

Advances in the global geomagnetic observatory network

Jürgen Matzka

DTU Space, Technical University of Denmark

with contributions from

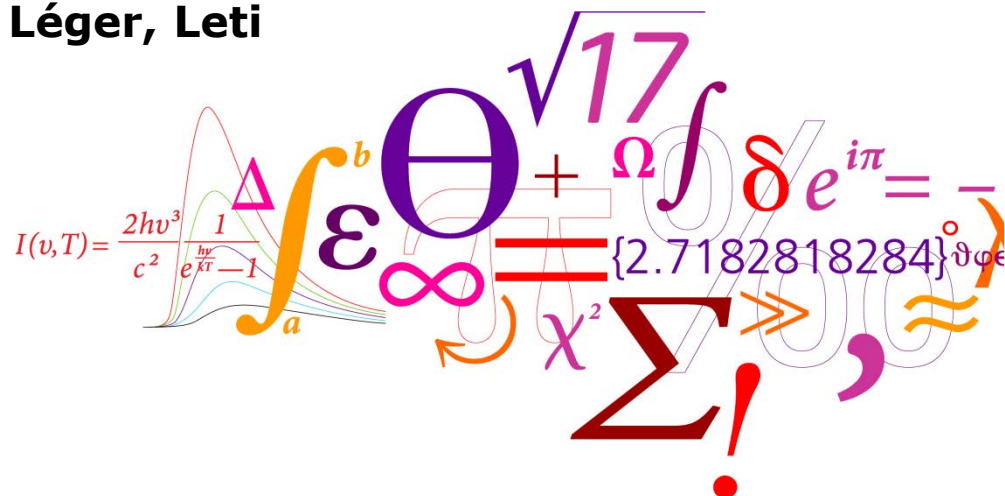
Ellen Clarke & Susan Macmillan, BGS; B. Veenadhari, IIG

Roman Krasnoperov & Anatoly Soloviev, GC RAS; Bill Worthington, USGS

Xavier Lalanne, IPGP; Jean-Michel L  ger, Leti

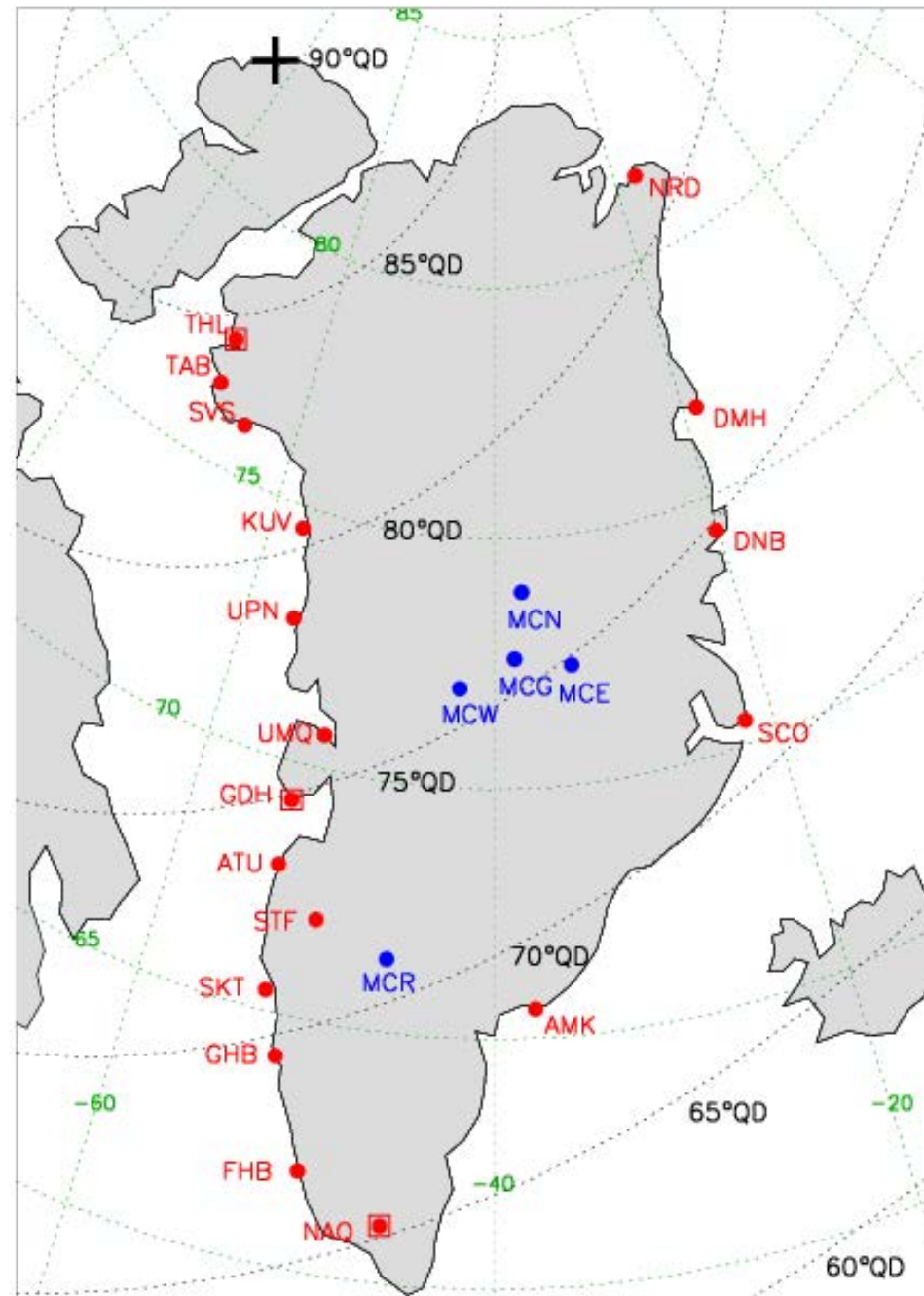
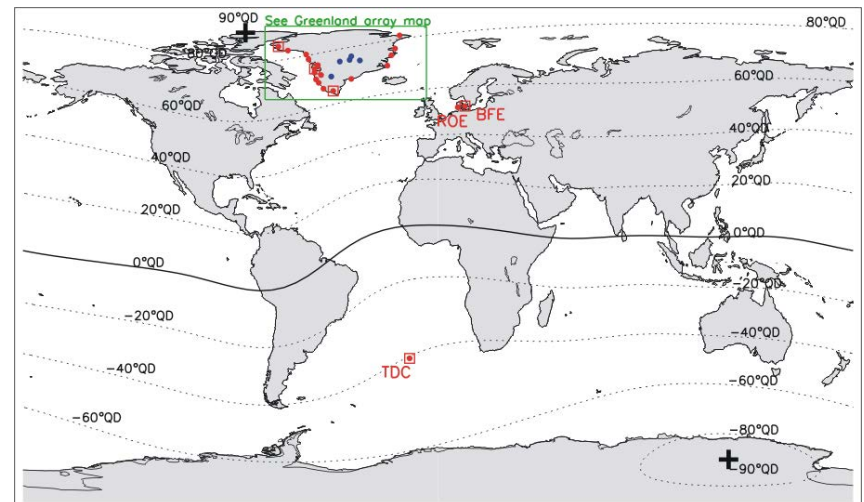
Laszlo Hegymegi, MinGeo

Achim Linthe, GFZ

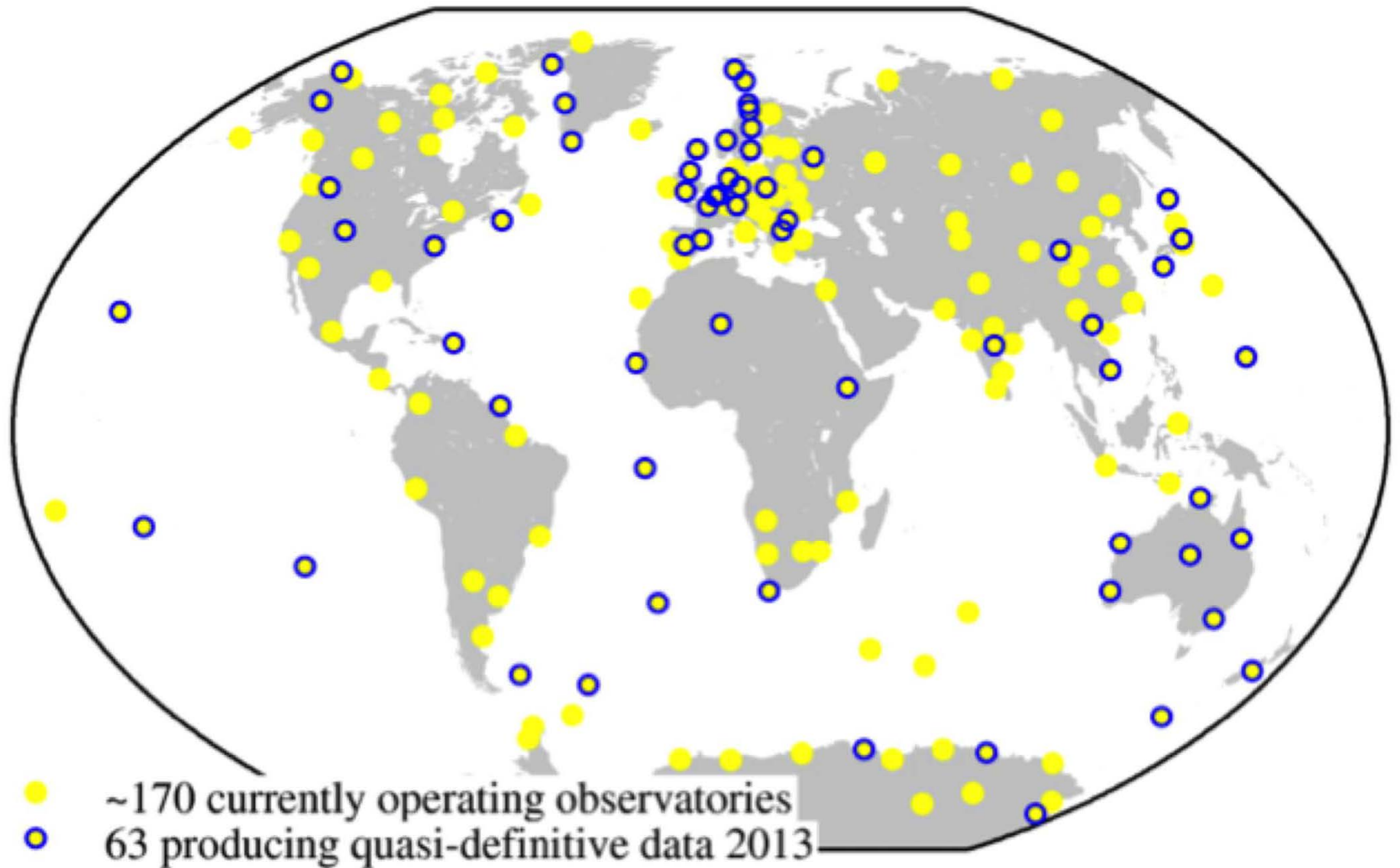


- Magnetic observatory
- Variometer station
- Variometer station (MAGIC)

My background: DTU Space geomagnetic observatories (THL, GDH, NAQ, BFE, TDC) and 15 variometer stations, most of them in Greenland.



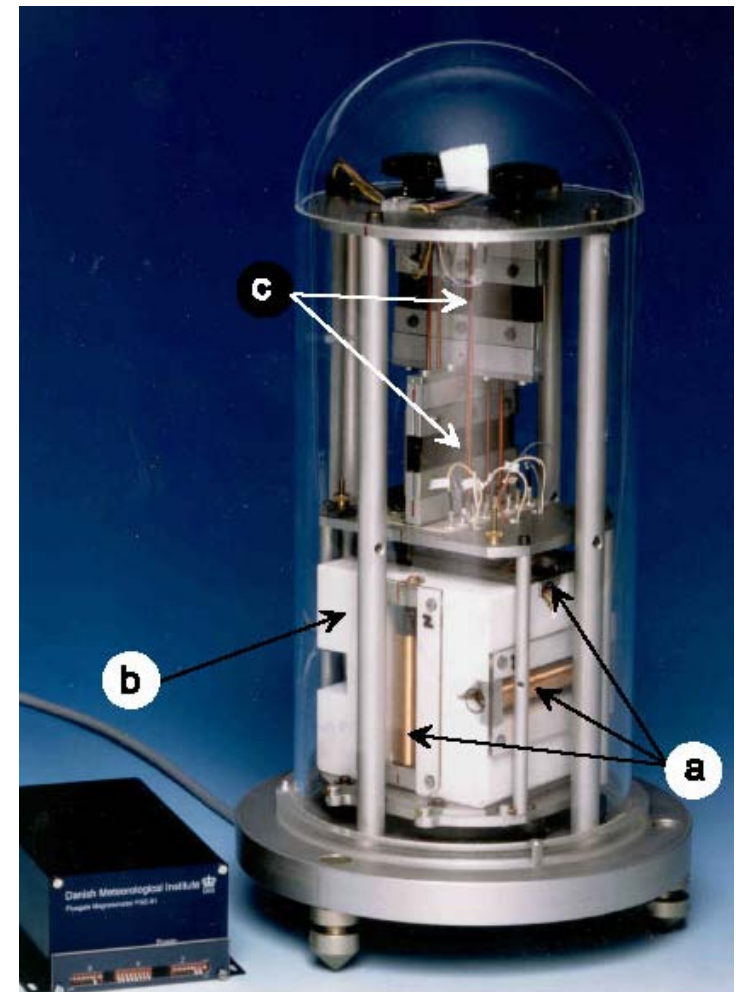
Geomagnetic observatories worldwide



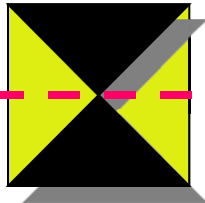
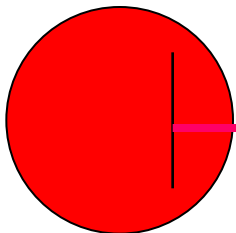
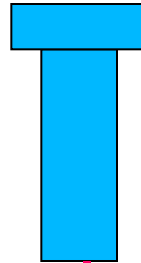
Instruments for geomagnetic observatories.

Variometer

DI-flux to measure direction absolutely.

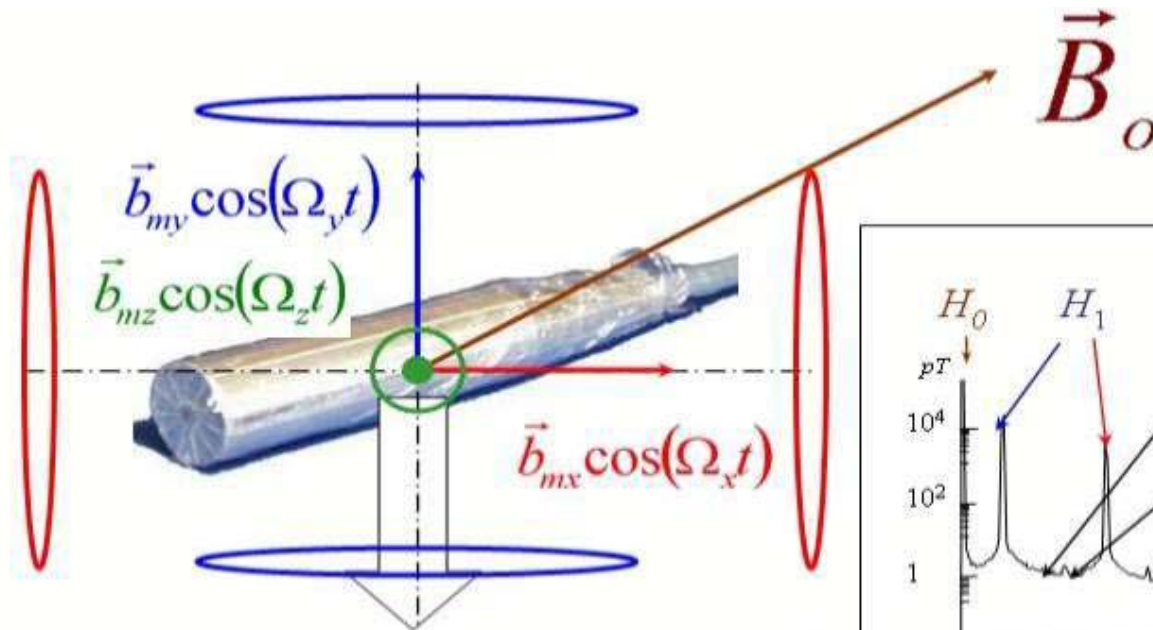


New development: Optical system to control declination baseline of a dIdD instrument.

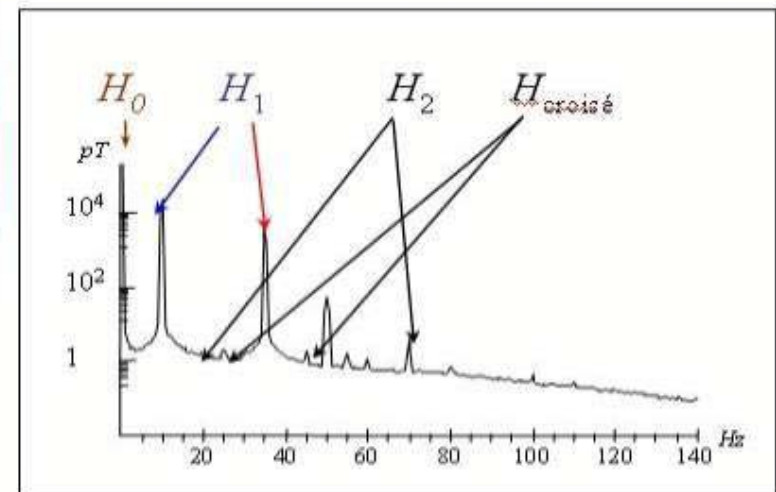


Absolute vector magnetometer for observatories based on Swarm ASM-V.

Based on an ^4He atomic resonance SCALAR magnetometer
superposition of 3 AC modulations along 3 orthogonal directions



$$s = \|\vec{B}_{tot}\| = \left\| \vec{B}_o + \sum_{i=x,y,z} \vec{b}_{mi} \cos(\Omega_i t) \right\|$$



Real time analysis of the scalar output

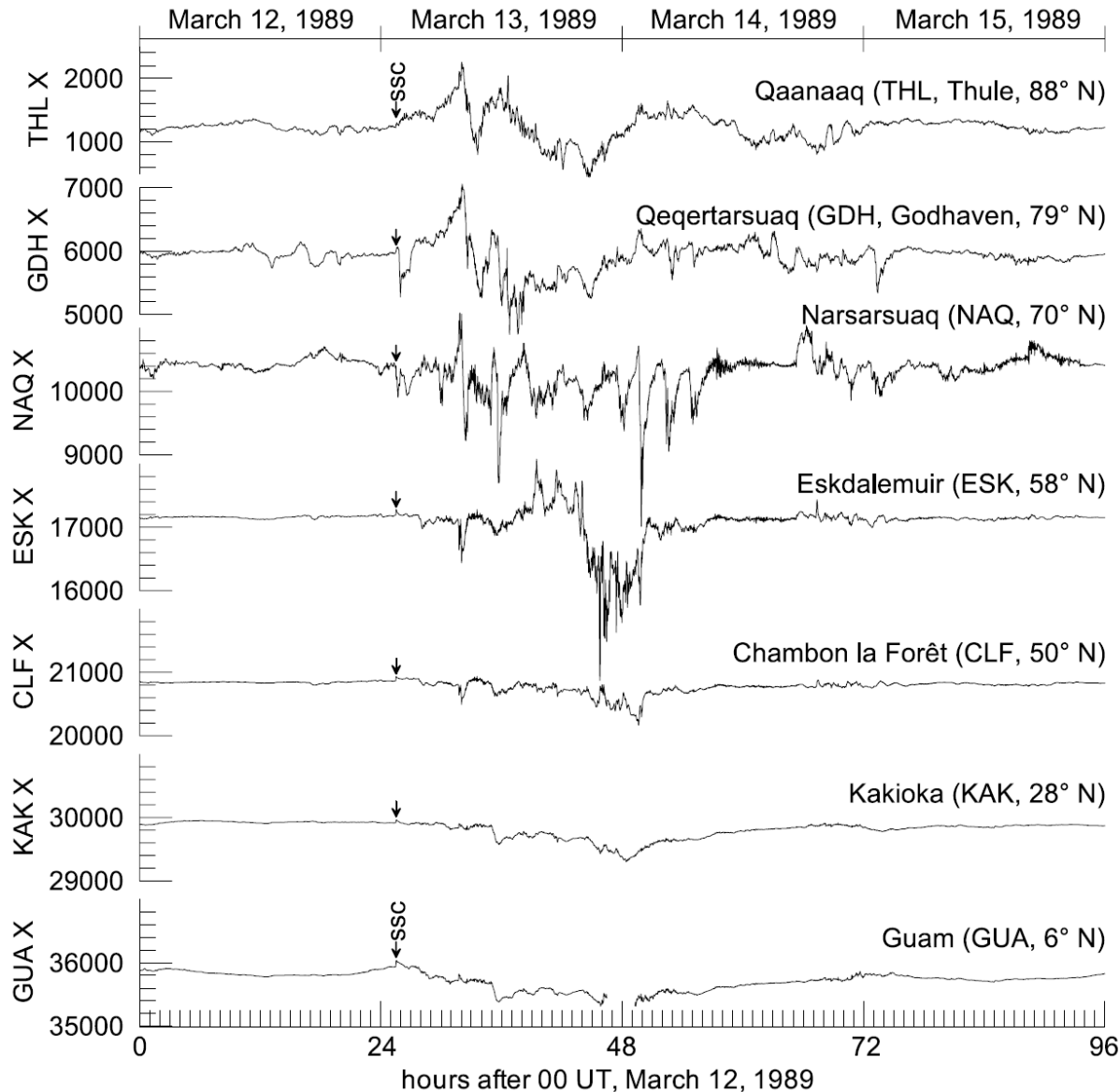
Hyderabad geomagnetic observatory, NGRI, India



Hornsund, Polish geomagnetic observatory on Spitsbergen



Geomagnetic storm recorded at various latitudes

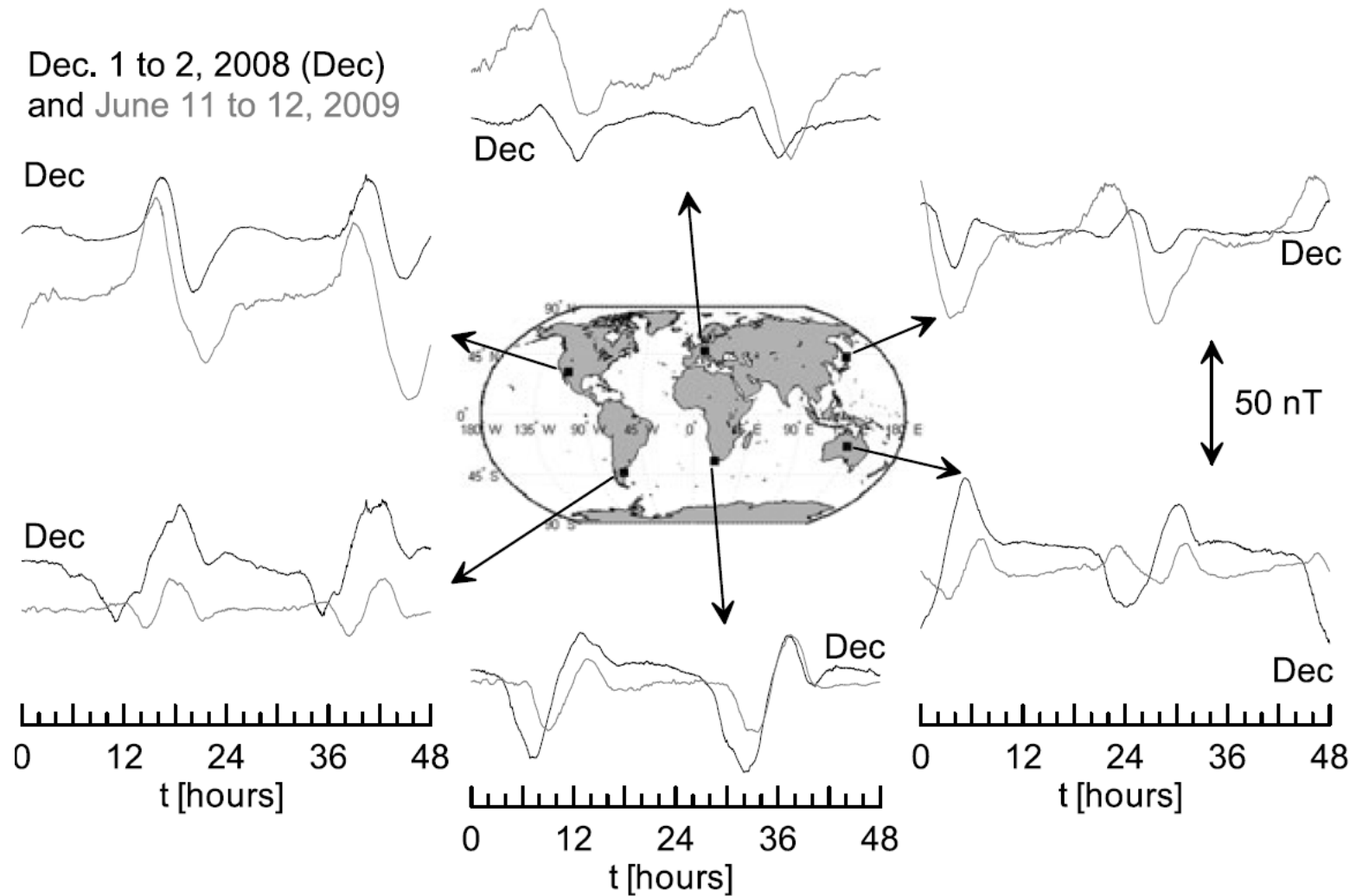


Observatories:

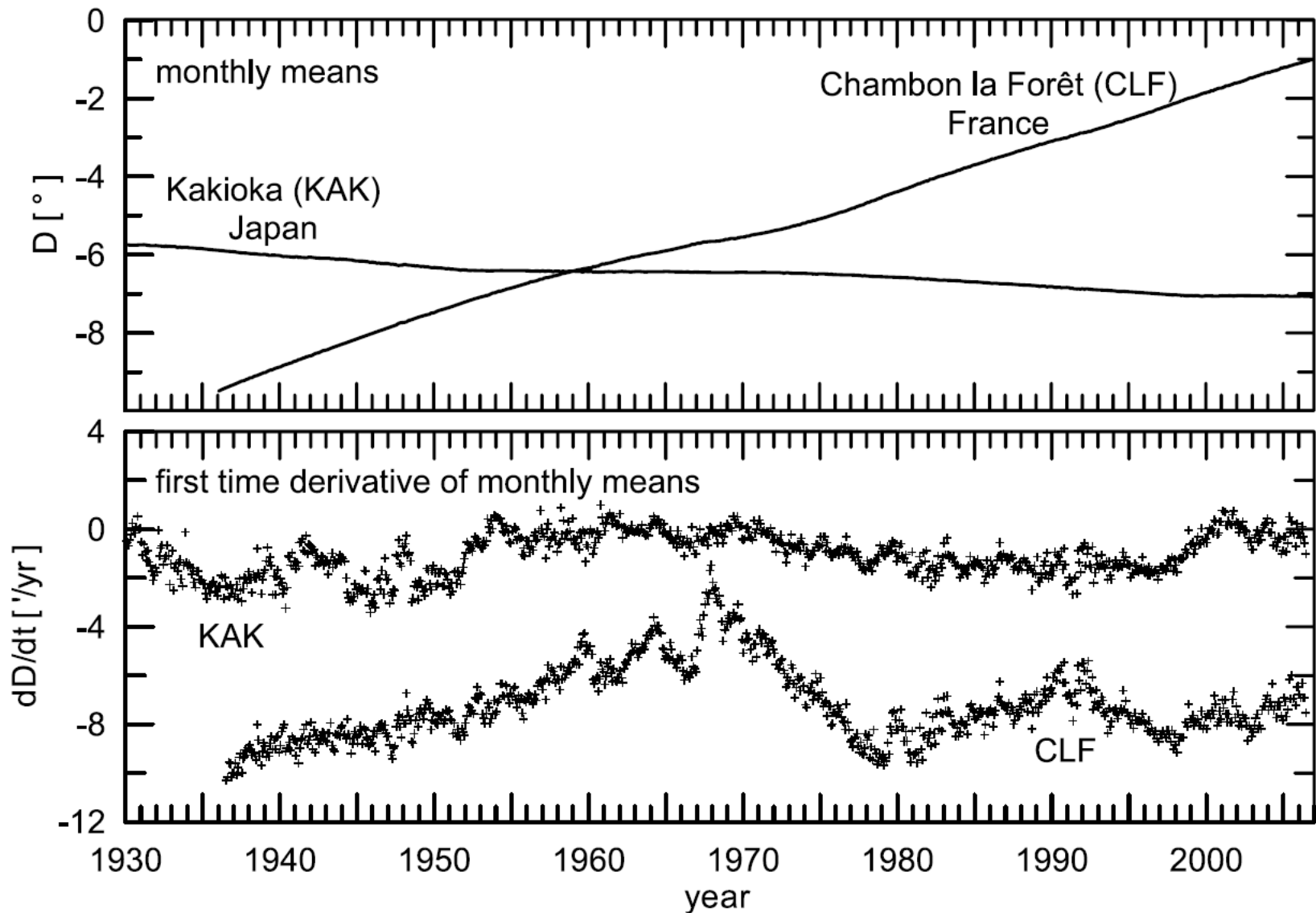
- Long term record of space weather
-> space climate
- Data selection criteria
- Temporal correction of survey data
- Long period EM induction

Part of this could be done by variometer stations.

Quiet time geomagnetic variations



Secular variation time series



IAGA

- **Support to observatories through training, instrument comparisons, resolutions.**
- **Requires absolute measurements, approves station code, only interested in definitive data. Data quality is operators responsibility.**

WDC and new WDS

- **Wish to provide data and metadata also to geomagnetic non-experts.**
- **For example to GEOSS 'Global Earth Observation System of Systems'. GEOSS provides decision-support tools to a wide variety of users.**

Intermagnet (consortium of observatory operators)

- **Checks quality of observatories and data (definitive)**
- **Near real time and definitive data**
- **Watch out for 1-second and Quasi definitive data.**

Quiet time geomagnetic variations

Firefox

Data Download

intermagnet.org/data-donnee/download-eng.php

Most Visited Getting Started Suggested Sites Web Slice Gallery

Français English

INTERMAGNET

INTERMAGNET Data Observatories (IMOs) Participating Institutes Publications/Softwares How to Reach Us

Home > INTERMAGNET Data > Data Download

Conditions of Use

Data Download

Data Formats

Observatory Plots

Magnetic Field (XYZ)

Magnetic Field (HDZ)

Declination/Inclination

Rate of Change (dB/dt)

CD-ROM/DVD (Definitive data)

List of Available CDs/DVD

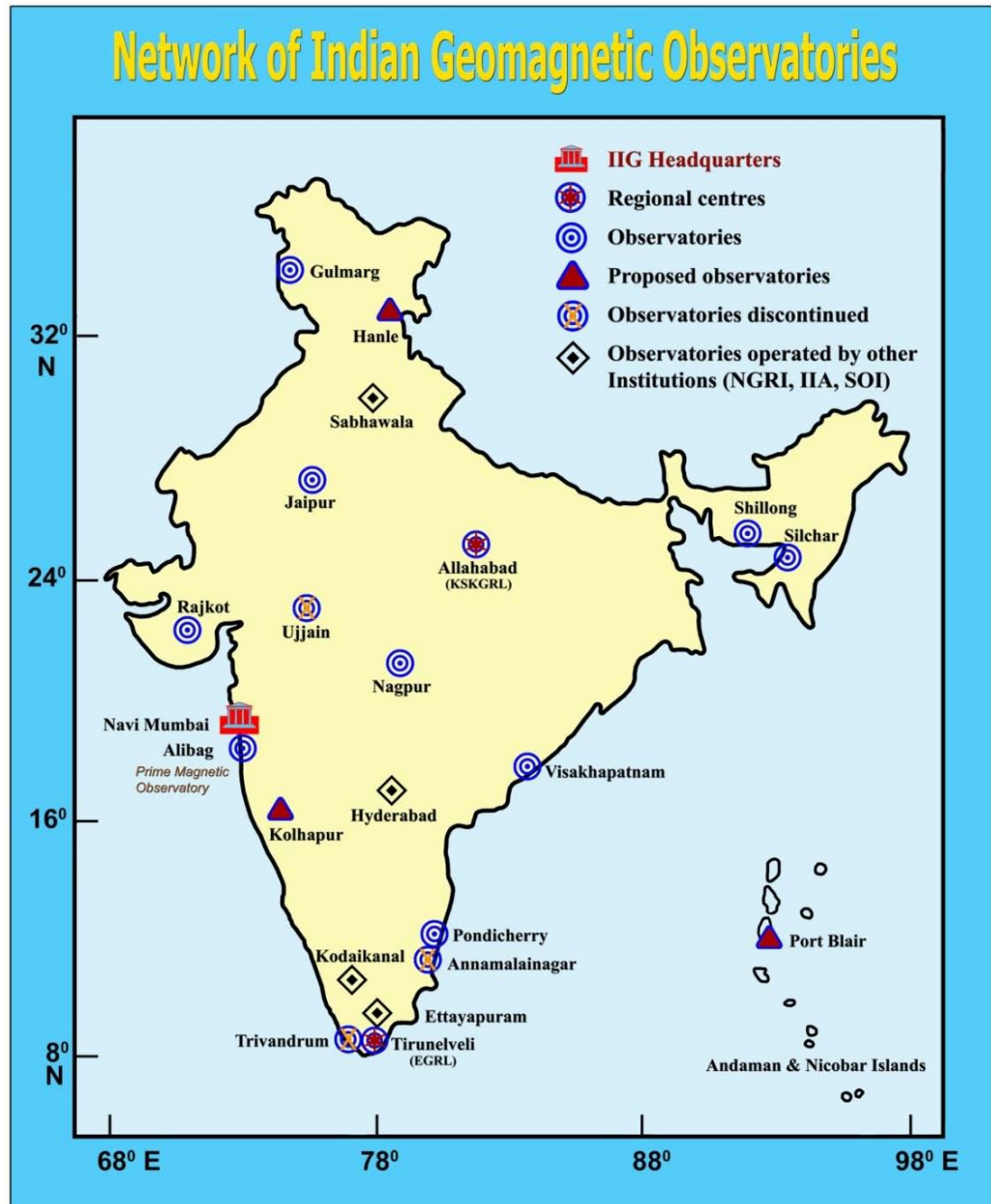
CD-ROM/DVD Production

Data Download

► How to use the Data Download application

Sample Rate	minute ?
Data Type	variation ?
Data Format	IAGA2002 ?
Start Date (YYYY-MM-DD)	2013 08 28
End Date (YYYY-MM-DD)	2013 08 28
Filter by:	► Regions ► Latitudes
Search for data	

Regional Networks








Indian geomagnetic observatories sorted after dip latitude.

Observatory Name	IAGA Code	Geographic		Geomagnetic		Dip Latitude
		Latitude (° N)	Longitude (° E)	Latitude (° N)	Longitude	
Gulmarg	GUL	34.08	74.4	25.6	149.65	30.80
Jaipur	JAI	26.92	75.8	18.35	150.16	23.55
Allahabad	ALH	25.47	81.9	16.43	155.74	22.13
Shillong	SHL	25.57	91.88	15.95	165.11	21.99
Silchar	SIL	24.93	92.82	15.27	165.96	20.99
Rajkot	RKT	22.3	70.93	14.21	145.08	18.23
Nagpur	NGP	21.15	79.08	12.33	152.71	16.26
Alibag	ABG	18.62	72.87	10.36	146.54	14.27
Visakhapatnam	VSK	17.68	83.32	8.56	156.49	12.42
Pondicherry	PND	11.92	79.92	3.07	152.75	5.36
Port Blair	PBR	11.68	92.72	2.03	165.25	4.76
Tirunelveli	TIR	8.7	77.8	0.03	150.4	0.97

Approved and potential places for new observatories in Russia.

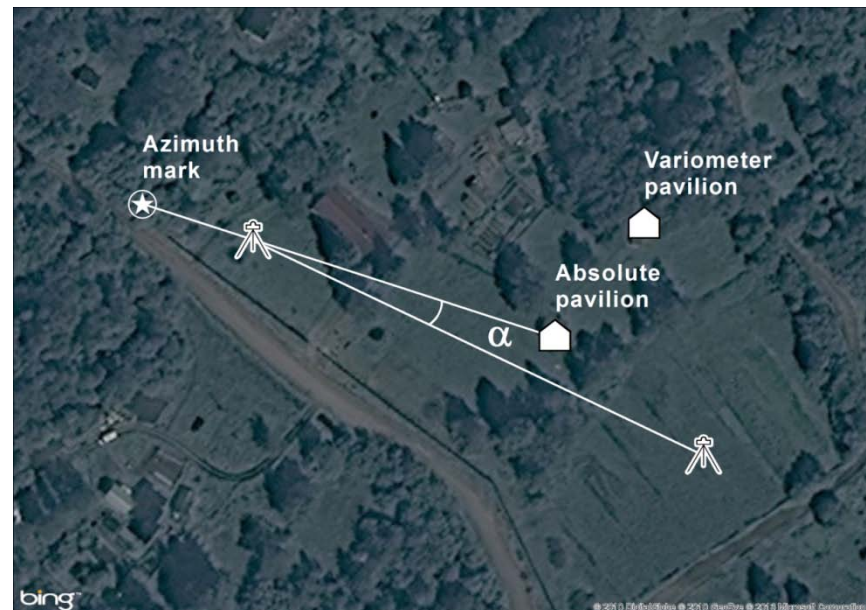
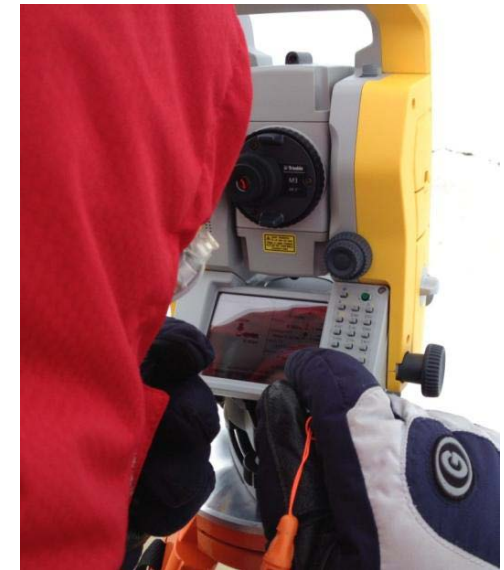
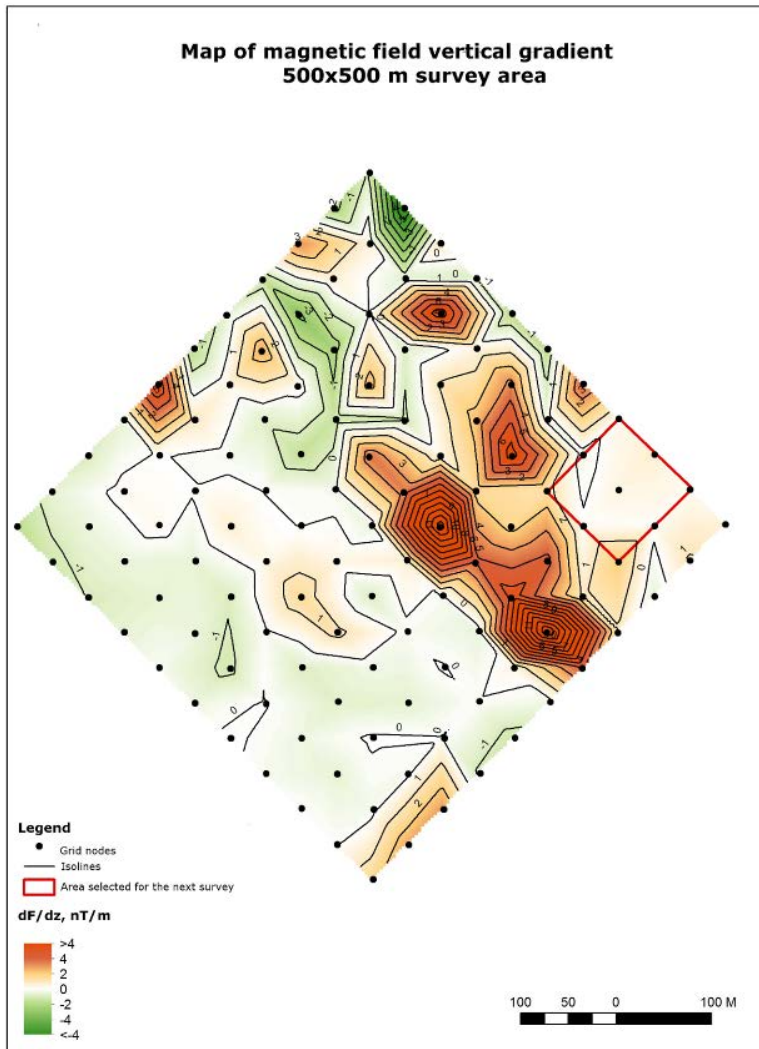


- LEGEND**
-  INTERMAGNET observatories
 -  GC RAS variometers
 -  Approved places for GC RAS observatories
 -  GC RAS test observatories
 -  Possible places for GC RAS observatories

(c) Geophysical Center of RAS (GC RAS)

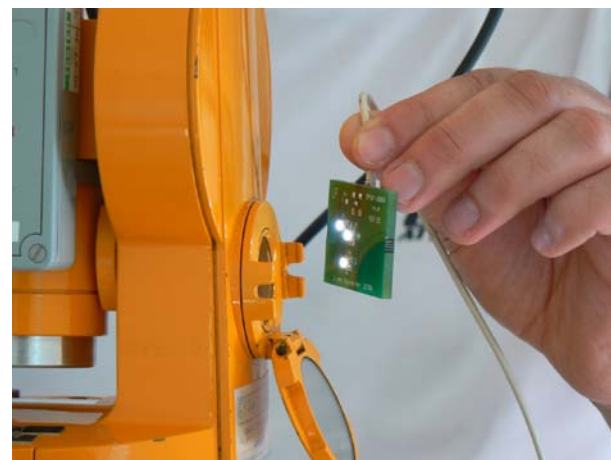
06 Aug 2013

Total field grid and azimuth determination, Russia



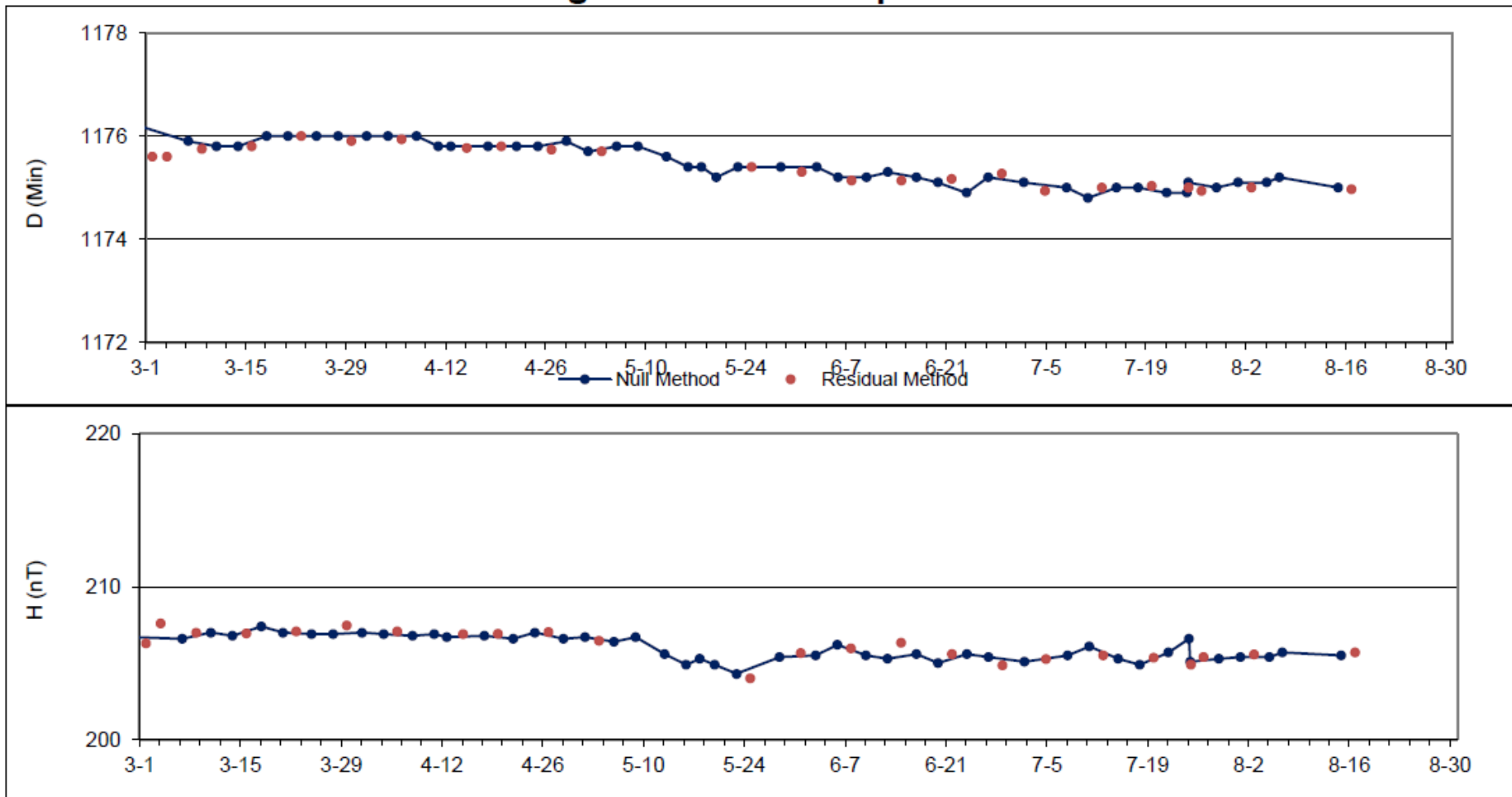
Courtesy Krasnoperov

New repeat station network, new method in France



Baselines for College, Alaska: 2 different methods compared

2013 College Baseline Comparison



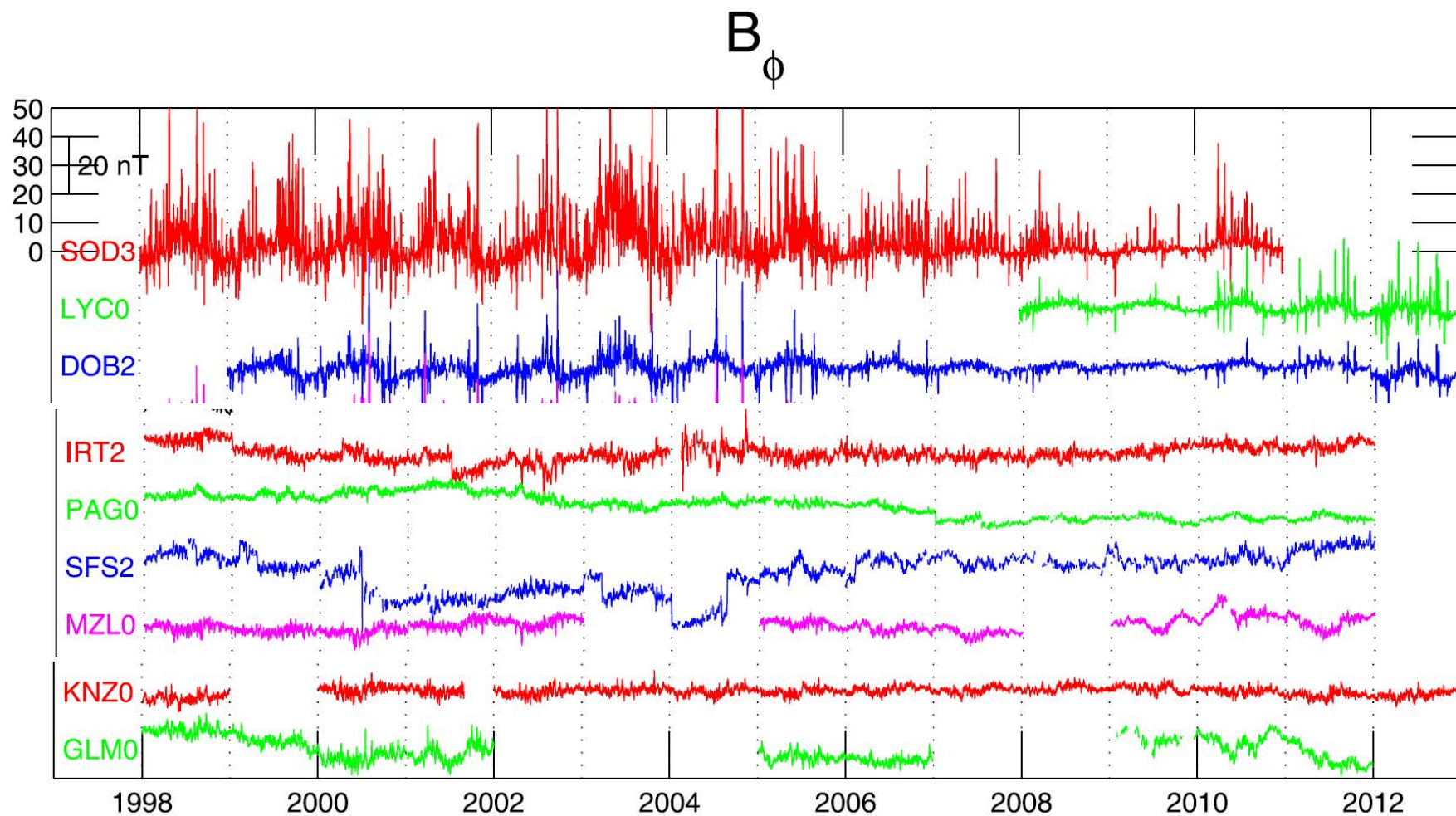
Quality check of observatory data

In preparation for the Swarm mission files of good quality observatory hourly means in a particular format and updated once every 3 months are required. These data should

- contain minimal measurement noise
- be as complete as possible (no data gaps in time)
- be corrected to absolute values over multi-year periods, i.e. drift-free
- be without discontinuities
- be in geocentric coordinate frame and time- and position-stamped

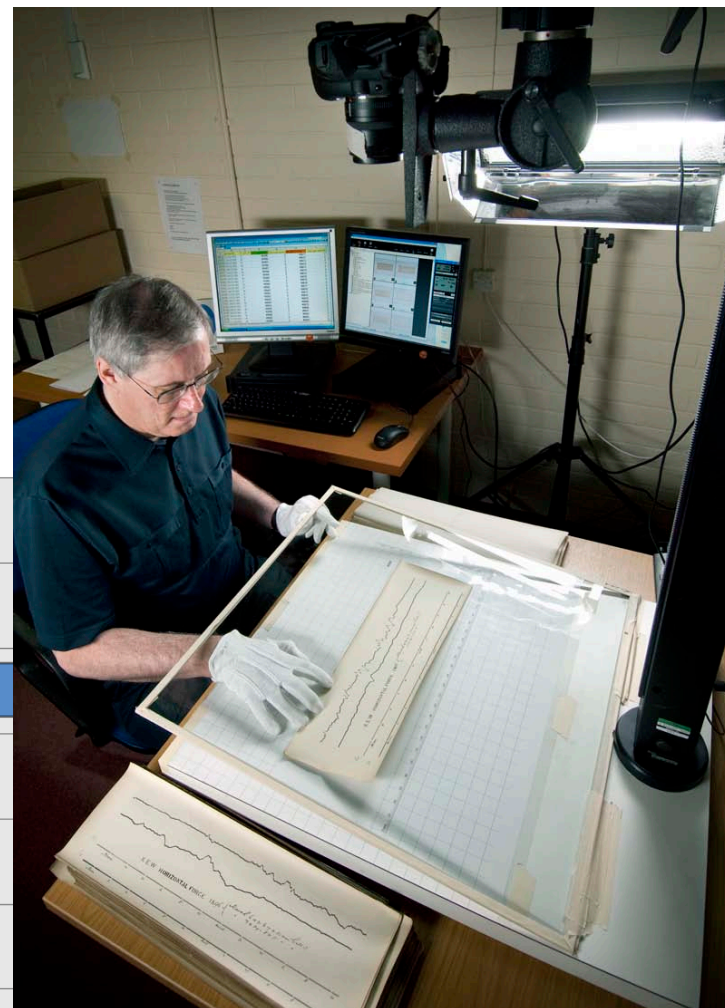
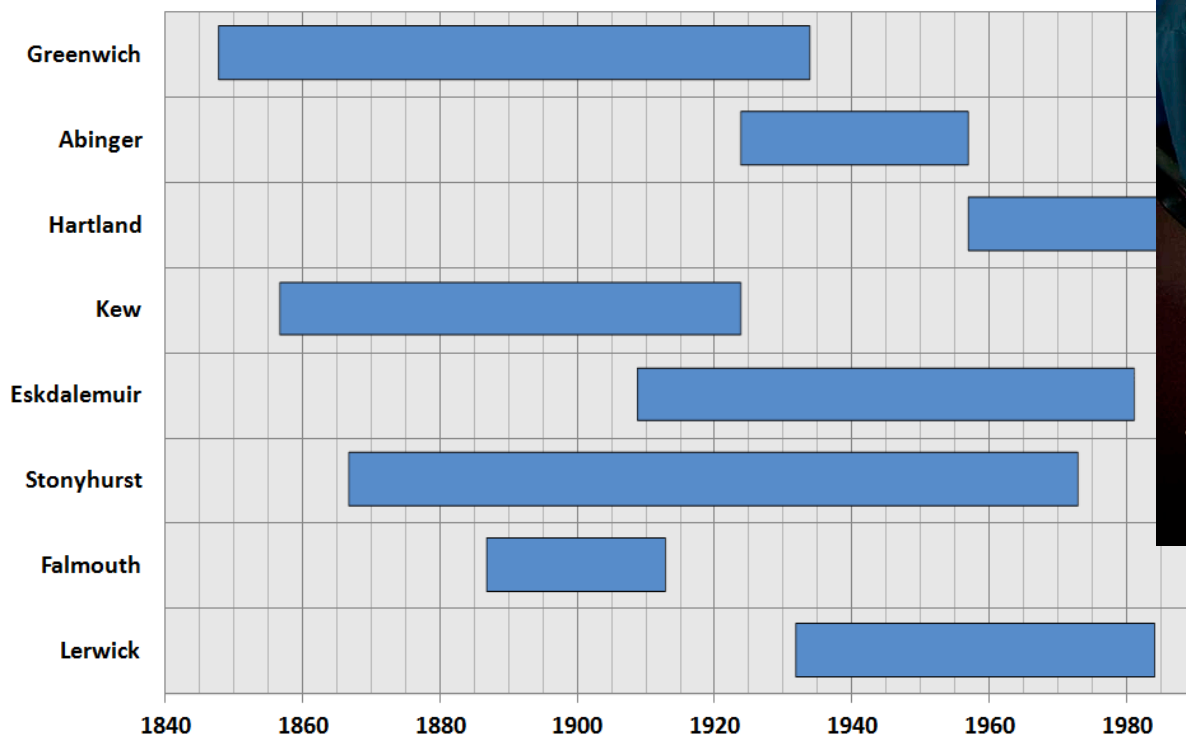
To meet these requirements misfits of spherical harmonic models can be inspected in temporal and spatial domains. **Pre-processing removes all known signals, i.e. core, crust and quiet-time ionosphere, and the modelling fits most of the remaining coherent field on an hourly basis. The misfits mainly represent measurement artefacts on the 0-10 nT scale** (Macmillan and Olsen, 2013).

Quality check of observatory data

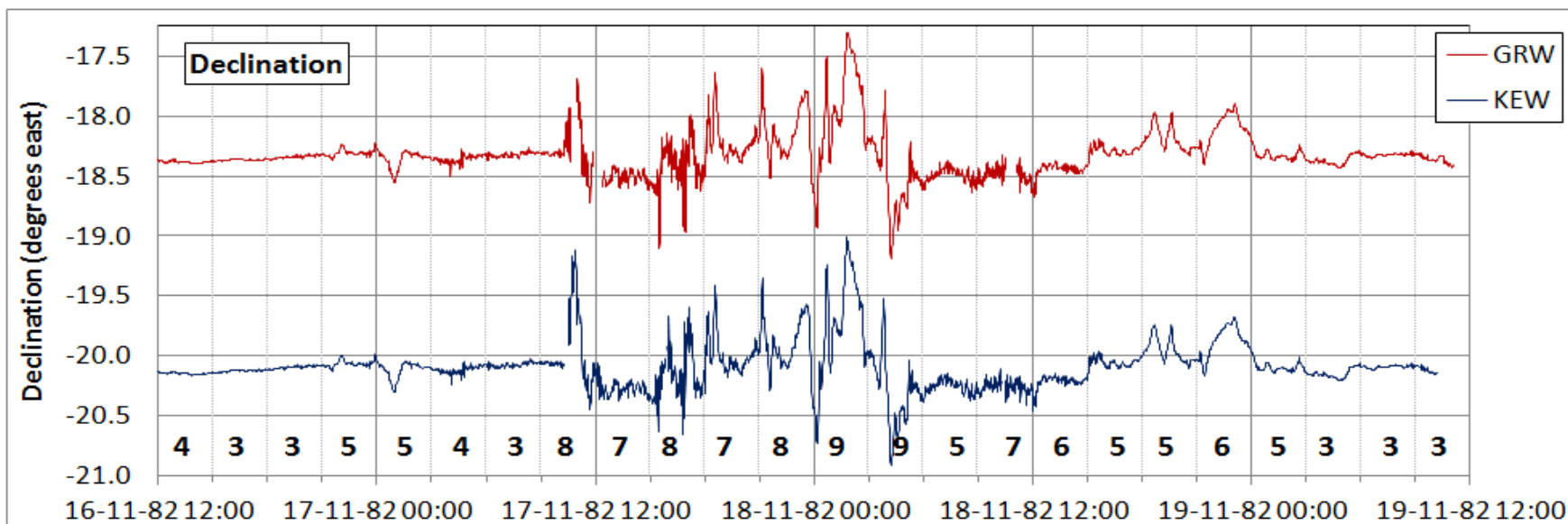
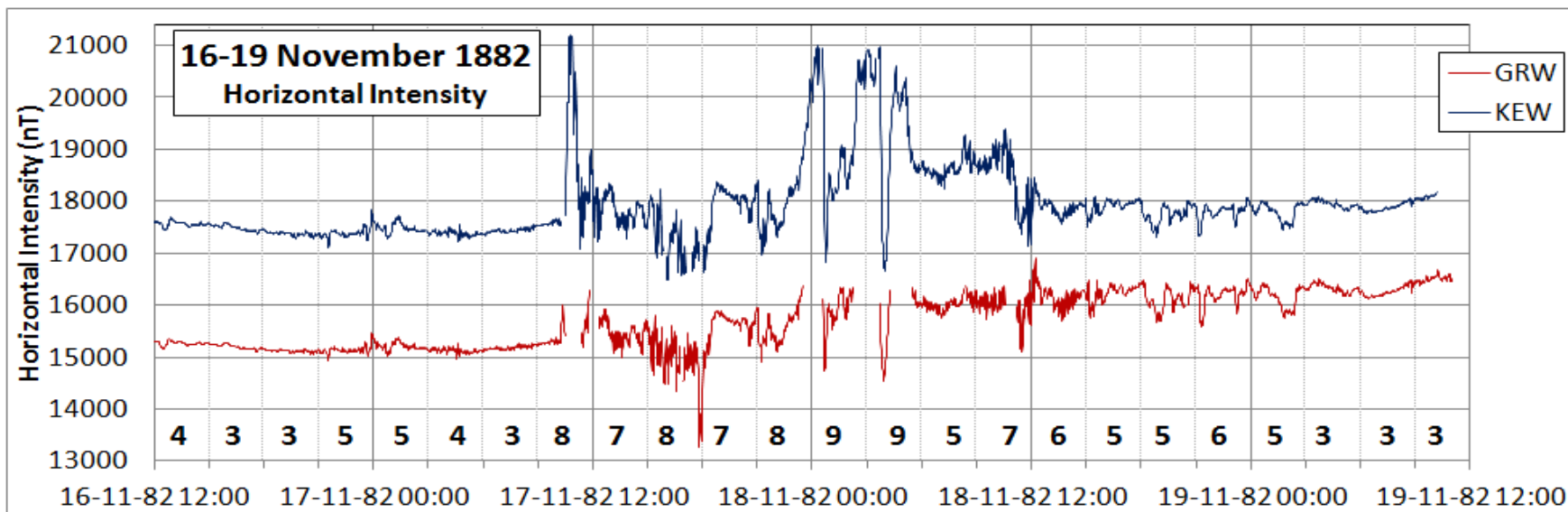


Digital capture of magnetograms, BGS

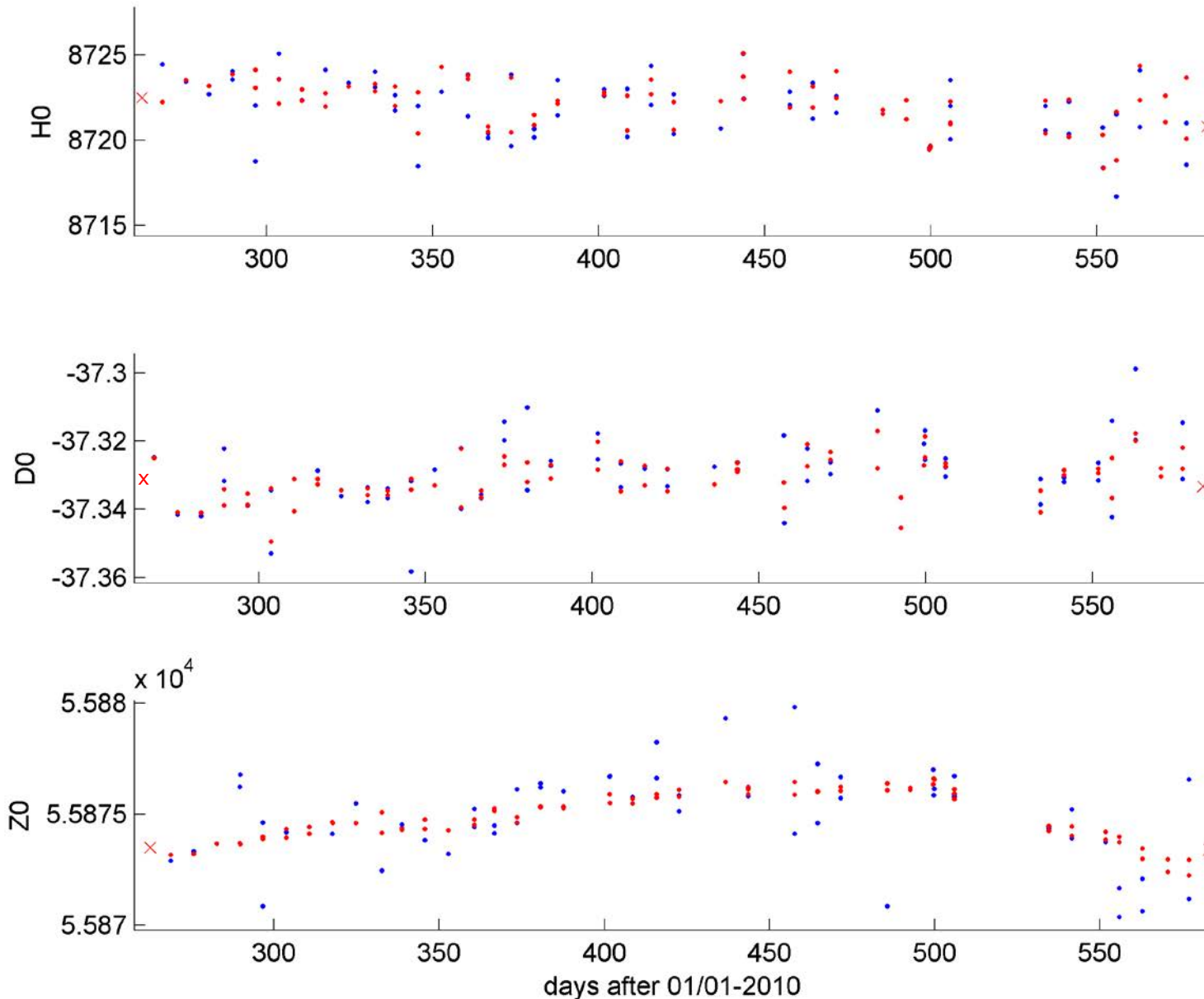
472 years
>300,000
magnetograms



Digitization of geomagnetic storms



Baselines Qeqertarsuaq, Greenland, from 29/9-2010 to 3/8-2012



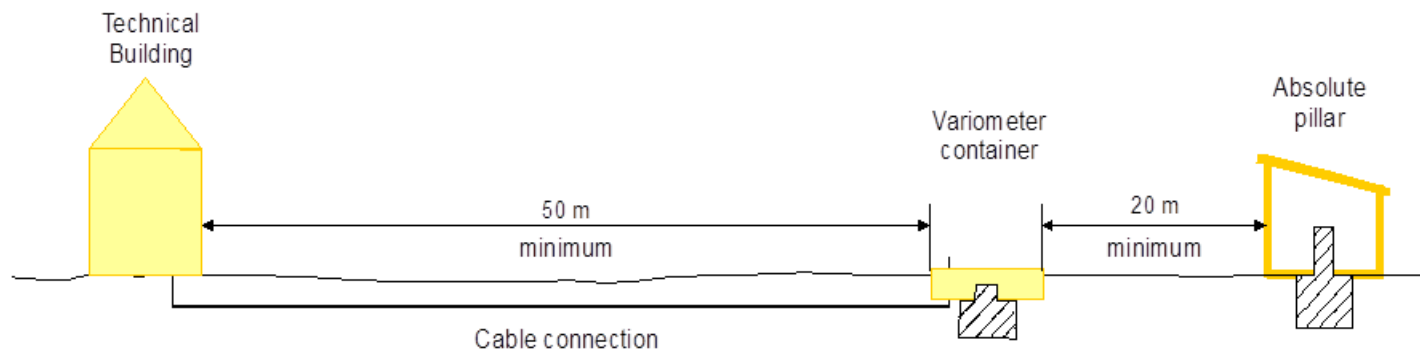
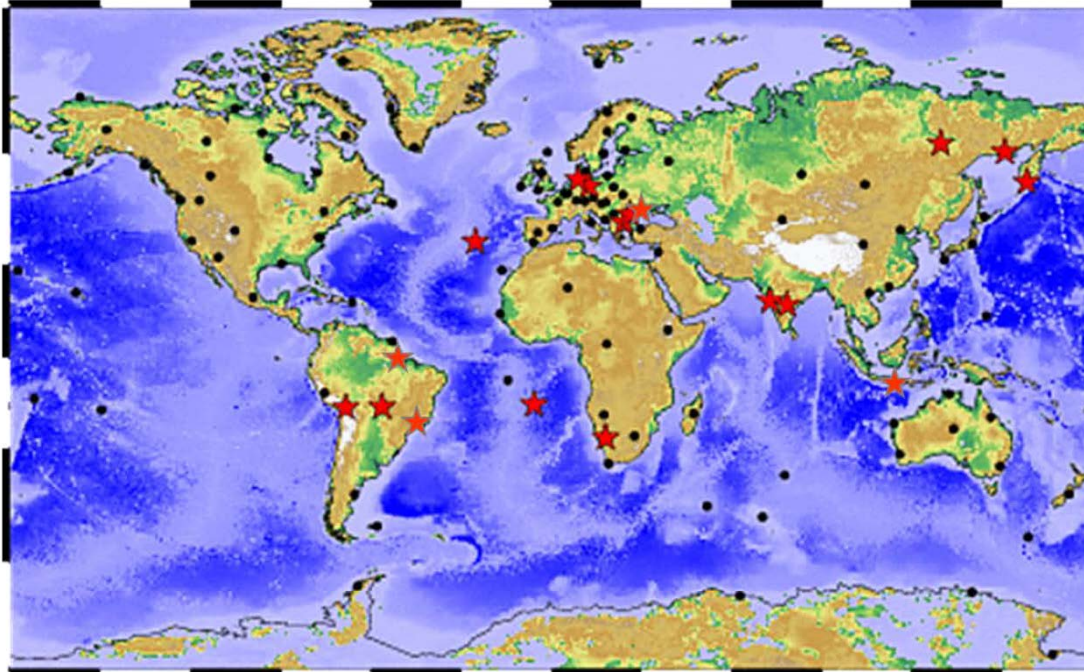
blue: before
time correction

red: after
time correction

x : absolutes by
Jürgen Matzka

Increase global cooperation, decrease observatory size

Network of GFZ-Cooperation Observatories





**Thule Air Base (TAB),
Greenland, variometer
established JUN 2013**



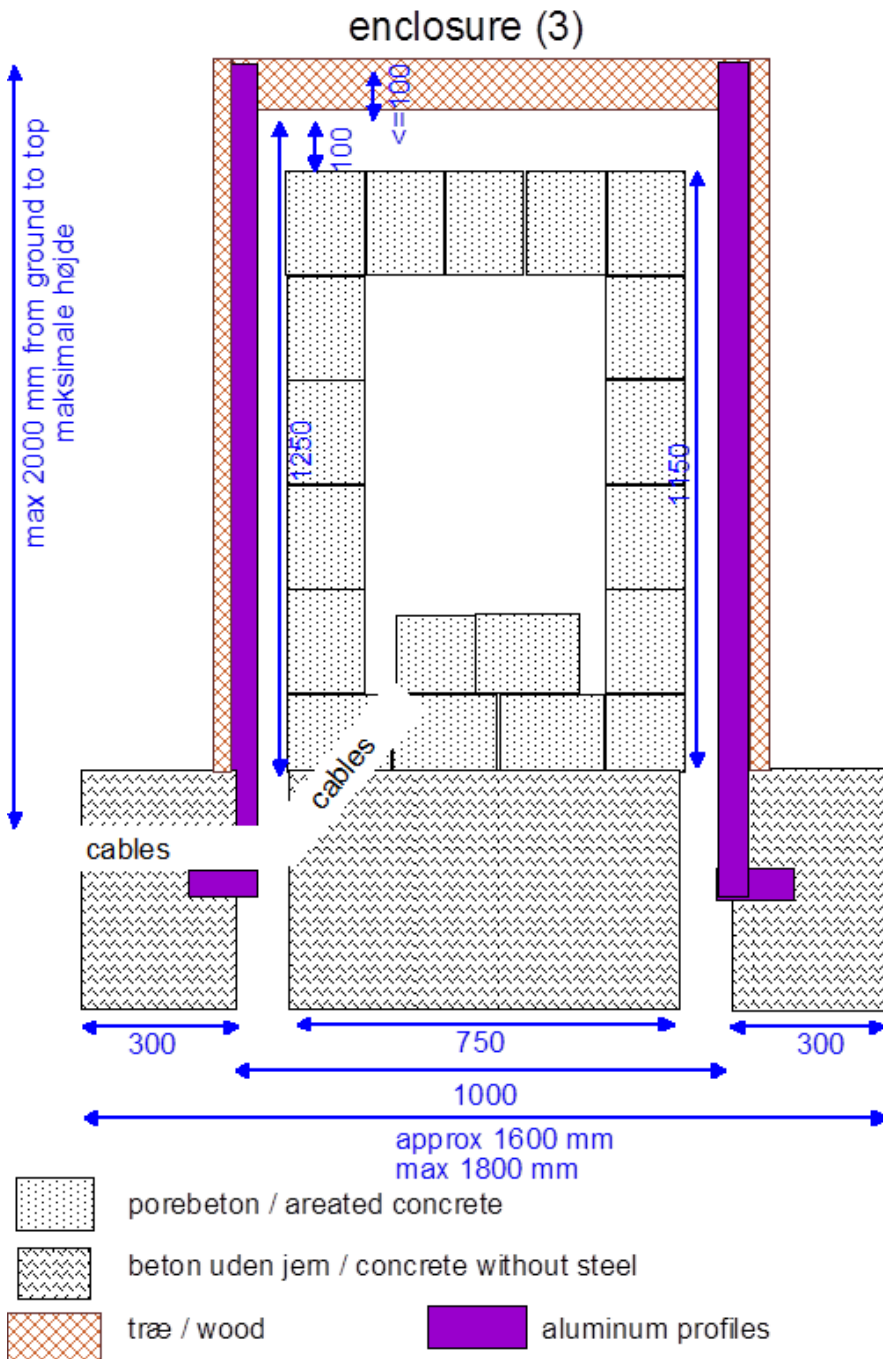
variometer hut:



electronics hut:



Variometer hut Thule Air Base



Variometer hut inside:
Sensor heating ca. 40 cm
distance



A photograph of the Aurora Borealis (Northern Lights) over a dark, icy landscape. The sky is filled with vibrant green and yellow light streaks, while the foreground shows a dark, textured surface, likely ice or snow.

Thanks to the contributors.
Thank you for your attention.

Photo: Stefan Christmann, Neumayer Station, Antarctica