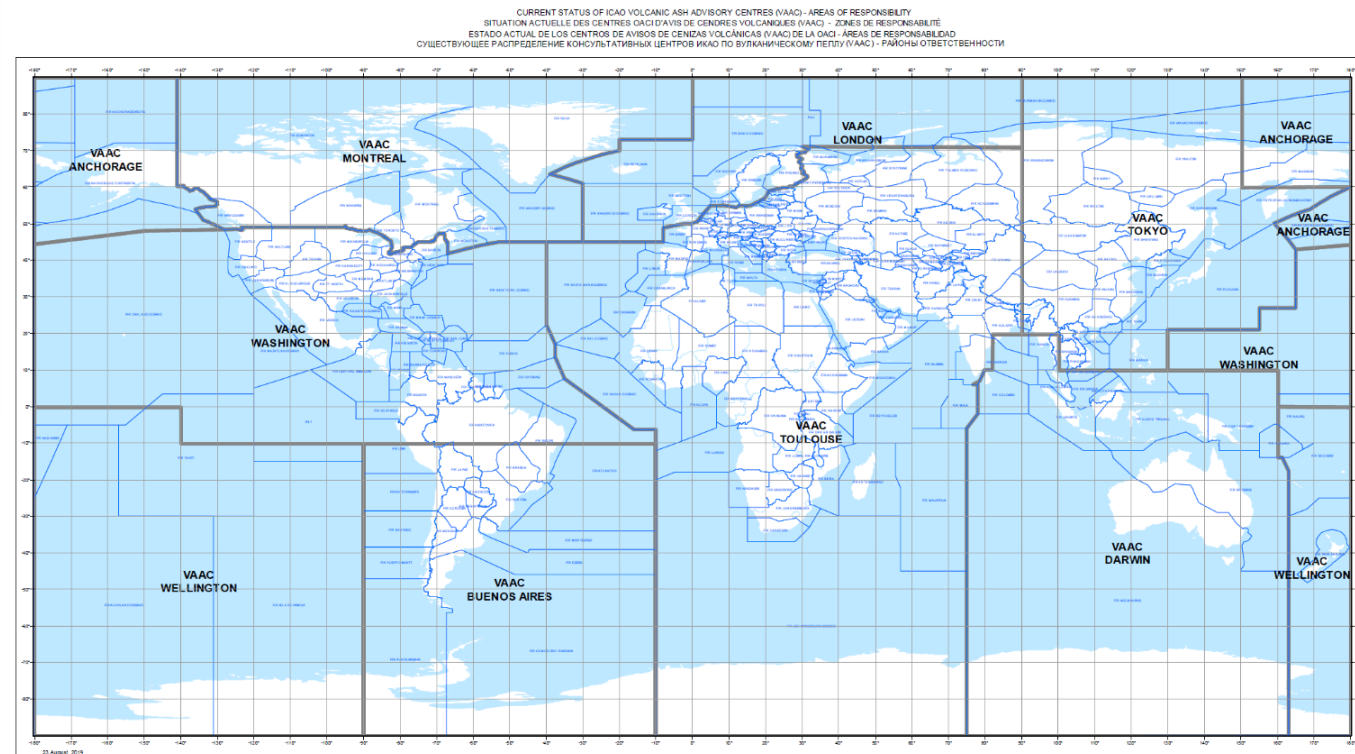
**Flying at 31.000 ft,
fl 310, no problems
with ash were
expected.**

**Safe circumnavigation
of VA-cloud from
Eyafjallajökul**



Austrian airlines wanted to start flying again and contacted ZAMG (since 2023 GeoSphere Austria) to make calculations.

2012-2015 ESA VAST project (ZAMG, NILU, FMI +2)
2016-2019 H2020 EUNADICS-AV



Set up by the International Civil Aviation Organization (ICAO),
an agency of the United Nations

Atmos. Chem. Phys., 8, 3881–3897, 2008
www.atmos-chem-phys.net/8/3881/2008/
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the Creative Commons Attribution 3.0 License.



Estimation of the vertical profile of sulfur dioxide in the atmosphere by a volcanic eruption using satellite cloud measurements and inverse transport modeling

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 117, D00U11, doi:10.1029/2011JD016844, 2012

Performance assessment of a volcanic mini-ensemble used for inverse modeling of the Eyjafjallajökull eruption

N. I. Kristiansen,
S. Henne,
P. Seibert,

Received 8 September 2011

[1] The reanalysis of the 2010 Icelandic eruption in the European context on the basis of a study presented with satellite data from different



Journal of Geophysical Research

Improving the accuracy of volcanic ash dispersion modeling

W. Degruyter

Received 29 May 2012

[1] We introduce a new method for fast assessment and bent-over plume modeling while first order relationships are confirmed to demonstrate the influence of wind on the

Eyjafjallajökull eruptions. The influence of wind on the

Atmos. Chem. Phys., 12, 9399–9415, 2012
www.atmos-chem-phys.net/12/9399/2012/
doi:10.5194/acp-12-9399-2012
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Profiling of fine and coarse particle mass: case studies of dust and Eyjafjallajökull/Grímsvötn volcanic plumes

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²Department of Applied Environmental Science, Stockholm University, Stockholm, Sweden

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Received: 7 May 2012 – Published in Atmos. Chem. Phys. Discuss.: 30 May 2012

Revised: 20 September 2012 – Accepted: 25 September 2012 – Published: 17 October 2012

Abstract A data insertion method, where a dispersion model is initialized from ash properties derived from a series of satellite observations, is used to model the 8 May 2010 Eyjafjallajökull volcanic ash cloud which extended from Iceland to northern Spain. We also briefly discuss the application of this method to the April 2010 phase of the Eyjafjallajökull eruption and the May 2011 Grímsvötn eruption. An advantage

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 115, D00L16, doi:10.1029/2009JD013286, 2010



Geophysical Research Letters

RESEARCH LETTER

10.1002/2014GL062307

Key Points:

- Combining satellite observations and modeling
- Volcanic constraints
- Estimate concentration
- Comment



Journal of Geophysical Research: Atmospheres

RESEARCH ARTICLE

10.1002/2013JD021129

Key Points:

- Ash and SO₂ source terms estimated using inverse techniques and satellite data
- The transport and separation of ash and SO₂ are modeled
- Model simulations correspond well with a range of independent observations

Supporting Information:

- Readme
- Text S1
- Text S2

Correspondence to:

K. L. Kristiansen,
nik@nilu.no
^aSch
^bCOMET, UK

HIGHLIGHTS

- The atmospheric transport of the 2011 Grímsvötn ash cloud is simulated using NAME.
- A data insertion update scheme is implemented with different configurations.
- Simulations compare well against height, mass load and concentration observations.
- Skill scores are similar to a simpler data insertion scheme.

ARTICLE INFO

Article history:
Received 9 February 2016
Received in revised form
10 May 2016

Stratospheric volcanic ash emissions from the 13 February 2014 Kelut eruption

N. I. Kristiansen¹, A. J. Prata^{1,2}, A. Stohl¹, and S. A. Carn^{3,4}



Separation of ash and sulfur dioxide during the 2011 Grímsvötn eruption

E. D. Moxnes¹, N. I. Kristiansen¹, A. Stohl¹, L. Clarisse², A. Durant^{1,3}, K. Weber⁴, and A. Vogel⁴

¹Norwegian Institute for Air Research, Kjeller, Norway, ²Spectroscopie de l'Atmosphère, Service de Chimie Quantique et Photophysique, Université Libre de Bruxelles, Brussels, Belgium, ³Geological and Mining Engineering and Sciences, Michigan Technological University, Houghton, Michigan, USA, ⁴Environmental Measurement Techniques, University of Applied Sciences, Düsseldorf, Germany

Abstract Modeling the transport of volcanic ash and gases released during volcanic eruptions is crucially dependent on knowledge of the source term of the eruption, that is, the source strength as a function of altitude and time. For the first time, an inversion method is used to estimate the source terms of both volcanic sulfur dioxide (SO₂) and ash. It was applied to the explosive volcanic eruption of Grímsvötn, Iceland, in May 2011. The method uses input from the particle dispersion model, FLEXPART (flexible particle dispersion model), a priori source estimates, and satellite observations of SO₂ or ash total columns from Infrared Atmospheric Sounding Interferometer to separately obtain the source terms for volcanic SO₂ and fine ash.

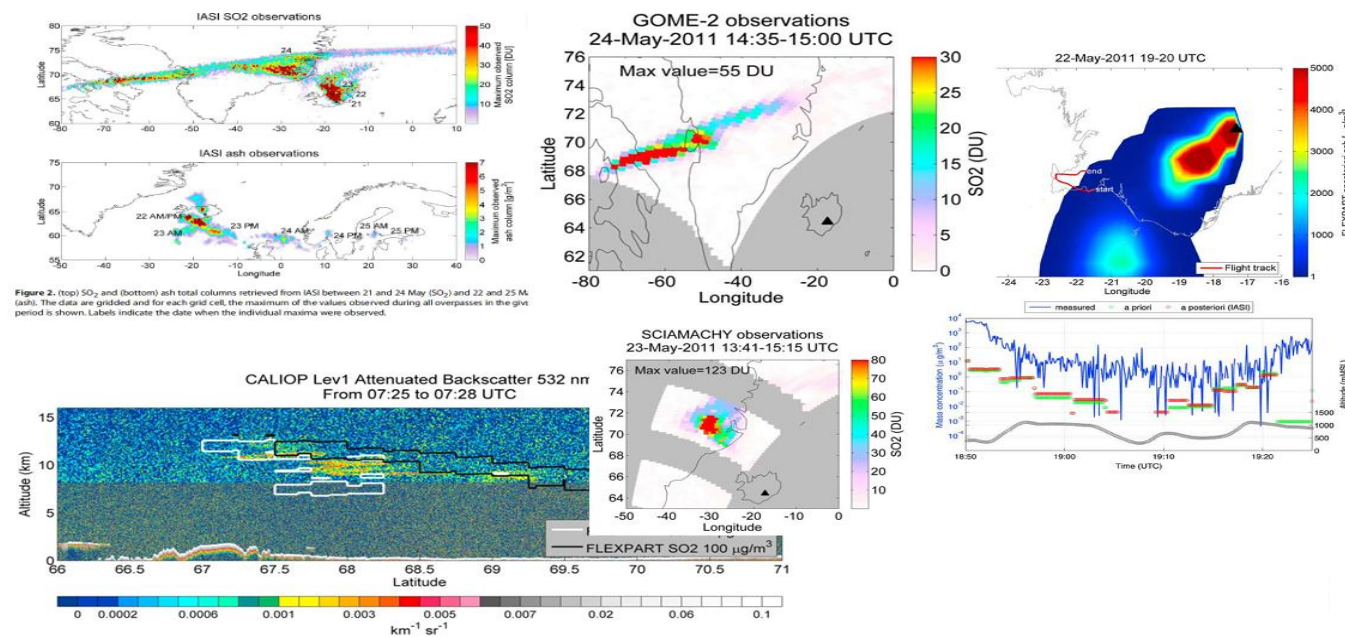
ABSTRACT

Effective modelling of atmospheric volcanic ash dispersion is important to ensure aircraft safety, and has been the subject of much study since the Eyjafjallajökull ash crisis in Europe in 2010. In this paper, a novel modelling method is presented, where the atmospheric transport of the 2011 Grímsvötn ash cloud

EUNADICS-AV: develop and test system to provide consistent and coherent information to aviation authorities, airlines and pilots in the event of a natural disaster affecting the airspace.

21 partners plus EIG EUMETNET as linked third party

12 different countries plus ECMWF and EUMETNET as international entities

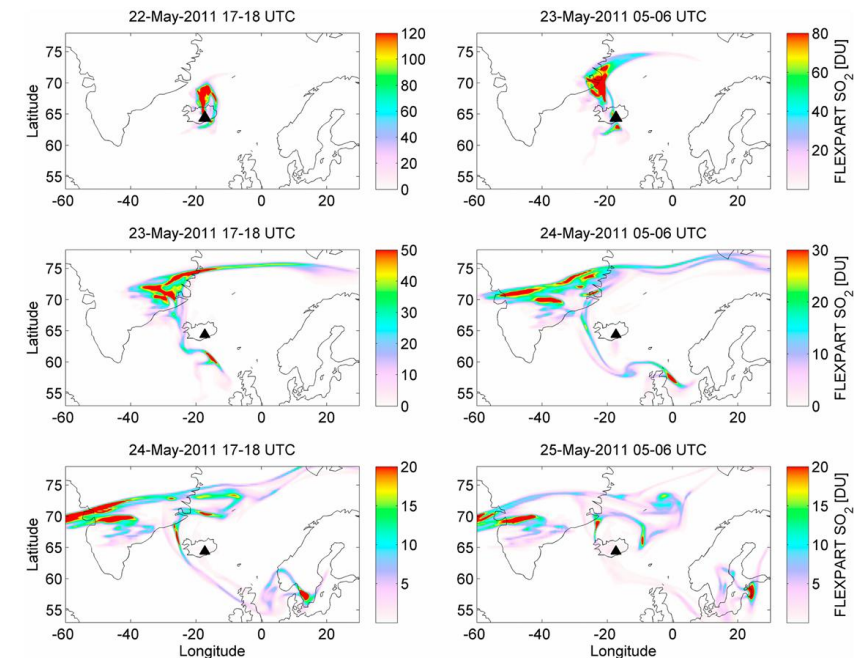
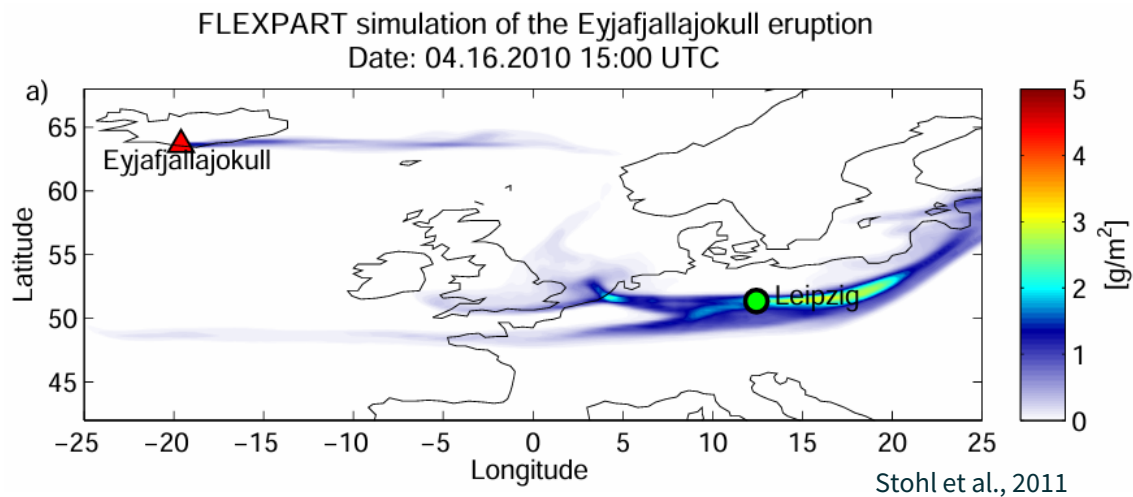


Grimsvötn remote sensing and flight data - can we use it in operational analyses

Why use FLEXPART for (semi)operational volcanic ash and SO₂ simulations?

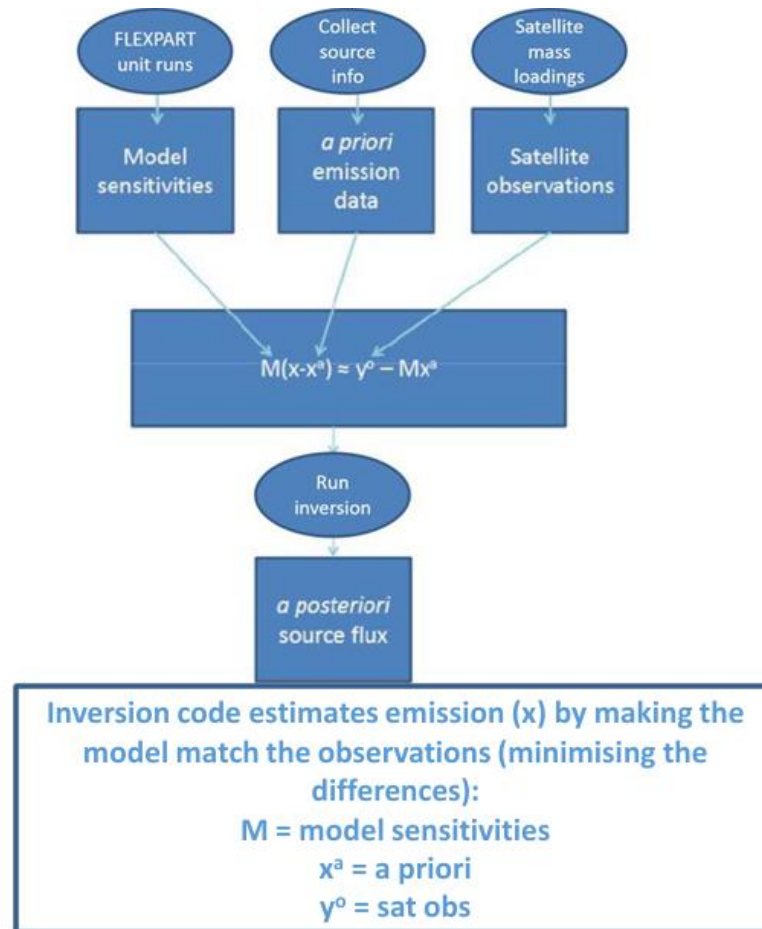
Fast • Parallelisation (v10 MPI; v11 OpenMP) • Extensively tested (see literature) • Global developers community • Suitable for operational usage • And many more

Limitations: • No ash aggregation -> underestimation • Only linear chemistry possible with climatological values; preprocessed from Eulerian model.



Moxnes et al., 2014

Routines developed during 'Volcanic Ash Strategic Initiative Team' (ESA project 2015-2018)



ZAMG Vulkanasche Berechnung

1. Userangaben 2. Vulkansuche 3. Ausbruchdaten 4. Zusammenfassung 5. Bestätigung

Vulkannamen	Grimsvötn					
Längengrad	-17.333°					
Breitengrad	64.417°					
Gipfelhöhe	1,725m					
Flugflächen	FL050, FL100, FL150, FL200, FL250, FL300, FL350, FL400, FL450, FL500, FL550, FL600, FL650					
Ergebnisbilder		Breitengrad	Längengrad	Auflösung	Projektion	
	☐ Ganze Welt	-90°	90°	-180°	180°	15° Zylindrisch
	☒ Europa	25°	70°	-25°	45°	5° Lambert
	☐ Lokal	40°	85°	-50°	20°	5° Lambert
	☐ Individuell	40	85	-50	20	5° Zylindrisch
Anzahl der Flexpart Levels	50					
Meter pro Flexpart Level	500					
Simulation-Anfang	21 . 05 . 2011 12					
	Format: TT.MM.JJJJ HH					
	Runde ab zu den letzten 3 Stunden, UTC					
Simulation-Ende	25 . 05 . 2011 00					
	Format: TT.MM.JJJJ HH					
	Runde auf zu den nächsten 3 Stunden, UTC					
Feinasche-Anteil	5%					
Flexpart-Version	ECMWF 0.2 Europa					
Ausbruchsform	☐ Linear ☒ Pilzwolke ☐ Gauss Verteilung					
Species	☒ Feinasche ☐ SO ₂ ☐ EUNADICS TRACER					
Ensemble	☐ Ja ☒ Nein					
Cluster	☐ Ja ☒ Nein					
Farbskala	☒ VAST+ACG ☐ VAST ☒ ACG					

Adapted from: Kristiansen, N. I., Arnold, D., Stohl, A, VAST Technical Report: Procedures for volcano inversions using FLEXPART

A PRIORI source term

What do we know?

- Location
- Plume height

What can we do:

- Mastin et al., 2009 formula:
 - 34 eruptions
 - Best-fit line (bold solid line) with mass eruption rate $\dot{M}$ (kg/s) converted to volumetric flow rate V (m^3 DRE* per second): $H = 2.00 \dot{V}^{0.241}$
- Or PLUMERIA or other plume models
- Estimate particle size distribution

*Erupted volume V (dense-rock equivalent or DRE)

Mastin, L.G. et al., A multidisciplinary effort to assign realistic source parameters to models of volcanic ash-cloud transport and dispersion during eruptions, Journal of Volcanology and Geothermal Research (2009), doi:10.1016/j.jvolgeores.2009.01.008

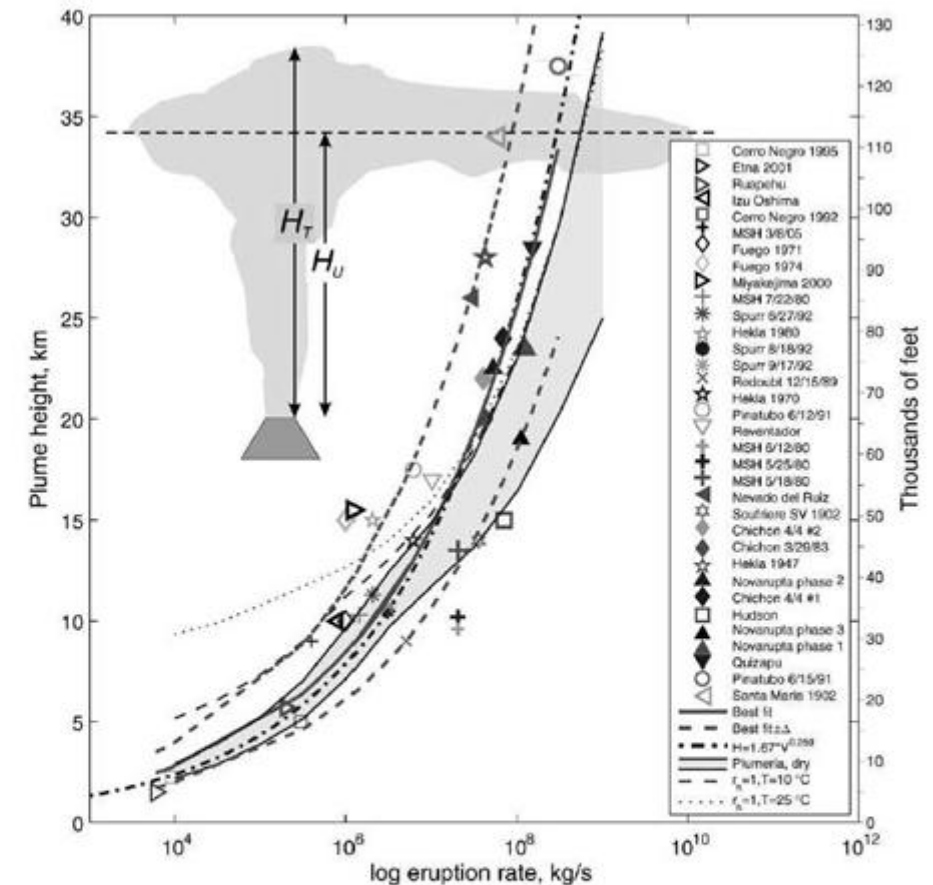
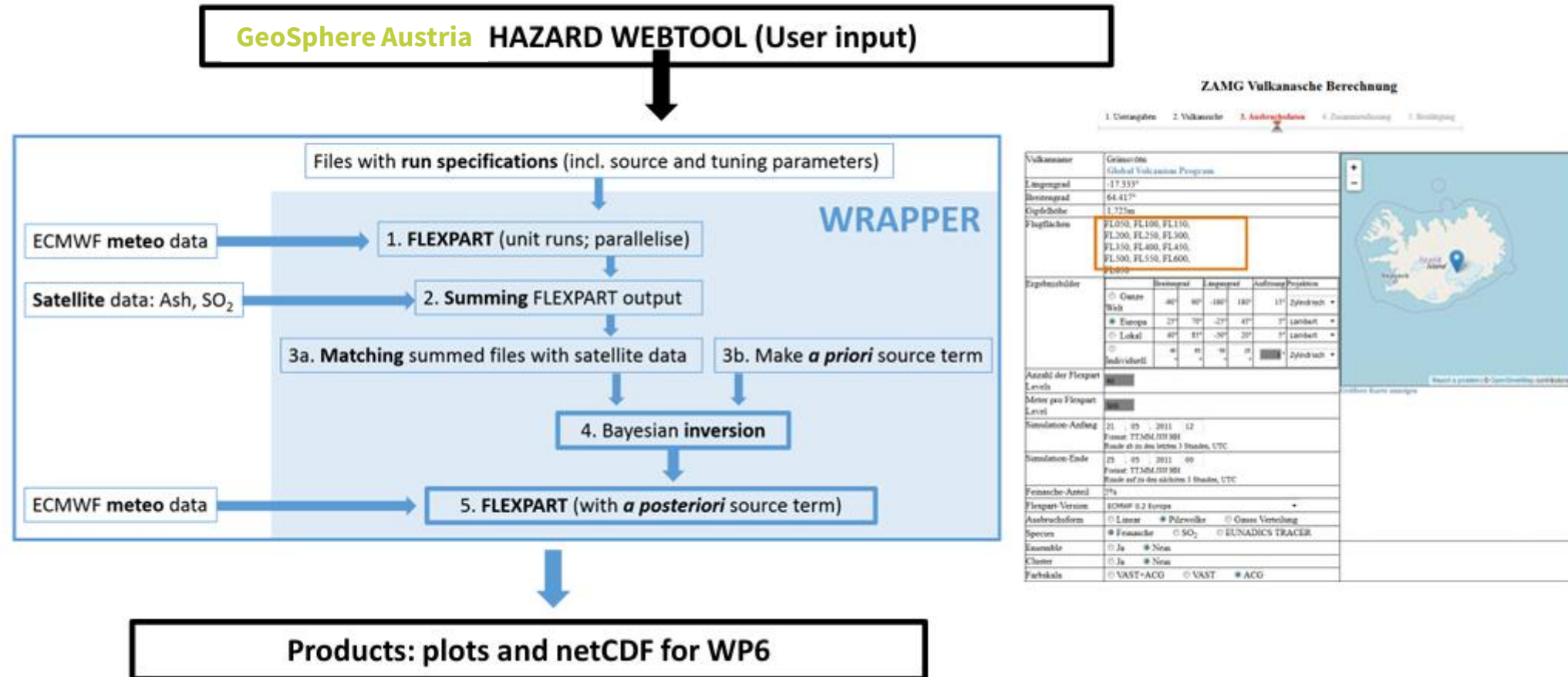
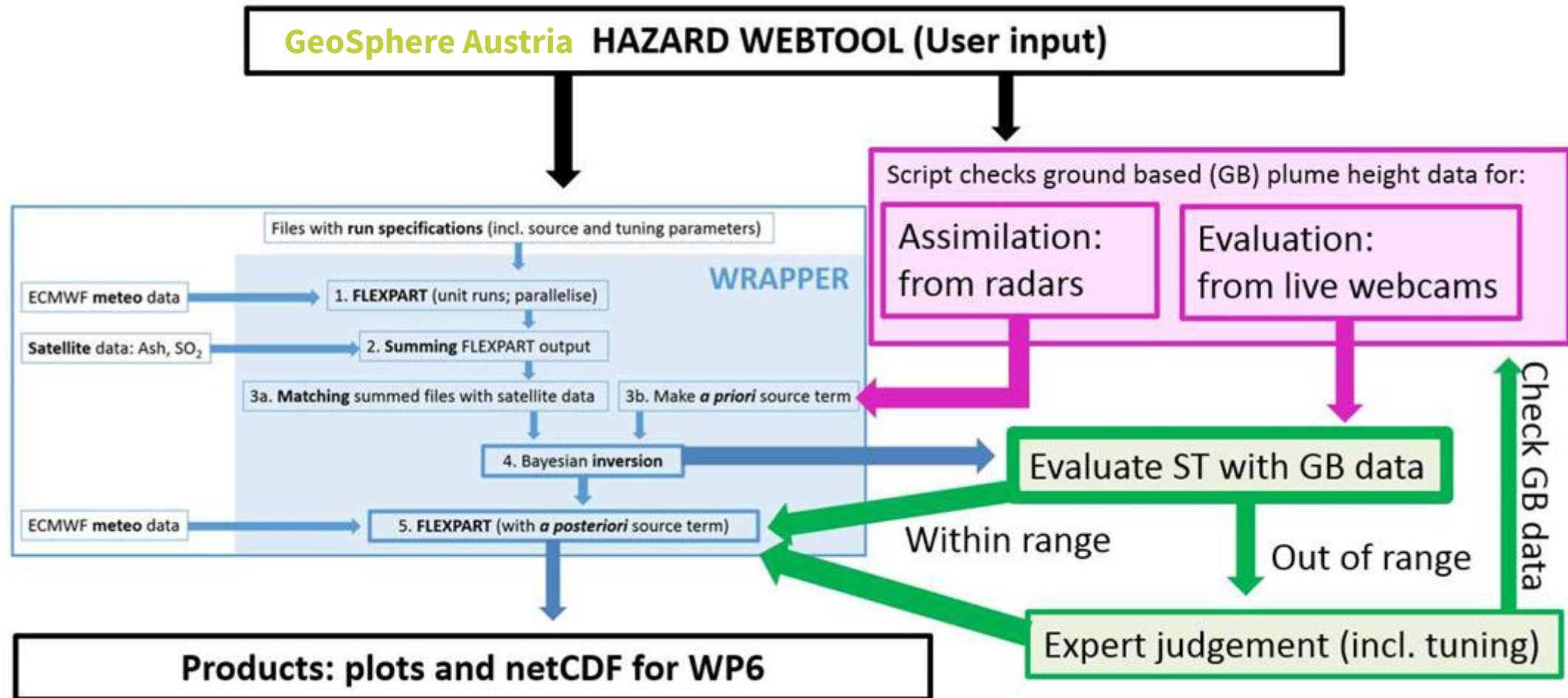


Fig. 1. Plume height above the vent versus mass eruption rate for eruptions listed in Table 1. Symbols for each eruption are given in the legend. The bold solid line is the best fit to the data (Eq. (1)). The bold dashed lines enclose the error envelope ($\pm \Delta$) calculated by the routine polyval in Matlab® (use of trade names does not constitute products). The error envelope corresponds to a 50% confidence interval, meaning that future observations have at least a 50% probability of falling within the dashed line is the empirical fit obtained by Sparks et al. (1997, Eq. 5.1). The upper light solid line is a theoretical curve of H_T calculated using the 1-D steady-state model (Mastin, 2007) using a magma temperature of 900 °C, 3 wt% gas, and a standard dry atmosphere (United States Committee on Extension to the Standard Atmosphere). The lower light solid curve is the elevation of neutral buoyancy, assumed to approximate H_U , calculated from the same model runs. The region between these two dashed light curves represents predictions of H_T by Plumeria using properties of a Standard atmosphere but with 100% relative humidity (r_h) and a temperature at ground level of 25 °C. The light dotted curve is a similar prediction using a relative humidity of 100% and a temperature at ground level of 25 °C. Symbols in the legend at the highest eruption rate. The Abbreviation "MSH" is Mount St. Helens, "Soufrière SV" is Soufrière de St. Vincent. The figure inset illustrates the difference between the plume (H_T) and the height of the umbrella cloud (H_U). The height H plotted includes both H_T and H_U depending on the method of estimation. Isopleth-based solid symbols give umbrella-cloud height H_U whereas all other methods are thought to give H_T .





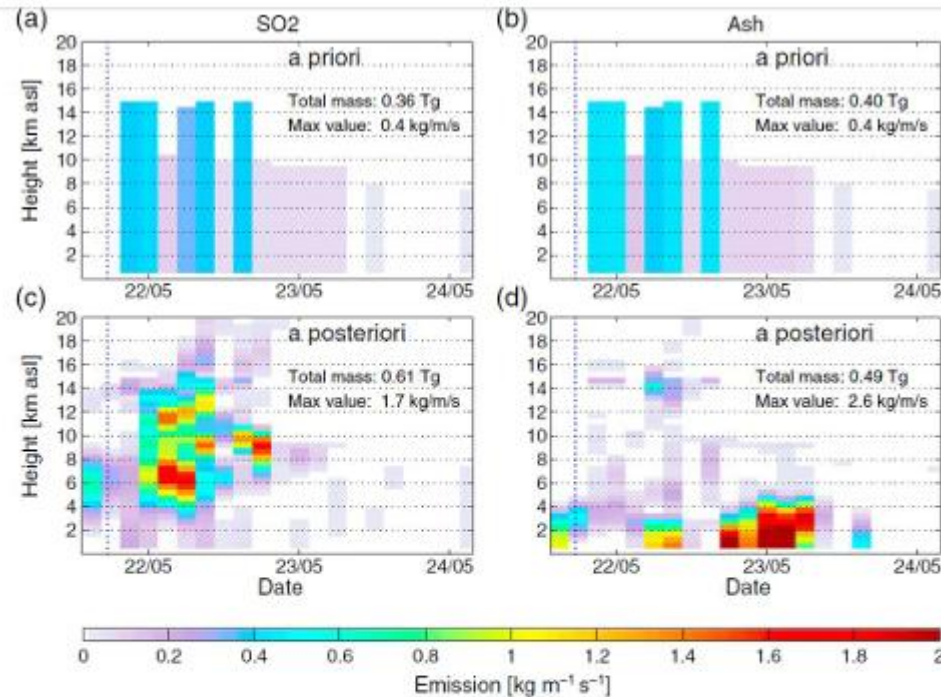
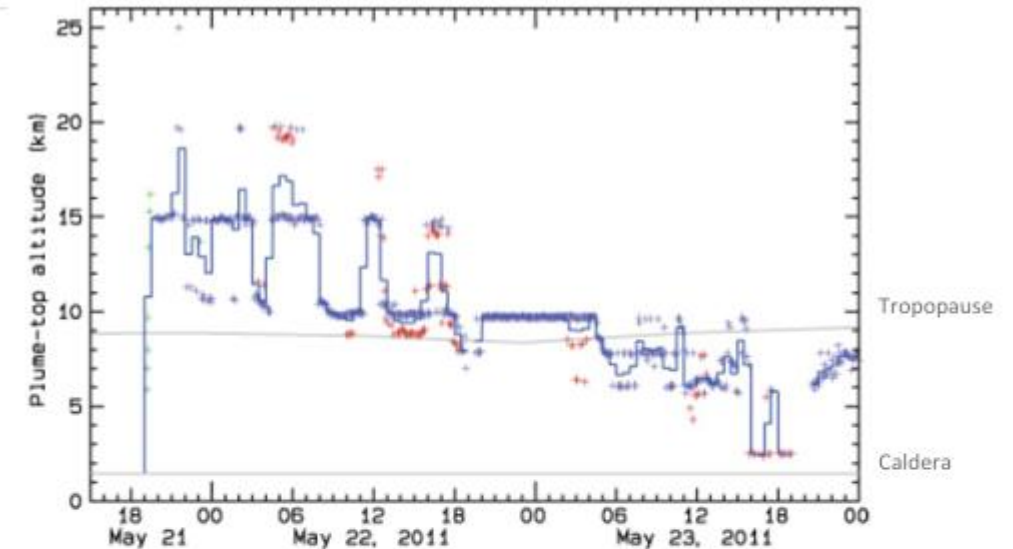


Figure 3. SO₂ and ash source terms for the 2011 Grimsvötn eruption showing the time, altitude, and strength of the emissions. (a, b) The *a priori* source term used as input to the inversion for SO₂ and ash. (c, d) The *a posteriori* source term estimated by the inversion method constrained by SO₂ and ash total columns retrieved from IASI data. The dashed blue vertical line represent the start time of the eruption as reported by IMO (21 May 2011 17:30 UTC).



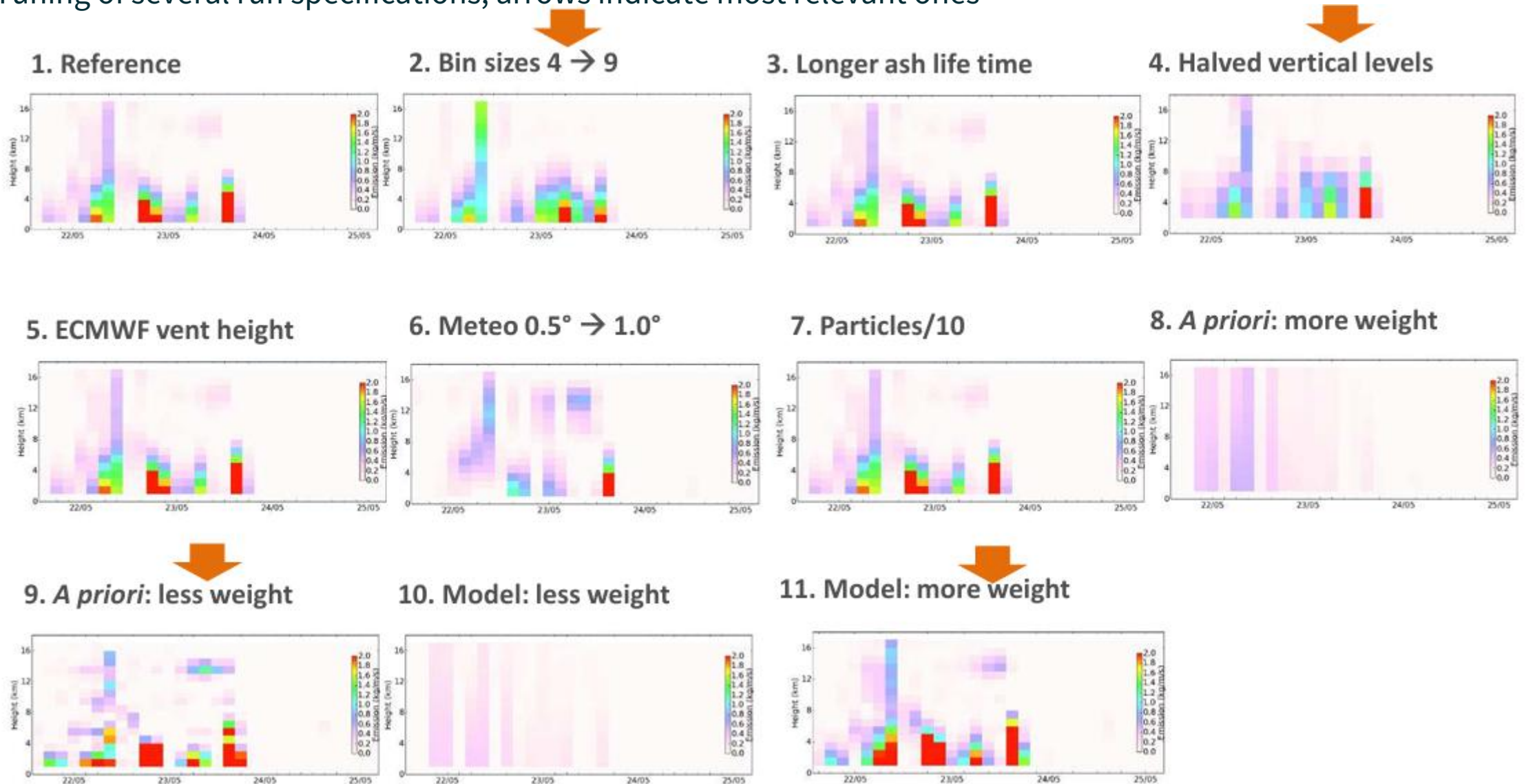
Time series of the 5-min detected plume-top altitude (km a.s.l.) from the:

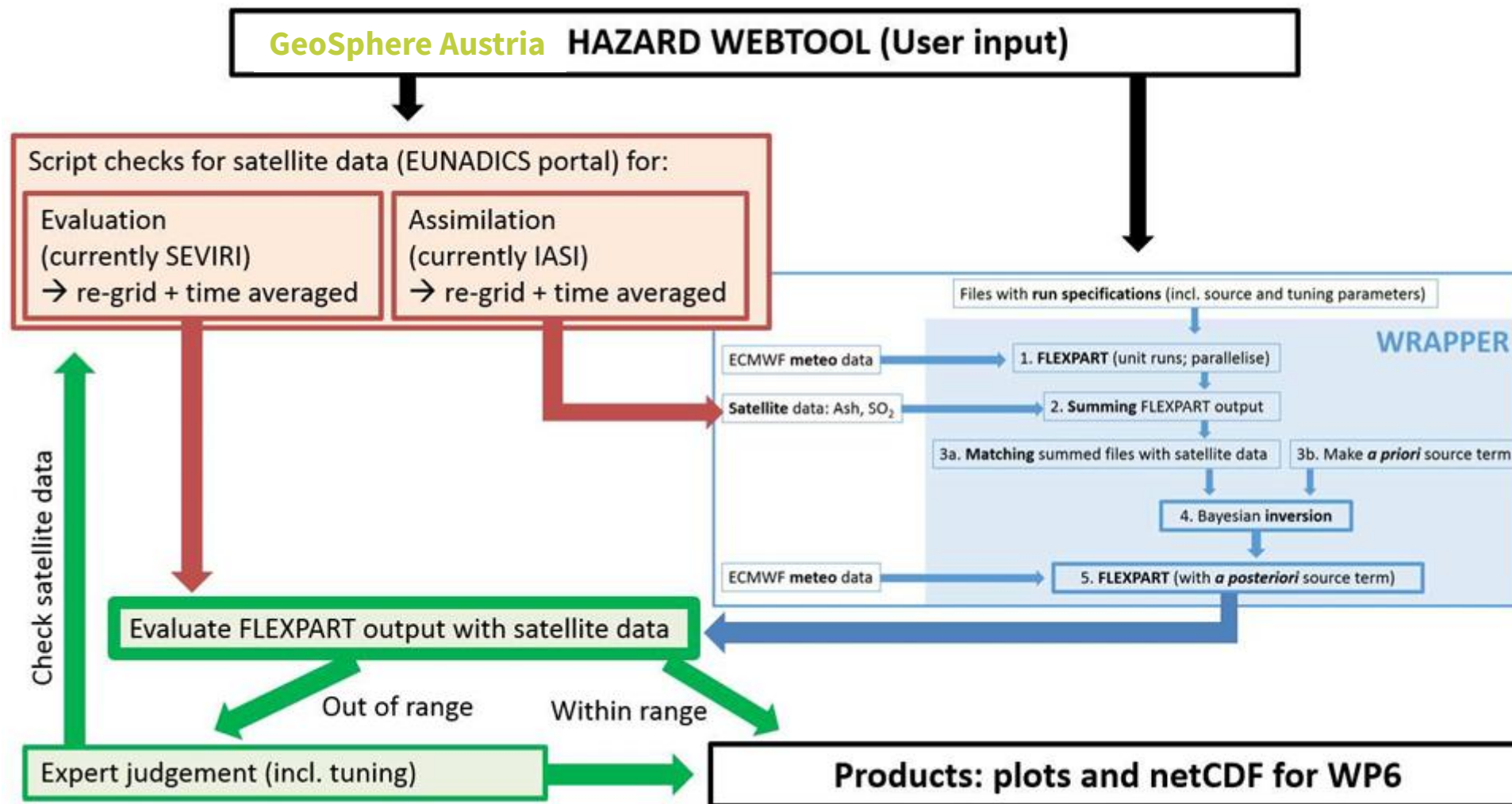
- C-band weather radar → go into *a priori* ST
- X-band mobile radar → for evaluation
- initial rise of the plume estimated from photographs
- 30-min average plume-top altitude of all the estimates is shown by the curve.

Moxnes, E. D., N. I. Kristiansen, A. Stohl, L. Clarisse, A. Durant, K. Weber, and A. Vogel (2014), Separation of ash and sulfur dioxide during the 2011 Grimsvötn eruption, *J. Geophys. Res. Atmos.*, 119, 7477–7501.

Petersen, G. N., H. Björnsson, P. Arason, and S. von Löwis (2012a), Two weather radar time series of the altitude of the volcanic plume during the May 2011 eruption of Grimsvötn, Iceland, *Earth Syst. Sci. Data*, 4(1), 121–127

Tuning of several run specifications; arrows indicate most relevant ones





Any questions?

Then let's move on to the exercises ...

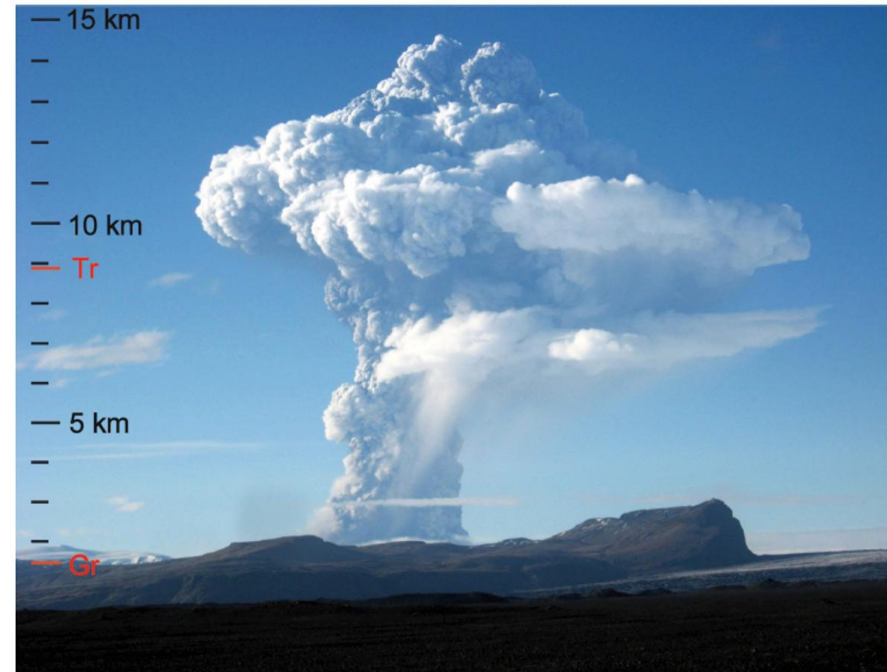
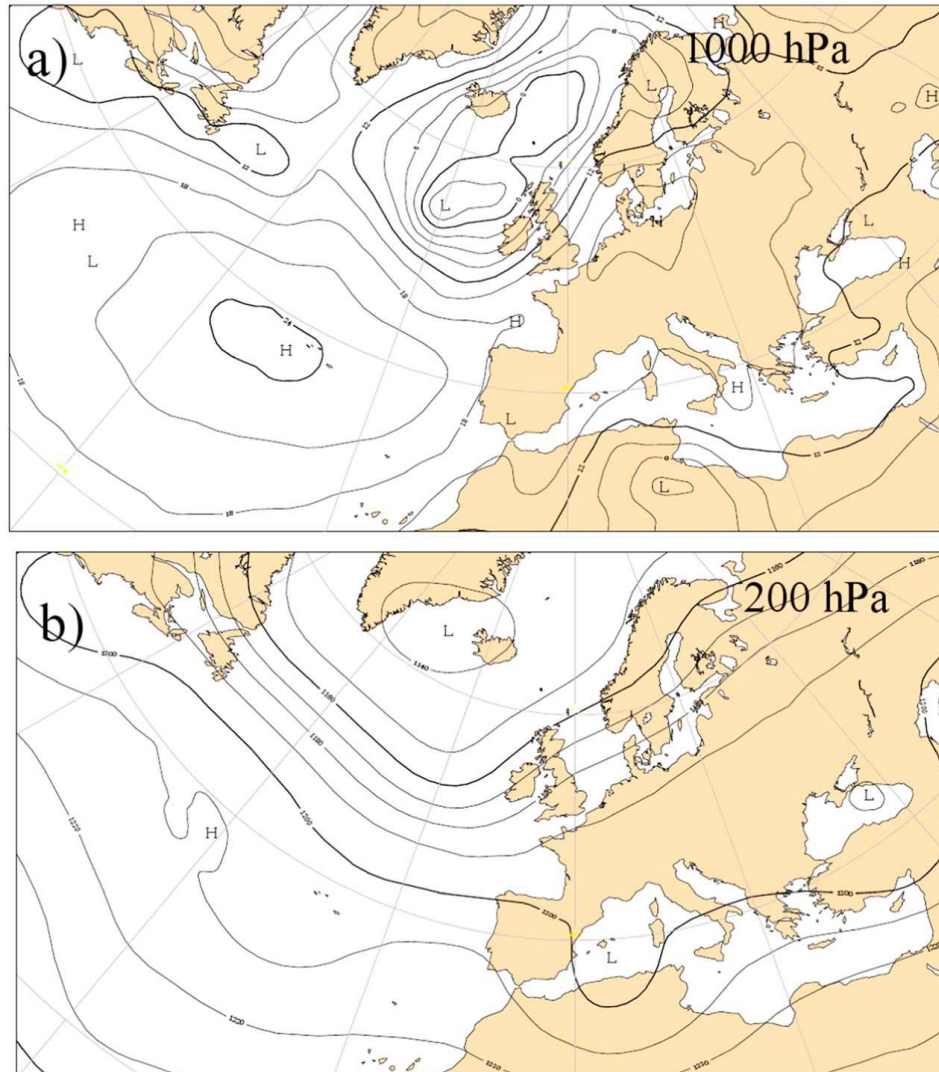


Figure 4. The initial Grímsvötn eruption plume seen from Skeiðarársandur, 50 km south of the volcano. Approximate altitude scale at the distance of Grímsvötn (Gr) on the left, and the tropopause (Tr) at this time was at about 8.9 km. Photo Bolli Valgarðsson, 21 May 2011 at 19:20 UTC.

Figure 1 is a map of the North Atlantic region showing SO₂ DU (Dose Units) data. The main map displays a color-coded distribution of SO₂ DU, with a color bar on the right indicating values from 0 to 80 DU. A red star marks the maximum value of 123 DU, located at approximately 71°N, 30°W. The map includes latitude and longitude axes, with latitude ranging from 64 to 76 and longitude from -50 to -20. An inset map in the bottom right corner shows a broader view of the region, with a black triangle indicating the location of the ship. The inset map's axes range from 64.6 to 65.0 latitude and 64.6 to 65.0 longitude.

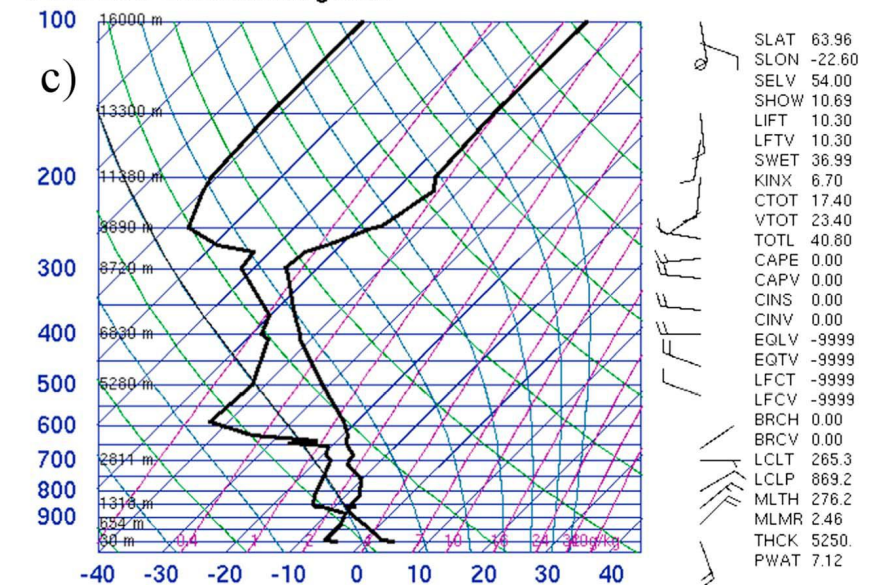
A map showing the FLEXPART ash concentration field on 15 April 2010. The map covers the North Atlantic region, with Latitude on the y-axis (ranging from 63 to 65) and Longitude on the x-axis (ranging from -25 to -16). A color scale on the right indicates ash concentration in $\mu\text{g}/\text{m}^3$, ranging from 1 (dark blue) to 5000 (dark red). A red line labeled 'Flight track' shows the path of the aircraft, starting near (22, 63.8) and ending near (17.5, 64.4). The highest ash concentrations (red/orange) are located in the northeast, near the flight track's end point.

21 May 2011, 12 UTC



Large vertical wind shear in the atmosphere, also seen in the Skew-T, Log-p thermodynamic chart, located 250 km west of Grímsvötn volcano.

04018 BIKF Keflavikurflugvöllur



12Z 21 May 2011

University of Wyoming

Figure 1. ECMWF geopotential analysis for 21 May 12 UTC at (a) 1000 hPa and (b) 200 hPa; data taken from <http://www.ecmwf.int>. (c) Skew-T, Log-p chart at Keflavik radiosonde station located 250 km WSW of Grímsvötn Volcano, at 12 UTC on 21 May 2011 (data from University of Wyoming, <http://weather.uwyo.edu/upperair/sounding.html>).

What do we know?

- Location
- Plume height

What can we do:

- Mastin et al., 2009 formula
 - Based on 34 eruptions
 - Best-fit line (bold solid line) with mass eruption rate $\dot{M}$ (kg/s) converted to volumetric flow rate $\dot{V}$ (m³ DRE* per second) vs. plume height:
$$H = 2.00 \dot{V}^{0.241}$$

-Or PLUMERIA or other plume models

-Estimate of size distribution

*Erupted volume V (dense-rock equivalent or DRE)

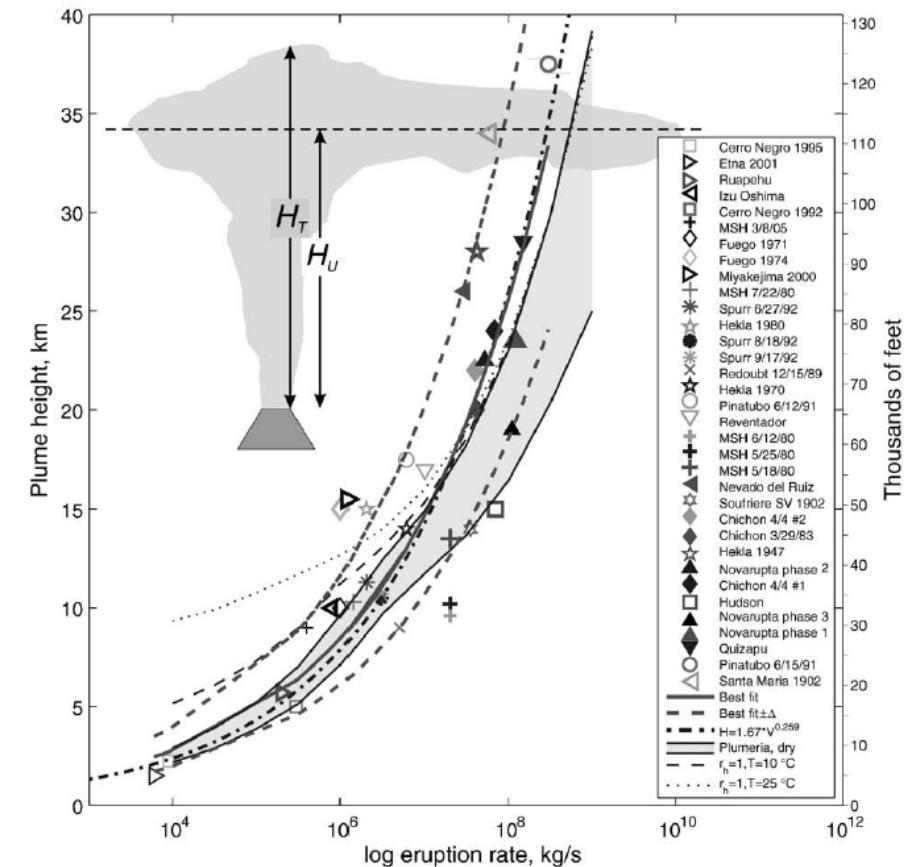


Fig. 1. Plume height above the vent versus mass eruption rate for eruptions listed in Table 1. Symbols for each eruption are given in the legend. The bold solid line gives the best fit to the data (Eq. (1)). The bold dashed lines enclose the error envelope ($\pm\Delta$) calculated by the routine polyval in Matlab® (use of trade names does not constitute endorsement of these products). The error envelope corresponds to a 50% confidence interval, meaning that future observations have at least a 50% probability of falling within this envelope. The dot-dashed line is the empirical fit obtained by Sparks et al. (1997, Eq. 5.1). The upper light solid line is a theoretical curve of H_T calculated using the 1-D steady-state model Plumeria (Mastin, 2007) using a magma temperature of 900 °C, 3 wt% gas, and a standard dry atmosphere (United States Committee on Extension to the Standard Atmosphere, 1976). The lower light solid curve is the elevation of neutral buoyancy, assumed to approximate H_U , calculated from the same model runs. The region between these two curves is shaded. The dashed light curve represents predictions of H_T by Plumeria using properties of a standard atmosphere but with 100% relative humidity (r_h) and a temperature at ground level of 10 °C. The light dotted curve is a similar prediction using a relative humidity of 100% and a temperature at ground level of 25 °C. Symbols in the legend are arranged from lowest to highest eruption rate. The Abbreviation "MSH" is Mount St. Helens, "Soufrière SV" is Soufrière of St. Vincent. The figure inset illustrates the difference between the height of the top of the plume (H_T) and the height of the umbrella cloud (H_U). The height H plotted includes both H_T and H_U depending on the method of estimation. Isopleth-based estimates, denoted by solid symbols, give umbrella-cloud height H_U whereas all other methods are thought to give H_T .

Mastin, L.G. et al., A multidisciplinary effort to assign realistic source parameters to models of volcanic ash-cloud transport and dispersion during eruptions, Journal of Volcanology and Geothermal Research (2009), doi:10.1016/j.jvolgeores.2009.01.008

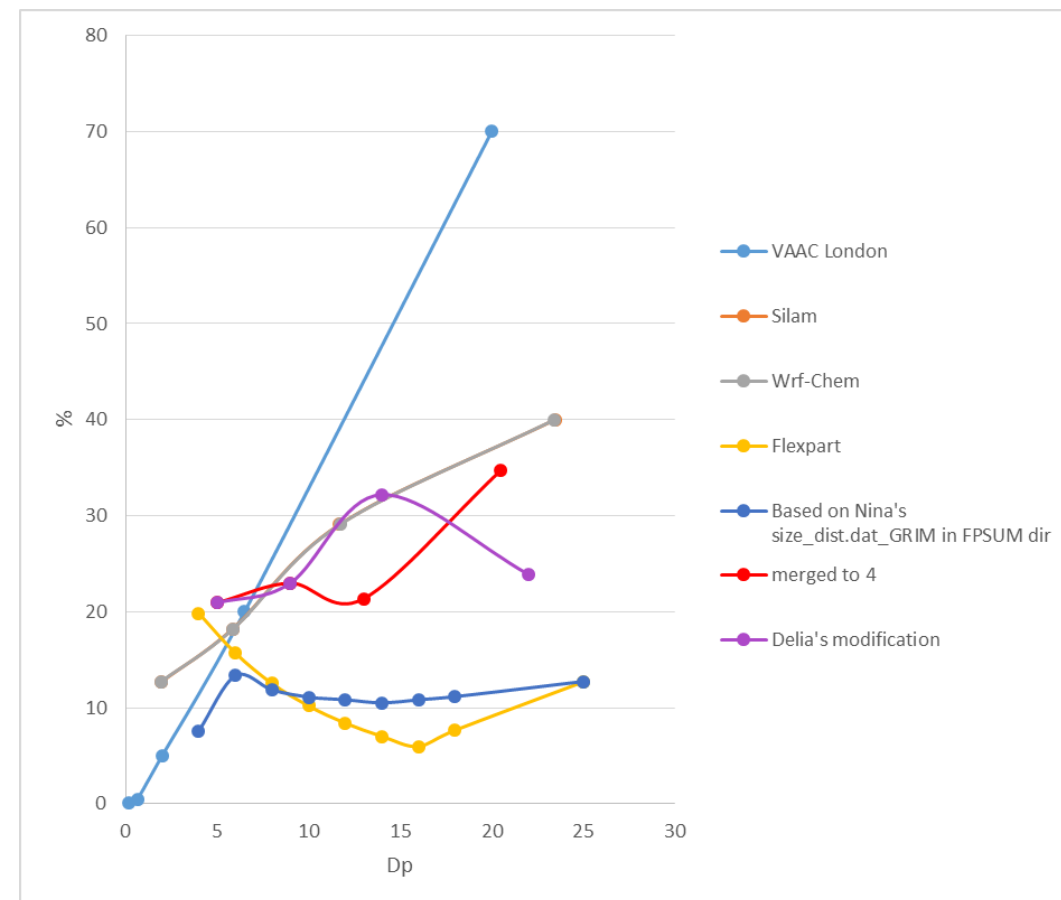
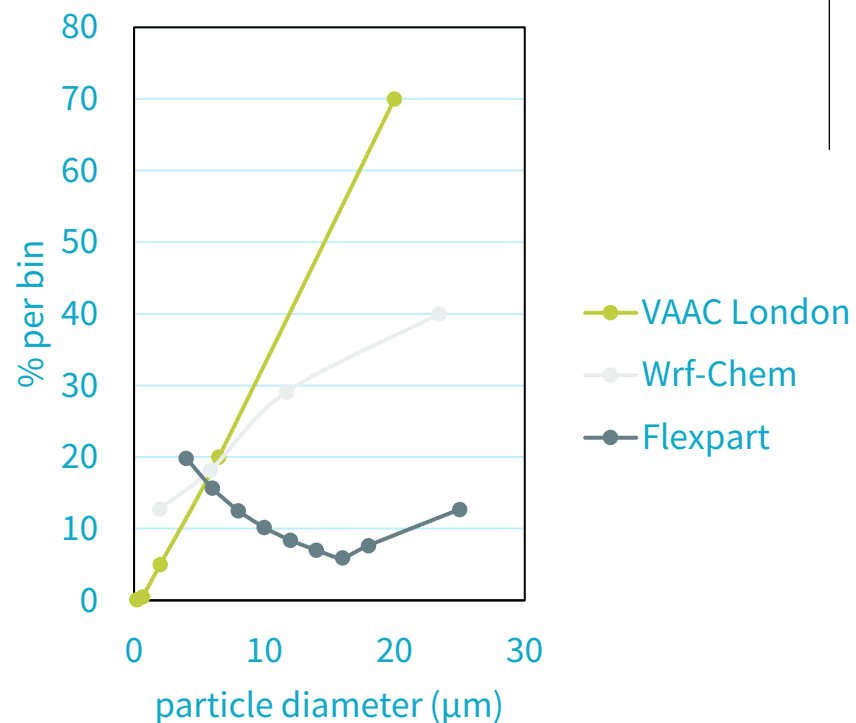
EXERCISE: size bins and distribution

WRF-Chem

Range [μm]	Median [μm]	%
0 - 3.9	1.950	12.727
3.9065 - 7.8125	5.860	18.182
7.8125 - 15.623	11.718	29.091
15.623 - 31.25	23.437	40

FLEXPART

Median [μm]	%
4	0.1985
6	0.157
8	0.1253
10	0.1018
12	0.084
14	0.0703
16	0.0596
18	0.0766
25	0.127



Set up your volcanic FLEXPART run

In Binder: compile FLEXPART (make).

Make a directory 'volc' with a link to the FLEXPART exe, an options dir, output dir, AVAILABLE file and pathnames file.

Prepare the COMMAND file:

Dates: 2011052118 – 2011052218

BINARY OUTPUT.

Prepare the OUTGRID file:

Domain: 40-70N 0-30W; 0.5 x0.5

Make RELEASES file: look up the latitude, longitude and elevation of the Grimsvötn volcano.

Do the run with 4 species (5, 9, 13, 21) of ash. Copy volcano/options/SPECIES/SPECIES_20*

&COMMAND

```
LDIRECT= 1,
IBDATE= 20110521,
IBTIME= 180000,
IEDATE= 20110522,
IETIME= 180000,
LOUTSTEP= 3600,
LOUTAVER= 3600,
LOUTSAMPLE= 900,
ITSPLIT= 99999999,
LSYNCTIME= 900,
CTL= -5.00000000 ,
IFINE= 4,
IOUT= 1,
IPOUT= 0,
IPOUTFAC= 1,
LSUBGRID= 0,

LCONVECTION= 1,
LAGESPECTRA= 0,
IPIN= 0,
IOUTPUTFOREACHRELEASE= 1,
IFLUX= 0,
MDOMAINFILL= 0,
IND_SOURCE= 1,
IND_RECEPTOR= 1,
MQUASILAG= 0,
NESTED_OUTPUT= 0,
LINIT_COND= 0,
LNETCDFOUT= 0,
SURF_ONLY= 0,
CBLFLAG= 0,
LINVERSIONOUT= 0,
```

&OUTGRID

```
OUTLON0= -30.0000000 ,
OUTLAT0= 40.0000000 ,
NUMXGRID= 60,
NUMYGRID= 60,
DXOUT= 0.50000000 ,
DYOUT= 0.50000000 ,
OUTHEIGHTS= 20000.0000 ,
```

While waiting for the run to finish, have a look at the SPECIES and RELEASES files.

Copy plotting files

plot_FLEX_binary_V11_sumREL.py, read_header.py and read_grid.py from **/volcanos/**

When the run is finished, start with plotting

```
python plot_FLEX_binary_V11_sumREL.py ./output/ False 1 0 63 20110522170000 cyl False -30,0,40,70  
mesh False
```

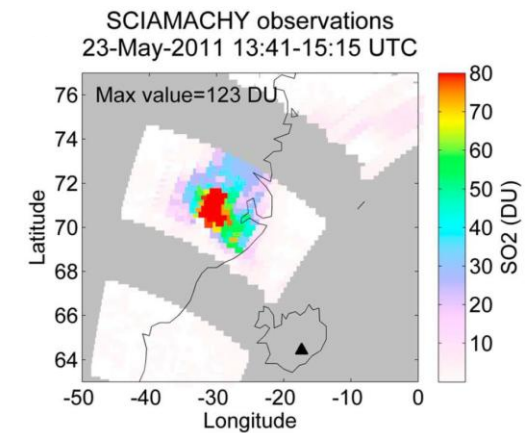
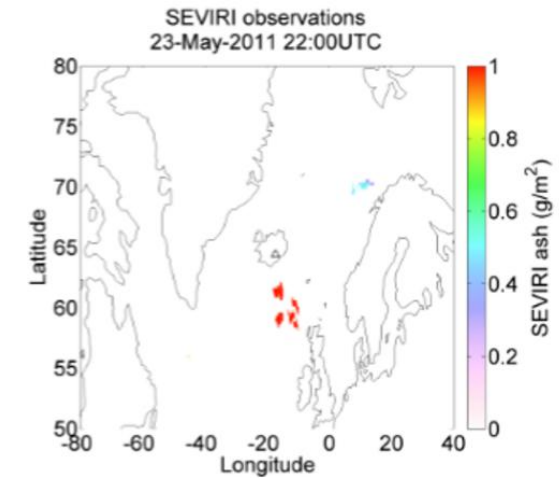
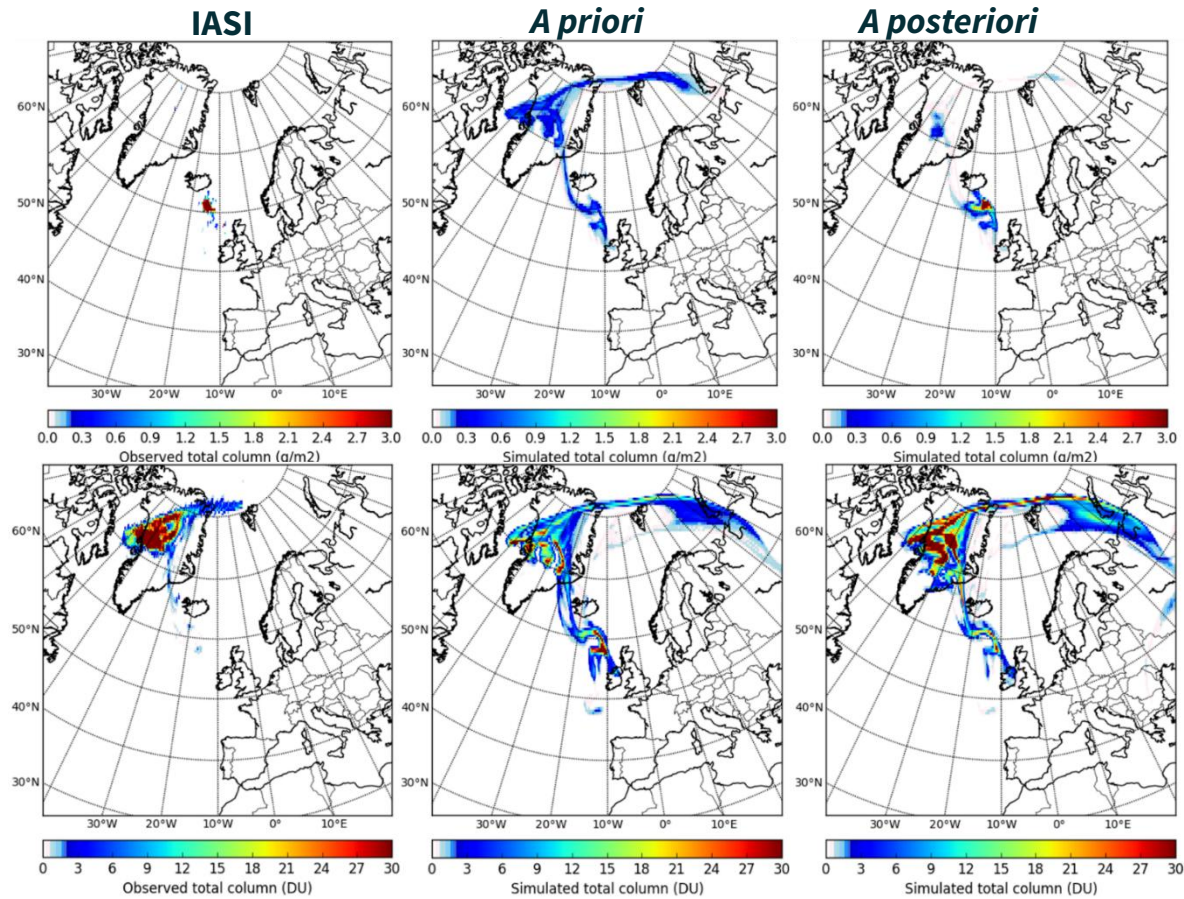
Also plot the 23rd of May 22 UTC

If you like you can plot also with 'lcc' (lambert) and/or 'contour' instead of 'mesh'

Check figures

Display figure_name

Results for May 23, 22 UTC: IASI, a priori ST, a posteriori ST, SEVIRI



Investigate the effect of tuning the input files

- Write in python yourself or copy the needed files from /volcanos/: „make_releases.py“ and „release_parameters.py“
- The release_parameters.py file should contain the following parameters:

<i>Crater elevation (,ventElevation') [m]</i>	<i>volcano longitude (,vlon')</i>
<i>volcano latitude (,vlat')</i>	<i>Number of particles per release (,particlesPerRelease')</i>
<i>number of release levels(,numRelLevels)</i>	<i>releases height interval (,relHeightInt') [m]</i>
<i>Species numbers (,speciesIndices')</i>	<i>Start time of the releases (,startTime')</i>
<i>Stop time of the releases (,stopTime')</i>	<i>Reference level (,elevCode')*</i>
<i>Folder to save RELEASES file (,releaseFileDir')</i>	
- Change one or more of the following parameter settings:
 - 4 -> 9 species
 - 100 -> 1000 particles (make a shorter run!)
 - Height levels of 500 or 2000 meter.
- Generate one or more new RELEASES files and start the run(s). Plot the output and compare.

* 1=above ground, 2=above sea level

Theory on using ash heights from radar observations and other sources

*“a priori information (xa) A pre-defined first guess estimate of the source emissions. This can be derived from any available data that are independent from the satellite observations used in the inversion, from e.g. **radar observations** of plume heights, calculations from **plume-models** such as ATHAM or PLUMERIA (Mastin, 2007), or from the **empirical relationship** between mass eruption rate and plume height found by Sparks et al. (1997) and Mastin et al. (2009).”¹*

Photographs: first estimates of the plume heights

(Mobile) radar: as soon as available

Independent satellite data products.



¹ vast_inversion_documentation_v6.1_vast_spsd-attachment_technicalreport

Building blocks of a *a priori* ST for a inversion

1. Open `volcanos/MAKE_APRIORI/make_apriori.py` – what happens inside?

2. Make a `plume_heights.dat` file, with the plume altitude per 3 hours. Use this format:

```
**** Startdate Starthour Enddate Endhour PLUME HEIGHT [km asl]  
20110521 120000 20110521 150000 XX  
20110521 150000 20110521 180000 XX
```

Read the plume heights from Figure 5 in, Petersen et al., 2012:

<https://essd.copernicus.org/articles/4/121/2012/essd-4-121-2012.pdf>

3. Make a `source_parameters.py`, with the following parameters:

Volcano elevation ('vol_alt') [m]

Fine ash fraction ('fineashfraction'), here: 0.05

Number of vertical levels ('nhlevels')

Interval of height levels ('hstep') [m]

Particle density ('partdens') [kg/m³]

Uncertainty ('unc_apriori'), here: 1000 [fraction]

Lowest boundary of first level ('hlevel_start') [m asl]

Scaling factor ('scaling_total_ash'), here: 4.0E8

Run the python script from `volcanos/MAKE_APRIORI/make_apriori.py` to generate the *a priori* ST file (`python make_apriori.py plume_heights.dat`). Compare with the ST file in `MAKE_APRIORI`.

¹ m63 from Mastins relationship

New developments – *check user mailing list or flexpart.eu*

➤ **FLEXPART-WRF v4.0**

- New features include: testing env, plume rise, new deposition scheme, bug fixes for steep slopes, new TKE scheme, FLEXINVERT coupling.
- Official release and publication expected Spring 2027

➤ **FLEXprep from MeteoSwiss (for ECMWF data)**

- Latest version is available here: <https://gitlab.phaidra.org/flexpart/flexprep>
- Contains only simple handling of precipitation (only deaccumulation) – patches for disaggregation are currently tested.
- No publication expected

THANK YOU

CBRN

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