ATDnet Lightning Data

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Veðurstofa Íslands

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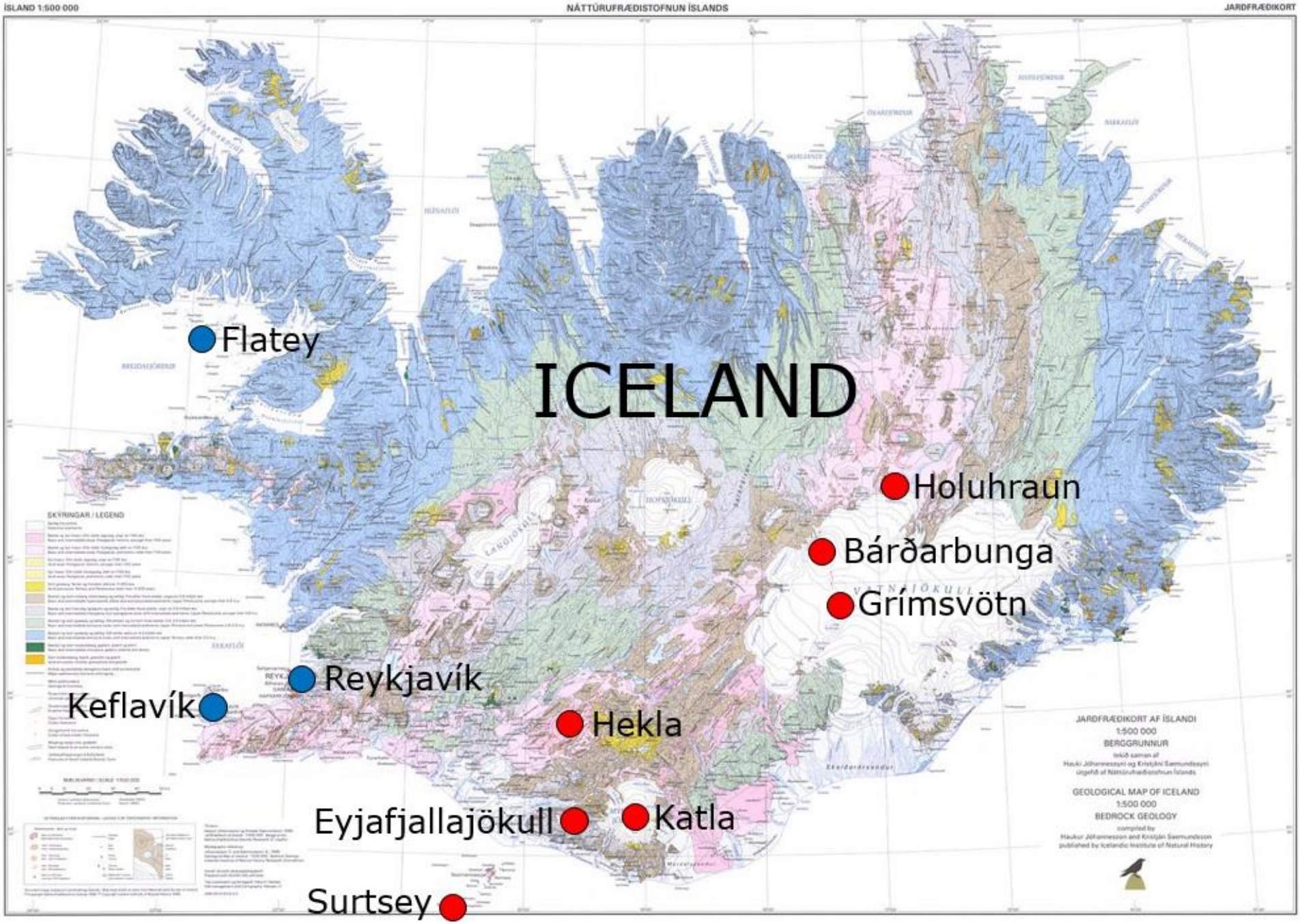

ÍSLAND 1:500 000
NÁTTÚRUFRÆÐISTOFNUN ÍSLANDS
JARDFRÆDIKORT
ICELAND
Flatey
Holuhraun
Bárðarbunga
Grímsvötn
Reykjavík
Keflavík
Hekla
Eyjafjallajökull
Katla
Surtsey
SKÝRINGAR / LEGEND
JARÐFRÆÐIKORT AF ÍSLANDI
1:500 000
BERGGRUNNUR
GEOLOGICAL MAP OF ICELAND
1:500 000
BEDROCK GEOLOGY

Icelandic Meteorological Office
Veðurstofa Íslands

- Government organization – National weather service. Founded in 1920; weather obs. since 1840s (1770s). 130 employees
- Weather – Climate – Atm. Pollution – Seismology – Tectonics – Volcanics – Glaciology – Avalanches – Hydrology
- Natural Hazards: Observations – 24-7 Monitoring – Forecasting – Warnings – Research

Icelandic Met Office

Systematic Dislocation of some Events

Eyjafjallajökull eruption. Photo Þórður Arason, 17 April 2010 at 16:35 UTC.

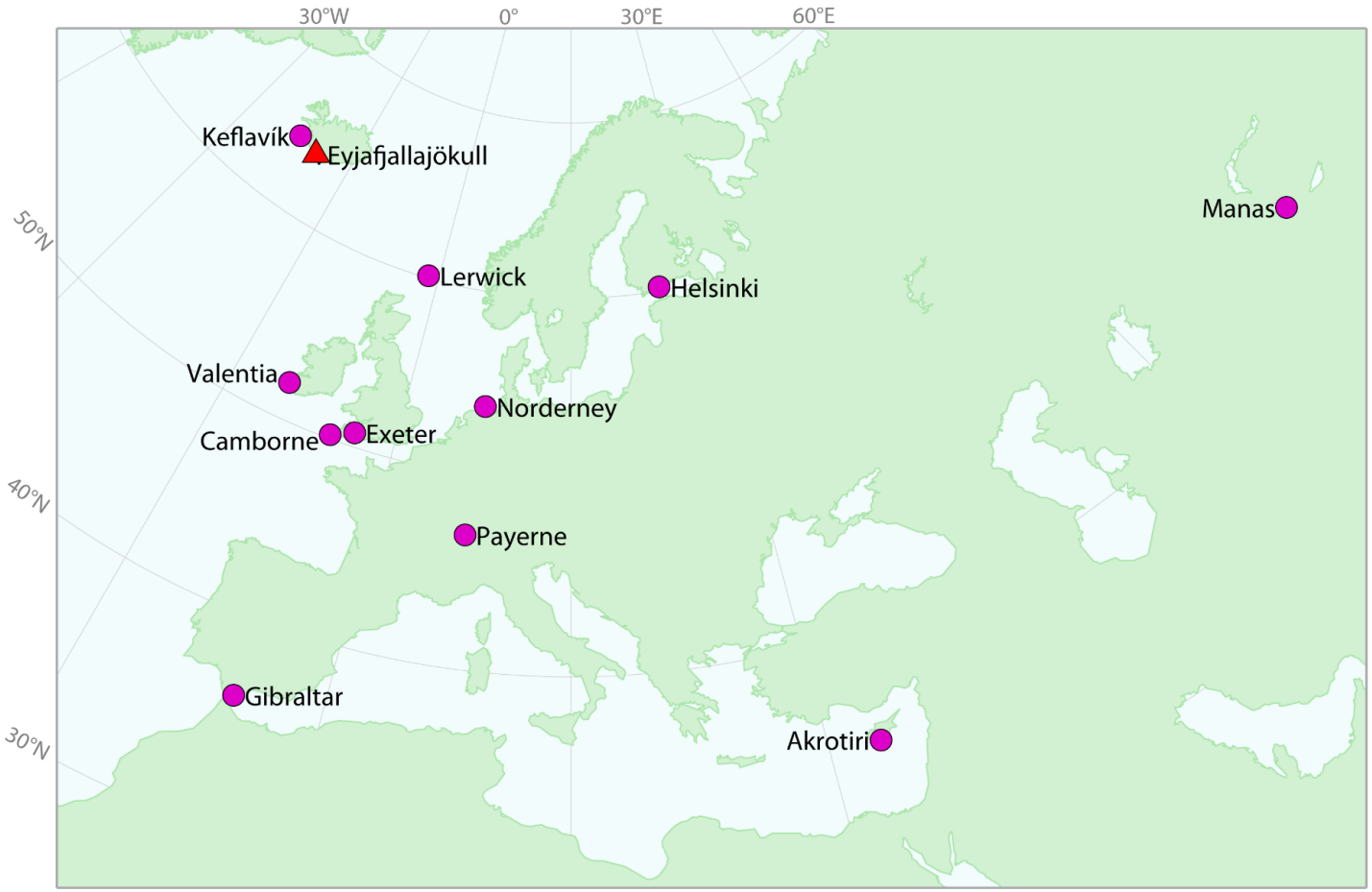
Eyjafjallajökull eruption
April 2010

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

ATDnet stations of the UK Met Office

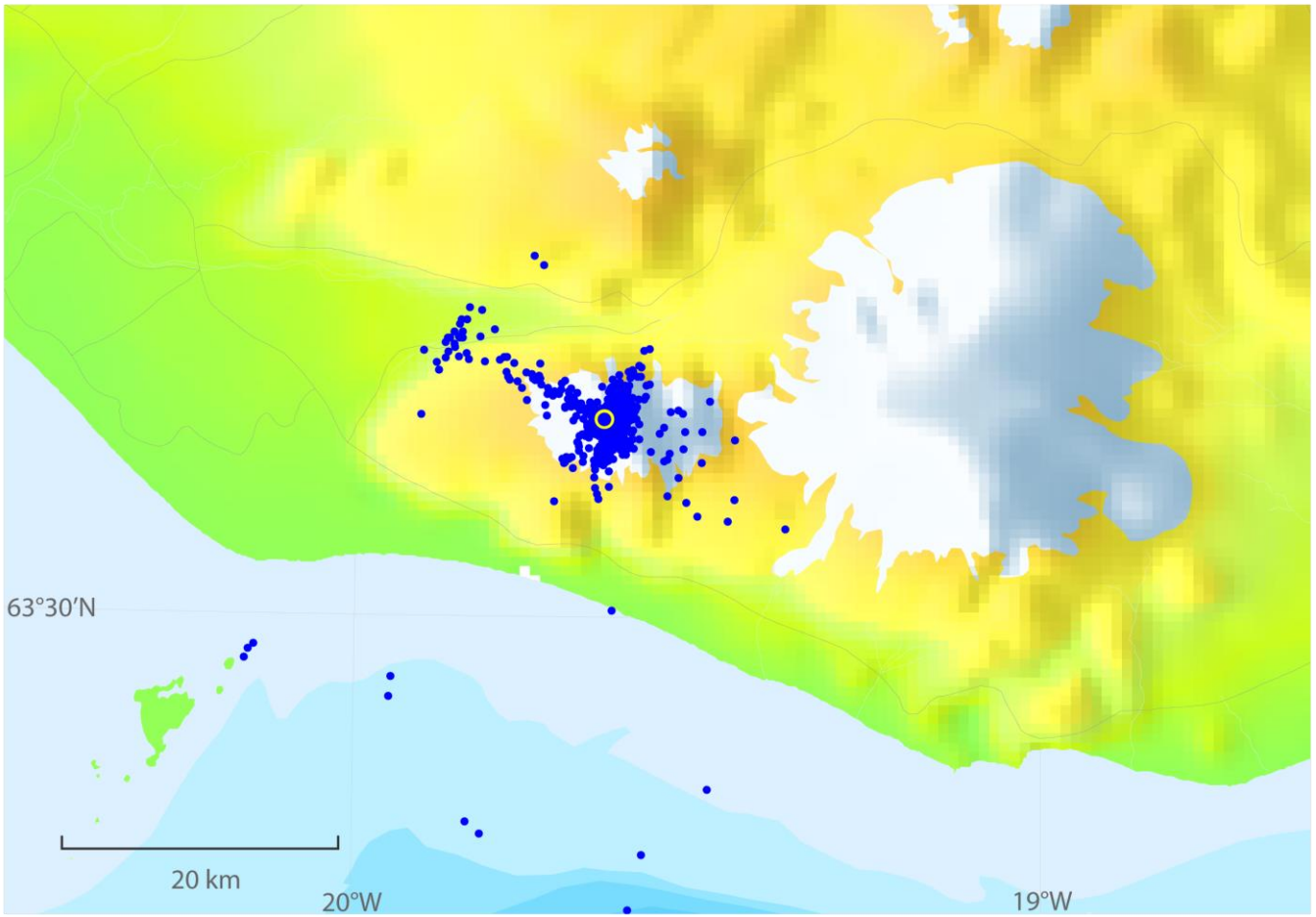
Icelandic Met Office



Arason, P., A. J. Bennett & L. E. Burgin (2011), Charge mechanism of volcanic lightning revealed during the 2010 eruption of Eyjafjallajökull, *Journal of Geophysical Research*, **116**, B00C03, doi:10.1029/2011JB008651

ATDnet lightning during Eyjafjallajökull April-May 2010

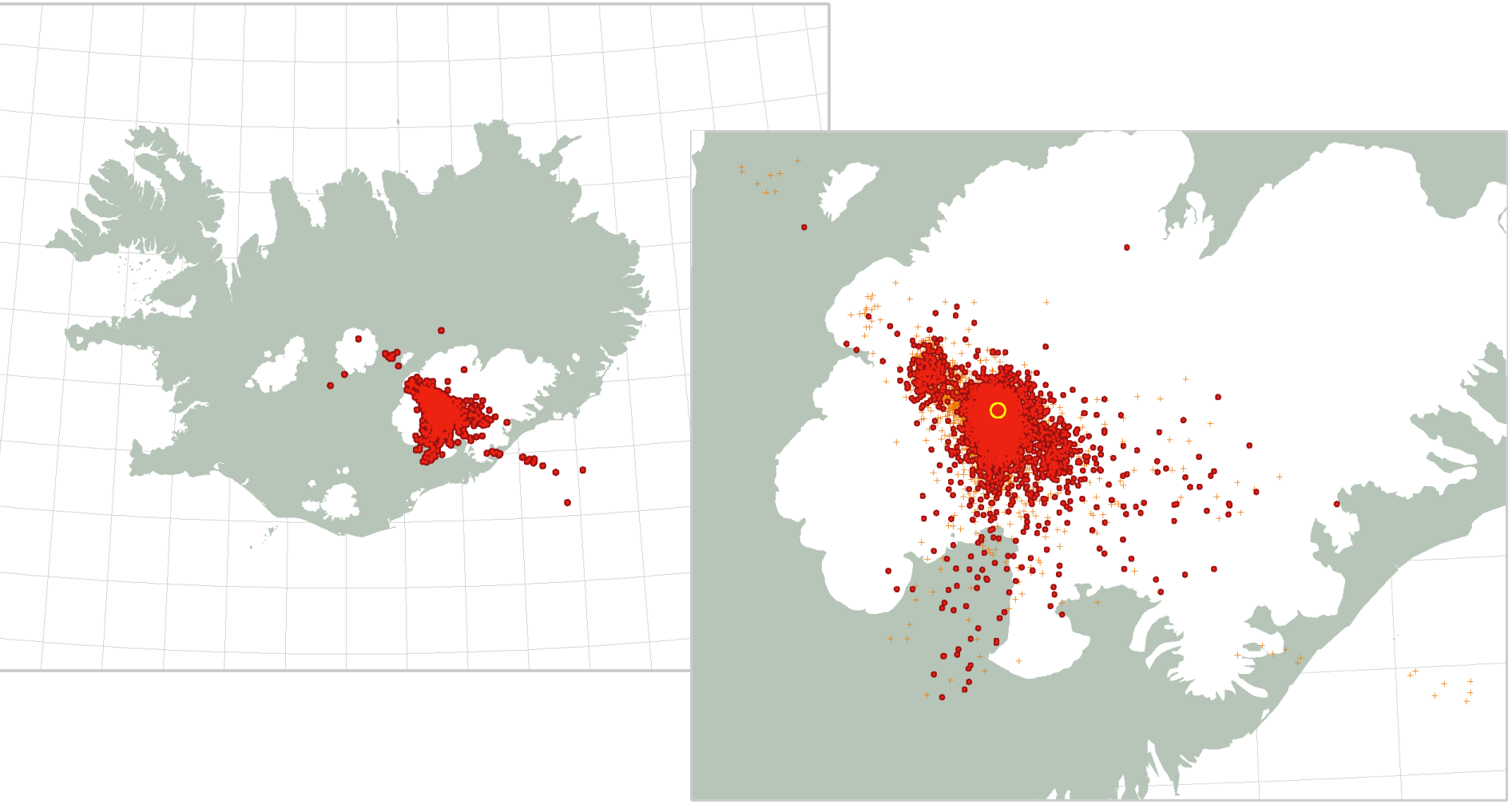
Icelandic Met Office



Arason, Bennett & Burgin (2011), *J. Geophys. Res.*, (Fig. 3)

ATDnet lightning during Grímsvötn 21-28 May 2011

Icelandic Met Office

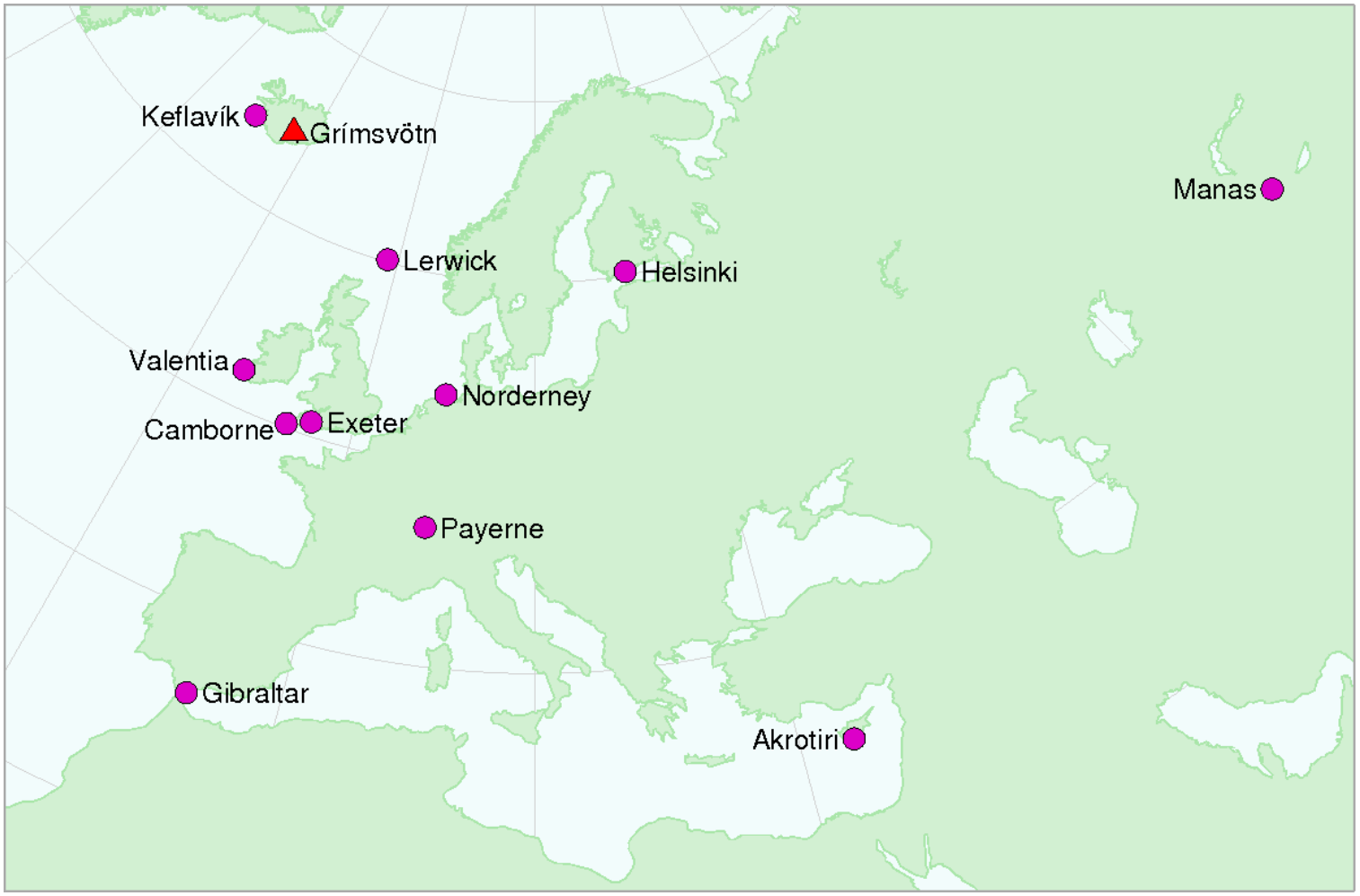



21. MAY 2011
19:19:44
ICELAND
(C) 2011 INGOLFUR BRUUN
VOLCANO GRÍMSVÖTN
KPS


15 km
10 km
Tr
5 km
Gr
Grímsvötn eruption
May 2011
Photo Bolli Valgarðsson 21 May 2011 at 19:20

ATDnet Out-Stations

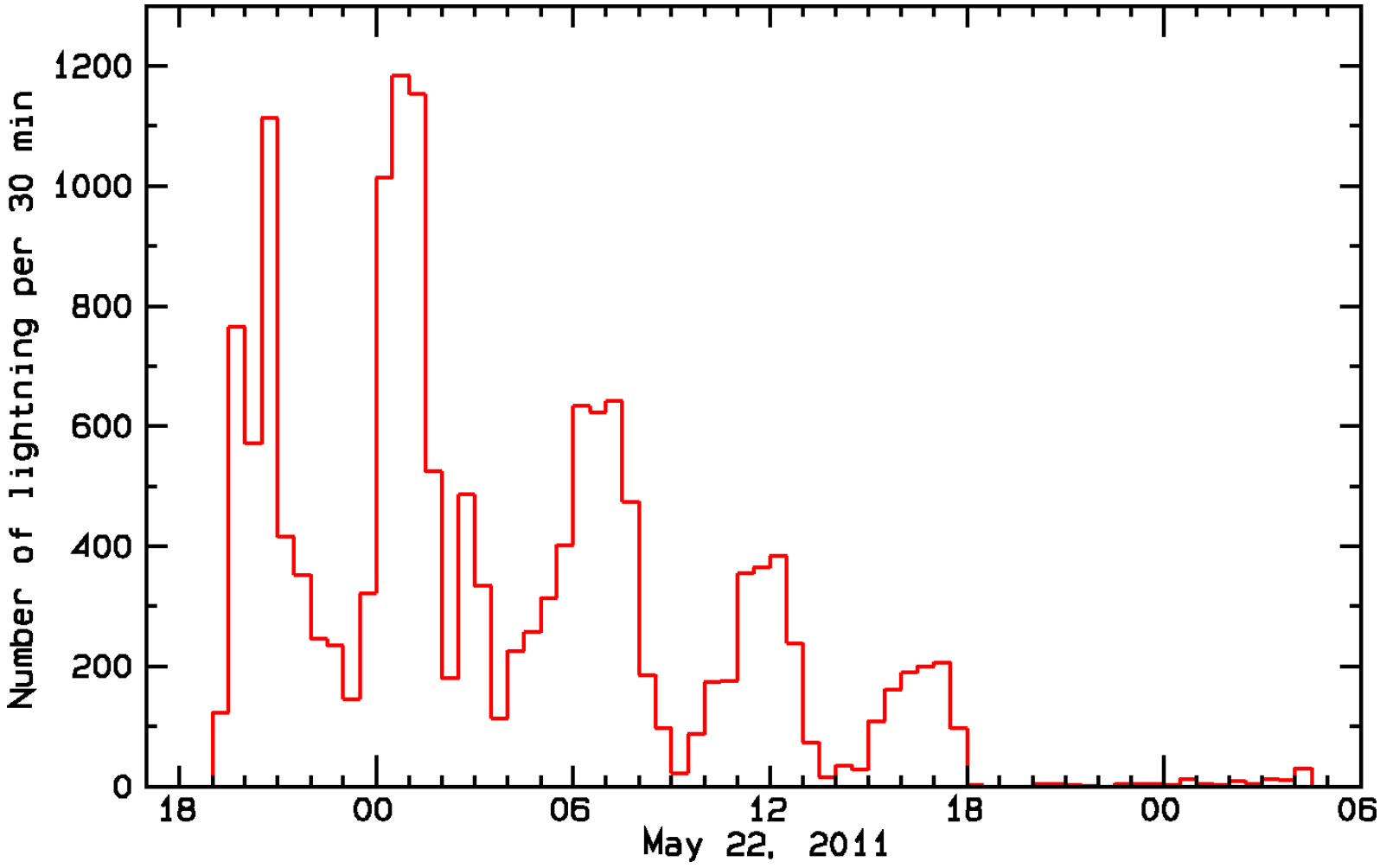
Icelandic Met Office



Grímsvötn May 2011

Lightning count per 30 min

Icelandic Met Office



Icelandic Met Office

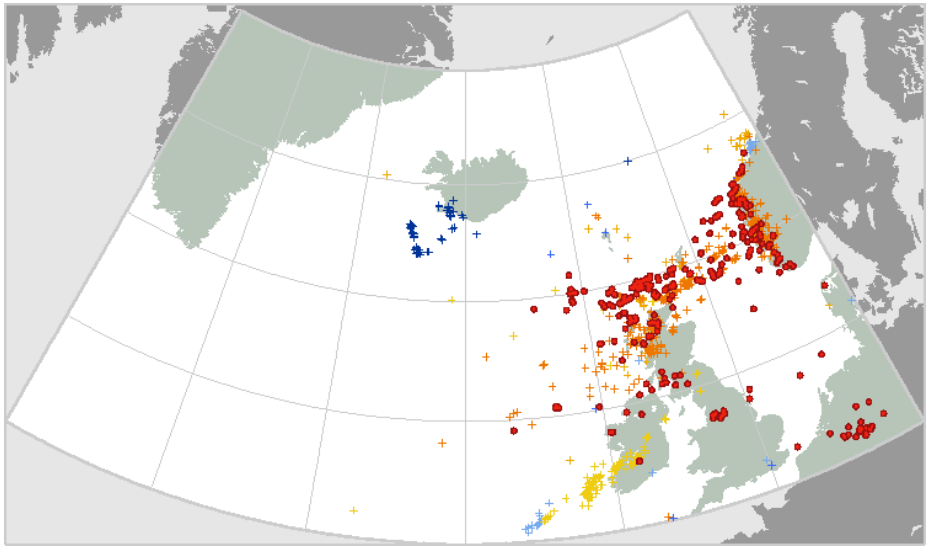
Comparison of ATDnet and WWLLN Data

ATDnet station in Iceland
Arrival Time Difference Network

Icelandic Met Office

- **ATDnet out-station, owned and operated by UK Met Office, was installed at Keflavík upper air radio-sonde station of the Icelandic Meteorological Office in July 2002.**
- **Detects 11-16 kHz vertical electric field**

Technicians from UK Met Office set up an ATD-sferics out-station in Keflavík, SW-Iceland.
Photo Þórður Arason 4 July 2002.



ATDnet located lightning from IMO-web on 30 January 2016.
http://brunnur.vedur.is/athuganir/eldingar/

WWLLN station in Iceland
World Wide Lightning Location Network

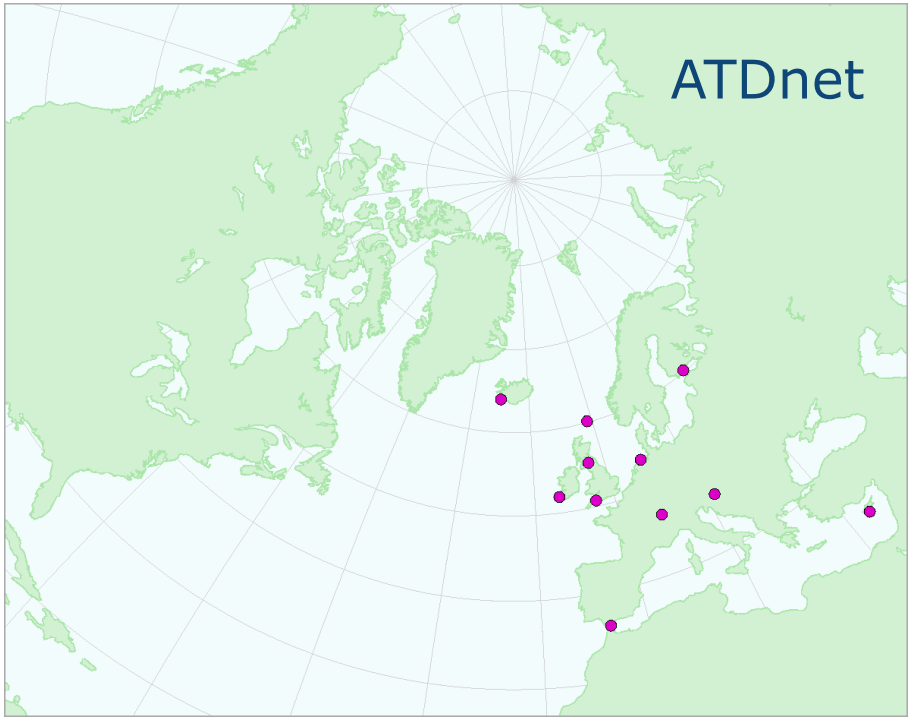
Icelandic Met Office

- Operated from University of Washington in Seattle, USA
- About 70 stations around the globe, often at universities
- Detects 3-30 kHz vertical electric field
- IMO has acess to data (with one week delay)
- Station installed at IMO headquarters in Reykjavík in 2013 and data has been collected since November 2013

WWLLN antenna at IMO rooftop in Reykjavík. Photo Þórður Arason 9 February 2016.

Station distribution

Icelandic Met Office



Data from the ATDnet & WWLLN

Icelandic Met Office

ATDnet lightning data

- Origin time of lightning, resolution 0.1 µs
- Location (lat, lon), resolution 0.001° (100 m)
- Uncertainty estimate in location (km)
- Data retrieved from UK Met Office every 10 min

```
2015-12-31_16:00:33.6992798    22 64.606 12.928   2.11 G
2015-12-31_16:00:33.8310394    23 64.562 12.743  13.22 G
2015-12-31_16:07:09.4906092   399 64.669 12.988   2.03 G
```

WWLLN lightning data

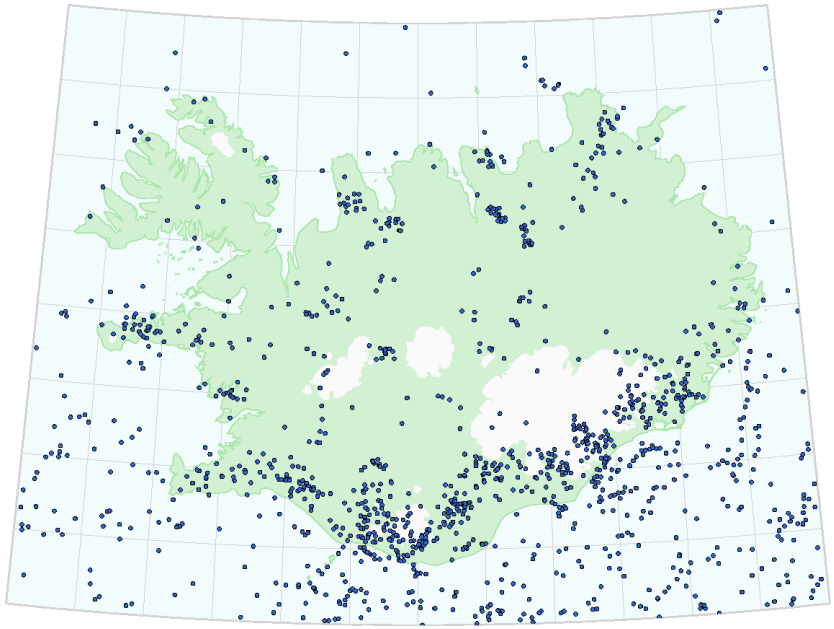
- Origin time of lightning, resolution 1 µs
- Location (lat, lon), resolution 0.0001° (10 m)
- Uncertainty estimate in time (ms)
- Data retrieved daily from UW in Seattle

```
2015-12-31_16:00:33.699179 64.6311  13.0452 20.2  9
2015-12-31_16:07:09.490489 64.6393  13.0528  9.6  6
2015-12-31_16:07:09.490493 64.6915  13.0129 16.8 14
```

Located lightning 2014-2015
Comparison: Two whole years; 63-67°N, 13-25°W

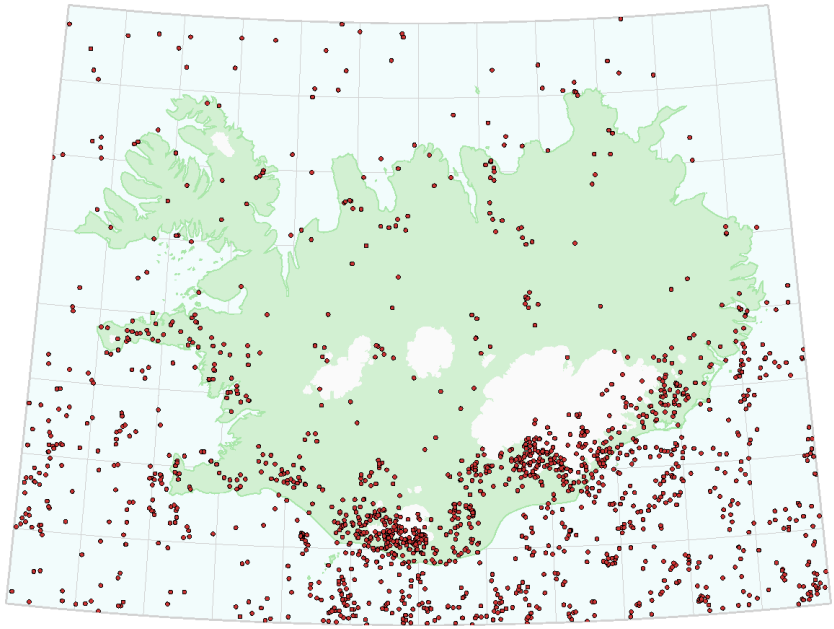
Icelandic Met Office

ATDnet



N = 1246

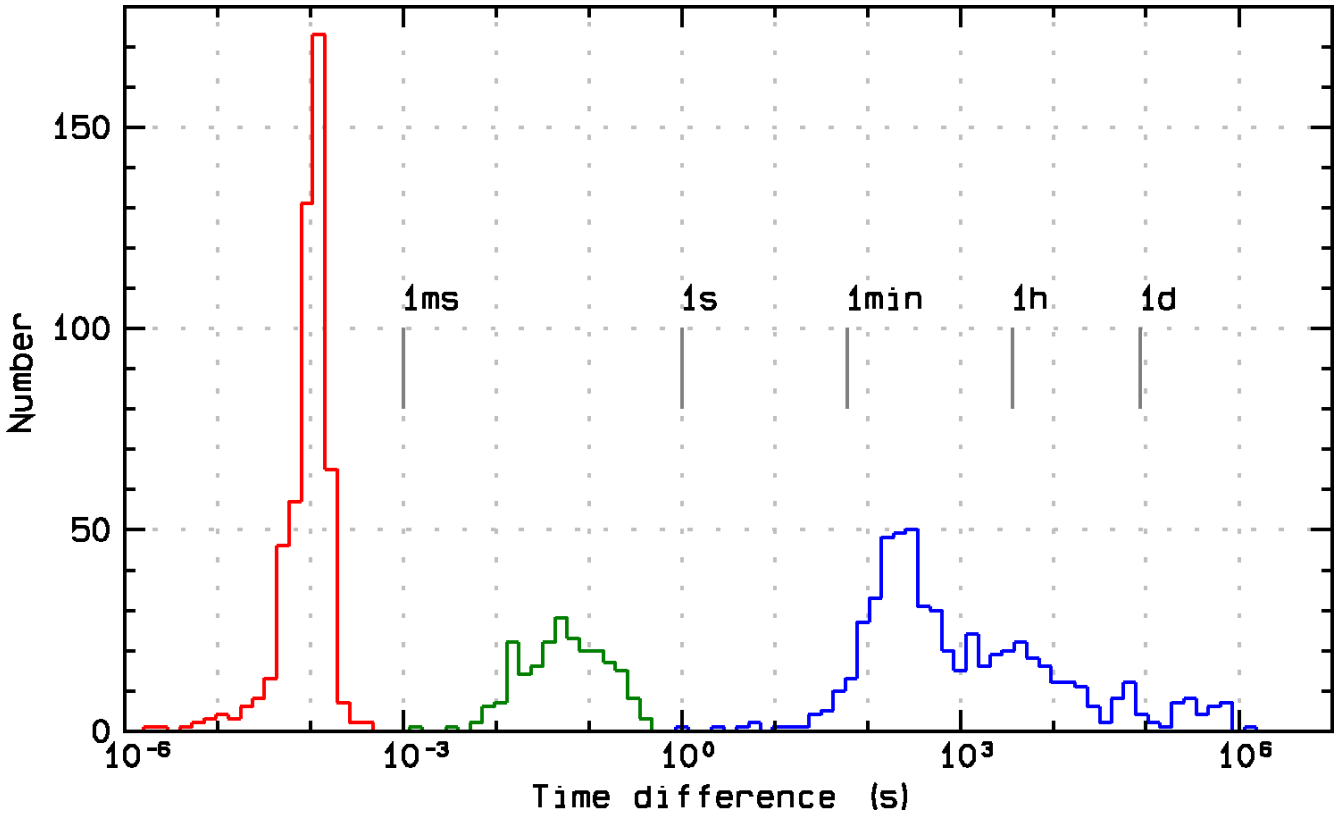
WWLLN



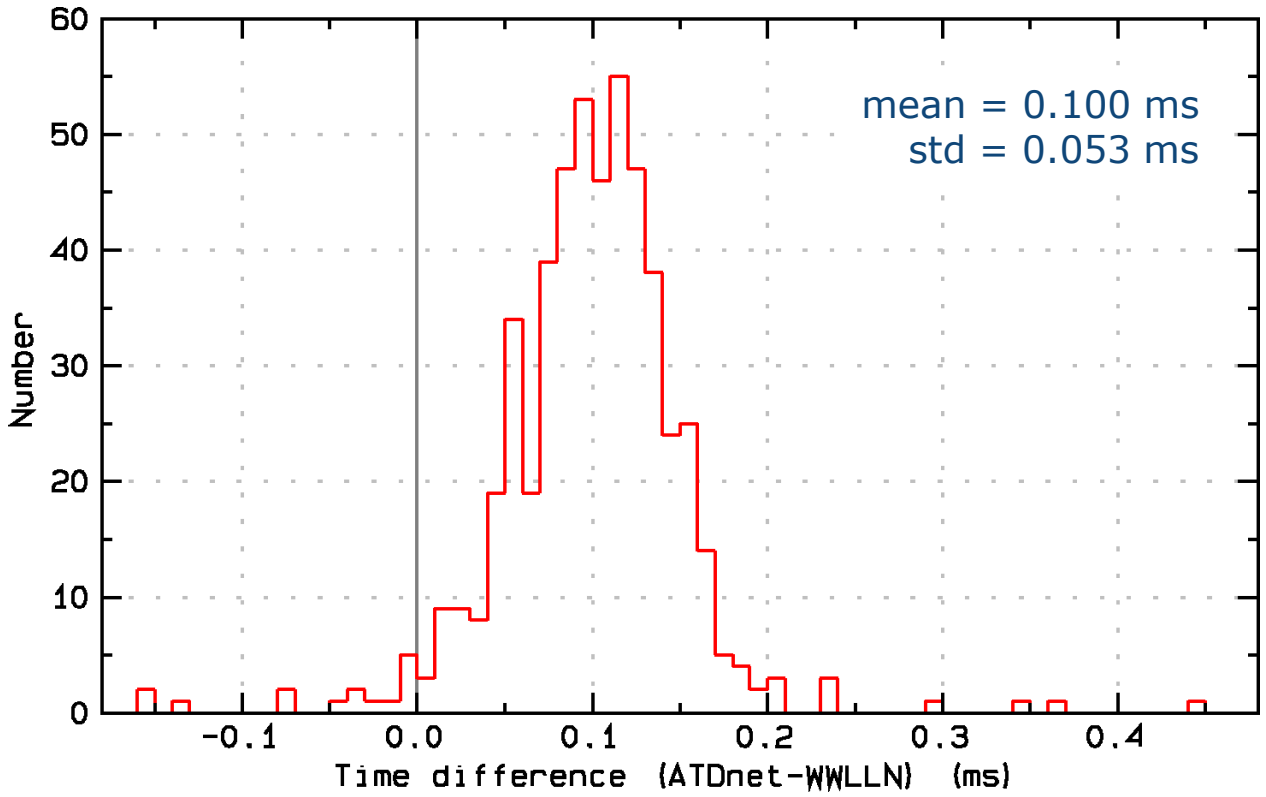
N = 1559

Time difference between systems
when next event is recorded by the other system

Icelandic Met Office



Time difference between systems when Δt < 1 ms



Number of synchronous events

Icelandic Met Office

N_{atd}

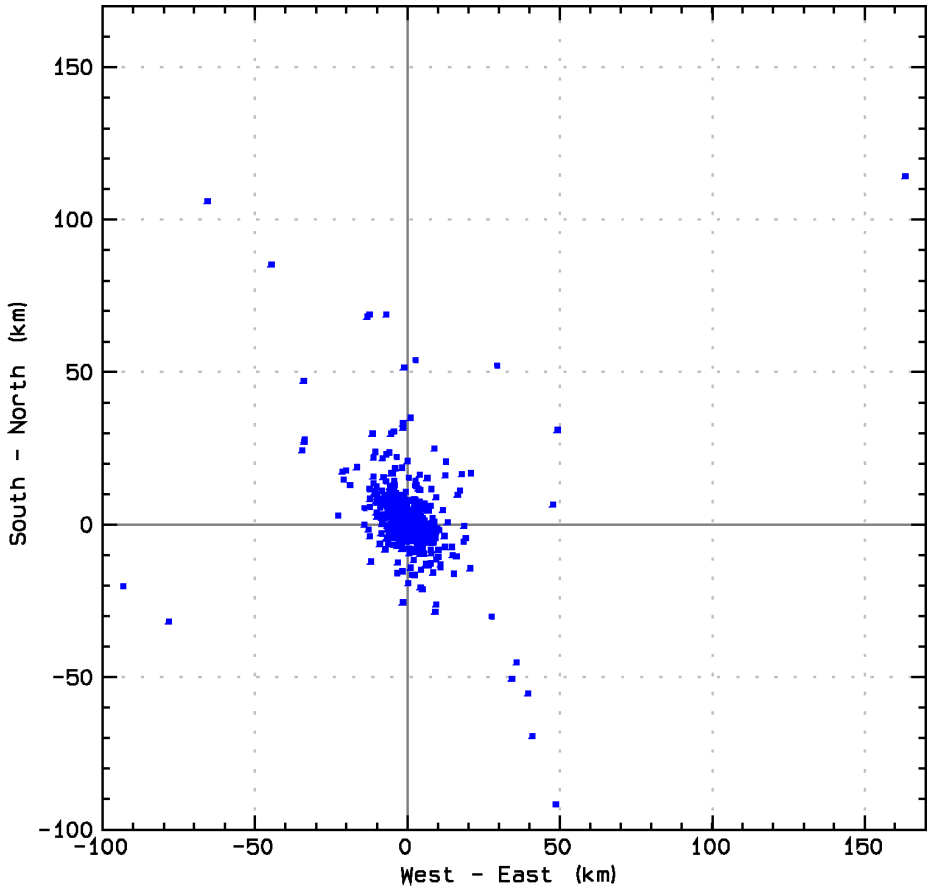
N_{wwlln}	0	1	2	3	4	5	6
0	*	388	53	6	0	1	0
1	385	195	61	10	4	0	0
2	125	124	27	6	3	0	1
3	23	27	13	6	2	1	1
4	3	4	6	1	2	1	1
5	0	1	3	0	1	1	1
6	0	0	1	0	0	0	0

N_{atd}

N_{wwlln}	0	1+	
0	*	435	
1+	526	527	53%
		48%	

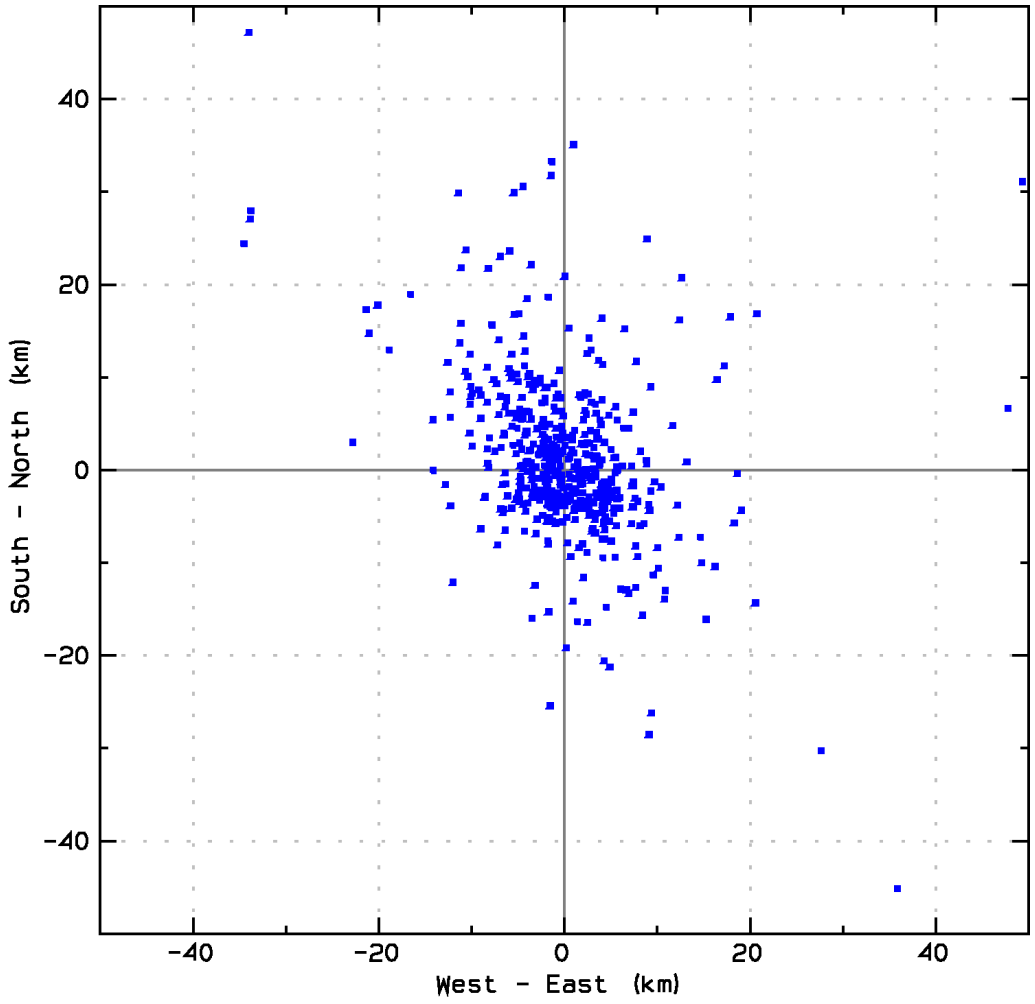
Relative location of synchronous events

ATDnet set at (0, 0)

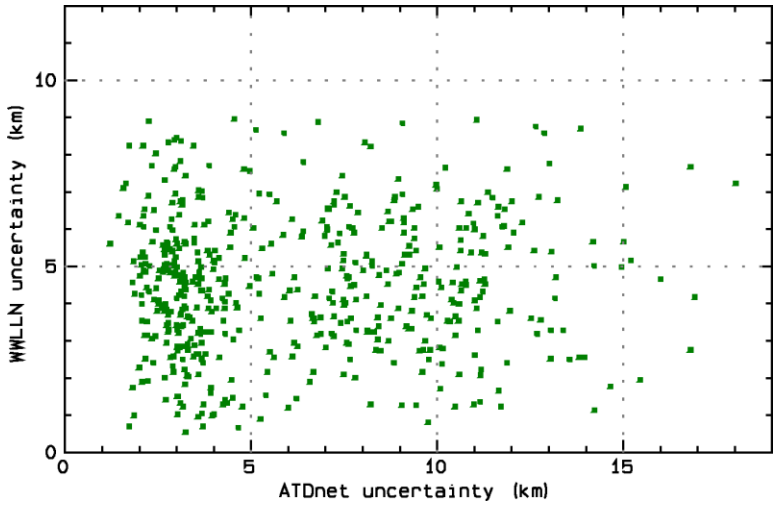


Relative location
<50 km

Icelandic Met Office



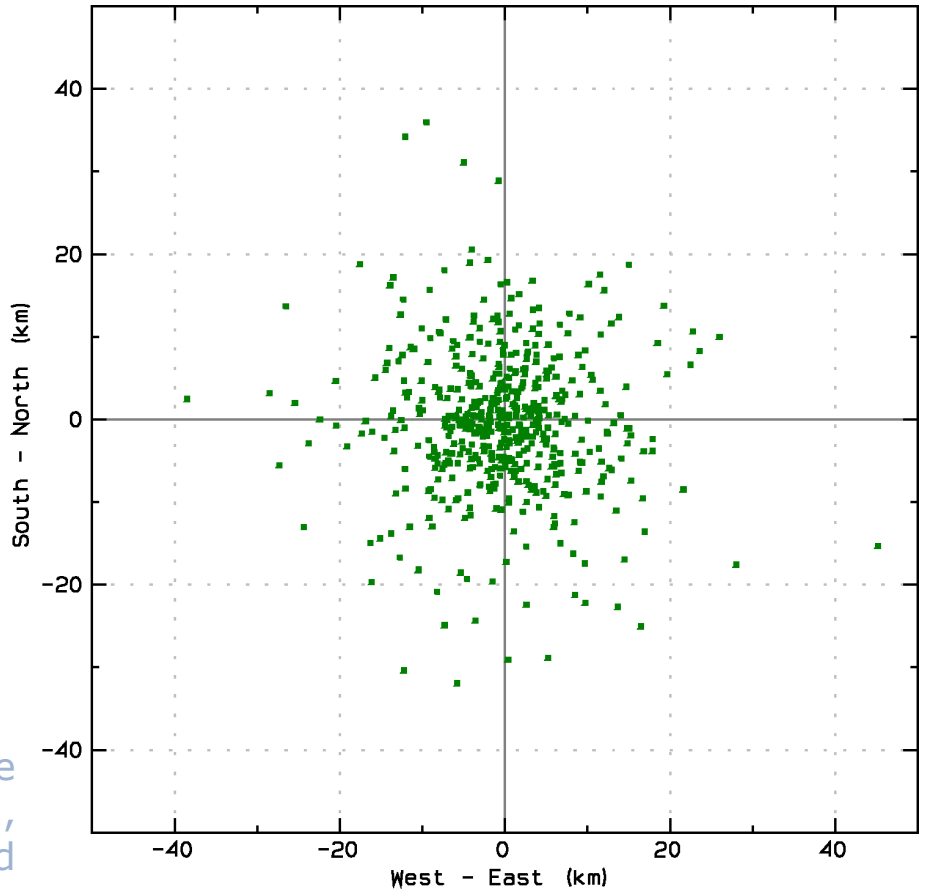
Location uncertainty



WWLLN uncertainty is given as a time uncertainty. Here the time is multiplied by speed of light to get location uncertainty.

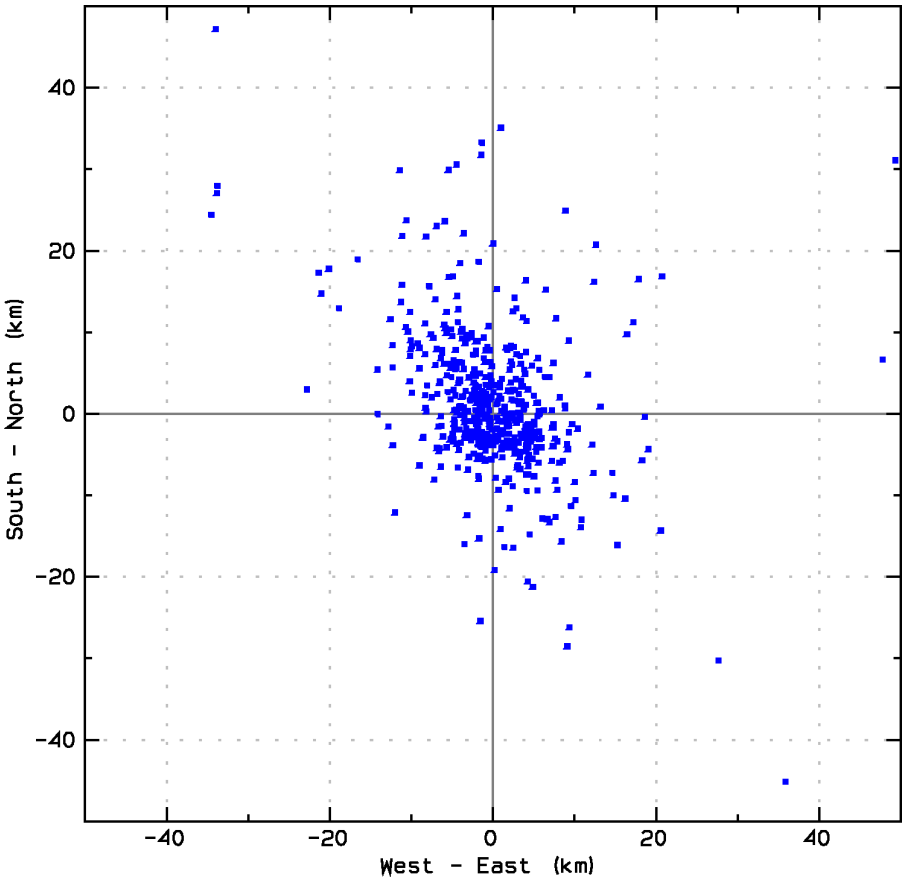
Assuming the given uncertainty is a one standard deviation of a normal distribution, then the relative location difference would look like this.

Calculated probable distribution

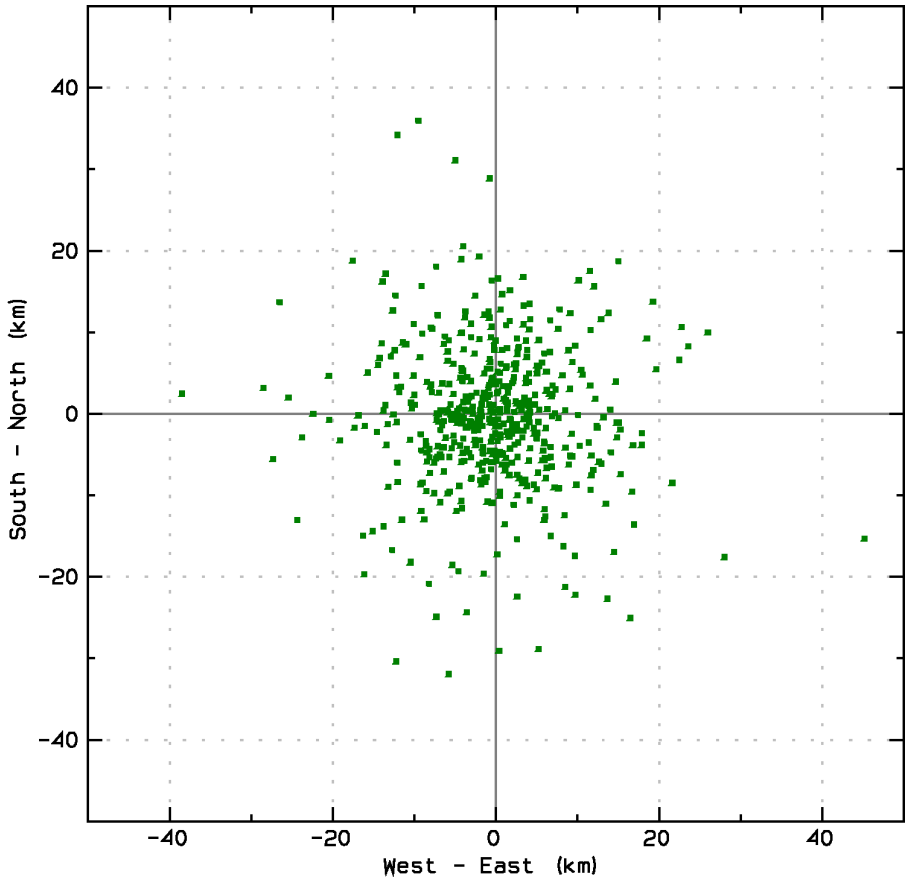


Comparison of locations
relative locations and calculated distribution

Icelandic Met Office



mean = (–0.047, 1.353) km
$st_{-30°}$ = 12.2 km; $st_{+60°}$ = 6.5 km



mean = (0, 0) km
Standard deviation = 8.7 km

Conclusions

Icelandic Met Office

- **Time difference of systems is about 0.1 ms**
- **Each system records about half of the lightning recorded by the other system**
- **No significant mean location bias is beetween the systems (<2 km)**
- **Location accuracy is usually well below 10 km**
- **On average the estimated uncertainty of the systems seems to be reliable**

Icelandic Met Office

Installation of the ATD-Sferics/ATDnet Out-Station in Keflavík, Iceland, July 2002

Keflavík – ATD-sferics station

- Photos by Þórður Arason taken on 4 July 2002 during installation of the Keflavík ATD-sferics / ATDnet station
- Upper-air radio-sonde station of the Icelandic Meteorological Office, at 63°58.098'N, 22°36.811'W, 38 m a.s.l. About 400 m to the West from the N-S runway (02) of the Keflavík International Airport
- Technicians Eric Hibbett & Mark Salkovskis of the UK Met Office installed the station, with a little help from Þórður Arason and Jens Kristinsson of the IMO

Mark Salkovskis and Eric Hibbett by the ground antenna. Photo Þórður Arason 4 July 2002.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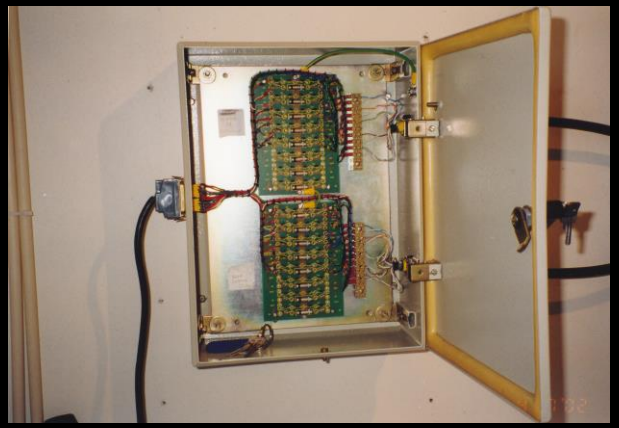


Arctic Tern (Kría) in Flatey island, W-Iceland. Photo Þórður Arason, August 2016.