Near real-time monitoring of the 2014 Holuhraun volcanic plume, its composition and dispersion

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Introduction

The 2014-2015 effusive eruption in Holuhraun, Iceland emitted high concentration of volcanic gases. Along with a release of metals this constituted the main threat from the eruption to health and safety in Iceland. The atmospheric monitoring of the volcanic plume utilized many different instruments and systems including both in-situ measurements and remote sensing.

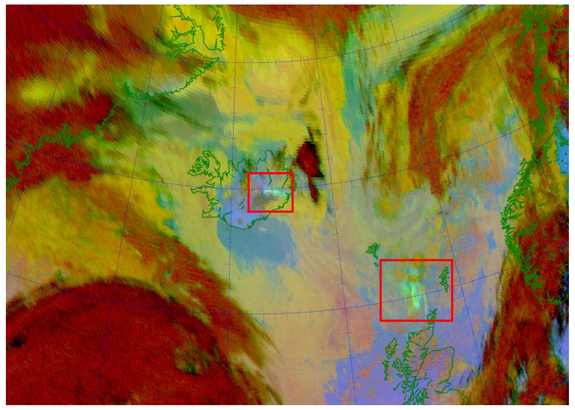


Image from SEVIRI 20 September 2014 at 12:00 UTC. Image is a dust microphysics RGB. The volcanic plume is clearly visible as cyan coloured (circled). This specific RGB was valuable to the real time monitoring due to the high temporal resolution of images (15 minutes)

Radars

Iceland has two permanent C-band radars. One in the southwest by the Keflavik International Airport and another one in the east part. In addition two mobile X-band radars are available. One X-band radar was moved close to the eruption site, but removed be for the onset of a harsh winter

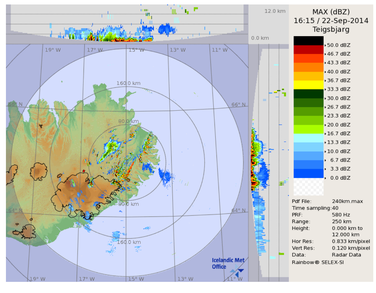


Image from C-band radar at Fljótsheiði, E-Iceland. on 22 September 2014. Plume is clearly visible at a distance from the eruption site. The plume was influenced by the atmosphere and continued rising above the lava and further away in unstable atmospheric conditions.

Satellites

Several polar-orbiting satellites pass Iceland daily. MODIS instruments on NASA's Aqua and Terra satellites as well as the AVHRR instruments on NOAA and EUMETSAT satellites provide high spatial resolution imagery but EUMETSAT SEVIRI instruments on geo-stationary satellites provide the best temporal resolution. Some of the polar-orbiting satellites are equipped with instruments able to detect SO2 from other gas species, with a dust microphysics algorithm SEVIRI's images can also be used to track SO2.

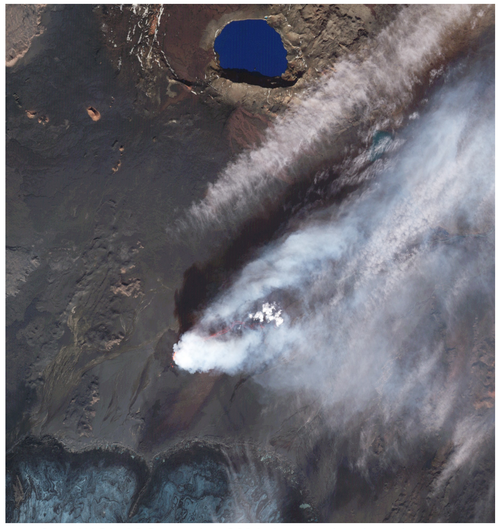
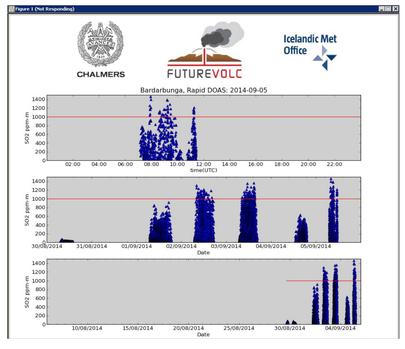


Image from NASA, 16 September 2014 showing the plume by the vent spreading eastward, and the pyrocumulus clouds forming over the hot lava northeast of the vent. Blowing dust can be seen to the east of the eruption, moving over the lava with cloud condensation nuclei getting caught in the convection.



Raw data from DOAS measurements measured in hours (top), days (middle) and weeks (bottom).

DOAS measurements

The SO2 emission rate was measured from the start of the eruption. Three scanning DOASes capable of streaming data were installed less than 15 km from the fissure. Long-distance traverses with a car-mounted DOAS were made along the ring road down-wind from the eruption as well as near-source traverses when conditions allowed.

Cameras

Two visible-light web cameras with different perspectives were deployed soon after increased unrest started in Bárðarbunga on 16 August 2014. Infrared cameras were installed, first during a field campaign and later as longer term monitoring devices. The sulfur-rich plume was qualitatively monitored using BTD technique on two wavelength filters on the infrared camera.

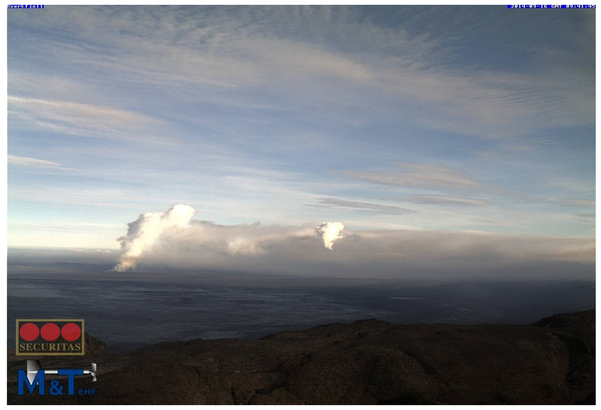
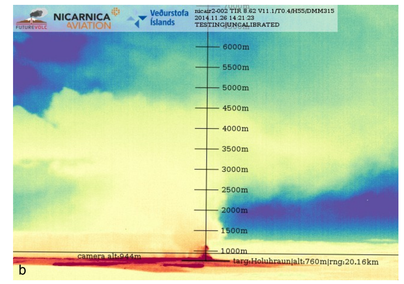
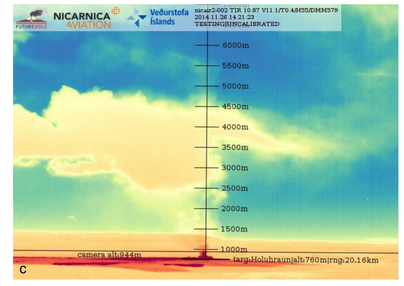
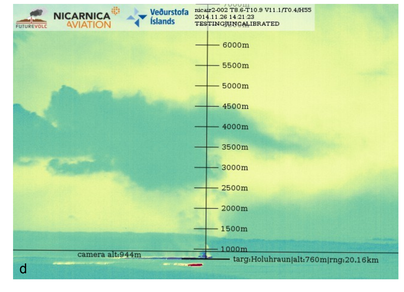


Image from M&T Webcam at Kverkfjöll, 16 September 2014 09:41 UTC showing the plume by the vent to the left and a pyrocumulus cloud forming over the lava to the right. The increasing lava field had signficant impact on the atmosphere above it, resulting in cloud formation and even precipitation events due to thermal convection above the lava

Overflights were an extremely important part of real time monitoring and often provided the only way to estimate the behaviour of gas release from the crater and lava, especially during the months when sunlight was scarce. Image taken in an overflight 22 January 2015. Photo by Elín Björk Jónasdóttir.







Images from NicAir IR cameras installed in late November. Images show the volcanic plume 26 November 2014 at 14:21 UTC. a) the visible image, b) 8.6 µm, c) 10.7 µm and d) the the brightness temperature difference between the 8.6 µm and 10.7 µm channels showing possible SO2 signal. Allthough cameras were not calibrated they proved to be useful monitoring tools.

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