FUTUREVOLC: A European supersite project on an integrated monitoring network for Icelandic eruptions

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1: Nordvulk, Institute of Earth Sciences, University of Iceland

2: FUTUREVOLC Team - 27 partners from 10 countires: 14 Universities, 6 Research and Monitoring Institutions, 1 Civil Protection Agency and 6 SMEs

2nd IUGG-WMO workshop on**Ash dispersal forecast and civil aviation**
World Meteorological Organization, Geneva, Switzerland, Nov. 18-20, 2013

Eyjafjallajökull 14 April 2010
Photo: Þórdís Högnadóttir

FUTUREVOLC: 27 partners in 10 countries

Iceland:
University of Iceland, Institute of Earth Sciences (leading)
Icelandic Meterological Office (leading)
Icelandic Civil Protection – the National Police Commissioner
Miracle (SME)
Samsýn (SME)

UK:
British Geological Survey
UK Met Office
Univ. Cambridge
Univ. Bristol
Univ. Leeds
Guralp Systems (SME)

Italy:
Univ. Florence
Univ. Palermo
Univ. L'Aquila
Himet (SME)
iTEM (SME)

Ireland:
Univ. College Dublin

Germany:
DLR – German Aerospace Center
GFZ, Potsdam
Univ. Würzburg

France:
Univ. Clermont-Ferrand

Norway:
NILU – Norsk Inst. Luftforskning
Nicarnica Aviation (SME)

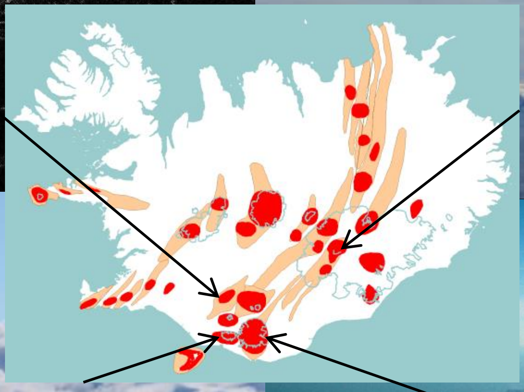
Switzerland:
Univ. Geneva

Netherlands:
Delft University

Sweden:
Univ. Uppsala
Chalmers Tech. Univ.


Hekla 1947
Photo: Sæmundur Þórðarson


Grímsvötn 2011
Photo: Björn Oddsson




Eyjafjallajökull 2010
Photo: MTG


Katla ?
Photo: MTG

Volcanic eruptions in Iceland in the last 100 years

Red = Explosive Black = Effusive Blue = Subglacial

Year	Volcano	VEI	note	style of activity
2011	Grímsvötn	4	ice	explosive
2010	Eyjafjallajökull	3	ice	explosive/effusive
2004	Grímsvötn	3	ice	explosive
2000	Hekla	3		effusive/explosive
1998	Grímsvötn	3	ice	explosive
1996	Gjálp (Grímsvötn)	3	ice	subglacial-explosive
1991	Hekla	3		effusive/explosive
1983	Grímsvötn	2	ice	explosive
1980-81	Hekla	3		effusive/explosive
1975-84	Krafla fires (9 eruptions)	1		effusive
1973	Heimaey	2		effusive/explosive
1970	Hekla	3		effusive/explosive
1963-67	Surtsey	3	ocean	explosive/effusive
1961	Askja	2		effusive
1947-48	Hekla	4		effusive/explosive
1938	Gjálp (Grímsvötn)	-	ice	subglacial
1934	Grímsvötn	3	ice	explosive
1922-29	Askja (5-6 eruptions)	2	(lake)	effusive/explosive
1922	Grímsvötn	3	ice	explosive
1918	Katla	4	ice	explosive
1913	Hekla	1		effusive

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Age of jet-engine passenger aircraft

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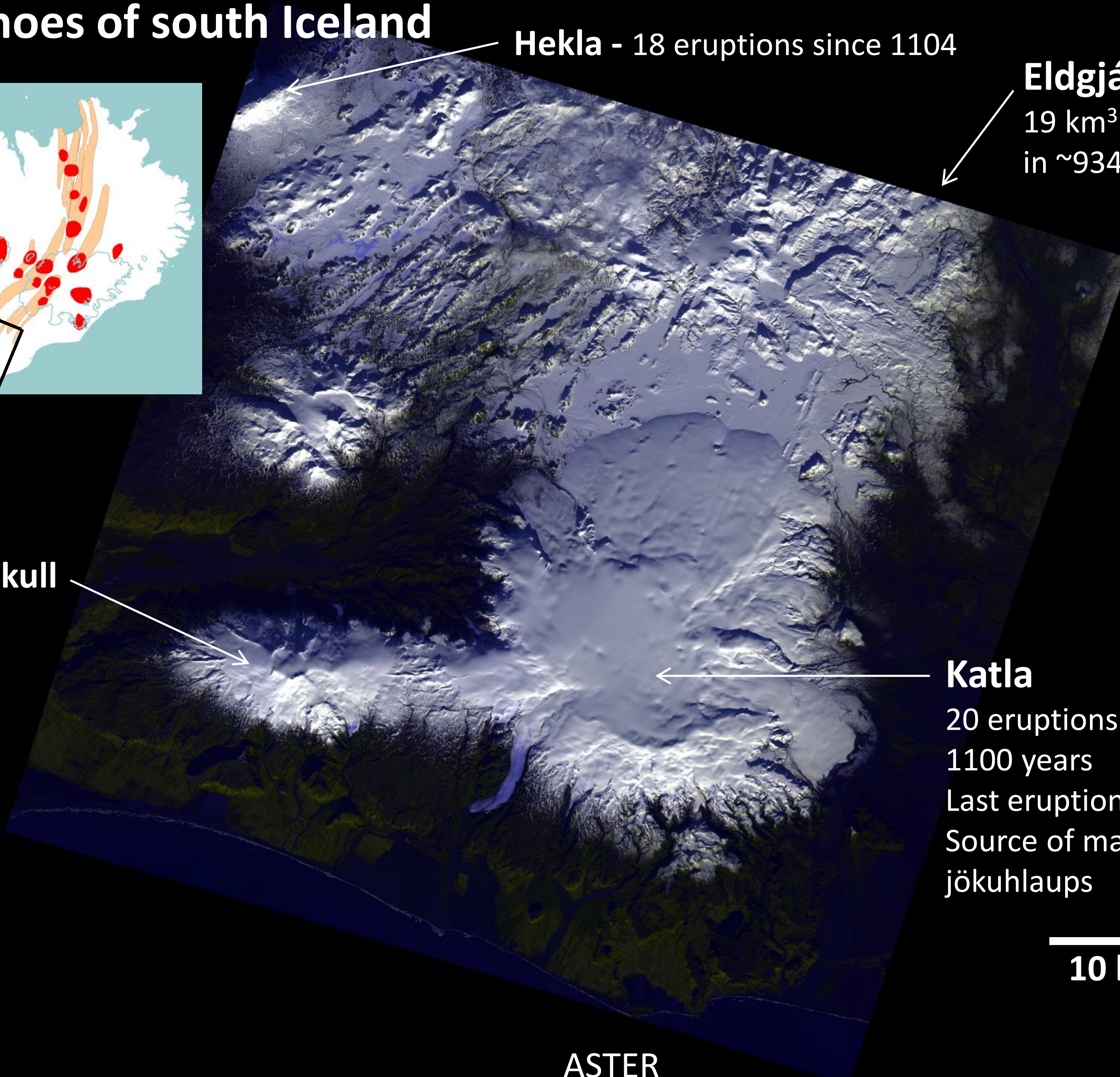
The volcanoes of south Iceland



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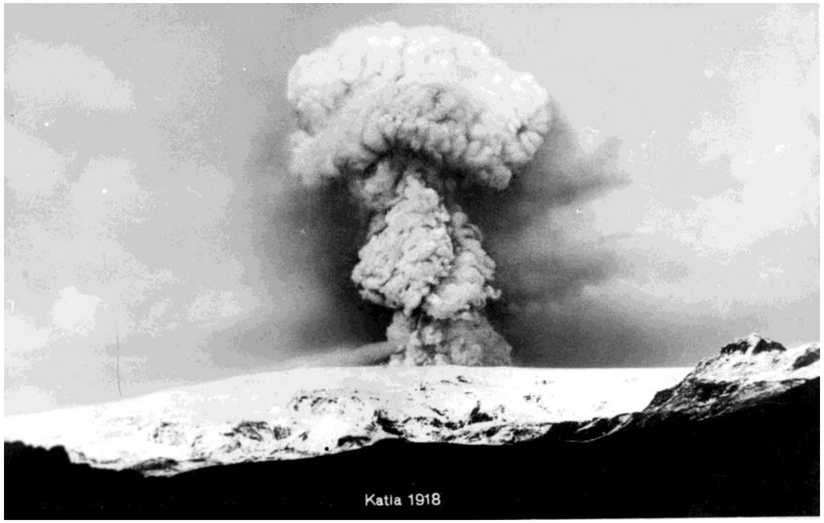
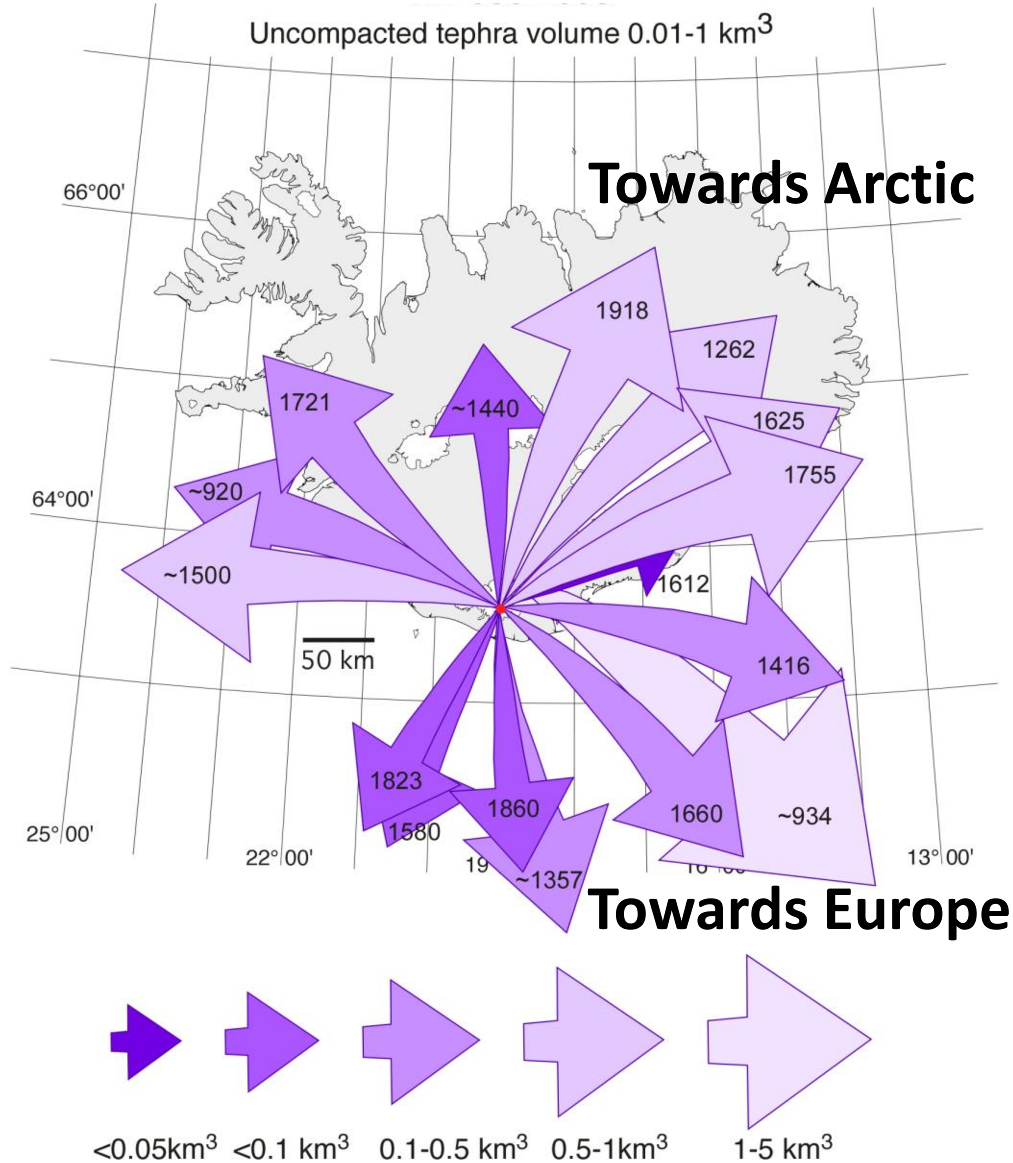


Katla eruptions 900-2000 AD



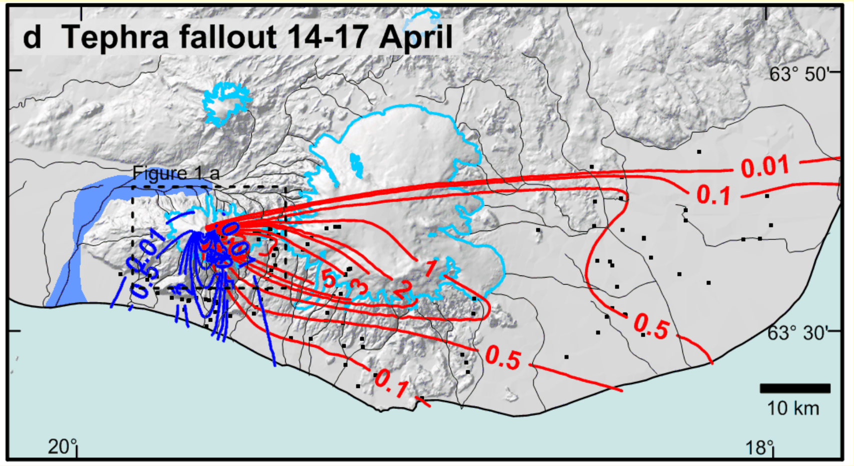
From Larsen and Eiríksson (2008)

Challenges in eruption source magnitude determination

Eruption rate – example of Eyjafjallajökull 2010 – first explosive phase

Method	MER (kg/s)	Reference
Ground sampling	$0.5\text{-}1 \times 10^6$	Gudmundsson et al. (2012)
Temporal distribution using scaled Mastin eq.		
Plume model (wind effect)	$>1 \times 10^7$	Bursik et al. (2012)
Plume model (wind effect)	$5\text{-}9 \times 10^6$	Woodhouse et al. (2012)

Mapping of mass of erupted material does not support the high eruption rates



Challenges in eruption source magnitude determination

Magnitudes of <30 µm ash emitted from volcano

Method	mass of <30µm	Reference
Ground sampling + grain size distributions	80 Tg	Gudmundsson et al. (2012)
Satellite derived	8 Tg	Stoll et al., (2011) Schumann et al. (2011)

An order of magnitude discrepancy – work needed to resolve the differences

FUTUREVOLC approach – better and faster estimates of ongoing processes – before eruptions and during eruptions

Long term magma tracking

Imminent eruptive activity, eruption onset and early warning

Determination and evolution or eruption source parameters

- In real-time or near real-time provide quantiative estimates of mass eruption rate
- Fast delivery of composition, grain size distribution and volatile emission
- Explosive, effusive and subglacial eruptions

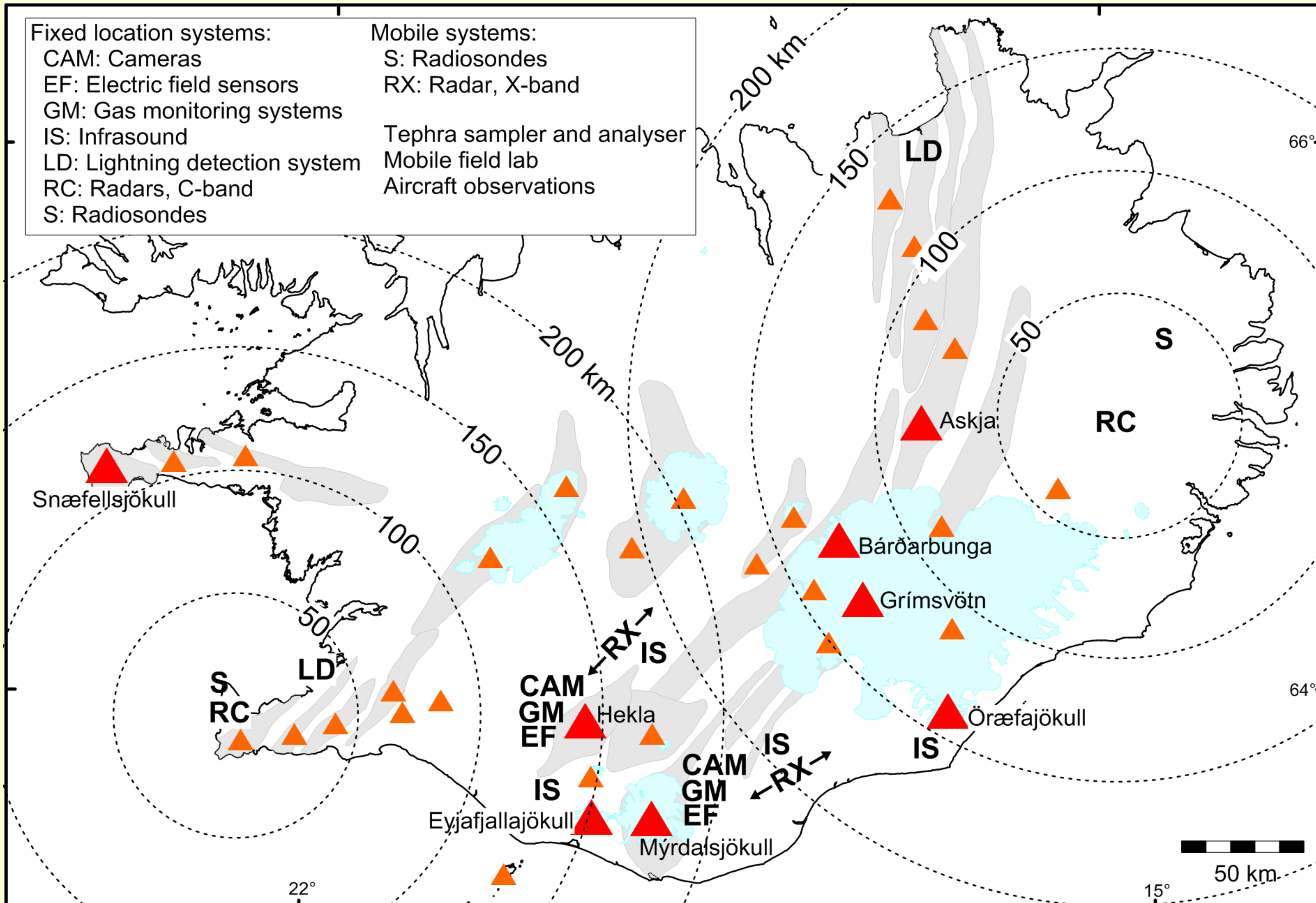
Distribution and description of eruptive products

- Fast quantitative information on atmospheric ash and sulphur dioxide concentrations in near and far field

Futurevolc: Sensors, types of volcanic eruptions, and contribution to multi-parameter system for near real time determination of eruption source parameters.

Method/sensor	Observed parameters	Explosive	Eff-usive	Sub-glacial	Data streaming
Infrasound	Acoustic waves	X	(X)		real time
Cameras	Optical and infrared	X	X	(X)	real time
Electric field sensors	Electric field gradients	X	(X)		real time
Radiosondes	Data on ambient atmosphere	X			near-real time
Tephra sampler and analyser	fallout magnitude and grain sizes	X			real time
Gas monitoring systems	release of volatiles	X	X	X	real time
Radars	microwave reflection signals	X			real time
Lightning detection system	electric field spikes	X			real time
Mobile field lab.	magma type, grain sizes	X	X		near-real time
Aircraft observations	visual, optical, infrared, SAR radar	X	X	X	near-real time
Empirical plume model calibration	plume height – mass discharge	X			calibration of system
Physics-based plume models	plume – vent – mass discharge	X			calibration of system
Multi-parameter system	All above	X	X	X	real time / near-real time

Futurevolc plan for observations of plumes – determination of MER In near real time



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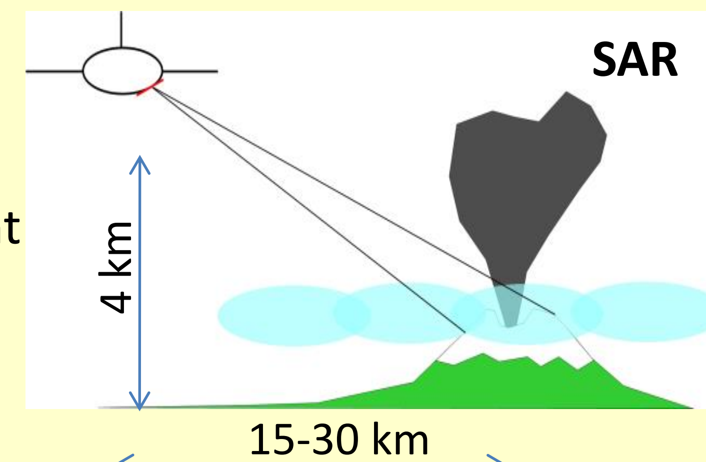
Airborne observations - SAR radar – comparison with photo

17 April 2010, 11:28

18 April 2010, 13:06

Airborne observations:

- Visual observations
- SAR radar – clouds and plume transparent
- Infrared cameras



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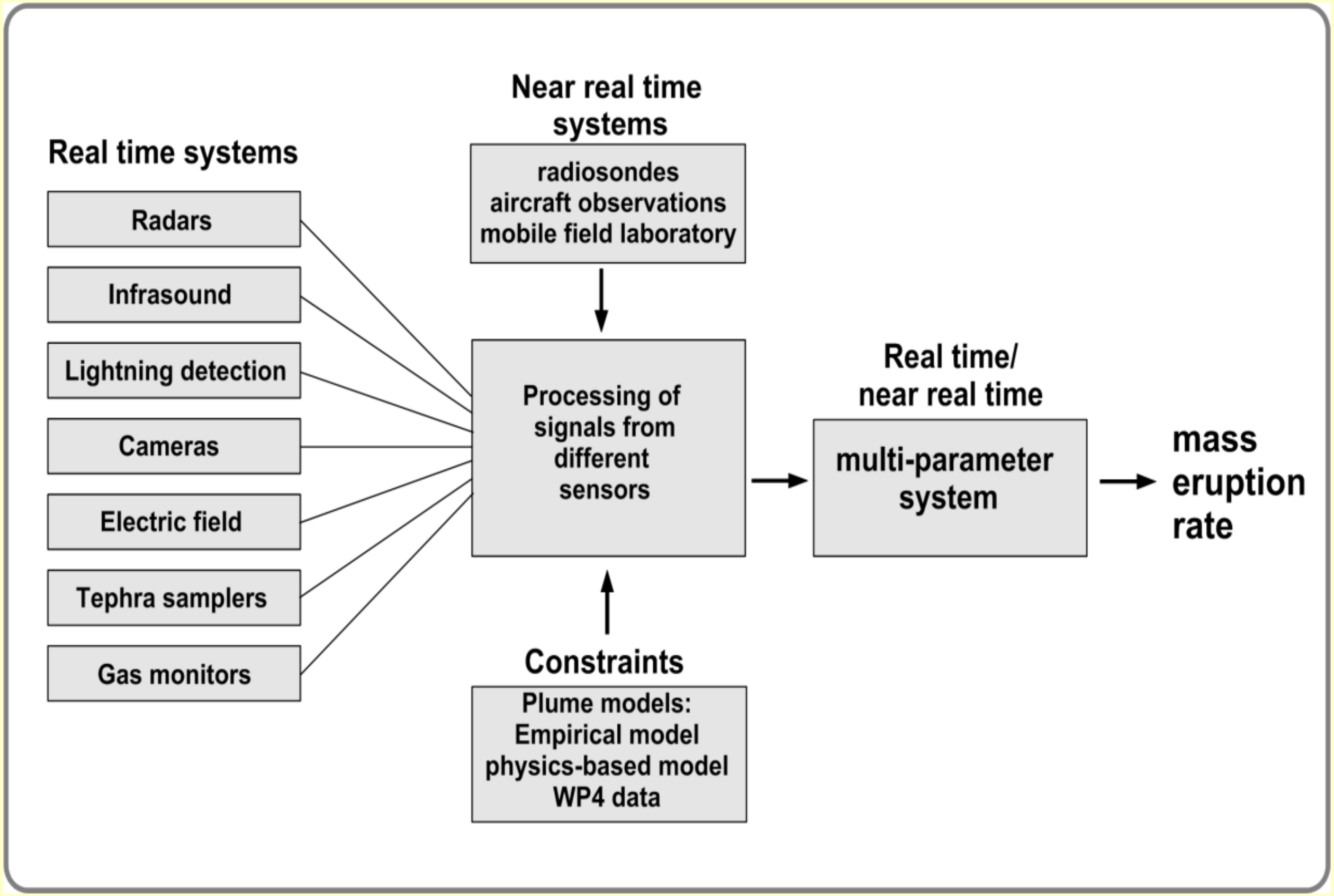
From Magnússon et al. 2012

Multi-parameter system estimating mass eruption rate using data from all sensors



Ash transport for long distances – FUTUREVOLC enhancement:

Satellite data:

- Visual
- Infrared – attenuation of thermal radiation from earth‘s surface
- Used to update – **starting from estimated MER**

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Improved MER estimates – FUTUREVOLC approach

- Interdisciplinary – multi-component bringing together physical volcanologists, geophysicists, geochemists and atmospheric scientists
- Provide a fast automated system for MER, based on a large variety of sensors
- Use well-tested methods together with new approaches
- Innovation with development of new sensors
- System tested with synthetic data – or a real eruption