

Radar volcano monitoring system in Iceland

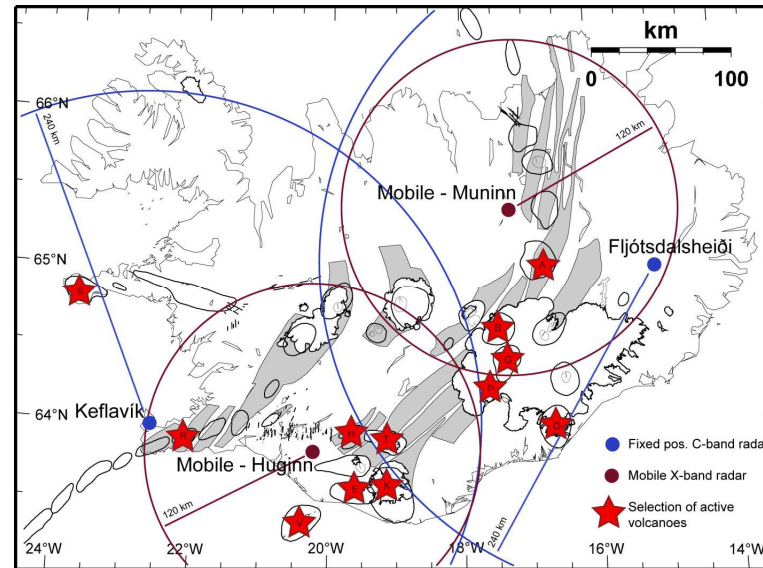
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Weather radars are valuable instruments in monitoring explosive volcanic eruptions. Temporal variations in the eruption strength can be monitored as well as variations in plume and ash dispersal. Strength of the reflected radar signal of a volcanic plume is related to water content and drop sizes as well as type, shape, amount and the grain size distribution of ash.

The Icelandic Meteorological Office (IMO) owns and operates four weather radars comprising this radar volcano monitoring system. In cooperation with the International Civil Aviation Organization (ICAO), IMO has recently invested in two mobile X-band radars and one fixed position C-band radar.

Explosive volcanic eruptions in Iceland during the past 22 years were monitored by the Keflavík radar: Hekla 1991, Gjálp 1996, Grímsvötn 1998, Hekla 2000, Grímsvötn 2004, Eyjafjallajökull 2010 and Grímsvötn 2011. Additionally, the Grímsvötn 2011 eruption was monitored by a mobile X-band radar on loan from the Italian Civil Protection Authorities.

Detailed technical information is presented on the four radars. This expanded network of radars is expected to give valuable information during future volcanic eruptions in Iceland.



(a) The Keflavík C-band weather radar, (b) Huginn mobile radar, (c) A sample radar reflectivity plot during the Grímsvötn 2011 eruption measured by the Italian mobile radar. Photos Pörður Arason and Geirfinnur S. Sigurðsson.

Table 4 Recent explosive eruptions in Iceland

Volcano	Date	Duration	Explosive phase
Grímsvötn	21 May 2011	8 days	8 days
Eyjafjallajökull	14 April 2010	39 days	29 days
Grímsvötn	1 Nov 2004	6 days	6 days
Hekla	26 Feb 2000	12 days	~12 hours
Grímsvötn	18 Dec 1998	10 days	10 days
Gjálp	30 Sept 1996	13 days	13 days
Hekla	17 Jan 1991	53 days	~10 hours
Hekla	9 April 1981	8 days	few hours
Hekla	5 May 1970	61 days	~2 hours

Table 1 Keflavík weather radar, SW-Iceland

Location	64°01.54' N, 22°38.11' W (fixed position)
Type	Ericsson UBS 103 04 radar system
Operational since	January 1991; doppler since April 2010
Operating frequency	5.61 GHz, C-band
Wavelength	5.3 cm
Peak transmitted power	~250 kW
Maximum range	480 km
TX type	Magnetron
RX type	Analog
Polarization	Linear horizontal
Signal Processor	UFC 108 14/8
Data managing software	Rainbow@5
Reflector diameter	4.2 m
Height of antenna	47 m above sea level
Pulse duration	0.58±0.05 µs (doppler); 2.0±0.2 µs (refl.)
Pulse repetition frequency	900/1200 Hz (0.6 µs); 250±2 Hz (2 µs)
Half-power beam width	0.9°
Range resolution	1 km (doppler); 2 km (reflectivity) (typical)
Actual gain of antenna	44.9 dB
Minimum detectable signal	-114 dBm (0.6 µs); -109 dBm (2 µs)
Scanning speed	1 - 6 rpm; 3 rpm (typical)
Elevation angles reflectivity scans	0.5°, 0.9°, 1.3°, 2.4°, 3.5°, 4.5°, 6.0°, 8.0°, 10.0°, 15.0°, 25.0° & 40.0° (typical)
Elevation angles doppler scans	0.5°, 1.3°, 2.4°, 5.0°, 7.0°, 10.0°, 15.0°, 20.0° & 30.0° (typical)
Reflectivity threshold (echo top)	-20 dBZ (typical)

Table 2 Huginn & Muninn mobile weather radars

Location	mobile
Type	Selex Gematronik Meteor 50DX
Gross weight	3500 kg
Operational since	Hu: June 2012 / Mu: February 2013
Operating frequency	Hu: 9.375 GHz / Mu: 9.355 GHz, X-band
Wavelength	3.2 cm
Peak transmitted power	~65 kW
Maximum range	120 km
TX type	Magnetron
RX type	Digital
Polarization	Horizontal and vertical
Signal Processor	GDRX
Data managing software	Rainbow@5
Antenna type	XDP15, parabolic, prime focus reflector
Reflector diameter	1.88 m
Height of antenna	3 m above ground
Pulse duration	0.5 µs, 1 µs & 2 µs
Pulse repetition frequency	250 - 2000 Hz
Half-power beam width	1.25°
Minimum gain of antenna	42.4 dB
Minimum detectable signal	Hu: H&V: -117 dBm; Mu: H/V: -117/-119 dBm
Range resolution	0.03 - 2.00 km; 0.1 km (typical)
Azimuthal resolution	1° (typical)
Angle position accuracy	< 0.1°
Scanning speed	1 - 6 rpm; 3 rpm (typical)
Elevation angles reflectivity scans	0.7°, 1.8°, 3.1°, 4.6°, 6.3°, 8.3°, 10.6°, 13.2°, 16.2°, 19.7°, 23.8°, 28.4°, 33.8° & 40.0° (typical)
Reflectivity threshold (echo top)	-20 dBZ (typical)

Table 3 Fljótsdalsheiði weather radar, E-Iceland

Location	65°01.68' N, 15°02.29' W (fixed position)
Type	EEC SWR-250C(F)
Operational since	May 2012
Operating frequency	5.52 GHz, C-band
Wavelength	5.4 cm
Peak transmitted power	~250 kW
Maximum range	480 km
TX type	Magnetron
RX type	Digital
Polarization	Linear horizontal
Signal Processor	IQ2
Data managing software	EDGE V5.5
Reflector diameter	4.25 m
Height of antenna	698 m above sea level
Pulse duration	0.8 µs & 2 µs
Pulse repetition frequency	250 - 934 Hz (0.8 µs); 250 - 300 Hz (2 µs)
Half-power beam width	1°
Range resolution	0.016 - 2.000 km; 0.25 - 0.50 km (typical)
Azimuthal resolution	0.2° - 1.2°; 0.4° (typical)
Minimum gain of antenna	44 dB
Minimum detectable signal	-115 dBm (0.8 µs); -117 dBm (2 µs)
Angle position accuracy	< 0.1°
Scanning speed	1 - 6 rpm; 2 rpm (typical)
Elevation angles reflectivity scans	0.2°, 1.8°, 3.1°, 4.6°, 6.3°, 8.3°, 10.6°, 13.2°, 16.2°, 19.7°, 23.8°, 28.4°, 33.8° & 40.0° (typical)
Reflectivity threshold (echo top)	-20 dBZ (typical)