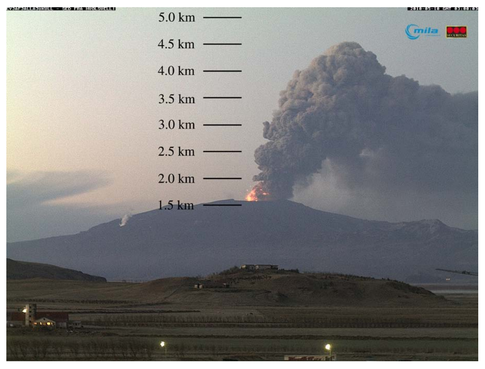

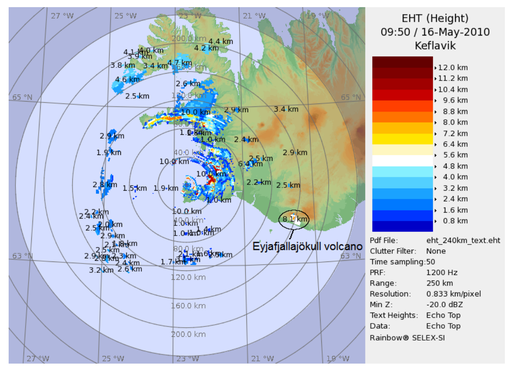

Veðurstofa Íslands
Icelandic Meteorological Office

Volcanic plume-top altitudes during the Eyjafjallajökull 2010 eruption

Þórður Arason, Halldór Björnsson, Guðrún Nína Petersen and Matthew J. Roberts
Icelandic Meteorological Office
(arason@vedur.is, halldor@vedur.is, gnp@vedur.is, matthew@vedur.is)

We present a unique high resolution time-series of the variations in plume height during the entire 39 day eruption of the Eyjafjallajökull volcano (63°38'N, 19°37'W), Iceland, 14 April - 23 May 2010.

Scans were made every 5 minutes during the eruption by the weather radar of the Icelandic Meteorological Office located at Keflavik International Airport, 154 km from the volcano. Due to a mountain range between the radar and the volcano and the curvature of the Earth, the plume could only be observed when over about 3 km a.s.l. The first radar scan detecting the plume was on 14 April at 08:50 UTC, and the last on 21 May at 10:20.

Due to the discrete elevation angles of the radar and the long distance to the volcano, the plume-top altitude estimates are severly grouped in discrete steps at about 2.8, 3.9, 5.0 and 7.9 km. This obvious stepping in the raw data can be decreased by taking averages over short time periods, e.g. 1 to 6 hours.

The telecommunications company Míla installed webcams to monitor the eruption. Their best webcam for observations of the plume was at Hvolsvöllur (63°45'N, 20°14'W), 34 km from the volcano. These webcam-photos were saved every 5 sec, from 14 April at 09:31 UTC to 23 May at 23:59. We defined a vertical height-scale above the volcano. Top of the photo-frame directly above the volcano is estimated to be at 5.2 km a.s.l. During periods when the plume was visible, we have analysed the photos every 5 min to create a time series of the plume-top altitude.

The radar was useful in monitoring the eruption 70-80% of the time, while the webcam was only useful 15-21% of the time.

Of the 5 min radar scans during the eruption, 7% are missing, 10% were intentionally short range doppler scans, 11% masked by precipitating clouds at the volcano, 27% show that the plume was below detection height, and from 45% of the scans we can estimate the plume-top altitude. Of the webcam-photos on the hour, there are 4% missing, 74% do not show the plume-top, due to darkness, poor visibility, low cloud cover, or intermittent clouds. In 5% of the photos the plume clearly extends above the photo-frame. The plume-top is clearly visible only on 16% of the hourly photos.

Comparison of the radar and webcam time-series shows that the radar is far superior in continuously monitoring the eruption plume. Due to poor visual conditions webcams do not give any useful information for many consecutive days. However, the height resolution of the webcam photos on a clear day is much better than of the radar.

In the altitude range where both data sets give useful estimates, there is good consistency between the two.

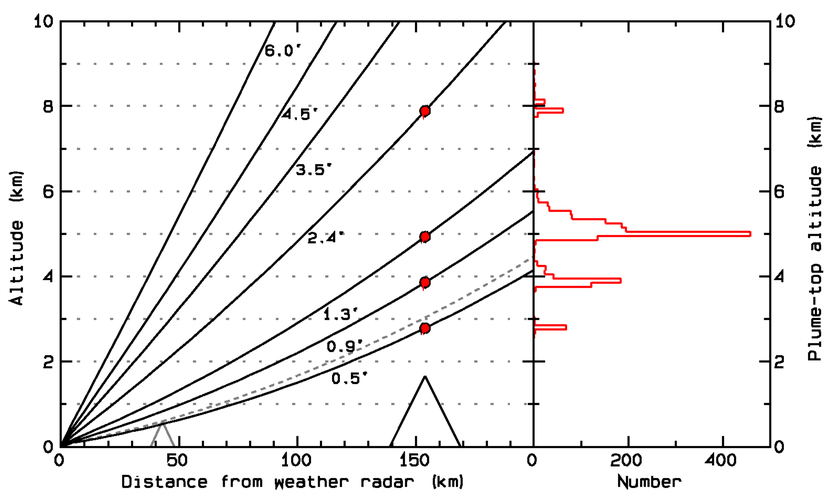

Fig. 3. (Left) Range-height diagram of the altitude (km a.s.l.) as a function of distance from the weather radar for the lowest elevation angles (0.5°-6.0°).
(Right) Histogram of plume-top altitudes estimated by the radar.

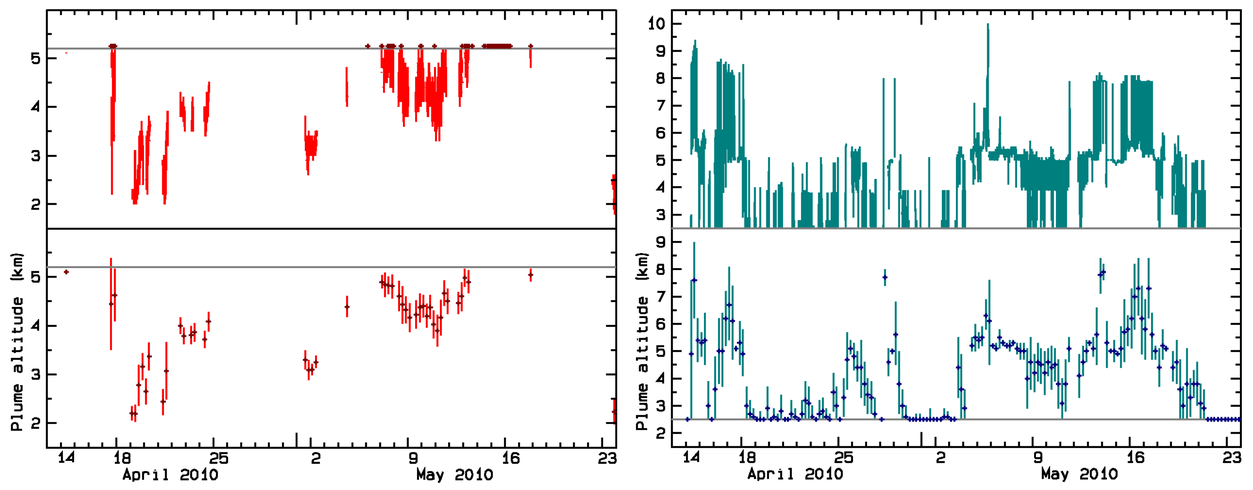

Fig. 1. The web camera (red) and weather radar (blue) time-series of the eruption plume-top altitude (km a.s.l.). The raw 5 minute time-series (top), and 6-hour averages, with one standard deviation (bottom).

Fig. 2. The weather radar at Keflavík International Airport, 154 km from the volcano.

Specifications of the weather radar

Type	C-band Ericsson (5.6 GHz)
Operational since	January 1991
Doppler since	April 2010
Location	64°01'35"N, 22°38'09"W
Height of antenna	47 m above sea level
Peak transmitted power	245.2 kW
Pulse duration	2.15 μs
Wavelength	5.4 cm
Pulse repetition rate	250 ± 2 Hz
Maximum range	480 km
Actual gain of antenna	44.9 dBZ
Half-power beam width	0.9°
Elevation angles (degrees)	
- reflectivity scans	0.5, 0.9, 1.3, 2.4, 3.5, 4.5, 6.0, 8.0, 10.0, 15.0, 25.0 and 40.0
- doppler scans	0.5, 1.3, 2.4, 5.0, 7.0, 10.0, 15.0, 20.0 and 30.0
Reflectivity threshold	–20 dBZ
Data managing software	Rainbow®5

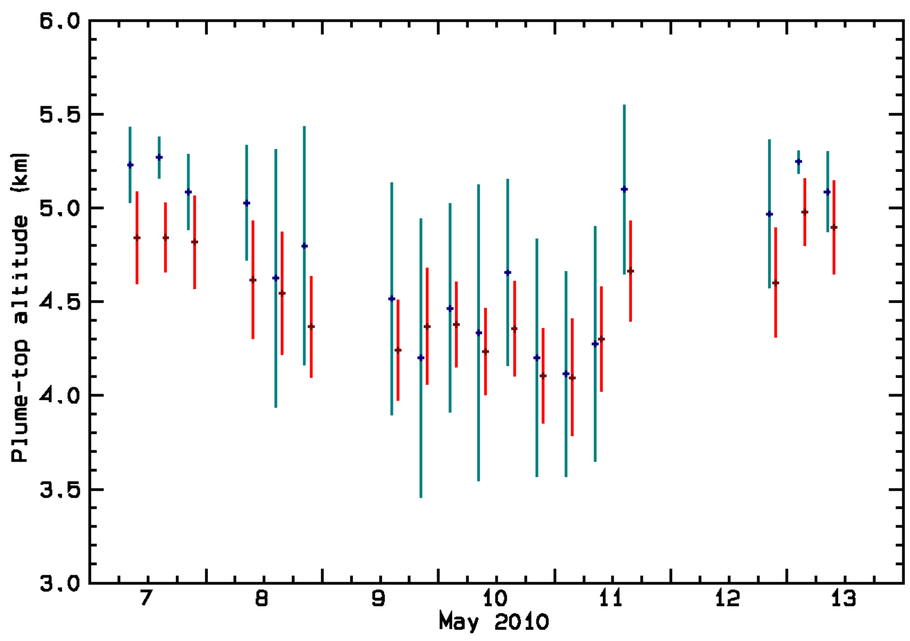

Fig. 4. Comparison of altitude estimates from synchronous radar (blue) and web camera (red) data, 7-13 May. Each bar shows a 6 hour mean and standard deviation.

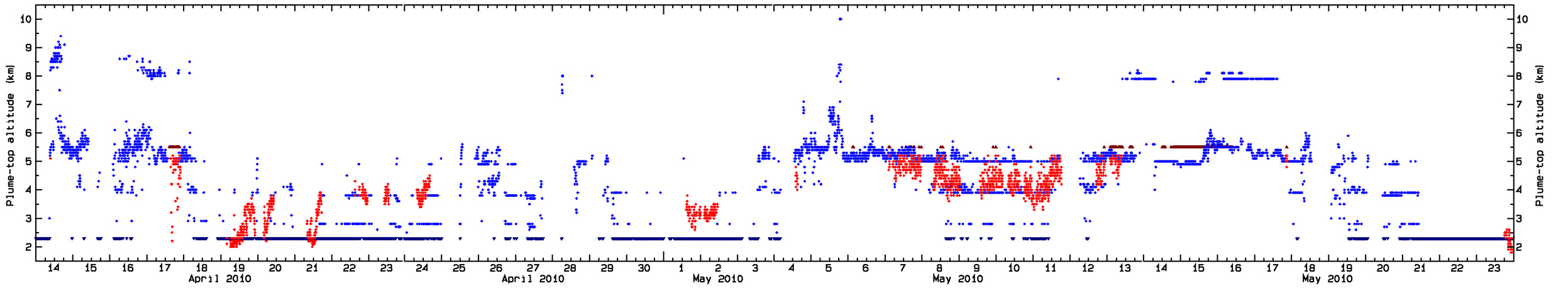

Fig. 5. Raw 5 minute data of the plume-top altitude from 14 April through 23 May, as observed by the weather radar (blue), and by the web camera photos (red). Sometimes the plume was below the radar minimum height of detection (dark blue shown at 2.3 km), and sometimes the plume extended above the camera ceiling frame (brown shown at 5.5 km).

Veðurstofa Íslands –
Icelandic Meteorological Office
Bústaðavegi 9, IS–150 Reykjavík, Iceland
Ph. +354 522 6000, www.vedur.is

International Union of Geodesy and Geophysics, XXV General Assembly, Melbourne, Australia, 28 June – 7 July 2011
Poster IAVCEI JV08 3883 - 2 July 2011

http://www.vedur.is/~arason/radar