

Magnetometers by IRF observatory



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- Peter Wintoft** (for TOR variometer)

Kiruna magnetometers

(1) Vector field (every 1 sec):

Flux gate variometer (Kiruna)

Primary $\leftarrow$ new one is standby

Secondary (backup)



(2) Absolute measurement (weekly):

DI flux magnetometer (Kiruna)

in operation

spare



(3) Total field (every 4 sec): Proton magnetometer = scalar value (Kiruna)

in operation (old one)

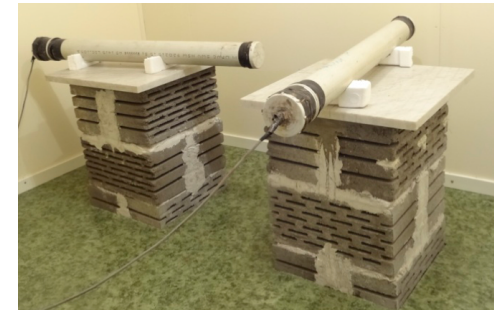
spare (new one)



(4) Higher frequency than 1 Hz: Pulsation magnetometer (Kiruna)

3 sensors (XYZ) in operation

no spae



Specialty of Kiruna:

(1) near the iron mining

(2) can combine with other measurements

- auroral image

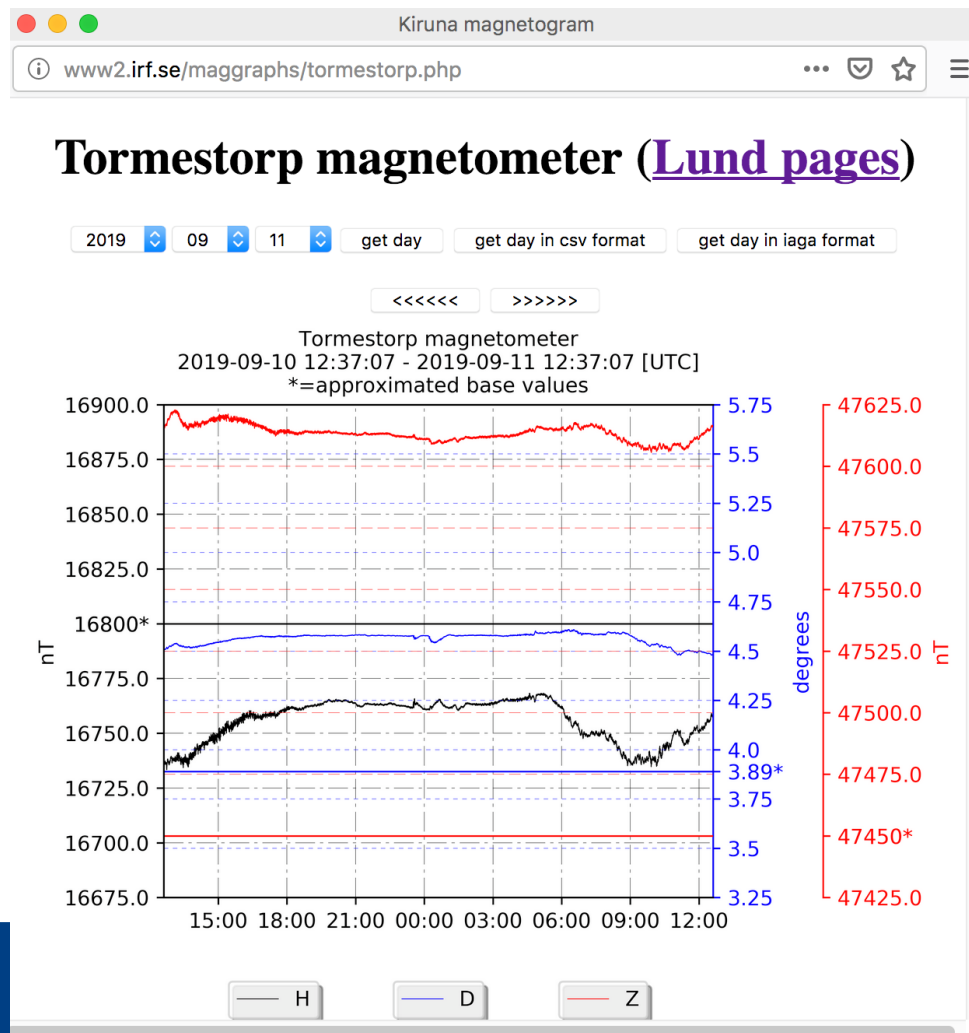
- riometer

- ionosonde (new dynasode from 2017!)

Hässleholm (TOR) instrument

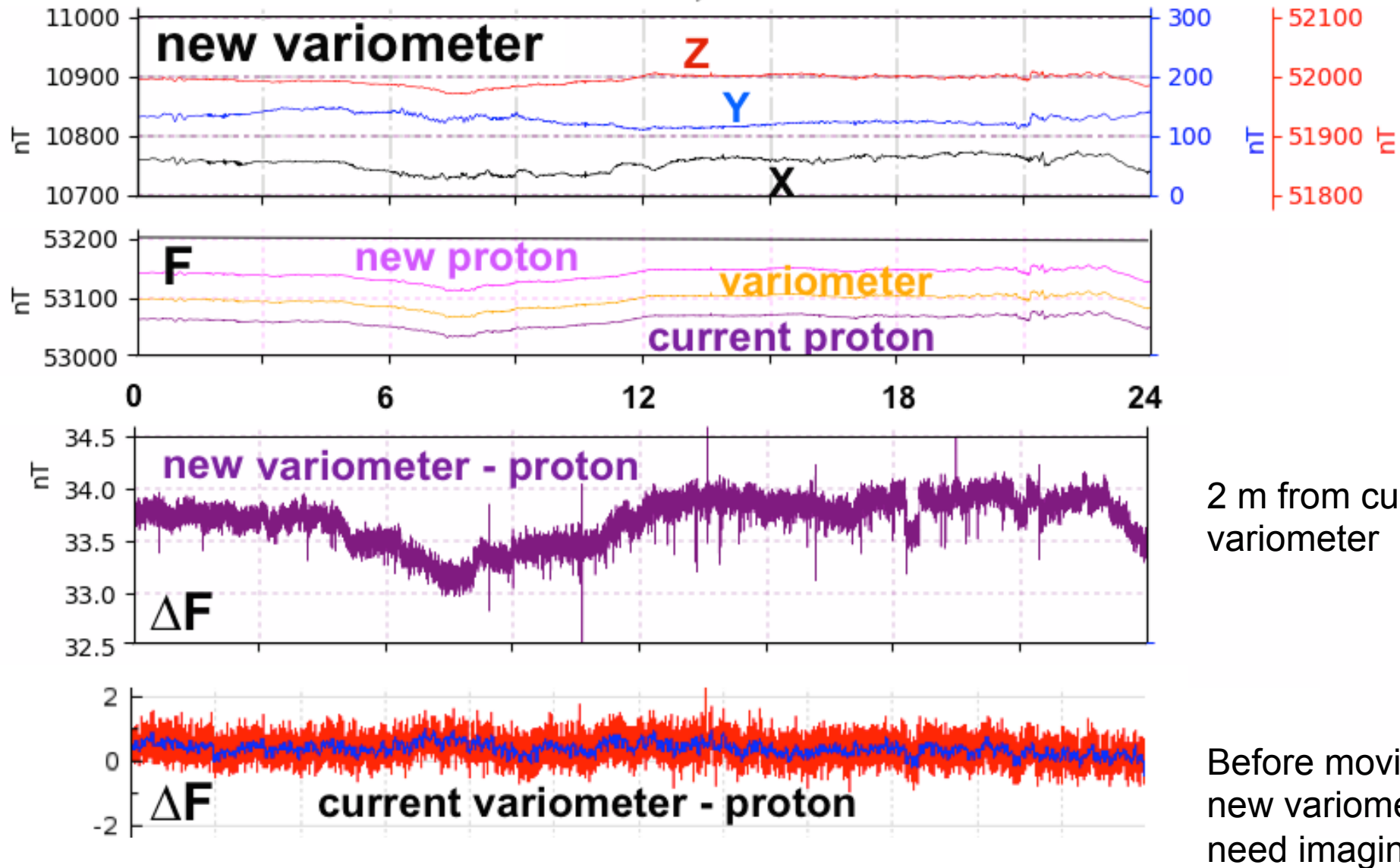
Variometer close to Hässleholm

- * site test with DTU: 2013
- * installment and first measurements: 2016
- * real-time since 2018: lund.irf.se/playground/tor/

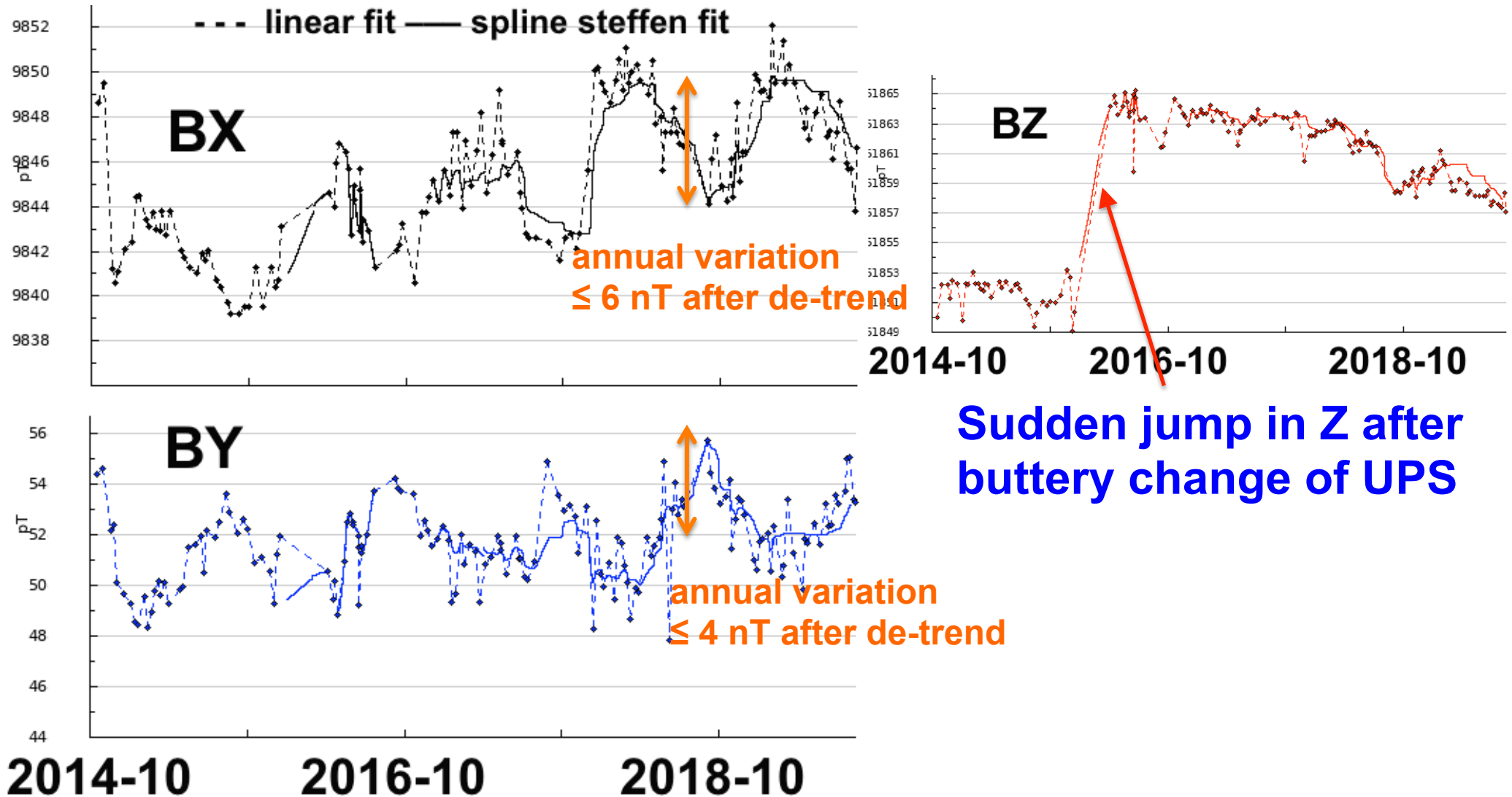


Kiruna magnetometers quality

2019-08-25



Absolute (baseline) measurement

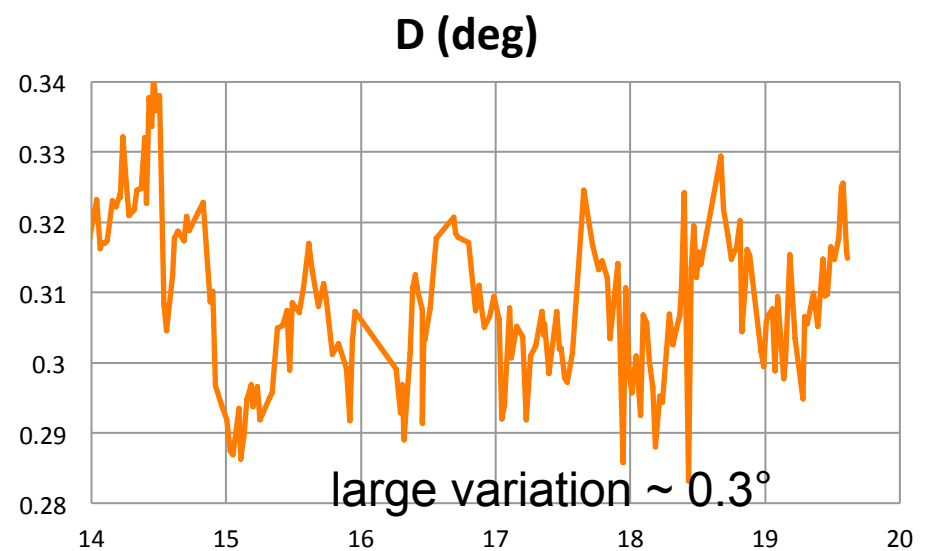
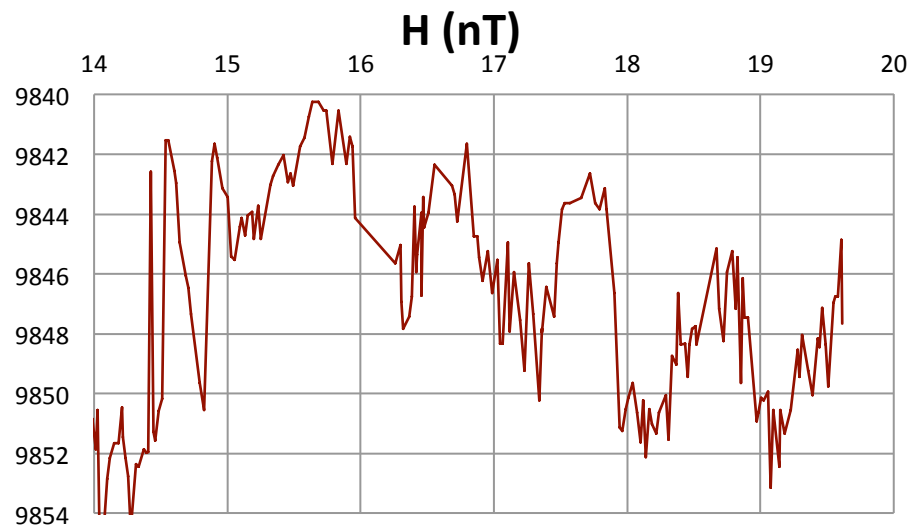
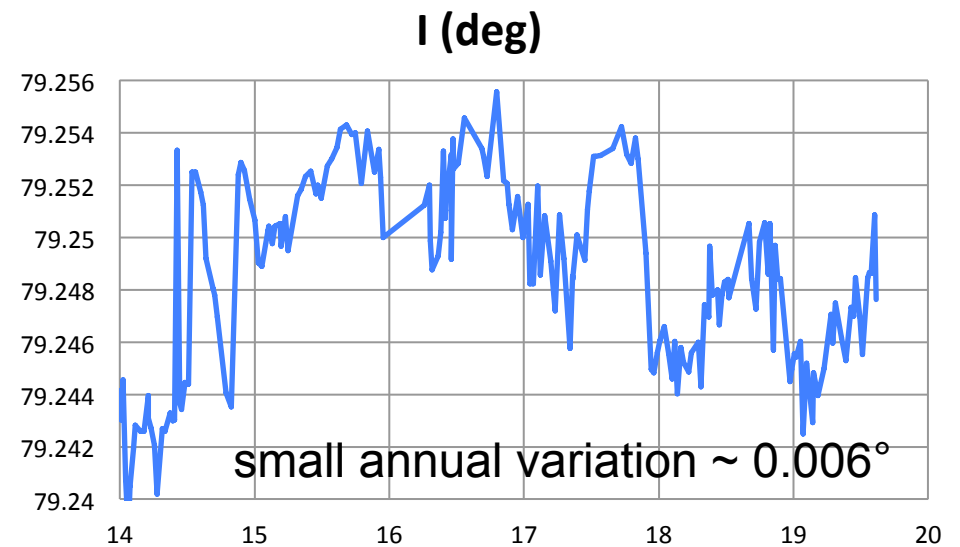
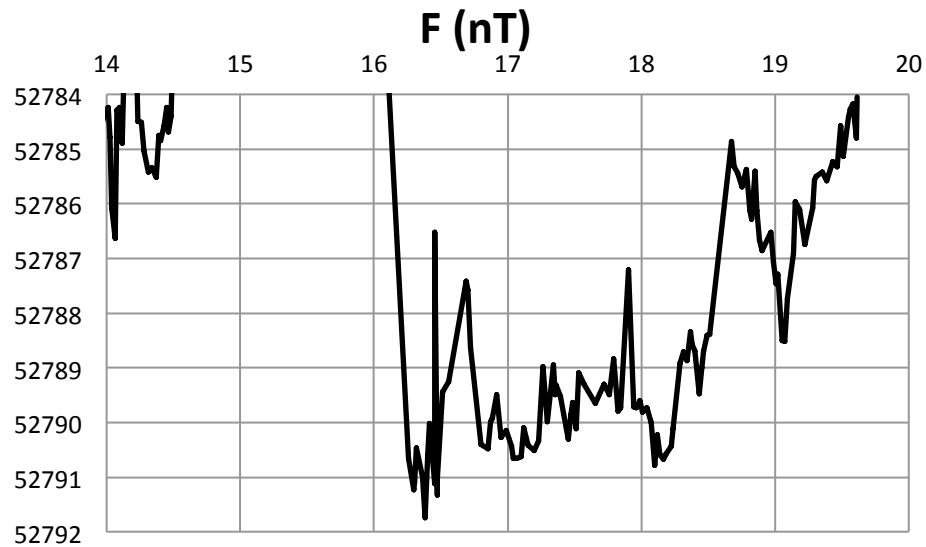


**Sudden jump in Z after
battery change of UPS**

Annual variation (X & Y correlate, but not completely)

⇒ Check with HDI values

Absolute (baseline) measurement

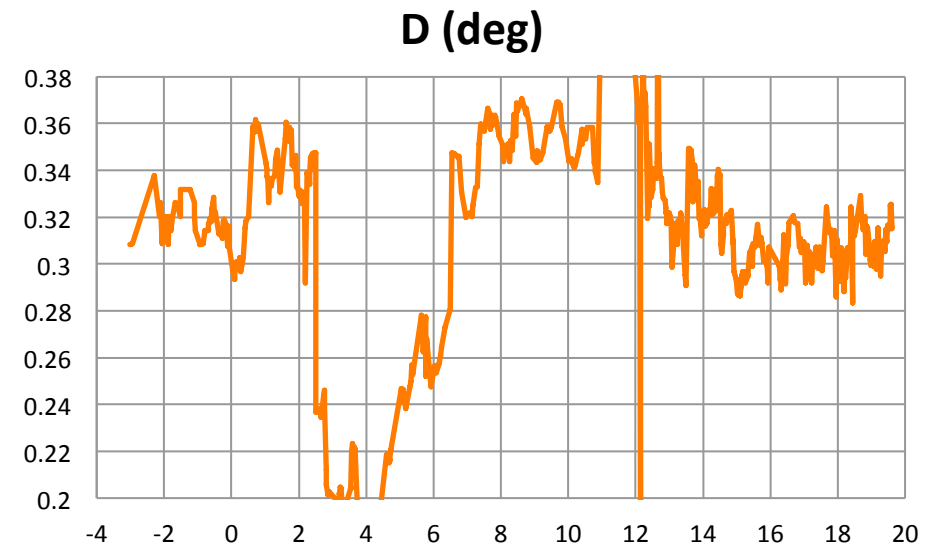
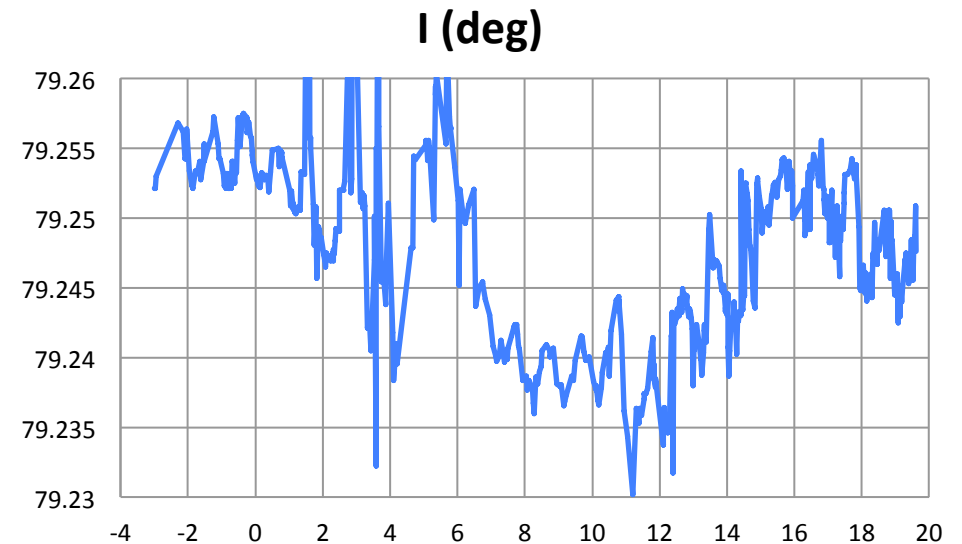
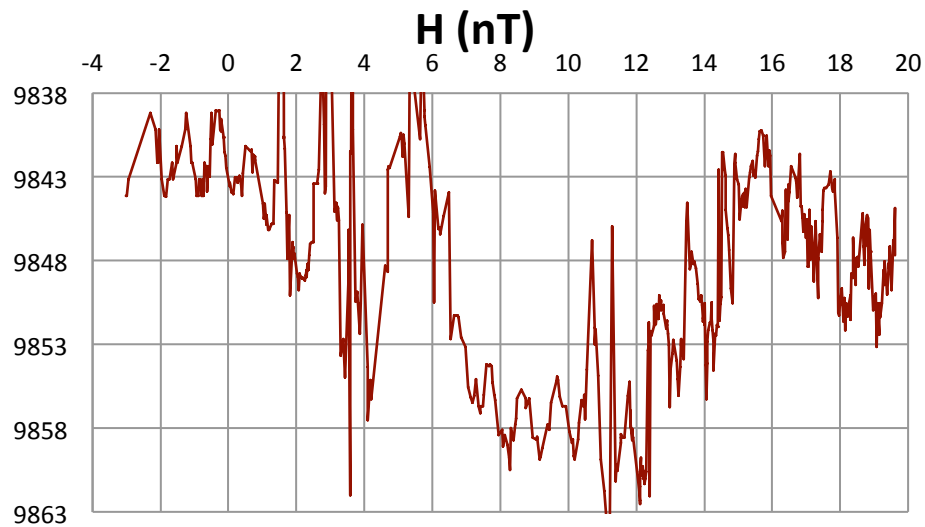


**D and I show annual variation but not correlated.
Change in F at 2018-2019 seems propagating to I and D.**

past > 20 years

Annual variation from the beginning

- same amplitude all the time
 - D-error 2002-2006 & 2011-2013
- ⇒ pillar change?



Recent developments (measurement)

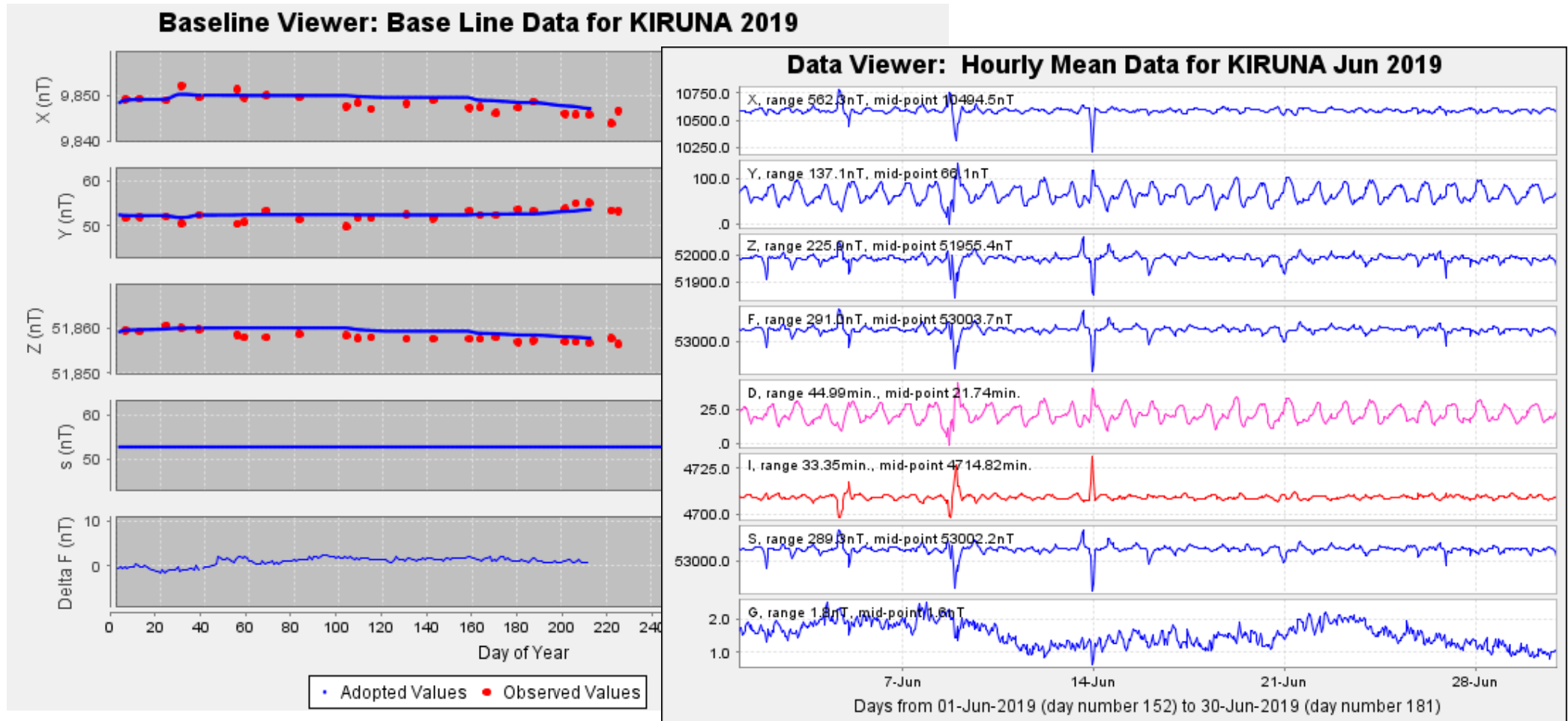
Aiming to INTERMAGNET quality

- * quality control of absolute measurements with new staff (2012~)
- * quality improvement of data processing: 2016~
- * application to INTERMAGNET: 2016 (**pending with 2 problems**)
 - (a) All components need a smoother fit than a linear interpolation between measured observations $\Rightarrow$ **fixed (use spline fitting)**
 - (b) Amplitudes of annual variation of X and Y (anti-correlated) and Z are not consistent. The annual variation remains in D and I, and effect of F change is also seen in D and I (X-Y-Z of variometer are found non-orthogonal, fall 2017) $\Rightarrow$ **(1) need to examine the cause of annual variation (e.g. snow/soil temperature effect on pillar?) & (2) need to examine with new variometer 2018**
- * a problem of "jump" due to UPS was found (2017-2018)
 $\Rightarrow$ **building new UPS house > 50 m away from 2019.**

UPS house plan

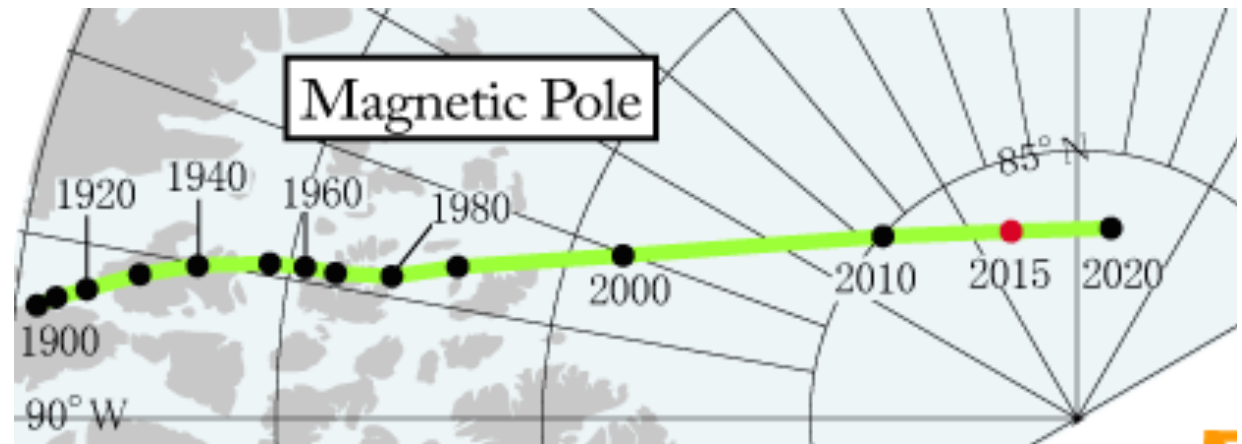


Some of data products (INTERMAGNET format, 2019)

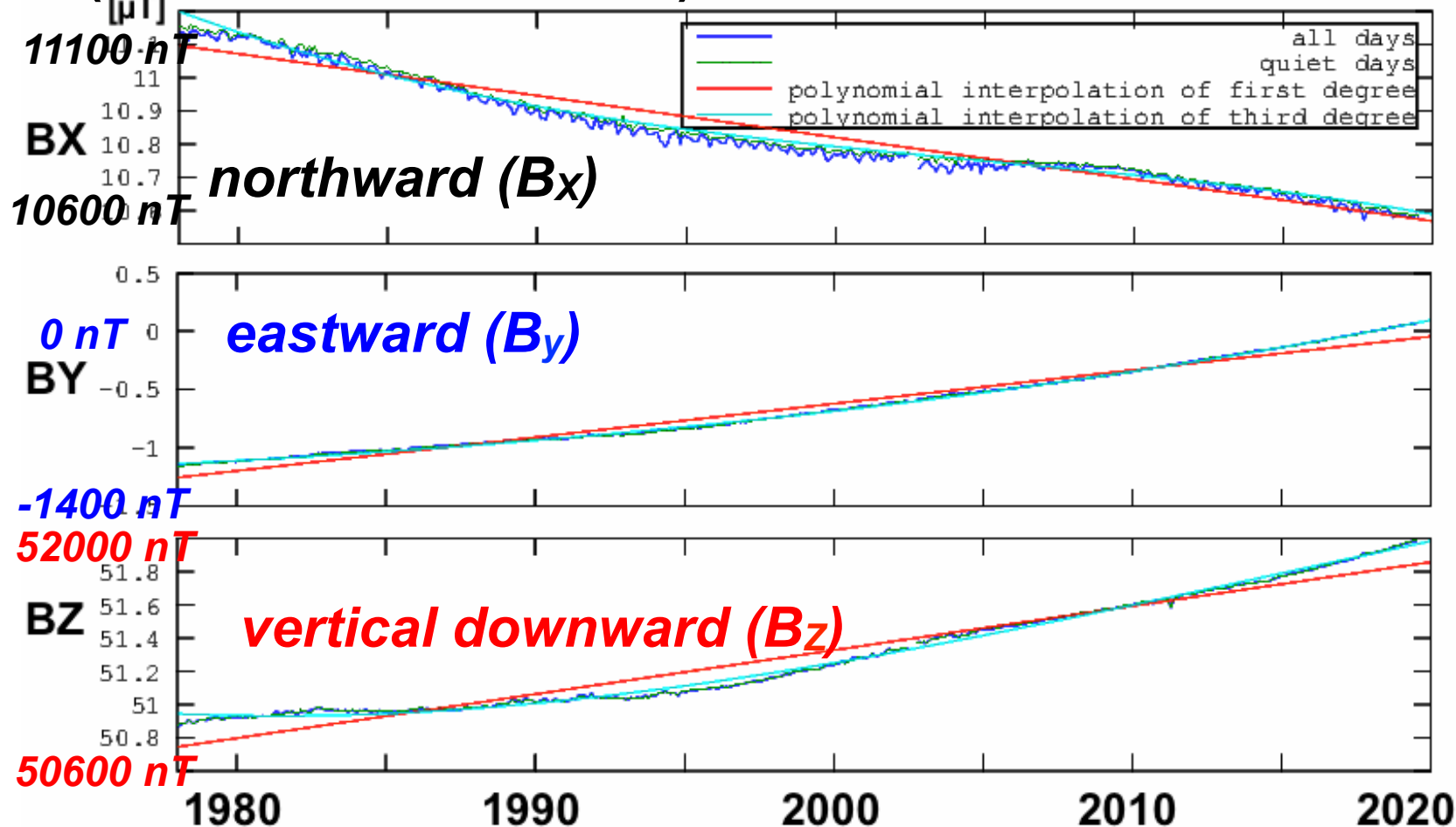


annual & monthly deviations of absolute measurements

Some of data products

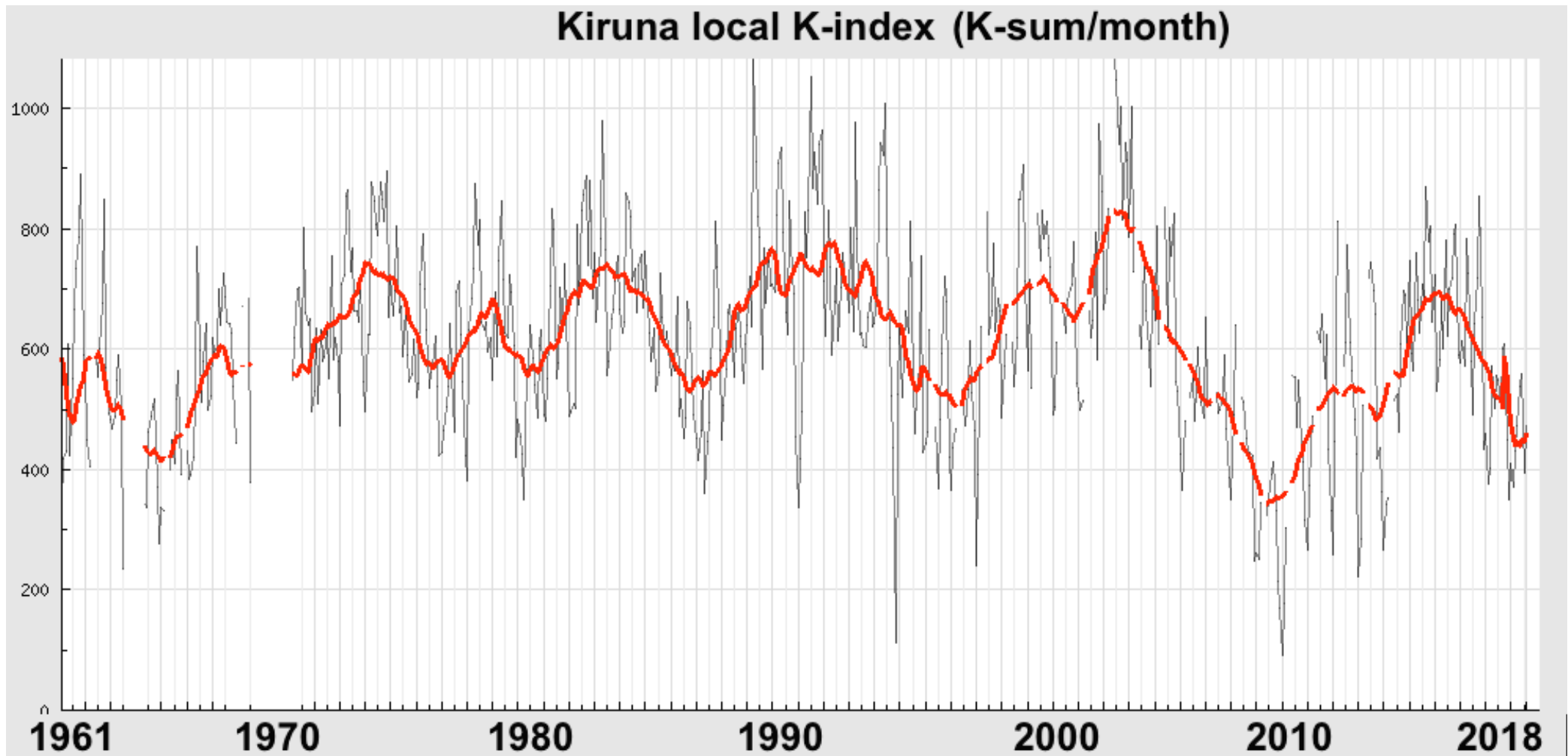


average
(baseline + variometer)



Declination
 $5^\circ \rightarrow 0^\circ$
in 20 years

Some of data products



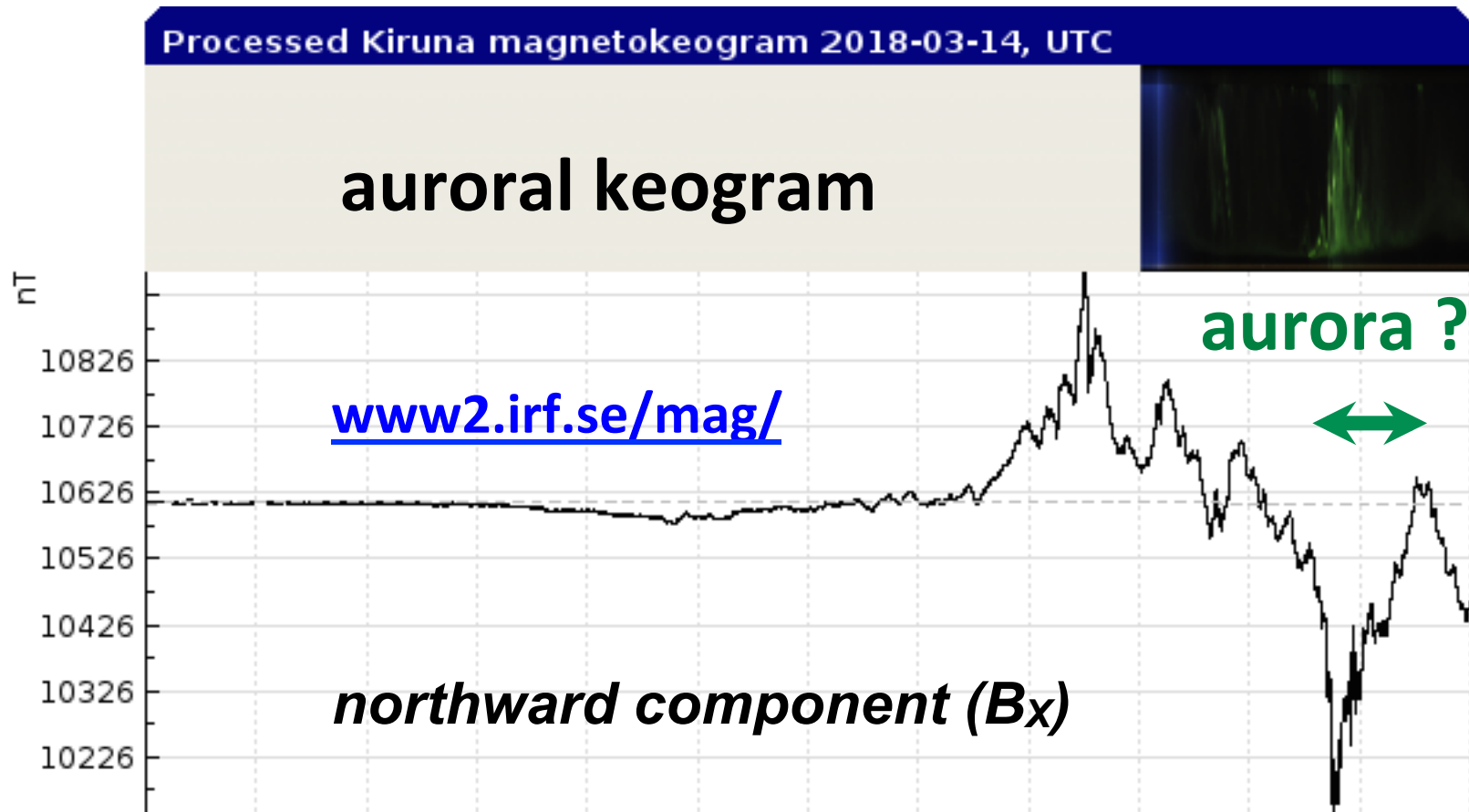
the same secular profile as Kp

Web-interface

(1) Unique nowcast ability: combining with auroral image

all-sky image $\Rightarrow$ take meridian part $\Rightarrow$ make keogram $\Rightarrow$ combine

(concept: aurora = optical energy + electric current energy)



B_Y and B_Z are also shown in the same graph

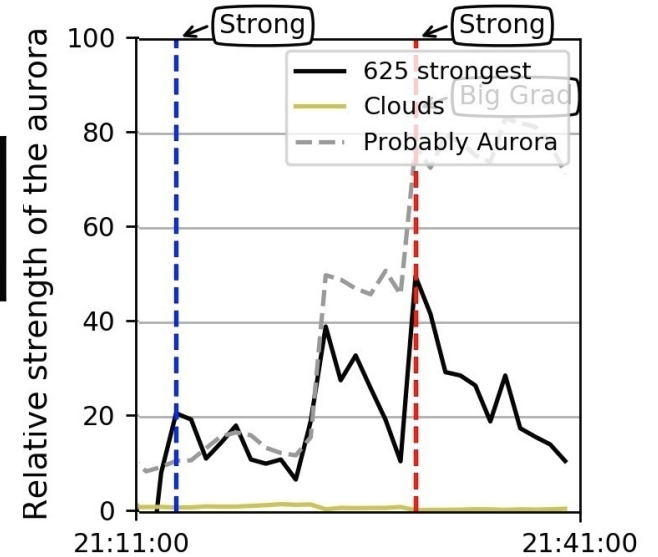
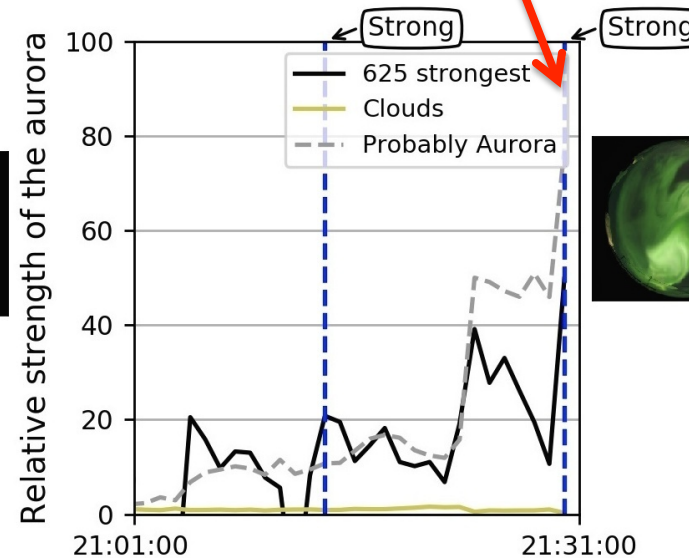
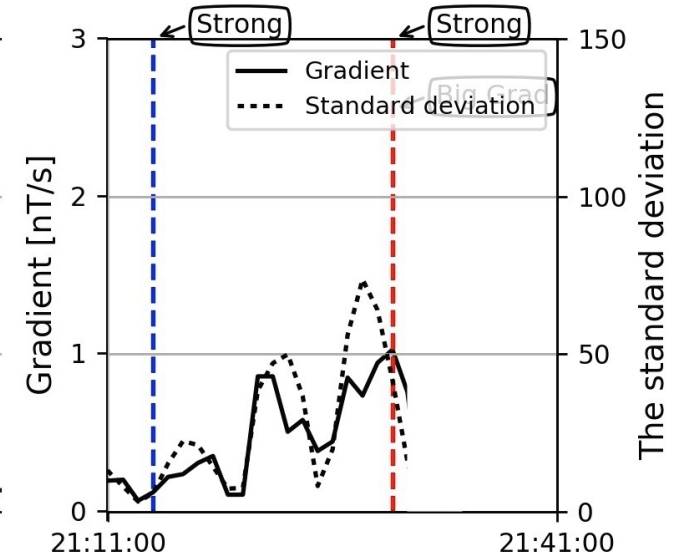
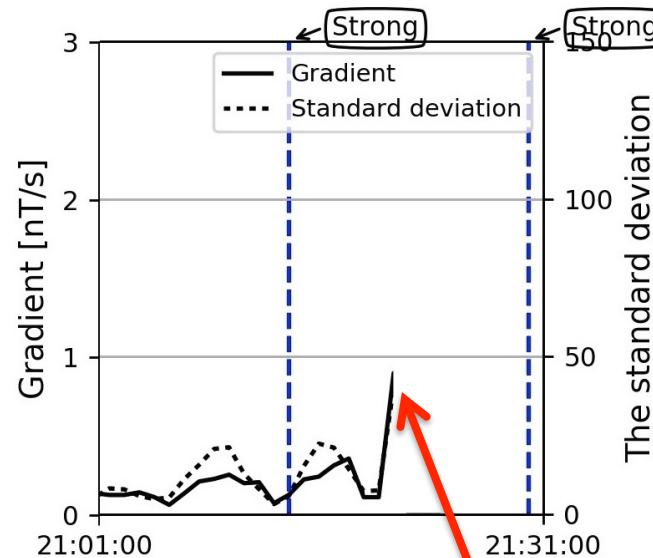
Web-interface (New !)

(2) Unique nowcast of dB/dt and $sd(B)$ over 10 min (+/- 5 min) window.

all-sky image $\Rightarrow$ calculate aurora luminosity at all pixel $\Rightarrow$ strength index

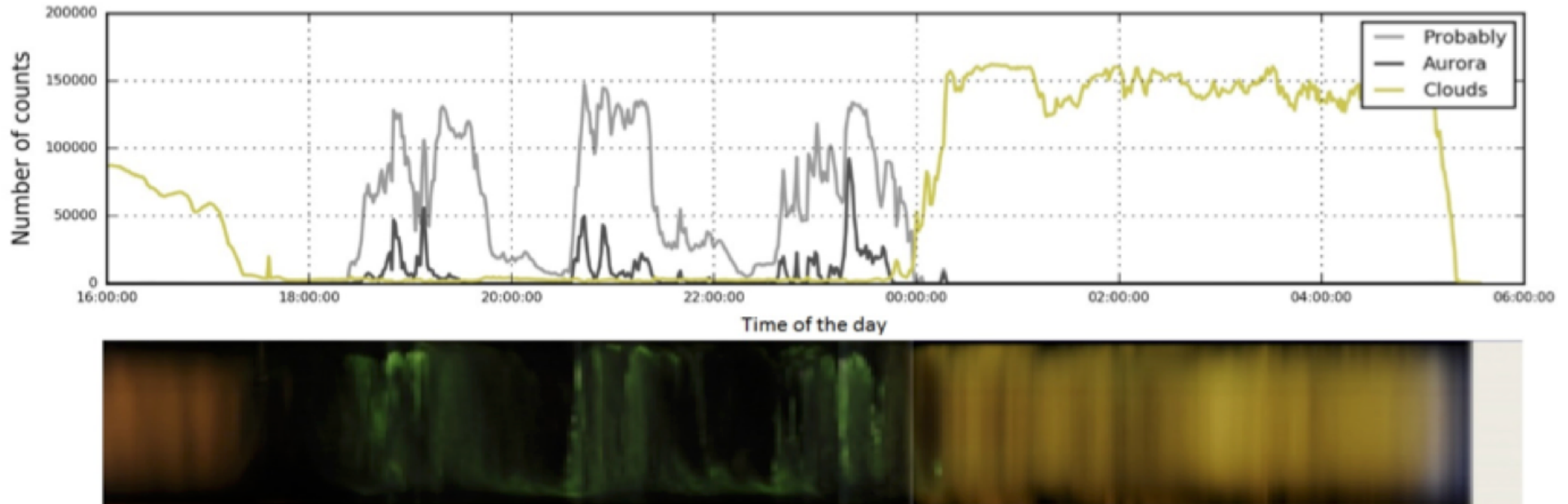
2018-3-14
breakup 21:30 UT

ΔB_x (10-min window)
also shows big jump



Web-interface

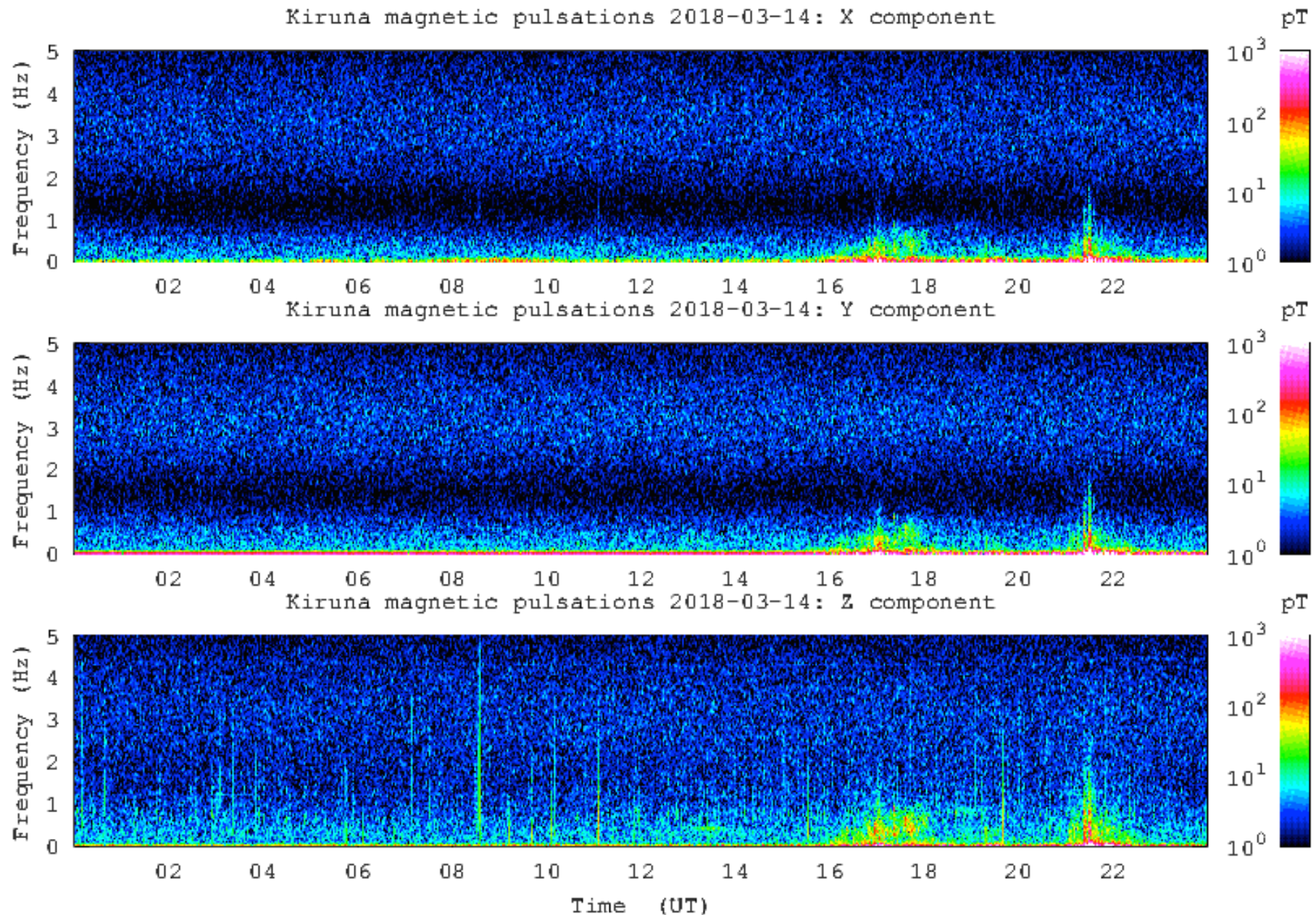
(2) cloud information is also possible to get



⇒ Applications

- (1) relation between aurora activity and dB/dt or $sd(B)$
- (2) warning (e.g., spaceweather, collaboration, tourism)

Add Pulsation magnetometer (future)



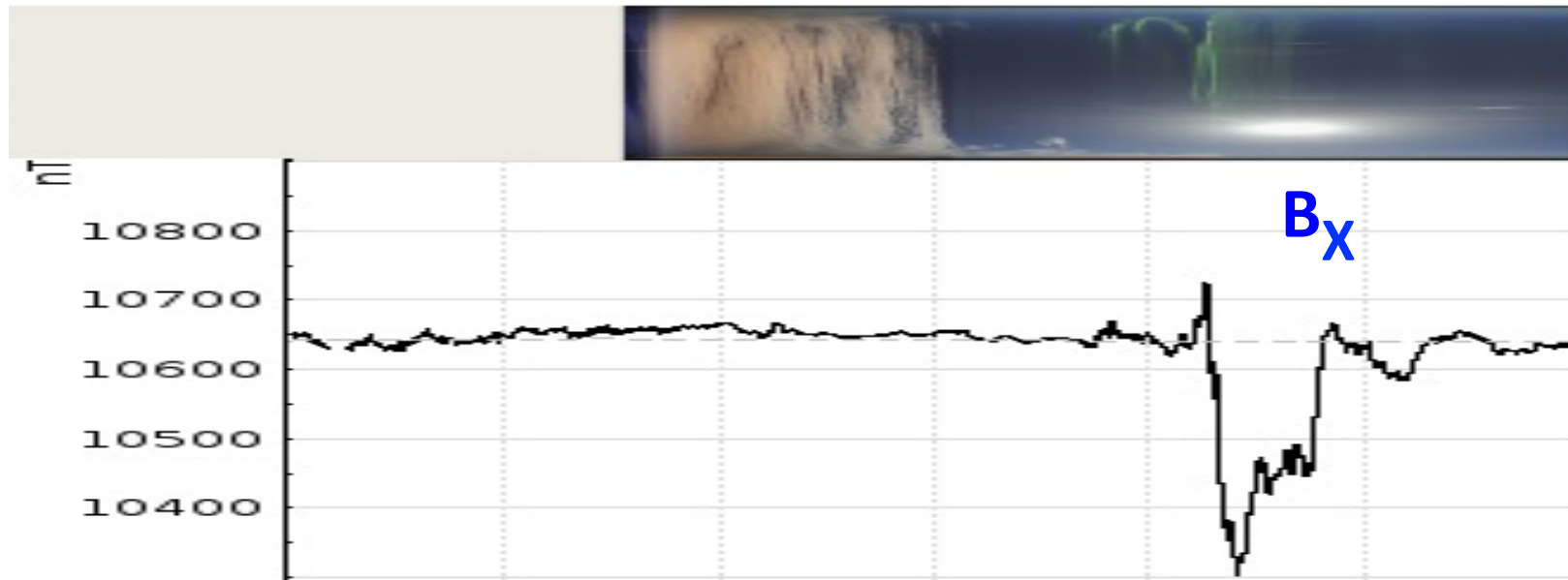
end

Recent developments (preparing for web)

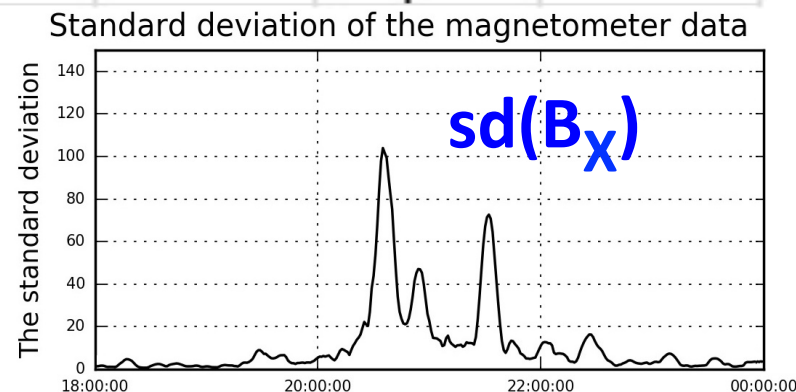
(2) Estimate GIC (Ground Induction Current) from ΔB for spaceweather

$B \Rightarrow dB/dt$ or $sd(B) \Rightarrow$ proxy for GIC

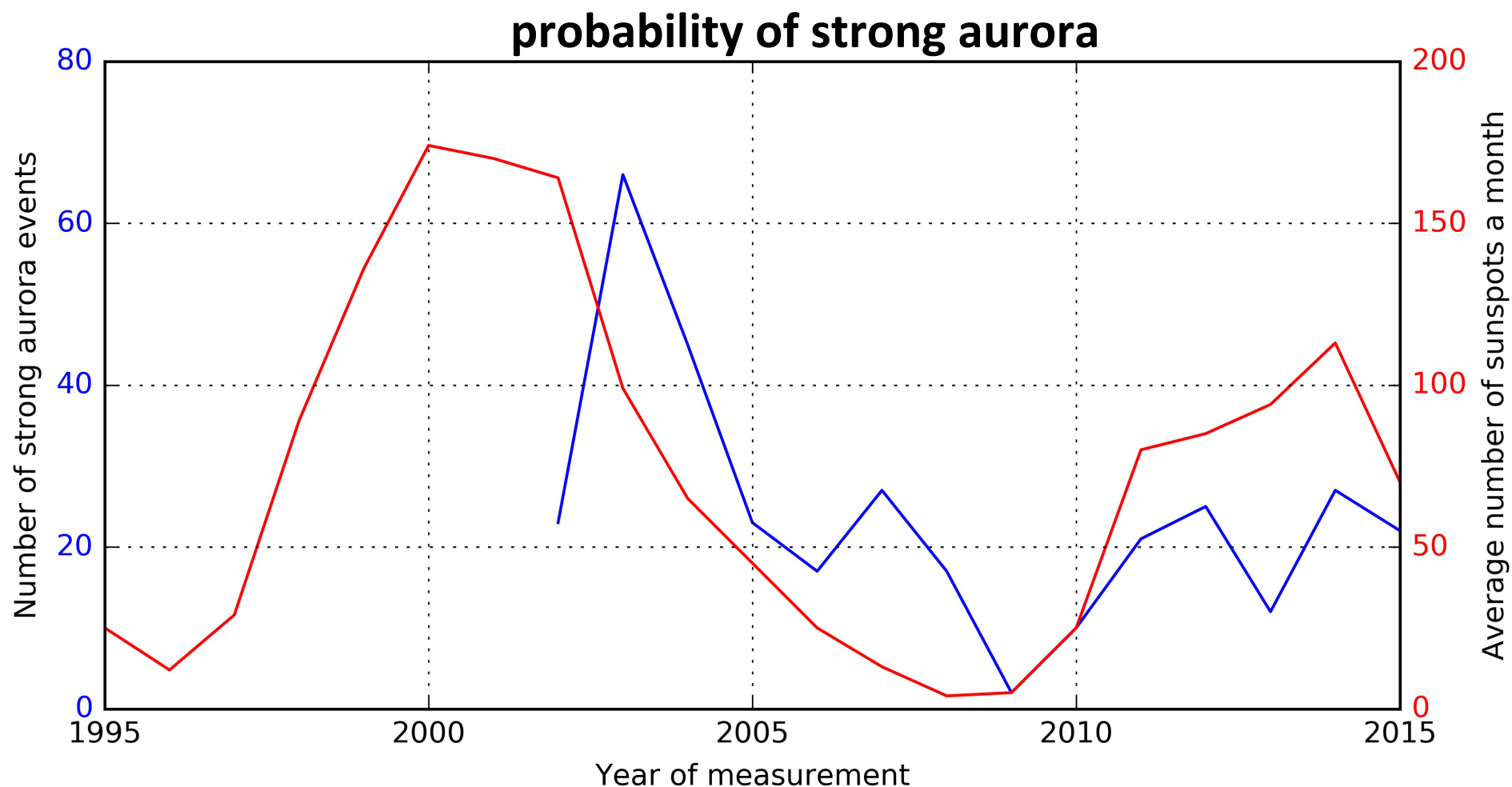
(concept: failure of transformer (and power grid) is by GIC but not $|\Delta B|$)



SD: minute values of SD are obtained from 11 min window data



example: long-term change



Future plan (for web-nowcast)

(5) Combine pulsation data for calculation of GIC proxy

pulsation data $\Rightarrow$????? $\Rightarrow$ combine B-based proxy

(concept: best use **our unique capability**)

(6) dynamic link to all-sky data image of the timing of big activity

clicking keogram $\Rightarrow$ all-sky image of that timing should pop-up

(concept: non-specialist want to see image when prognosis is big aurora)

(7) Combine with Lund forecast page

format TBD

(concept: one can see the expected accuracy of "forecast")

Future discussion (for web-nowcast)

- * **adding to much data makes web-site difficult to digest for non-specialist**
⇒ should we prepare one more web-page for detailed information?

(8) Combine ionospheric data (line-plot forms)?data for calculation of GIC
e.g., density (ionosonde), temperature (EISCAT)

(concept: best use **our unique capability**)

(9) Combine with line-plot form of atmospheric data

- * Radar data
- * etc

(concept: spaceweather effect on neutrals is newly emerging field)