



British
Geological Survey

Expert | Impartial | Innovative



Gateway to the Earth

From Raspberries to Aurora:

Sensing the Northern Lights (Aurora Borealis)
with a *Raspberry Pi* magnetometer

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British Geological Survey

Royal Astronomical Society, 12-Apr-2019

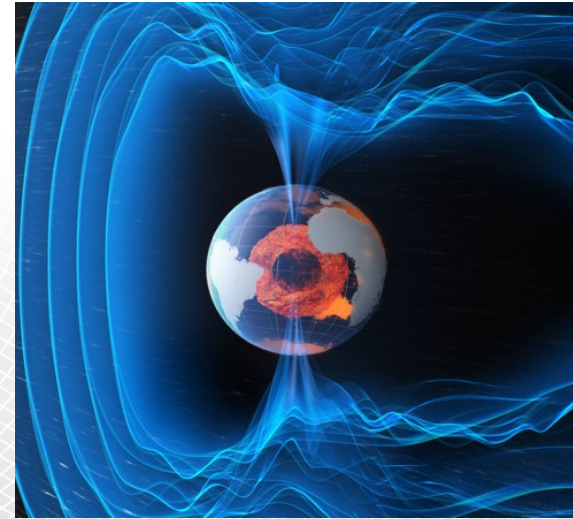
Magnetometers = compasses



Earth's magnetic field

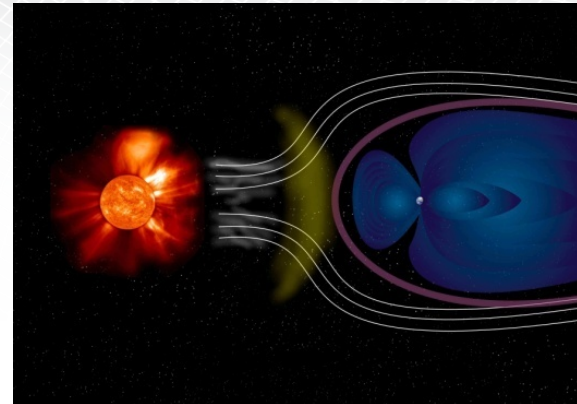
Core field

- Most of the field is from the **Earth's liquid iron core**
- Generated > 3500 km away
- Weaker than your average fridge magnet
- Changes slowly over time (years - millennia)



External field

- Fields due to currents in the tenuous upper atmosphere & space
- **ionosphere** (from about 100 km altitude)
- **magnetosphere** (>2 Earth radii)
- Changes rapidly (seconds - days)

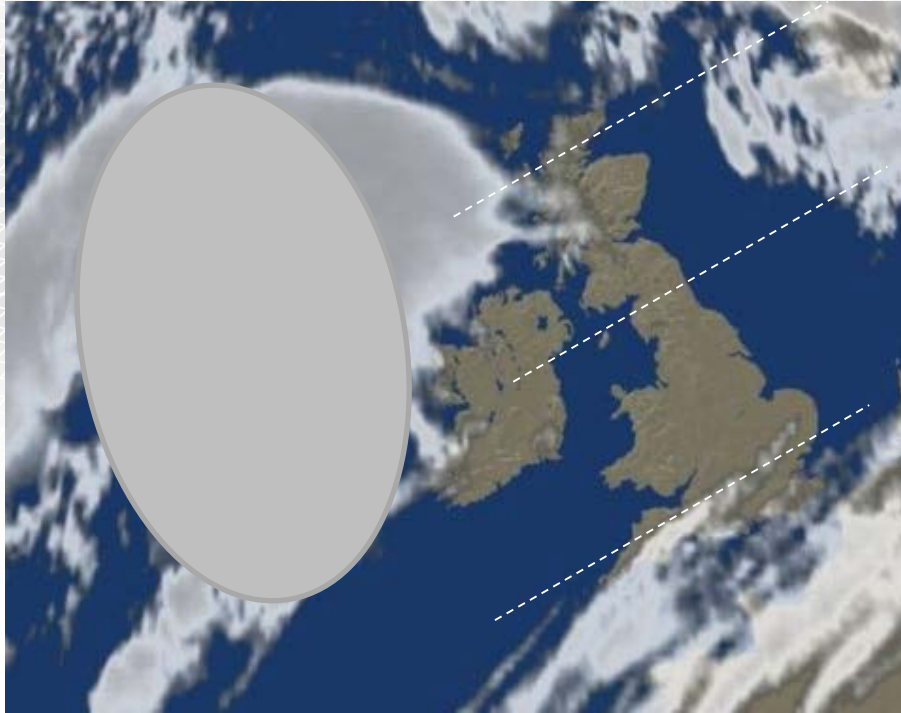


Aurora: Greenock in October 2015



© Doug Collinson:
Northern Lights Over Cloch Lighthouse [07-Oct-2015]
<https://www.flickr.com/photos/60122552@N08/>

How common are the aurora in the UK?

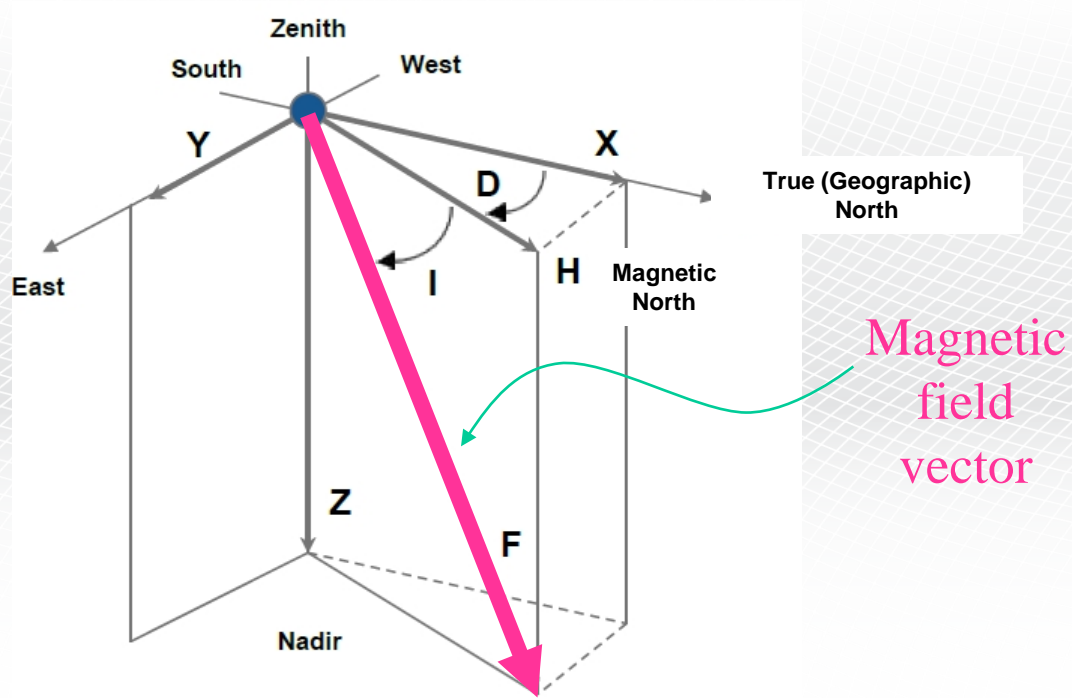


Once per month

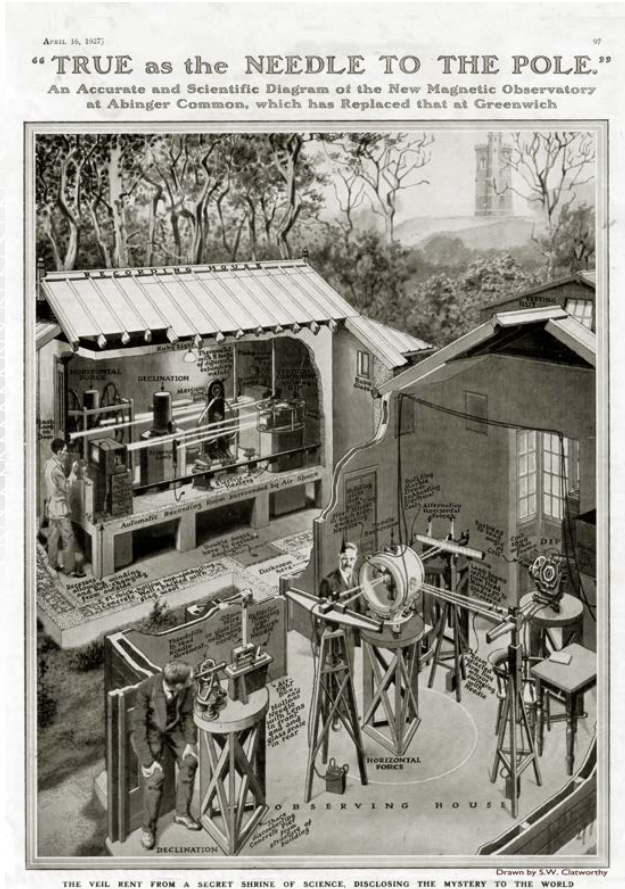
Once per year

Once per decade

Some magnetic field words



Measuring the Earth's magnetic field: the past



**Abinger observatory
(formerly Greenwich)**

Measuring the Earth's magnetic field: present day

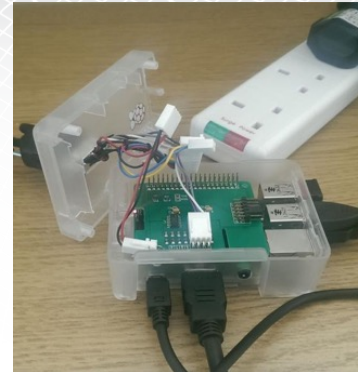
Scientific Magnetometer

- Absolute measurements
- Long-term magnetic cleanliness of site
 - Platform stability important
 - Temperature control/correction important
- Good for main magnetic field
- Cost: £15,000+



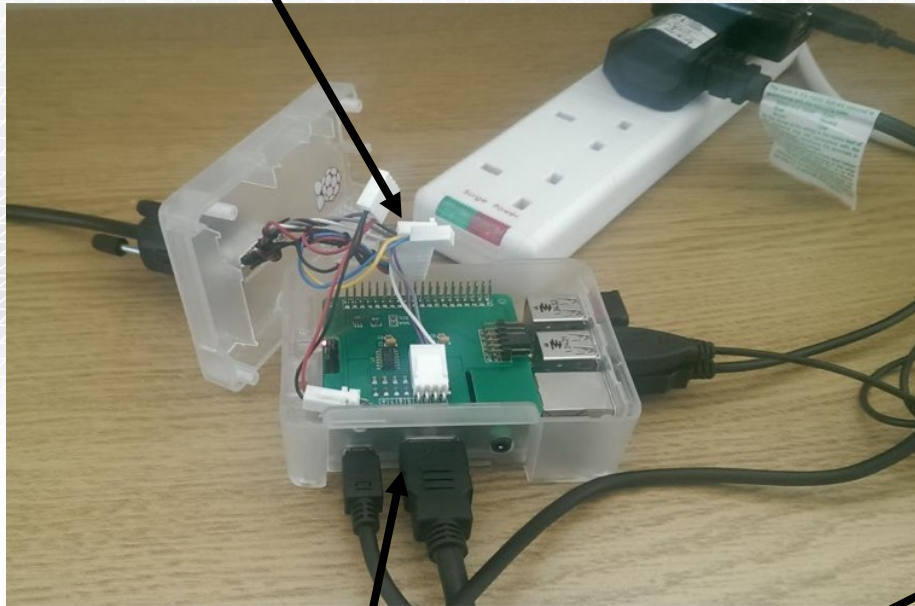
Raspberry Pi magnetometer

- Relative not absolute accuracy
- Not temperature controlled
- Good for external magnetic fields
- Cost: £150
- ~100 times less accurate but more than good enough!



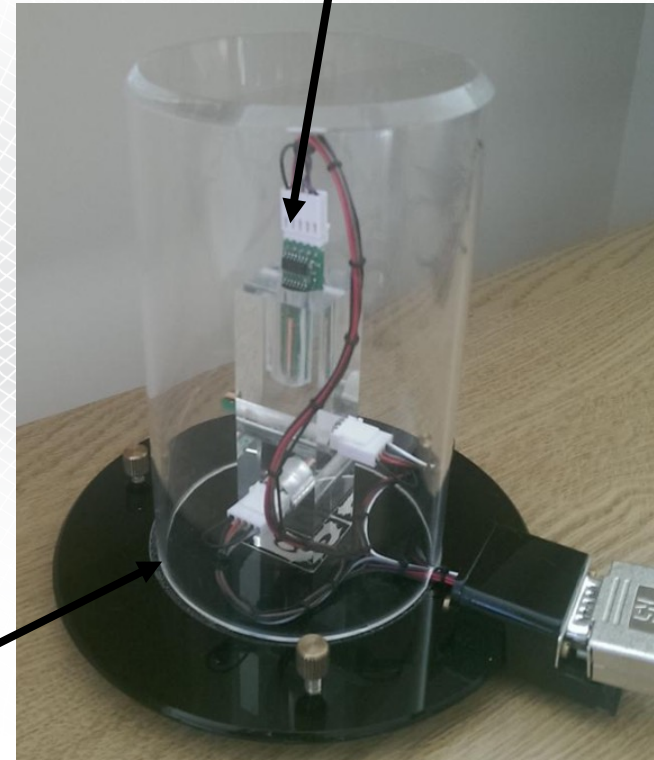
The initial model

AB Electronics
17-bit digitiser



Raspberry Pi
B-model

Adafruit TM36
thermometer

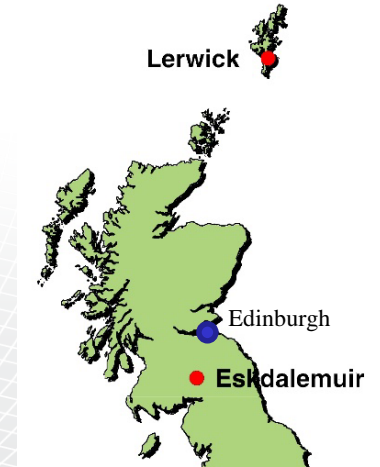
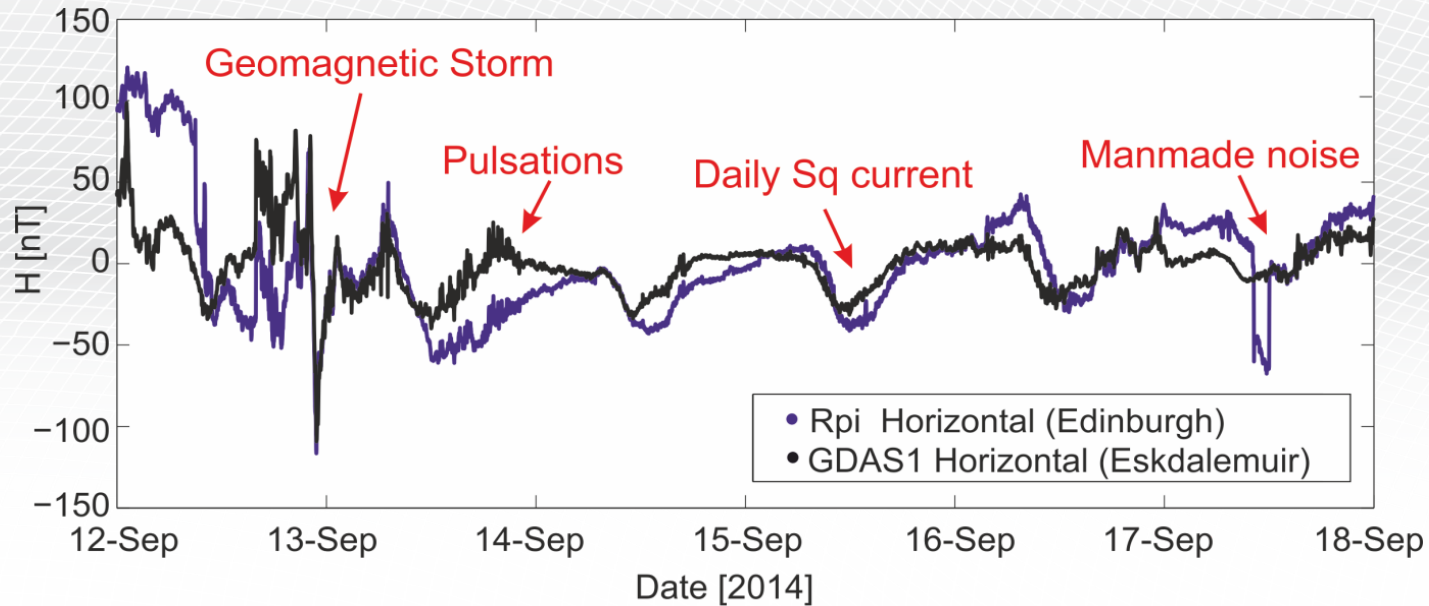


Stefan Mayer
FLC-100
fluxgate magnetometer

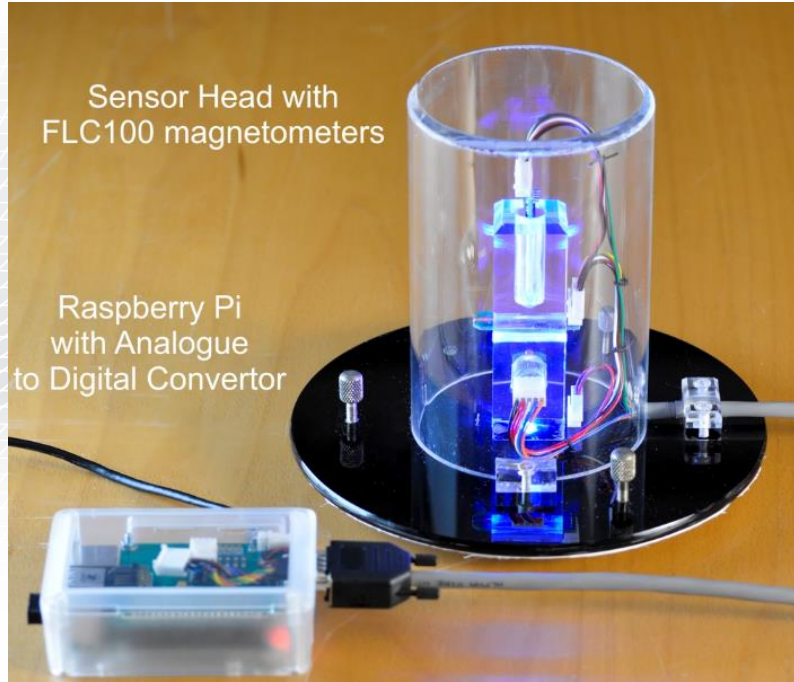
Tests in Edinburgh

Comparison of Horizontal (H) force:

- Black: Eskdalemuir Observatory
- Blue: Rpi in Edinburgh

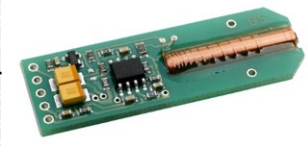
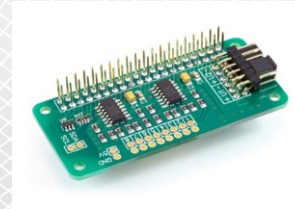


The Schools version (v2)



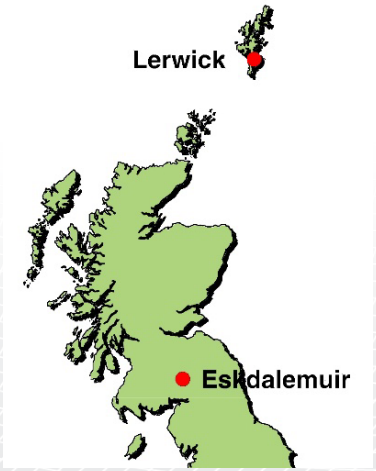
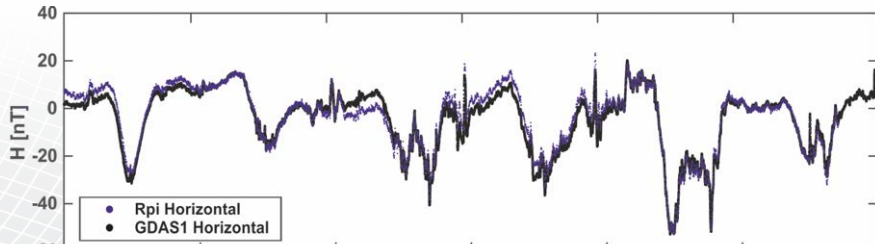
FLC-100 fluxgates:
North, East Down

AB Electronics
Analogue to Digital
Converter



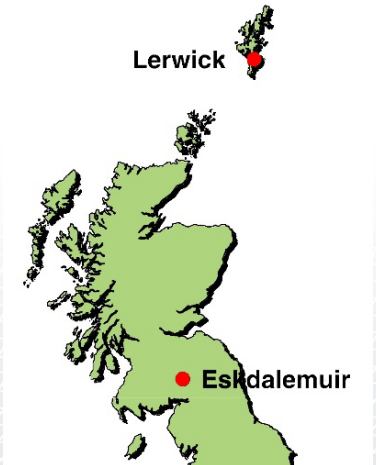
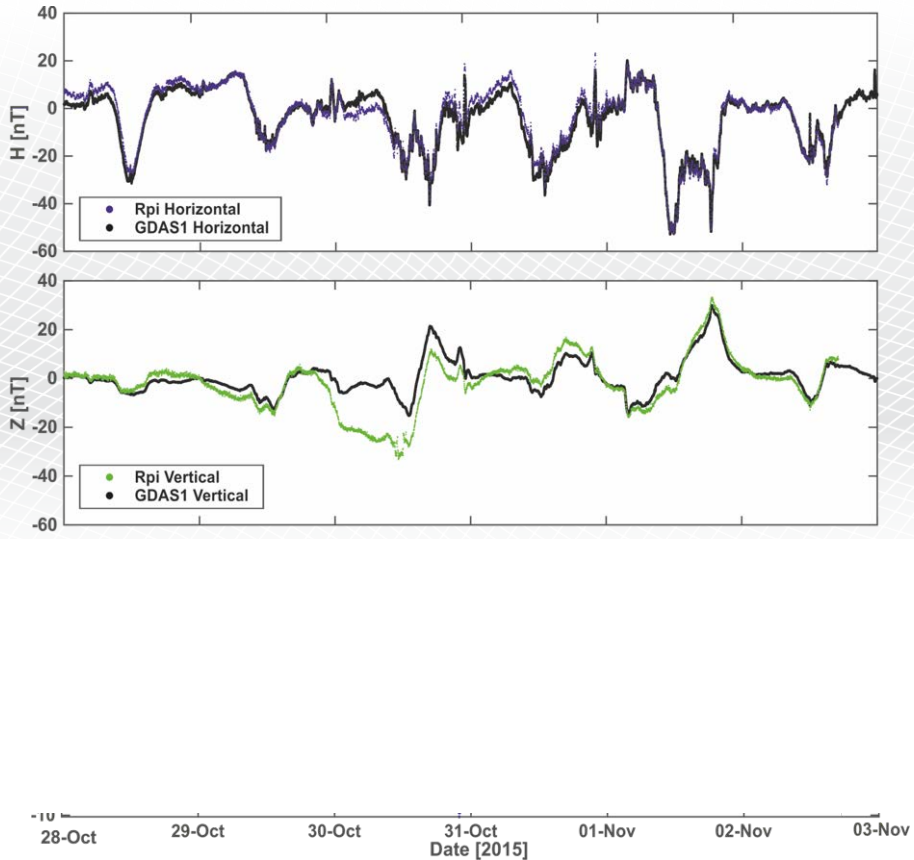
Raspberry Pi B+ computer

On test in Eskdalemuir



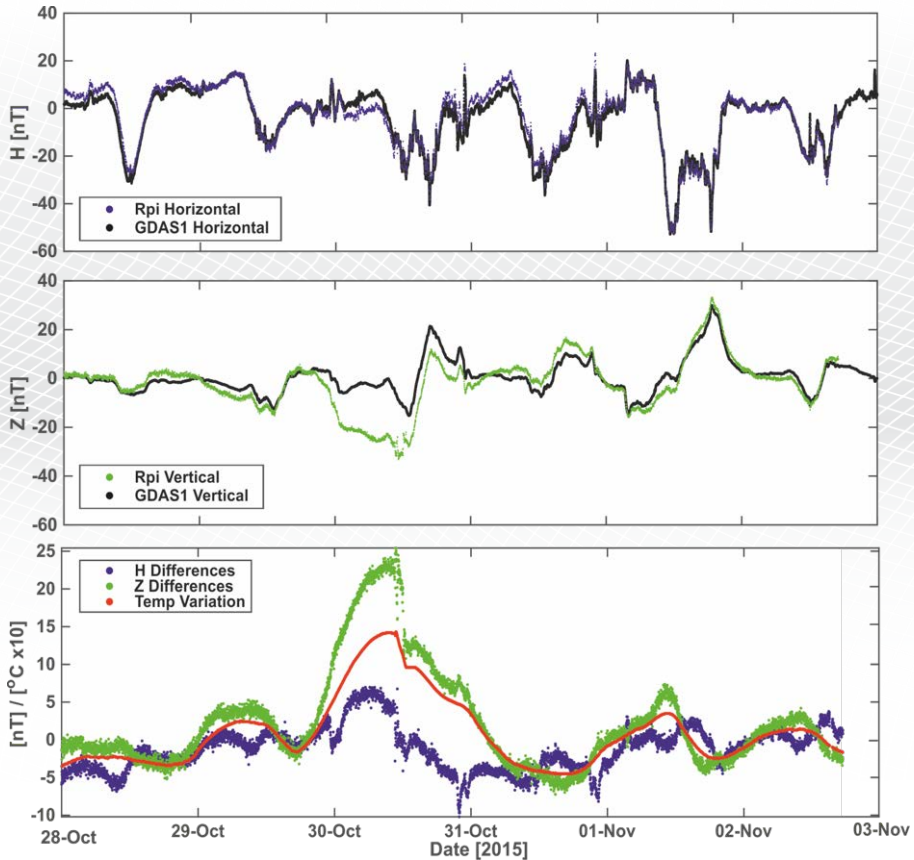
28-Oct 29-Oct 30-Oct 31-Oct 01-Nov 02-Nov 03-Nov
Date [2015]

On test in Eskdalemuir

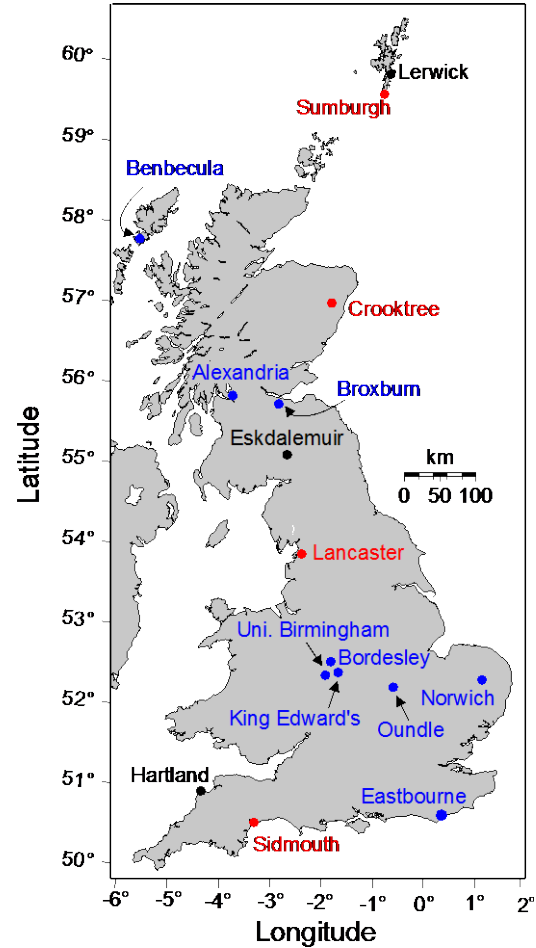
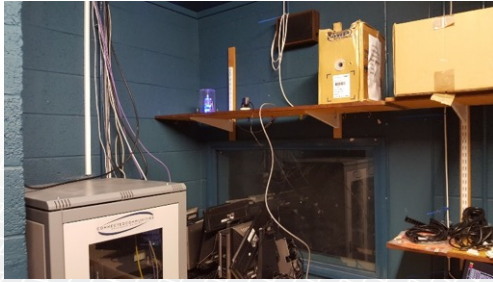


On test in Eskdalemuir

Lerwick



A school network



Website and back-end software



Magnetometer status

Live activity and site status

Project:

Site:

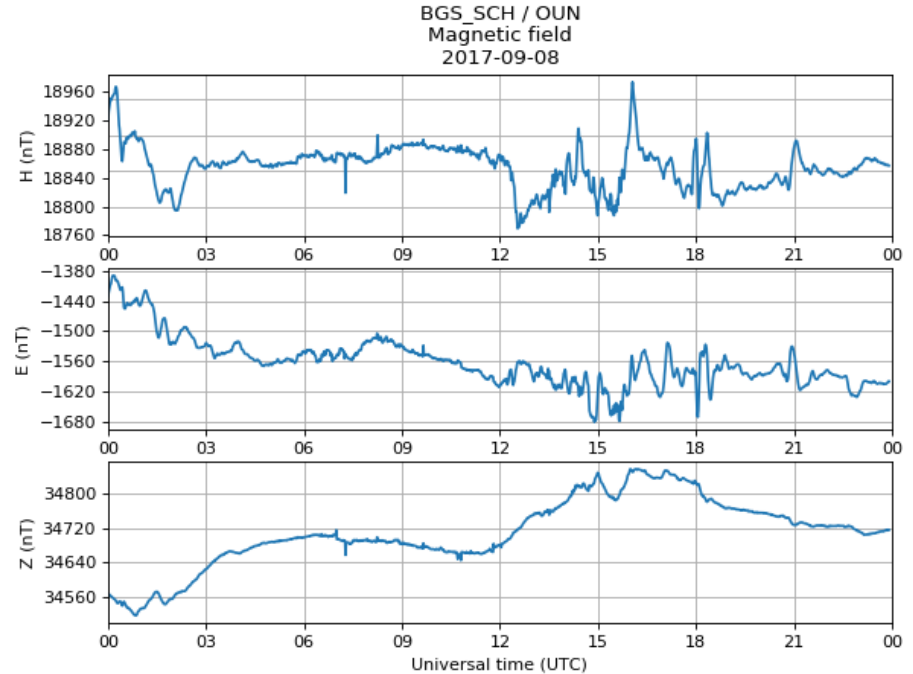
Date: - -

BGS_SCH OUN

Location: Oundle, UK. 52.4809° N, 0.4690° W.
Start time: 2016-08-15 14:30:00+0000.
End time: still operational.

◀ Rolling plot ▶

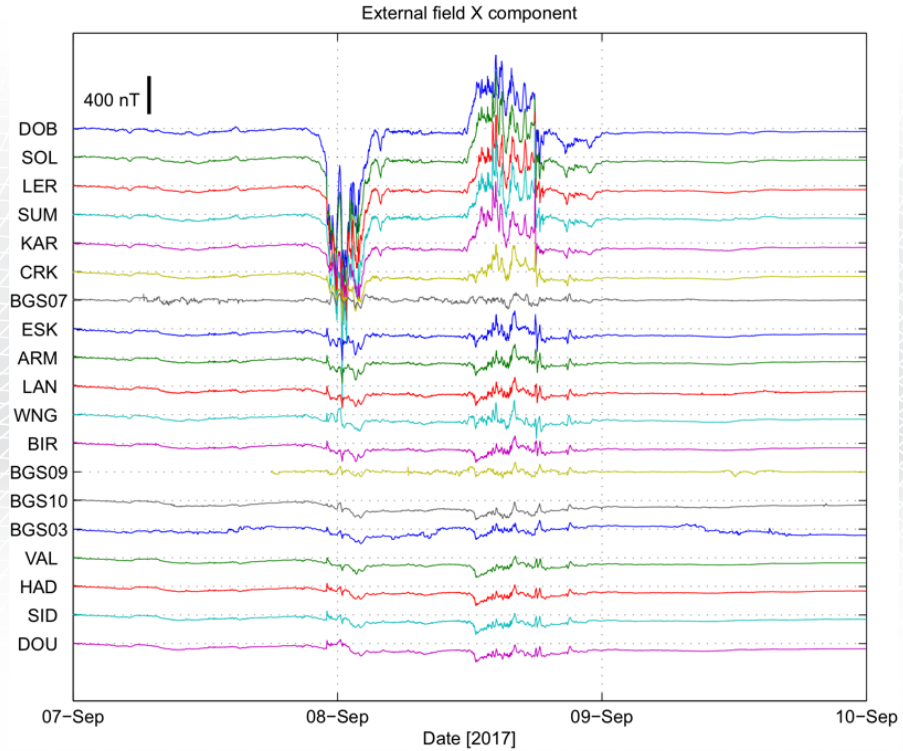
BGS_SCH / OUN
Magnetic field
2019-02-23



<https://aurorawatch.lancs.ac.uk/plots/>

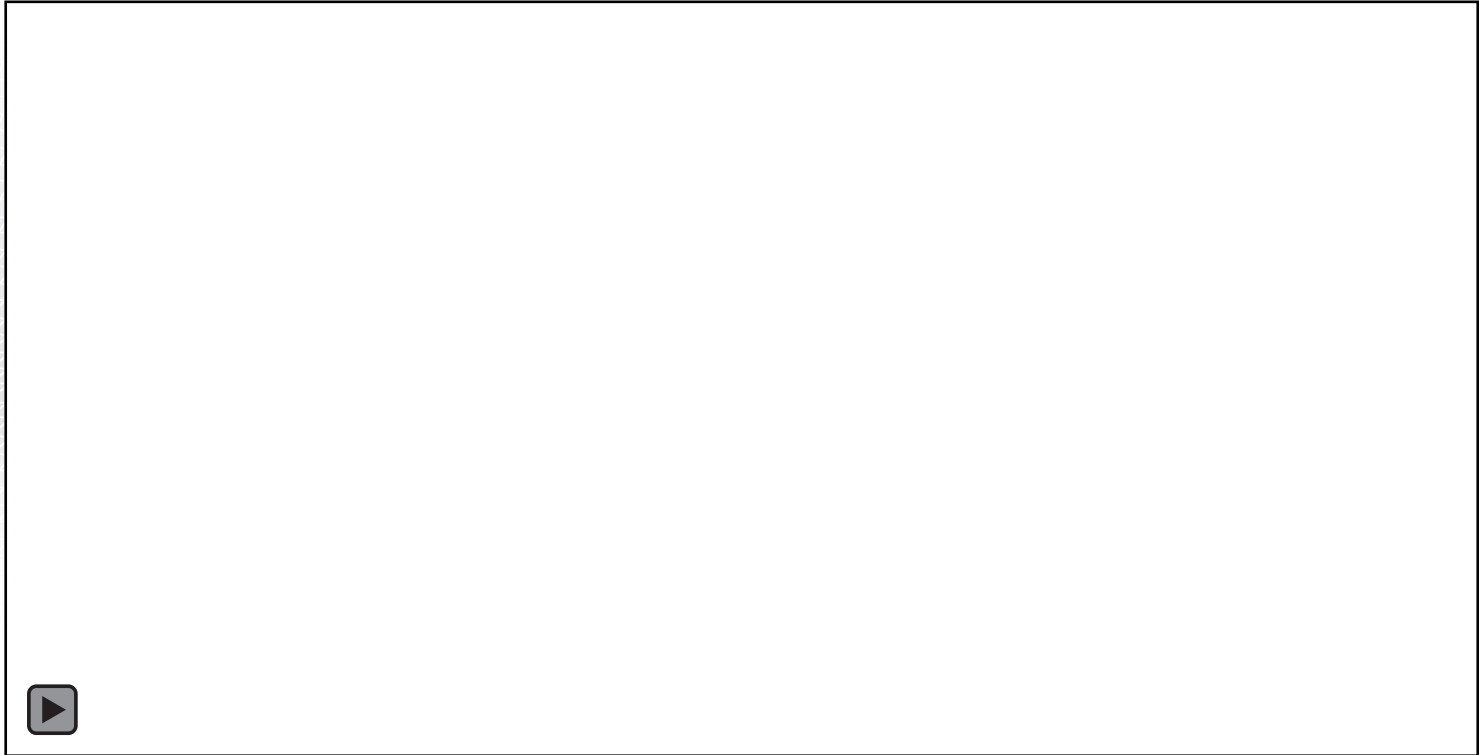


Geomagnetic storm: 7-8th September 2017

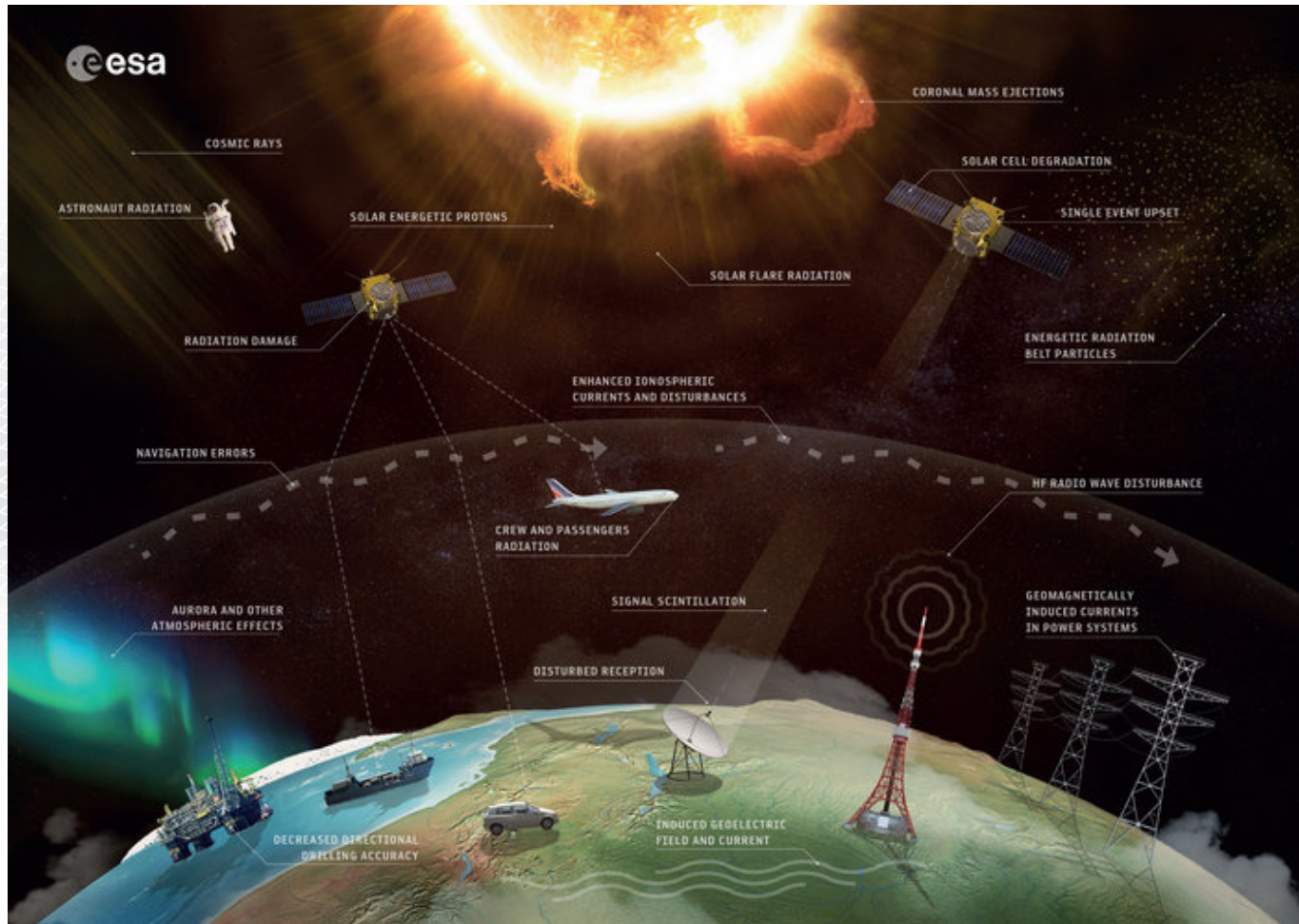


<https://aurorawatch.lancs.ac.uk/data/>

Citizen science adding to the professional network



Space weather



Thank you!

Acknowledgements:

STFC Small Public Engagement Grant 2015

- Dr Steve Maple (Lancaster University)
- Prof Farideh Honary (Lancaster University)
- BGS Geomagnetism Engineering team: *Tony Swan, Tim Taylor, Ted Harris*
- All the schools and teachers who have contributed





What are the aurora?

