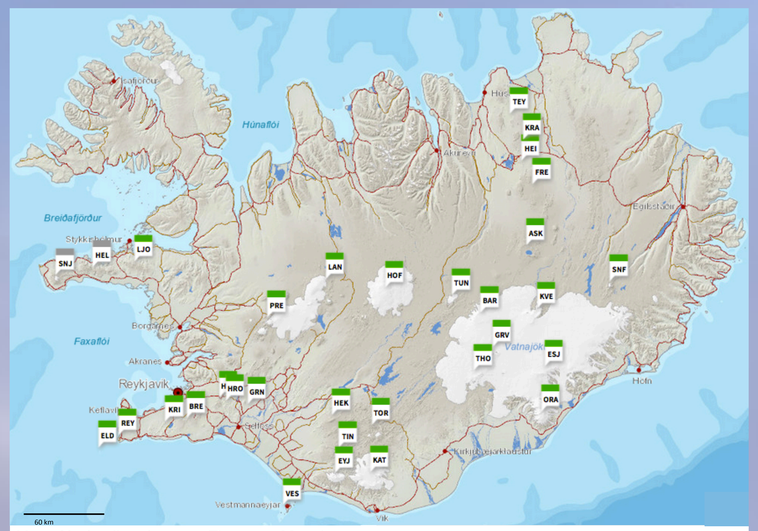
Aerosol measurements from the Icelandic mobile observatory

*Michelle Parks[1], Sibylle von Löwis[1], Melissa Pfeffer[1], Throstur Thorsteinsson[2], Yang Shu[3,1], Sara Barsotti[1], Þórður Arason[1], Guðrún Nína Petersen[1], Sigrún Karlsdóttir[1]

1. Icelandic Meteorological Office, Reykjavík, Iceland.
2. School of Engineering and Natural Sciences, University of Iceland, Reykjavík, Iceland.3. University of Reykjavík, Reykjavík, Iceland.
* Corresponding author email: michelle@vedur.is

Overview

The main purpose of the Icelandic Meteorological Office (IMO) is to contribute towards increased security and efficiency in society by: **Monitoring**, analysing, interpreting, informing, giving advice and counsel and providing **warnings** and **forecasts** regarding natural events and hazards (including volcanic eruptions and ash). Iceland comprises 32 active volcanic systems, many of which have the capacity for ash-rich eruptions and the capability of disrupting both national and international airspace.



Map of Icelandic volcanoes. There are 32 active volcanic systems. They erupted at least once in the last 10,000 years and may erupt again. Information about the volcanoes can be found at: Catalogue of Icelandic Volcanoes http://icelandicvolcanoes.is.

GREY: Volcano appears quiet but is not monitored adequately. Absence of unrest unconfirmed.

GREEN: Volcano is in normal, non-eruptive state. or, after a change from a higher alert level: Volcanic activity considered to have ceased, and volcano reverted to its normal, non-eruptive state.

Grímsvötn 1998 eruption. Photo: Þórdís Högnadóttir.

Icelandic Mobile Observatory


Photo: Melissa Pfeffer.


Photo: Sibylle von Löwis.


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Photo: Melissa Pfeffer.

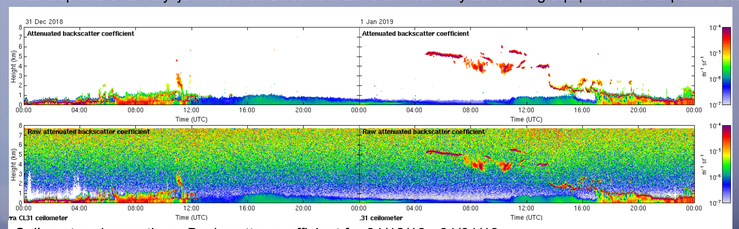
Mobile observatory equipment. From left: OPC, sunphotometer, lidar and multigas instruments. Bottom right: mobile X-band radar.

During 2018-2019 IMO has been working on establishing a mobile volcano observatory – primarily aimed at aerosol and gas detection. This currently comprises a Windcube 200S scanning lidar with depolarization functionality and CL31 Vaisala ceilometer (both contained within trailer that can be moved to even remote locations within Iceland). An optical particle counter (OPS 3330, TSI inc.), a sun photometer (CE318 Cimel; currently on loan from Ludwig Maximilian University of Munich) and a Multigas instrument (for measuring H_2S, SO_2 , CO_2 and H_2). IMO also has two mobile X-band radars which can be moved close to the eruption site. The radars provide valuable information about the volcanic plume, which are used to estimate mass eruption rate and data are used as input into volcanic ash dispersion models.


Photo: Þorgils Ingvarsson.

Test case: New Year's Eve 2018

The Icelandic public launches a considerable amount of fireworks on New Year's Eve, causing significant pollution in Reykjavík. We measured aerosols and gas in the atmosphere over Reykjavík from 30 December 2018 to 7 January 2019 using equipment that is planned to be used to measure volcanic emissions during the next eruption.



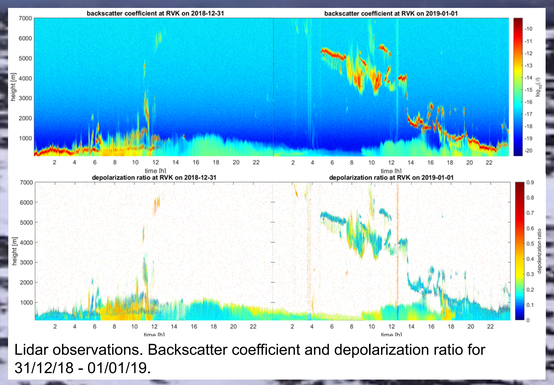
Ceilometer observations. Backscatter coefficient for 31/12/18 - 01/01/19.

Ceilometer measurements:

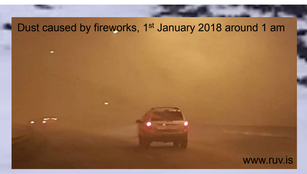
- Precipitation until noon (sleet or snow)
- Clears in early afternoon
- Increase of backscatter in afternoon due to firework release
- High density around midnight
- Re-suspension in afternoon on New Year's day
- Starts snowing around 17 UTC

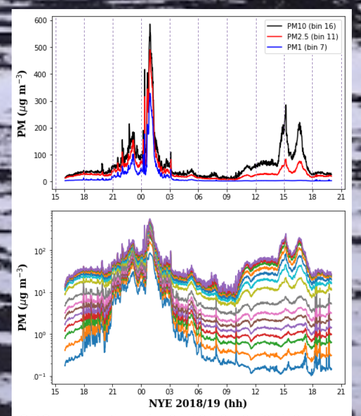
Lidar measurements:

- Backscatter coefficient shown above, depolarization ratio on bottom
- Sleet or snow before noon on NYE
- Clears but inversion develops and level of air pollution increasing
- Firework particles appear to be non-spherical
- Re-suspended particles observed in afternoon on New Year's day



Lidar observations. Backscatter coefficient and depolarization ratio for 31/12/18 - 01/01/19.





OPC observations for 31/12/18 - 01/01/19.

OPC Measruements

- OPC size range: 0.3 to 10 μm
- Particle number concentration measured in 16 size bins
- Particle number converted in PM1, 2.5, and 10
- PM concentration decreases from 22:30 - 23:30 UTC
- Maximum PM concentration at 1:00 am
- High number and mass concentration of particles smaller than 1 μm around midnight
- Secondary peak probably due to re-suspension in the afternoon
- Not visible for fine particles (PM1)

Summary

Information on the presence (and ideally the concentration) of volcanic ash in the atmosphere is extremely important for key stakeholders such as aviation authorities, VAACs, airlines and civil protection agencies – to assess the potential risks to aircraft, passengers and local populations. With this in mind, IMO has designed a mobile volcano observatory, capable of being moved to even remote locations within Iceland in the event of the next eruption, with the primary goal of ash detection, providing information to key stakeholders and constraining input parameters for dispersion models.

Acknowledgements

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