FLEXPART for volcanic applications

Exercise 7

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EXERCISE Grimsvotn eruption in 2011

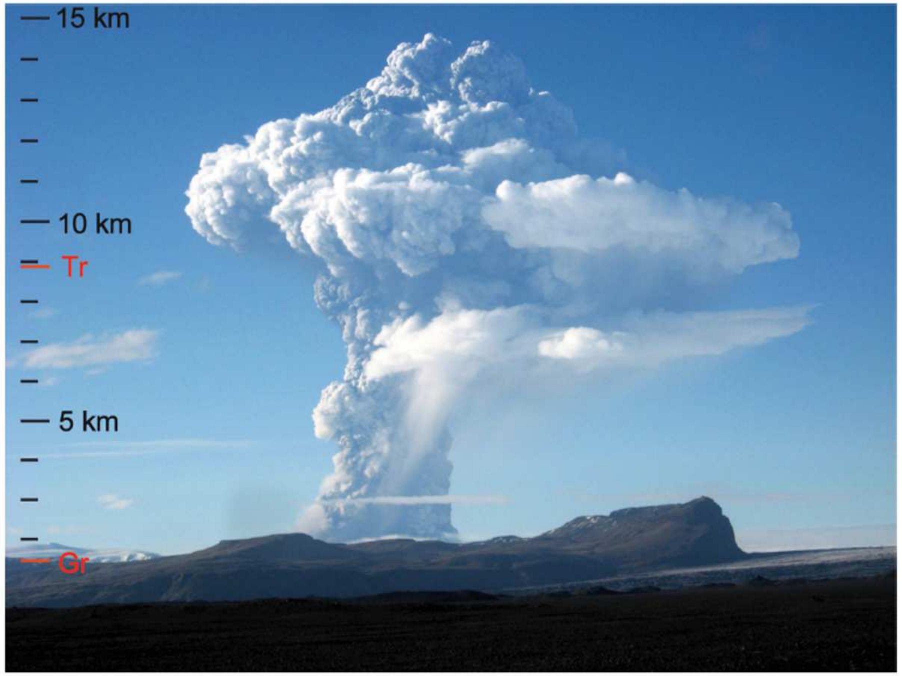
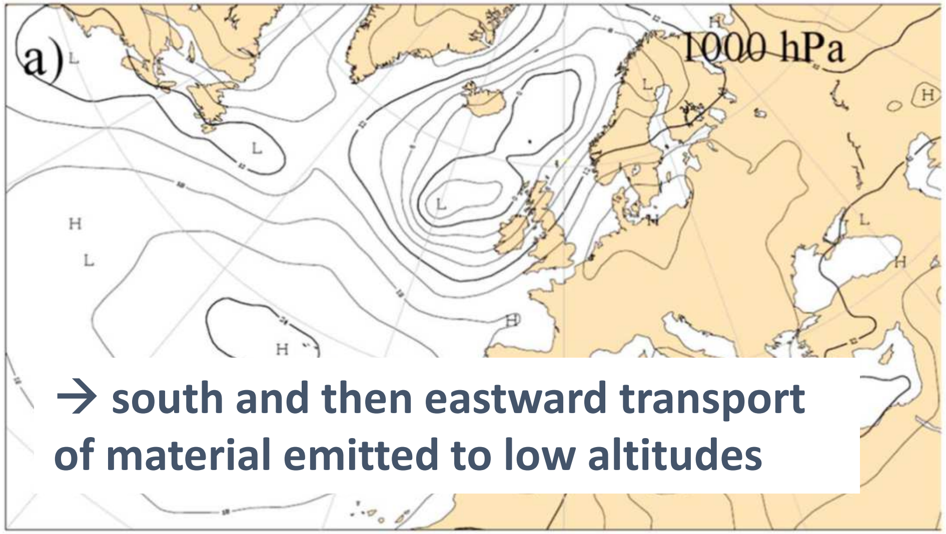


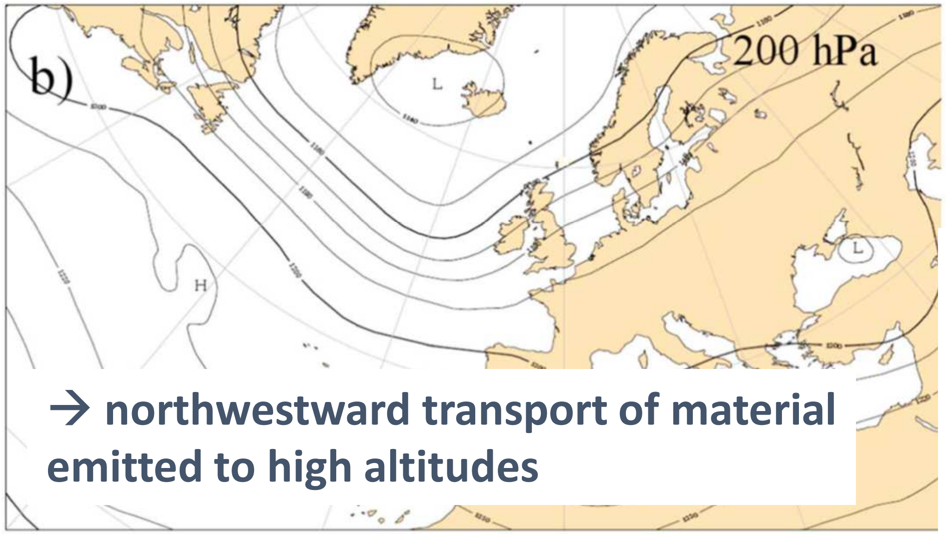
Figure 4. The initial Grímsvötn eruption plume seen from Skeiðarársandur, 50 km south of the volcano. Approximate altitude scale at the distance of Grímsvötn (Gr) on the left, and the tropopause (Tr) at this time was at about 8.9 km. Photo Bolli Valgarðsson, 21 May 2011 at 19:20 UTC.

Grimsvotn weather situation

21 May 2011, 12 UTC



→ south and then eastward transport of material emitted to low altitudes



→ northwestward transport of material emitted to high altitudes

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

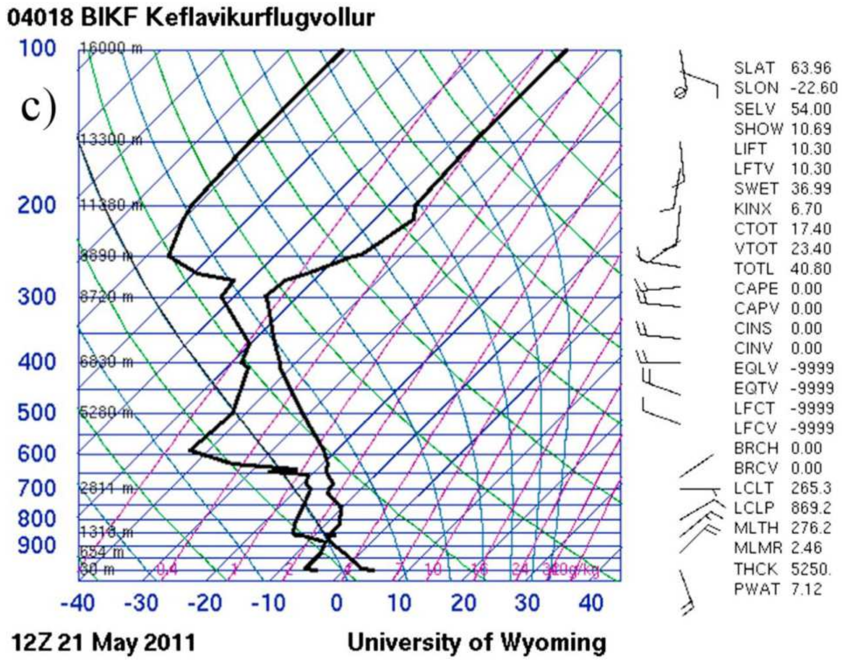


Figure 1. ECMWF geopotential analysis for 21 May 12 UTC at (a) 1000 hPa and (b) 200 hPa; data taken from http://www.ecmwf.int. (c) Skew-T, Log-p chart at Keflavik radiosonde station located 250 km WSW of Grímsvötn Volcano, at 12 UTC on 21 May 2011 (data from University of Wyoming, http://weather.uwyo.edu/upperair/sounding.html).

A priori source term

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 $\dot{V}$(m3 DRE* per second):

    $H = 2.00\ \dot{V}^{0.241}$
- Or PLUMERIA or other plume models
- Estimate of size distribution

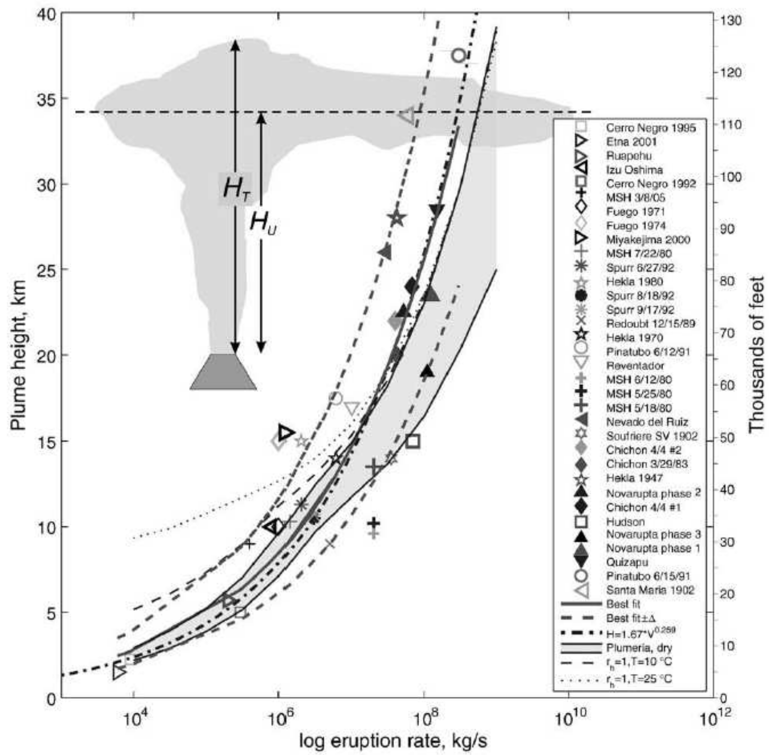
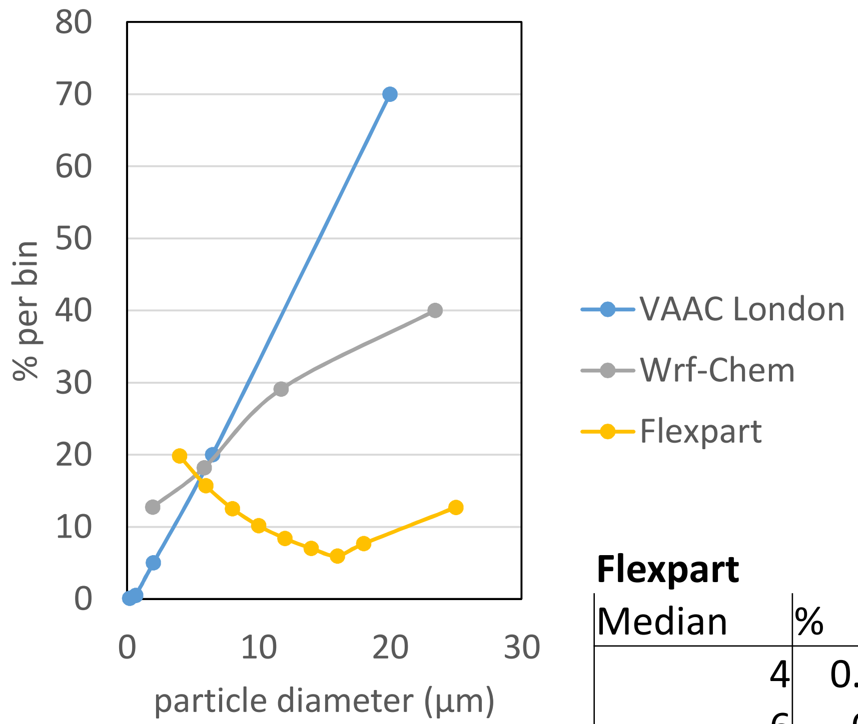


Fig. 1. Plume height above the vent versus mass eruption rate for eruptions listed in Table 1. Symbols for each eruption are given in the legend. The bold sol the data (Eq. (1)). The bold dashed lines enclose the error envelope (±Δ)calculated by the routine polyval in Matlab® (use of trade names does not constit products). The error envelope corresponds to a 50% confidence interval, meaning that future observations have at least a 50% probability of falling withi 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 ste (Mastin, 2007) using a magma temperature of 900 °C, 3 wt% gas, and a Standard dry atmosphere (United States Committee on Extension to the Standar 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 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 temp 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 ar highest eruption rate. The Abbreviation "MSH" is Mount St. Helens, "Soufrière SV" is Soufrière of St. Vincent. The figure inset illustrates the difference betwe 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-ba solid symbols, give umbrella-cloud height H_U whereas all other methods are thought to give H_T.

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

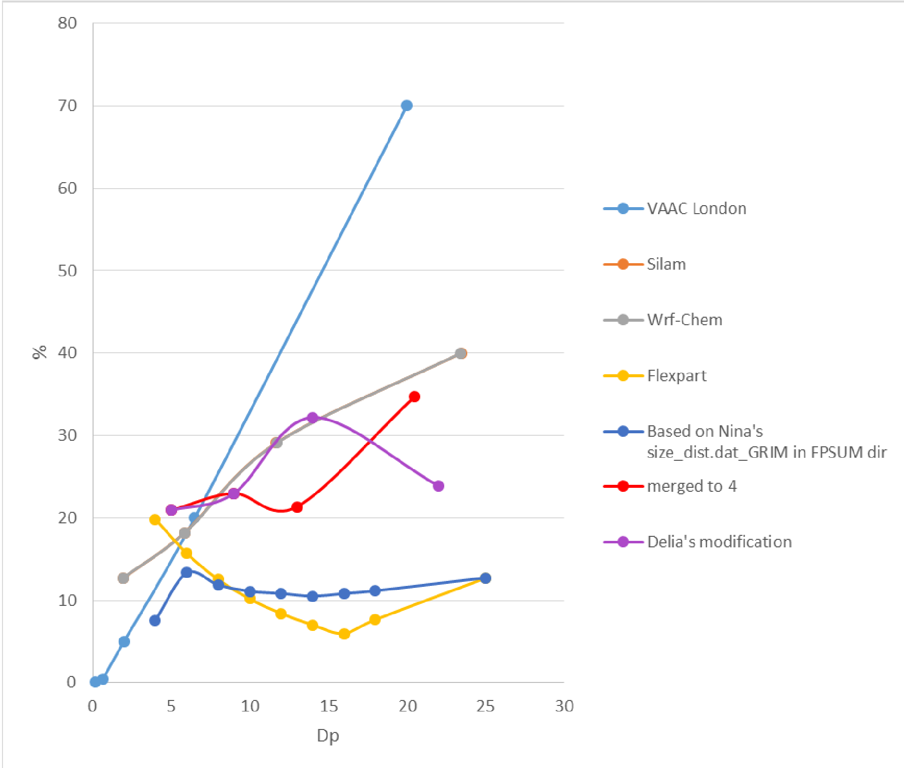
Mastin, L.G. et al., A multidisciplinary effort to assign realistic source parameters to models of volcanic ash-cloud transport and dispersion during eruptions, Journal of Volcanology and Geothermal Research (2009), doi:10.1016/j.jvolgeores.2009.01.008

Methods: size bins and distribution



Flexpart

Median	%
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



WRF-chem

Range	Median	%
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

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Simulate Grimsvötn eruption

1. Make directory volc with link to FLEXPART exe
2. Copy RELEASES and SPECIES files from the zip file to your dir /volc/options
3. Check: output units, AVAILABLE in met dir?
4. Adapt pathnames

Dates: 2011052118 – 2011052218

Domain: 40-70N 0-30W

Run with A priori with 4 species (5, 9, 13, 21) of ash

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 LOUTAVER=       3600,   MDOMAINFILL=         0,
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 DXOUT= 0.250000000    ,
 DYOUT= 0.250000000    ,
 OUTHEIGHTS=  20000.0000    ,
```

Plotting

Copy **makePLOTFLEXwithST.py, read_header.py and read_grid.py** from zip file

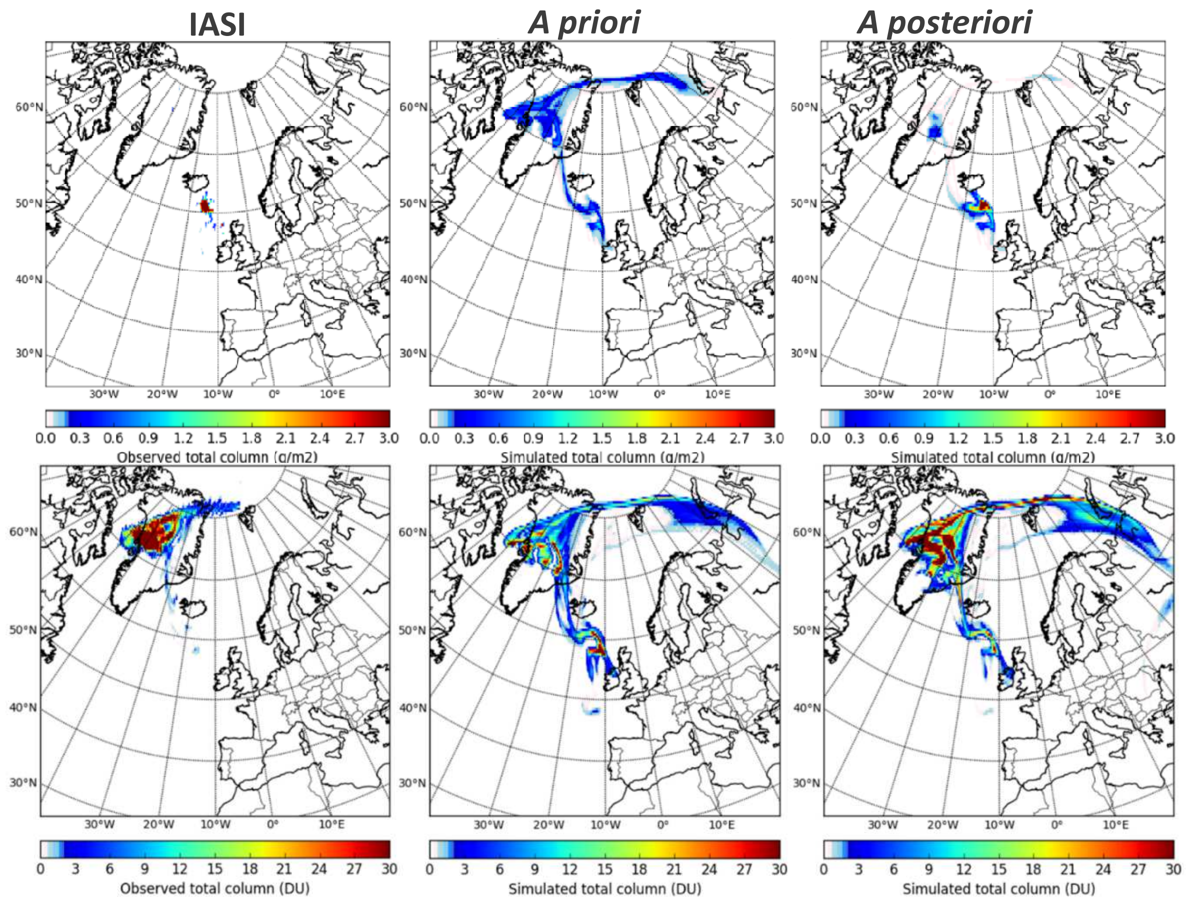
Start plotting:

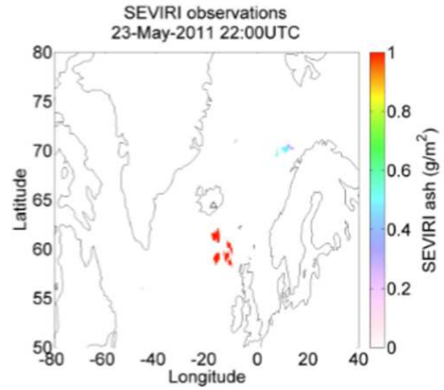
python makePLOTFLEXwithST.py ./output/

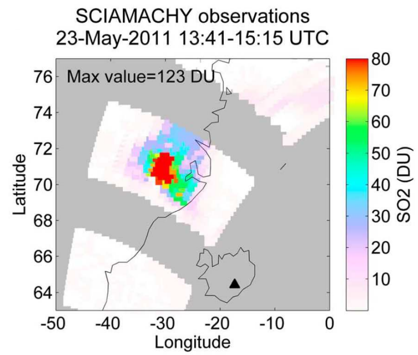
See figure:

Display figure_name

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







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