Hail and its effects on ash detection by radar

Herman Arngrímsson

Veðurstofa Íslands
Icelandic Meteorological Office, Reykjavík, Iceland
Equipment and resources

Radars
- 2 C-band systems in the east and west of Iceland
  - Fixed sites, 240km range
- 2 mobile X-band systems (ICAO)
  - Re-locateable, 150km range

Optical
- Ceilometer network
- 2 LIDAR systems
- Infrared cameras

Geophysical
- Seismometers and Strain stations
- Glacial GPS stations
- Gas ratio measurements

Others
- Mobile sonde launching system
- UAVs
Optical systems

**Lidars**
- 2 x Windcube 200S with dual polarization capabilities (1.5 μm)
- One Windcube is permanently located at Keflavik
- Mobile system which can be deployed to areas of interest
  - Windcube and CL31 celiometer
- The LIDARs will **not** provide ash density, just presence and possibly particle size/shape.

**Celiometer network**
- Network of Vaisala CL31 (0.91 μm) and CT25K instruments
- Once an ash layer has been detected, the celiometer network may provide information about its extent.
- No polarisation data, so they will **not** distinguish between aerosol types

**Cameras**
- The infrared camera systems may also provide plume height information.
- These are part of the FUTUREVOLC project
Radar Network
Plume lightning seen from a distance of 72 km
Notice the characteristic fibrous anvil shape of the plume top

Photo Þórður Arason 17 April 2010 at 04:47:09
Ash-infused hail on the glacier about 5 km east of the Eyjafjallajökull crater

Photo Thor Thordarson 22 April 2010
Grímsvötn eruption
May 2011

Photo Bolli Valgarðsson 21 May 2011 at 19:20
Radar Data from Grímsvötn 2011

Data type retrieved from X-band mobile radar

- **dBz** (Reflectivity)
- **ZDR** (Differential reflectivity)
- **uPhiDP** (Differential phase shift)
Hagl-01: Grímsvötn 2011 ash section 3 km from the crater

Photo Þórður Arason 11 June 2011
Radar detection of ash vs. ash-infused hail

Ash grains embedded into much larger hail lead to stronger received radar signal.

On the ground we may observe the fine ash grain size distribution after the hail has melted.

Glaciers can store information on grain type and size distribution.
Grímsvötn 2004
Sampling of ash deposits and estimates of ground mass loading (kg/m²)

Bárðabunga – August 2014
Radar Data from Holuhraun 2014

Data type retrieved from X-band mobile radar
- \( \text{dBz} \) (Reflectivity)
- \( \text{ZDR} \) (Differential reflectivity)
- \( \text{uPhiDP} \) (Differential phase)
- \( W \) (Spectral width)
Summary

- Hydrovolcanic eruptions have great affect on measurements.
- Glaciers can be used to access information on grain type and size distribution.
- Scan Patterns constantly being revised. Input on this well appreciated.
Thank you

Scan from X-band radar, Grímsvötn 2011