Recovery of Magnetic Recordings from Scandinavian SMA network

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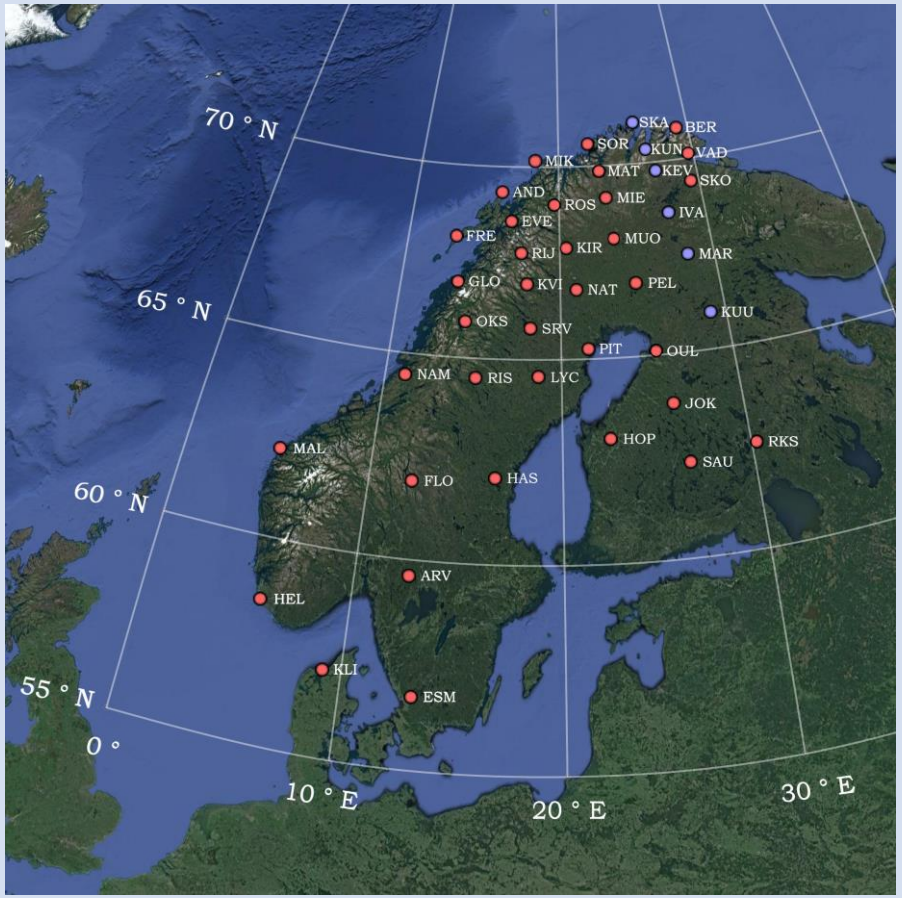
- Scandinavian Magnetometer Array (SMA) was part of the International Magnetospheric Study (IMS 1977 – 1979)
- 36 instruments were buried in the ground
- Instruments were based on modified Gough-Reitzel magnetometer with three wire-suspended magnets and a camera
- The stations recorded 44000 days / 29km of optical data



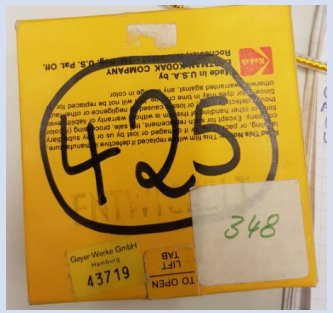


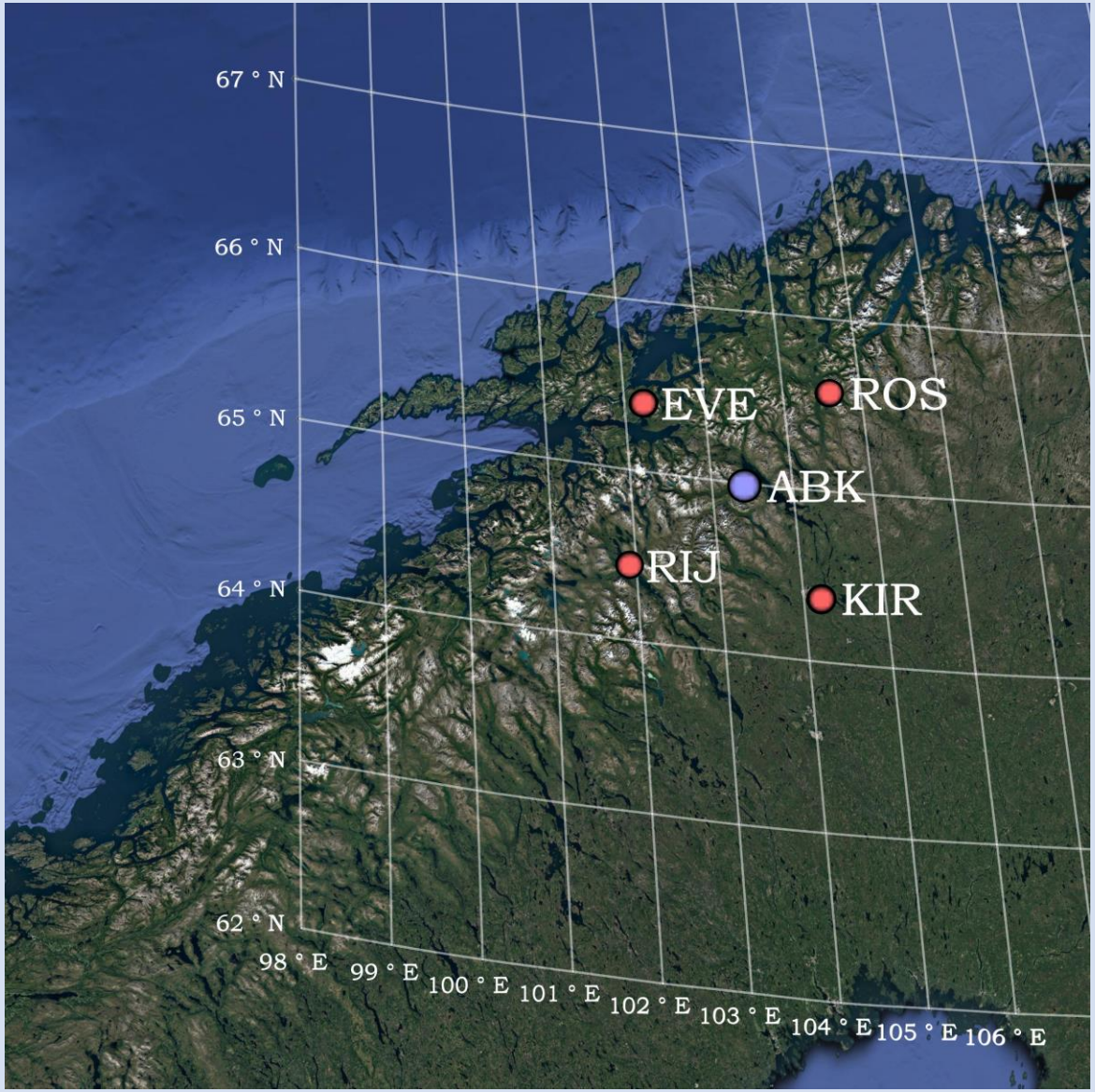
Table 4: Scandinavian Magnetometer Array Observatory Station List.

Symbol	Name	Geographic Coord.		CGM Coord. 1977		Installation	Country
		Lat.	Long.	Lat.	Long.		
BER	Berlevag	70.85	29.13	66.83	113.29	Sep. 1976	NO
SOR	Sørøya	70.60	22.22	67.02	107.99	Oct. 1975	NO
VAD	Vadsø	70.10	29.65	66.07	113.00	Sep. 1976	NO
MIK	Mikkelvik	70.07	19.03	66.72	105.16	Aug. 1974	NO
MAT	Mattisdalen	69.85	22.92	66.23	107.79	Oct. 1975	NO
SKO	Skogfoss	69.37	29.42	65.36	112.22	Sep. 1976	NO
AND	Andenes	69.30	16.02	66.18	102.23	Sep. 1976	NO
MIE	Mieron	69.12	23.27	65.47	107.39	Oct. 1975	NO
ROS	Rostadalen	68.97	19.67	65.57	104.59	Aug. 1974	NO
EVE	Evenes	68.53	16.77	65.34	102.08	Sep. 1976	NO
FRE	Fredvang	68.08	13.17	65.18	99.04	Sep. 1976	NO
MUO	Muonio	68.03	23.57	64.36	106.74	Oct. 1975	FI
KIR	Kiruna	67.83	20.42	64.37	104.22	Dec. 1974	SE
RIJ	Ritsemjokk	67.70	17.50	64.45	101.93	Sep. 1976	SE
GLO	Glomfjord	66.90	13.58	63.94	98.38	Oct. 1975	NO
KVI	Kvikkjokk	66.90	17.92	63.60	101.63	Sep. 1976	SE
PEL	Pello	66.85	24.73	63.10	106.76	Oct. 1975	FI
NAT	Nattavaara	66.75	21.00	63.24	103.84	Aug. 1974	SE
OKS	Okstindan	65.90	14.27	62.86	98.14	Sep. 1976	NO
SRV	Storavan	65.78	18.18	62.44	101.02	Sep. 1976	SE
PIT	Pitea	65.25	21.58	61.67	103.27	Aug. 1974	SE
OUL	Oulu	65.10	25.48	61.29	106.20	Oct. 1975	FI
LYC	Lycksele	64.57	18.68	61.16	100.60	Sep. 1976	SE
RIS	Risede	64.50	15.13	61.35	97.84	Sep. 1976	SE
NAM	Namsos	64.45	11.13	61.62	94.76	Sep. 1976	NO
JOK	Jokikylä	63.77	26.13	59.89	105.94	Oct. 1975	FI
HOP	Hööpakka	63.01	22.56	59.30	102.70	Jul. 1978	FI
RKS	Röksä	62.57	30.26	58.47	108.64	Jul. 1978	FI
SAU	Sauvamäki	62.30	26.65	58.36	105.59	Oct. 1975	FI
MAL	Malöy	62.18	5.10	59.80	88.73	Sep. 1976	NO
HAS	Hassela	62.07	16.50	58.71	97.43	Sep. 1976	SE
FLO	Flötningen	61.88	12.23	58.83	94.01	Jul. 1978	SE
ARV	Arvika	59.60	12.60	56.36	93.09	Sep. 1976	SE
HEL	Hellvik	58.52	5.77	55.77	87.23	Sep. 1976	NO
KLI	Klim	57.12	9.17	53.92	89.22	Oct. 1976	DK
ESM	Esmared	56.74	13.22	53.20	92.26	Jul. 1978	SE

- The researchers noticed that the digitization of the data is extremely time consuming

- For local magnetic disturbances, the current SMA results are generally one-hour periods

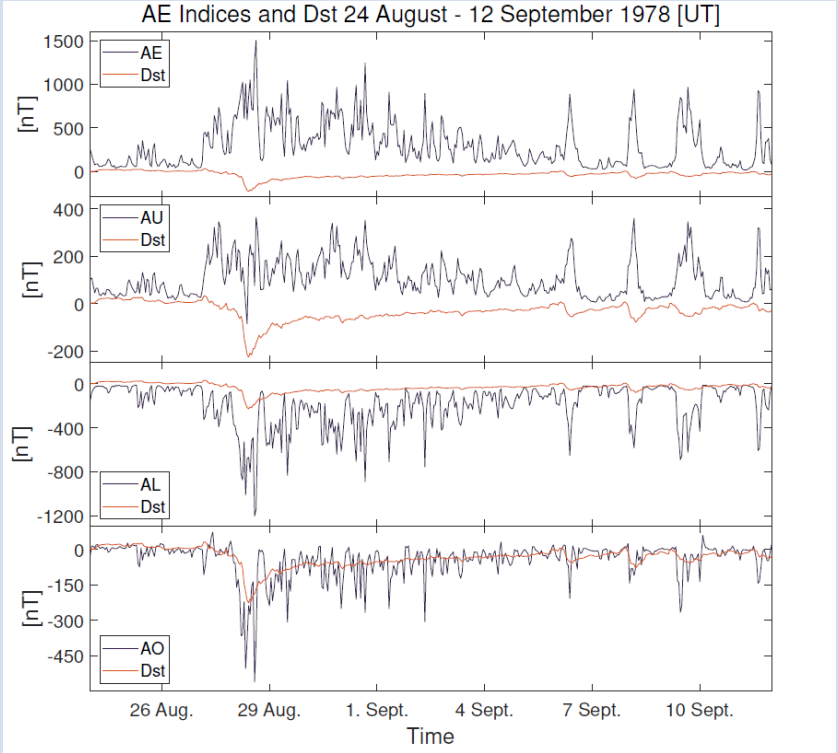
- The main goal of my Master's Thesis is to find and digitize the strongest magnetic storm in Auroral Zone in 1977

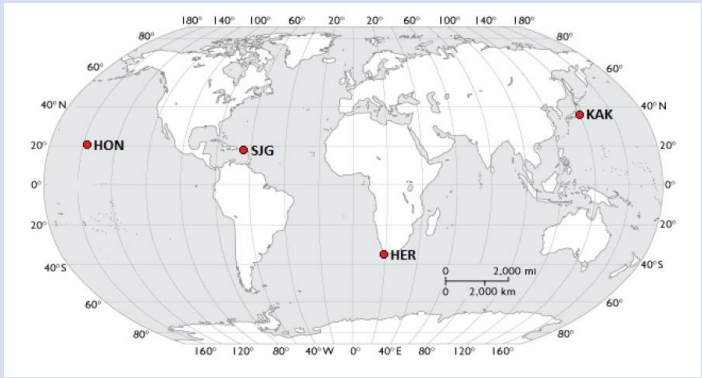


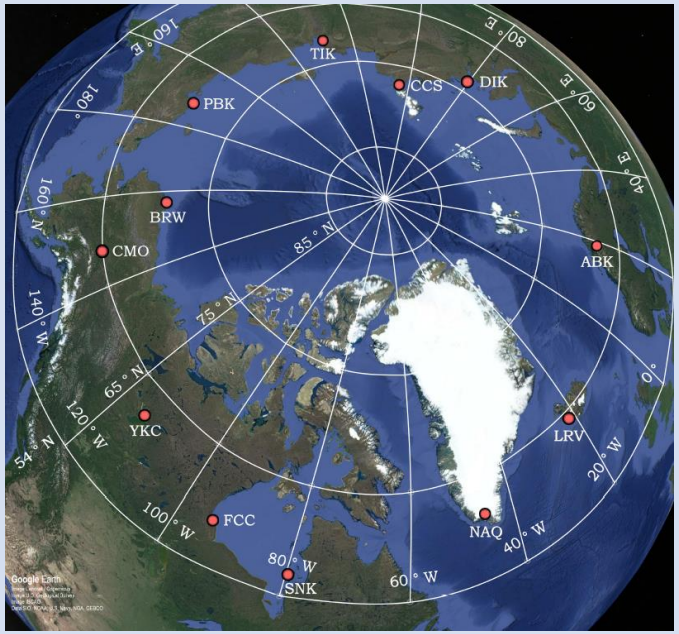
◆There is no Auroral Electrojet (AE) indices for year 1977

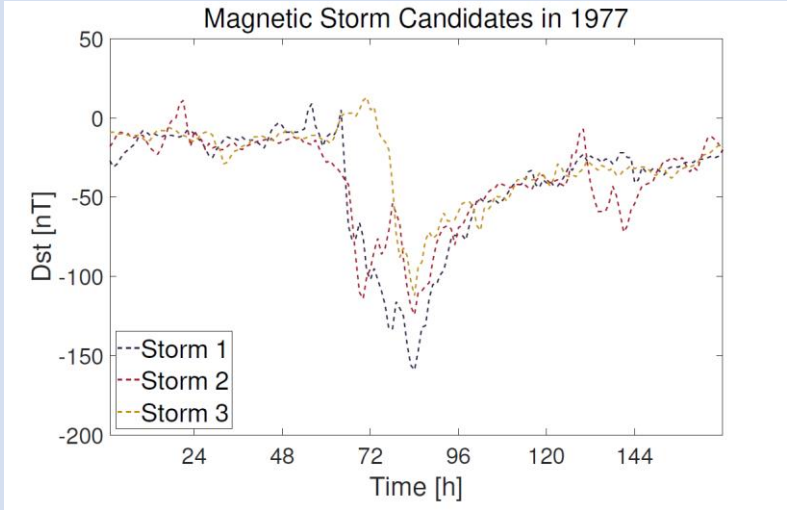
◆AE indices are measured in the Auroral Zone and Disturbance Storm Time (Dst) index near the equator

◆We can find the greatest magnetic storm in the Auroral Zone by using the Dst index









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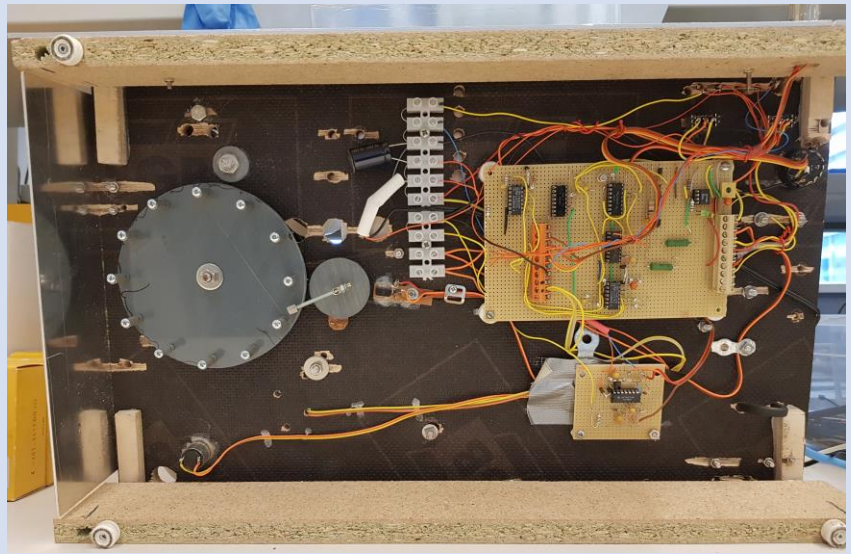
The AE and Dst indices used in this presentation was provided by the WDC for Geomagnetism, Kyoto (http://wdc.kugi.kyoto-u.ac.jp/wdc/Sec3.html).

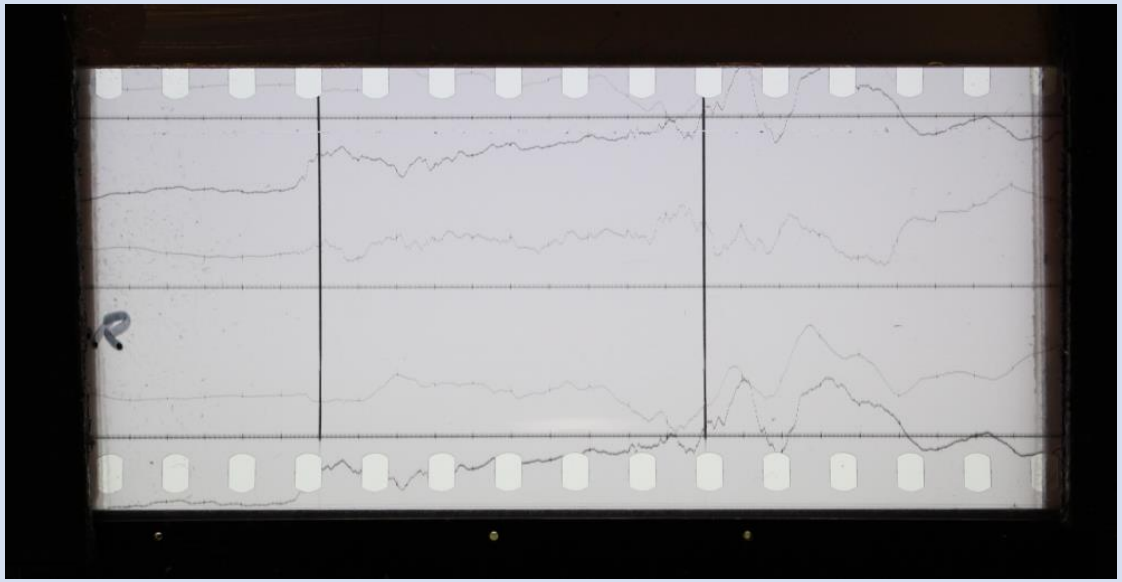
- DigiMAG is custom build digitization device built by Markku Mäkelä
- If the camera settings are not changed between the images, the height of recorded optical data remains the same in pixels
- DigiMAG makes it possible to photograph a 50 meters long film reel in less than two hours

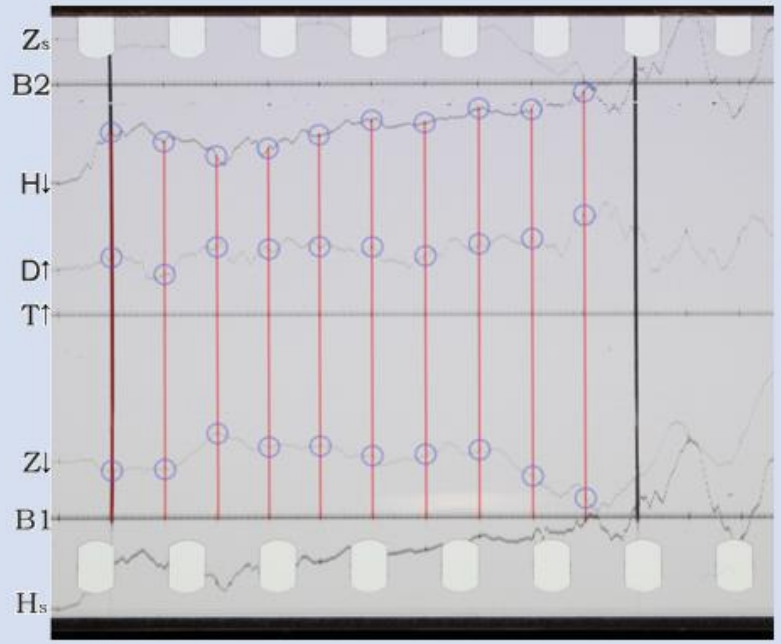


◆The data must be collected from photographs by measuring the distances of the curves to the base line

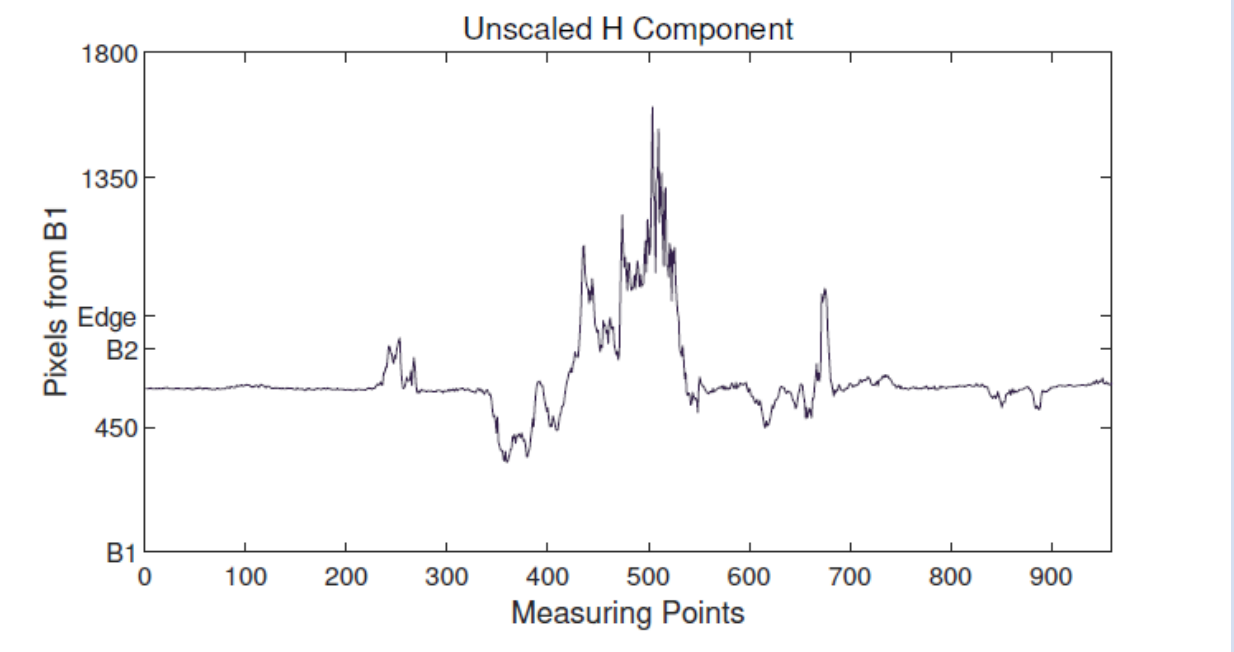
◆We achieve a 6-minute resolution by measuring the B1—component curve distances every 6 minutes

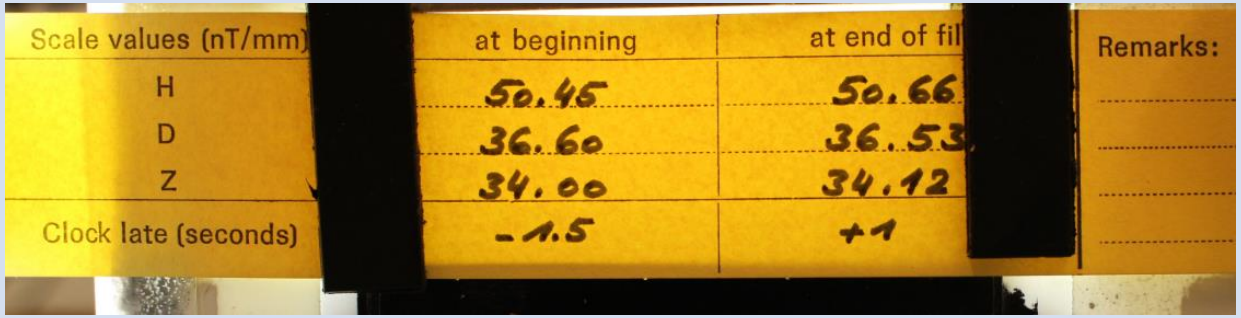
◆The best possible resolution would be 10 seconds because the lamp of the instrument turned on and burned the curves to the film every 10 seconds



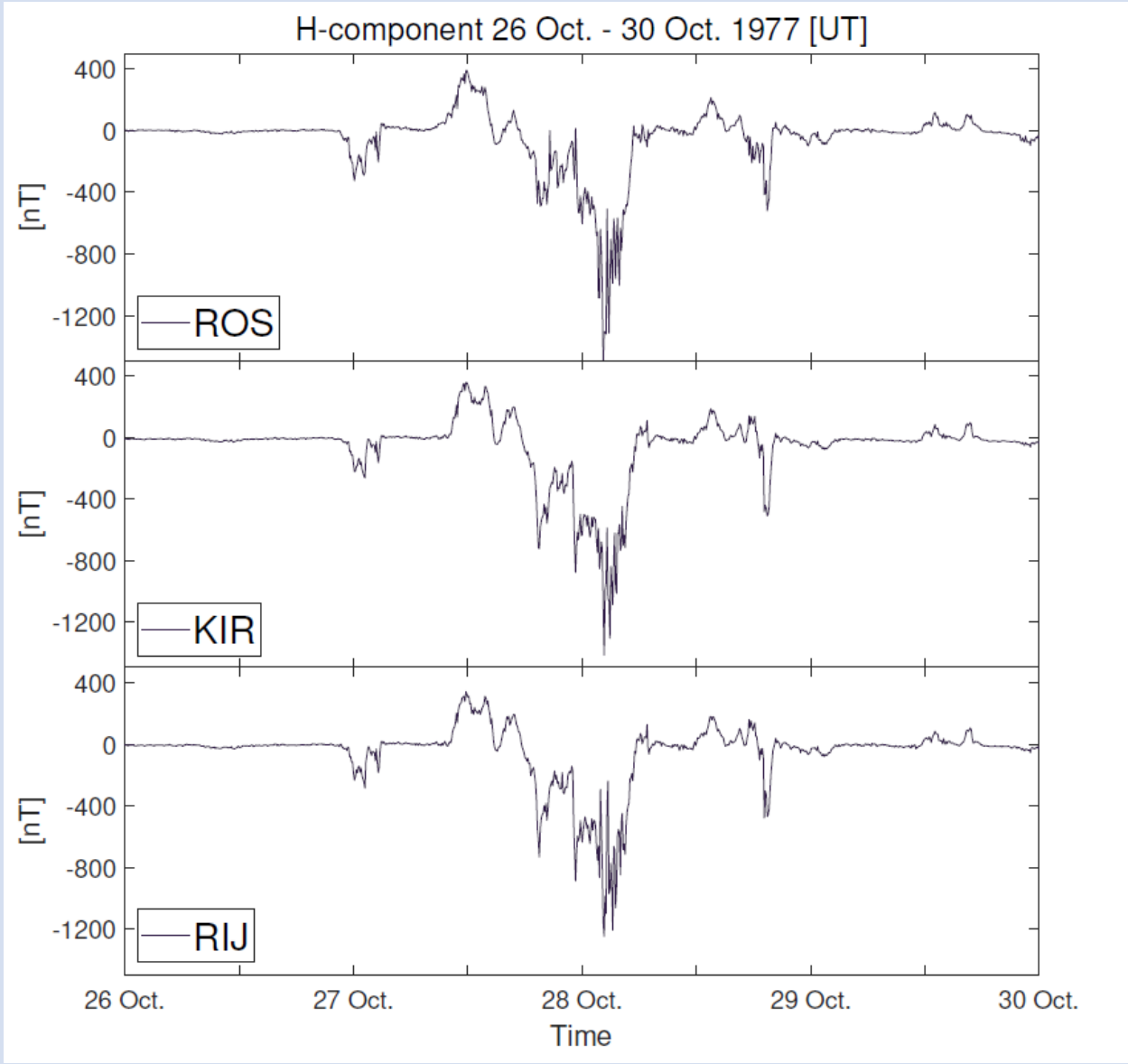


- The data needs to be scaled in order to know the actual fluctuations in the magnetic field
- The height of the curves is compared with the quiet time reference when the magnetosphere was relatively stable
- Unscaled H-component figure is basically upside down because H-component curve increases downwards and pixel measurements are made from down to up



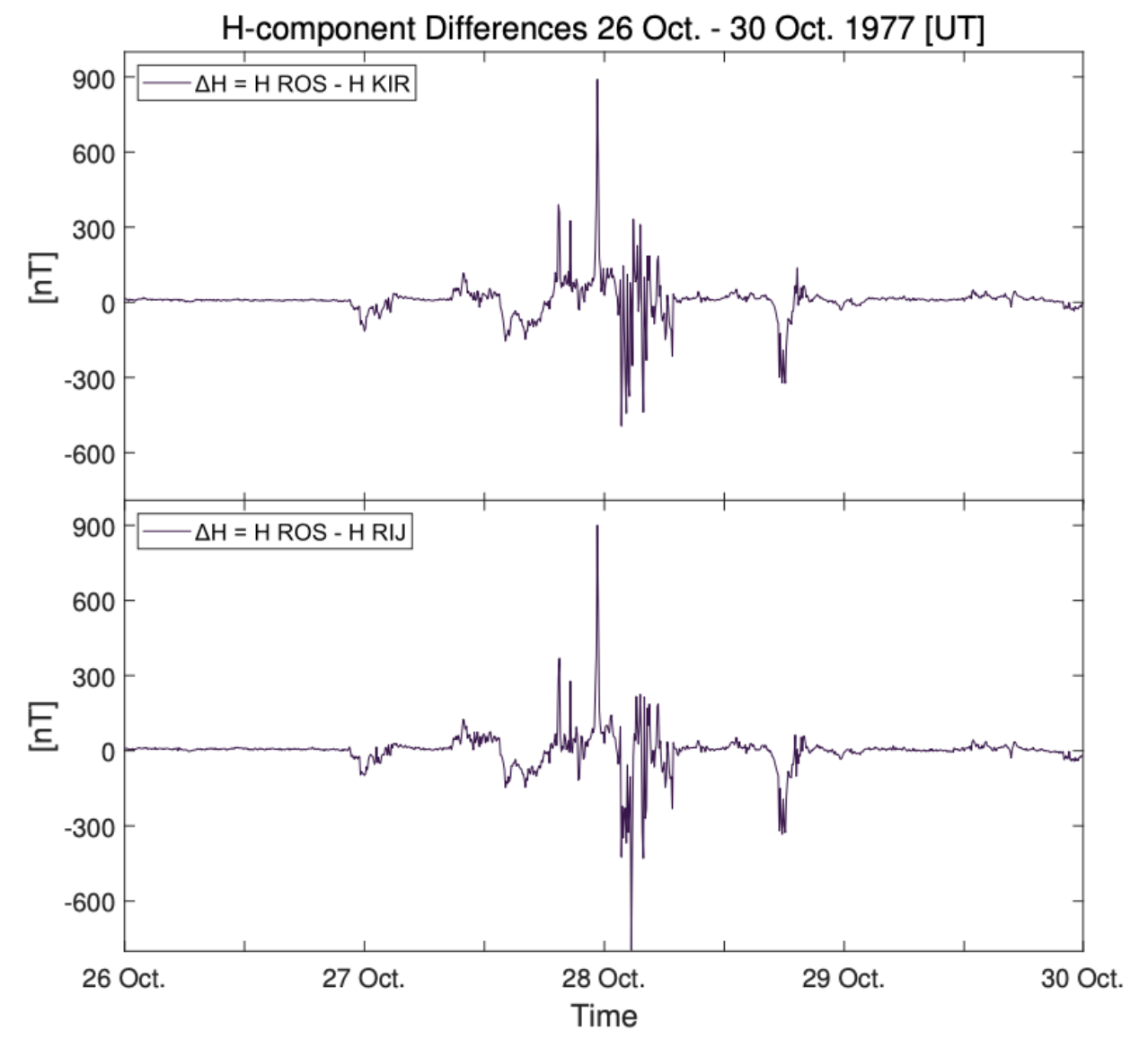


- The results show that onset of the storm began on October 27, 1977
- During the main phase, the strength of the Earth's ring current increased and decreased several times
- The D and Z components are also digitized



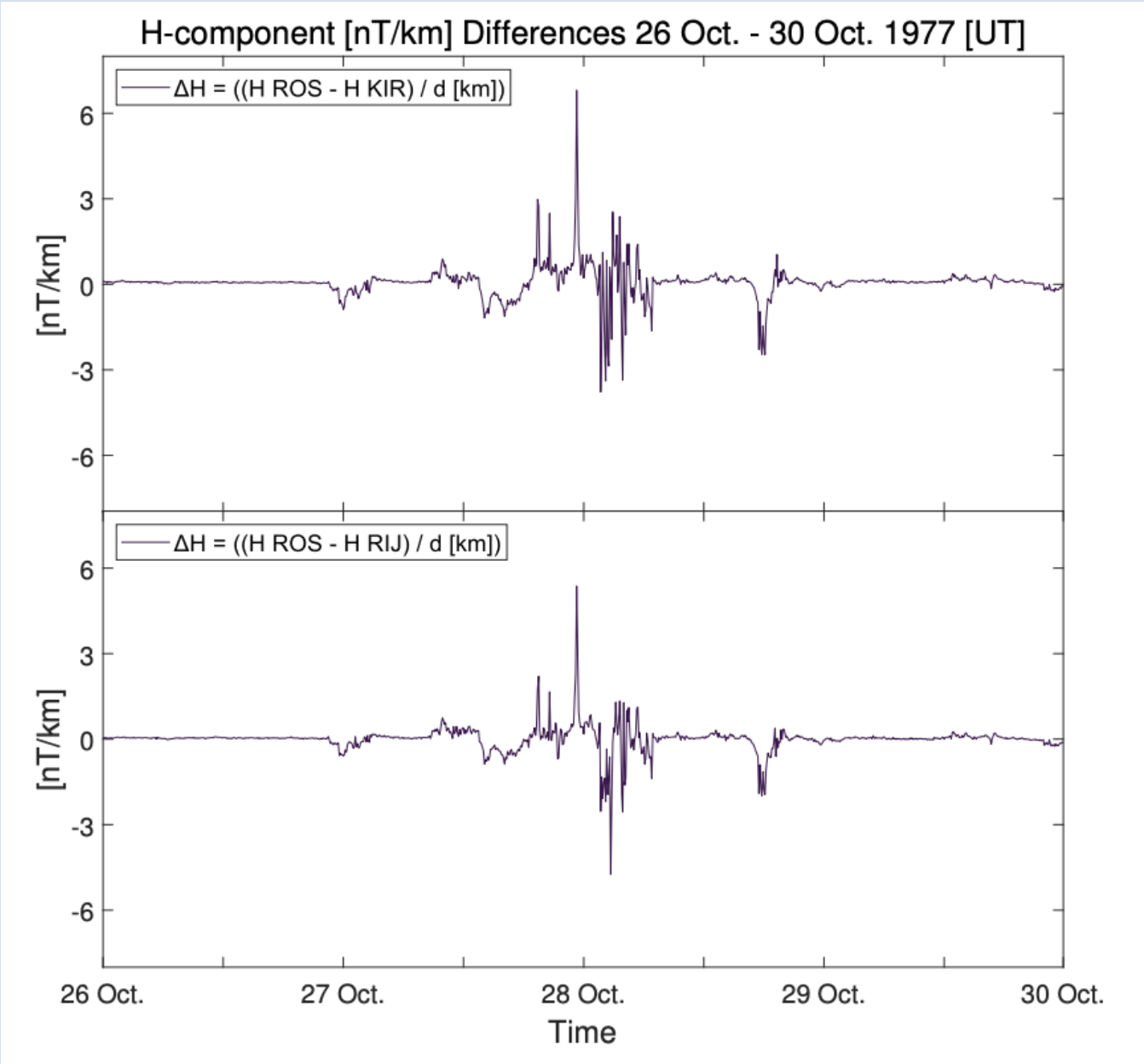
- The beginning of the main phase can be detected first at lower latitudes

- The KIR and RIJ stations are located approximately one degree lower latitude than ROS station



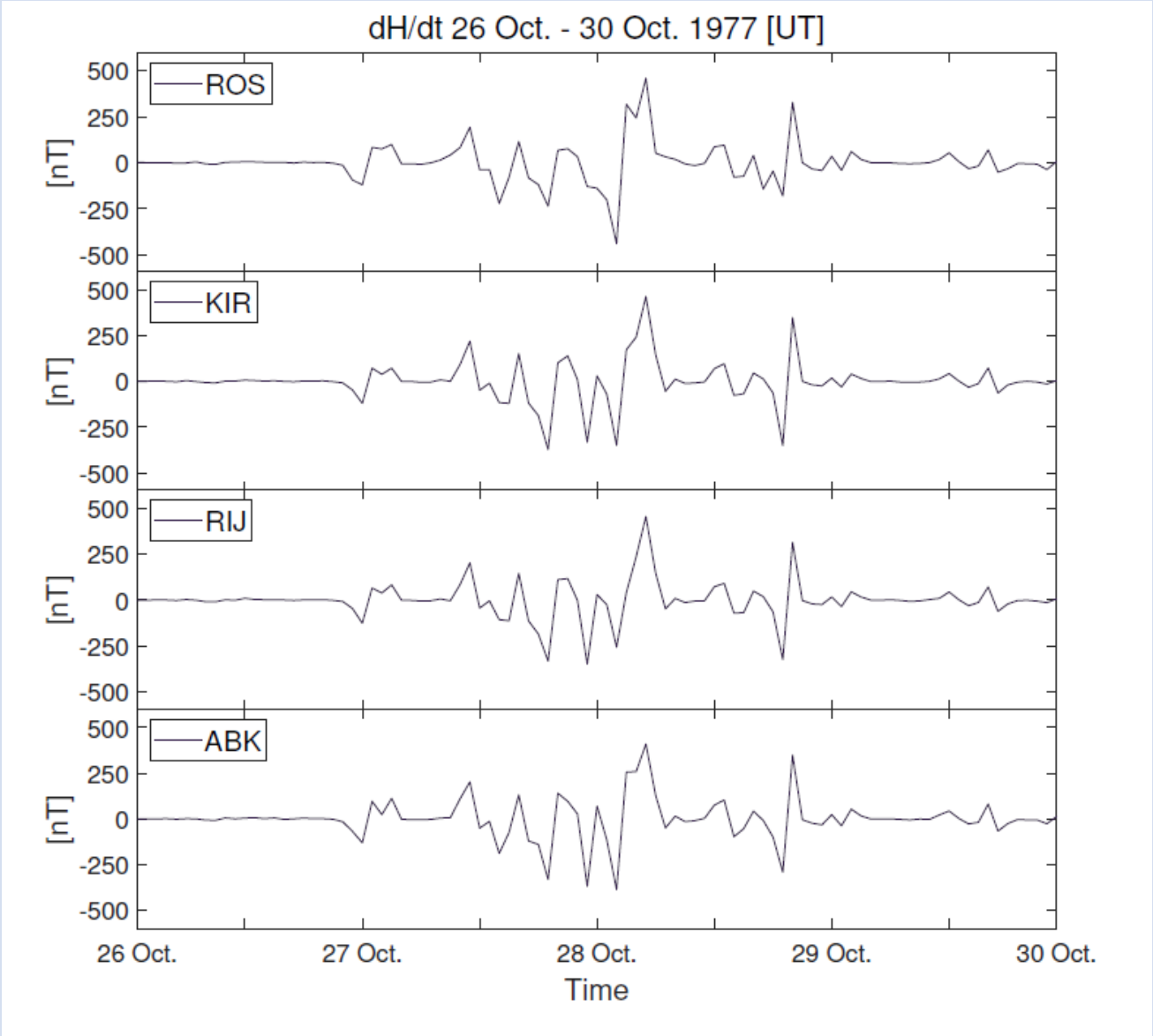
- The RIJ station is further away from the ROS station location than the KIR station

- When the distance is taken into account, the differences between the graphs are reduced



- The time derivatives match well with permanent station located in Abisko (ABK)

- This confirms the usability of the SMA data



Thank you!
Questions? Comments?

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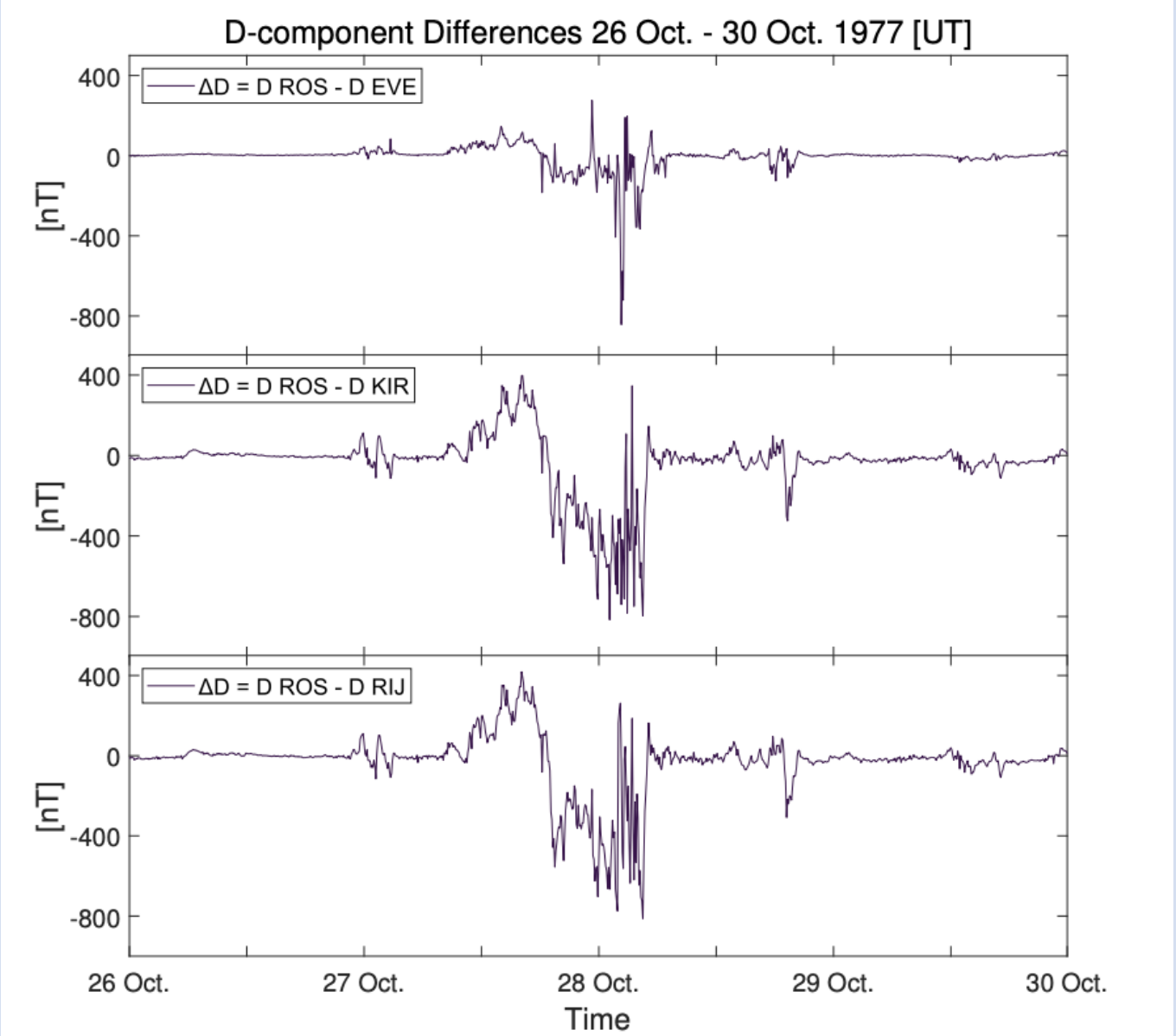
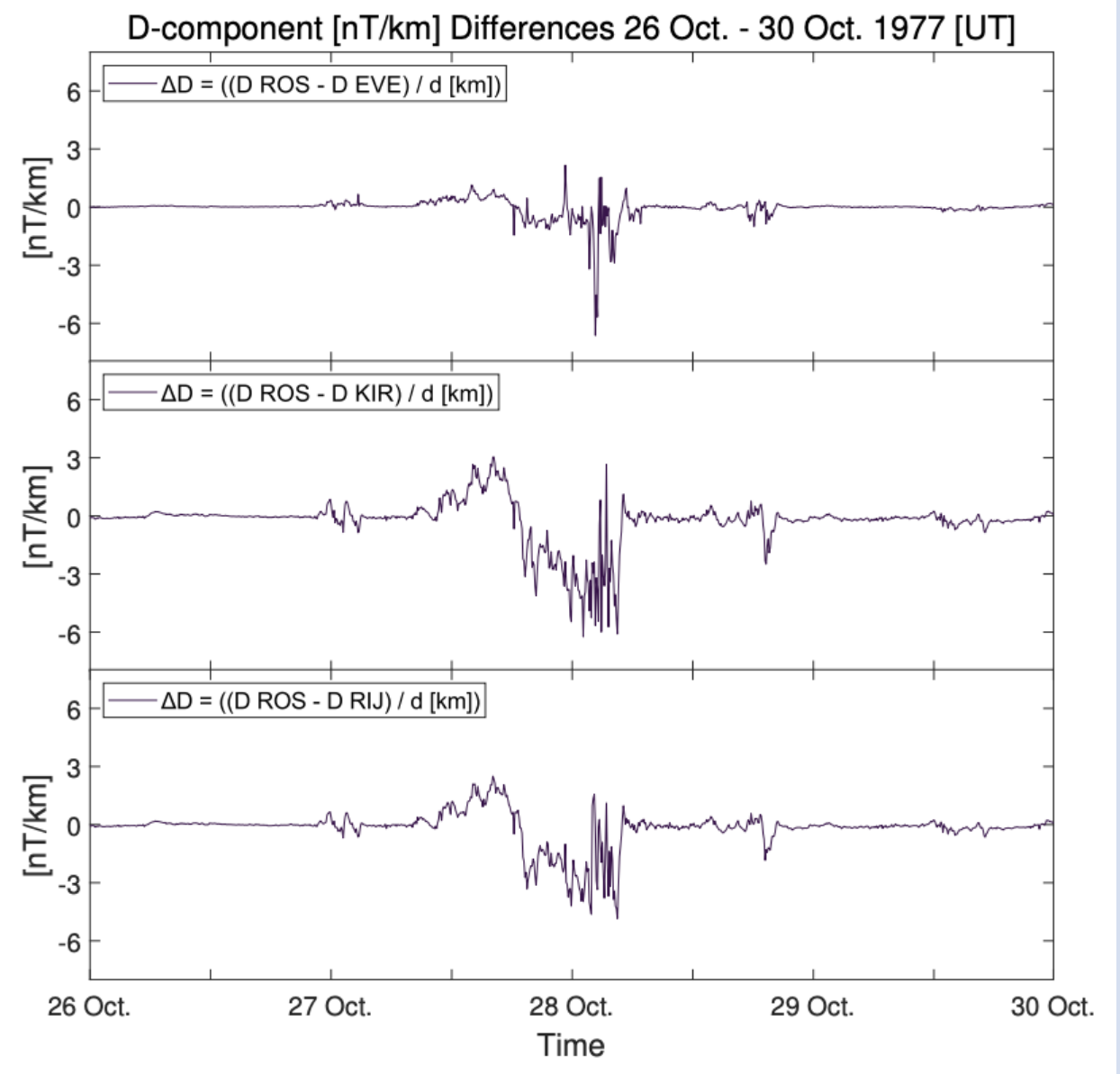
- Magnetic disturbances measured at the ROS and EVE station are very similar

- The difference between the stations located at the higher latitude compared with the stations located at the lower latitude were high especially during the main phase of the storm



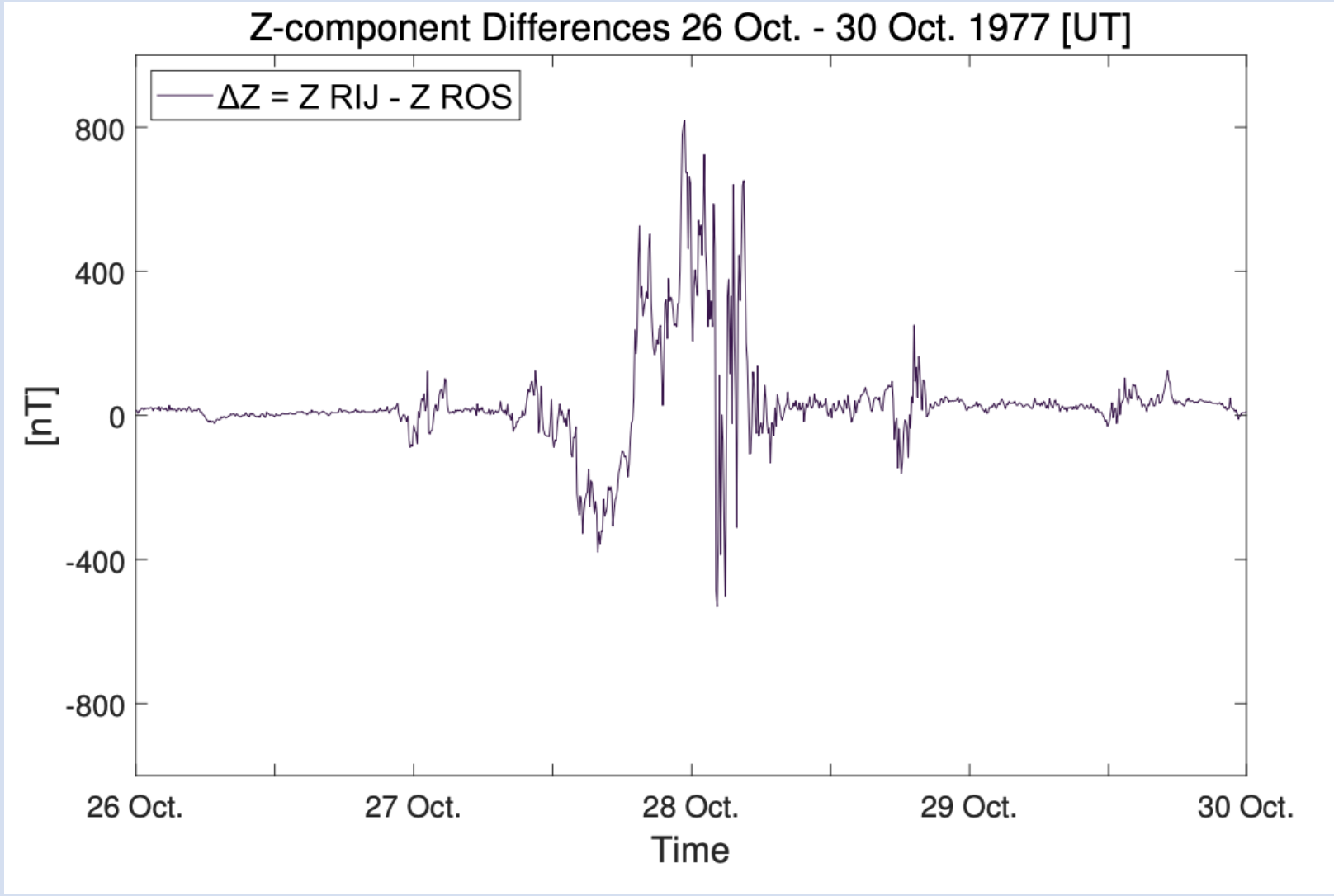
- The EVE station is closer to the ROS station than the other stations

- There is still large differences in the data measured at the lower latitude stations



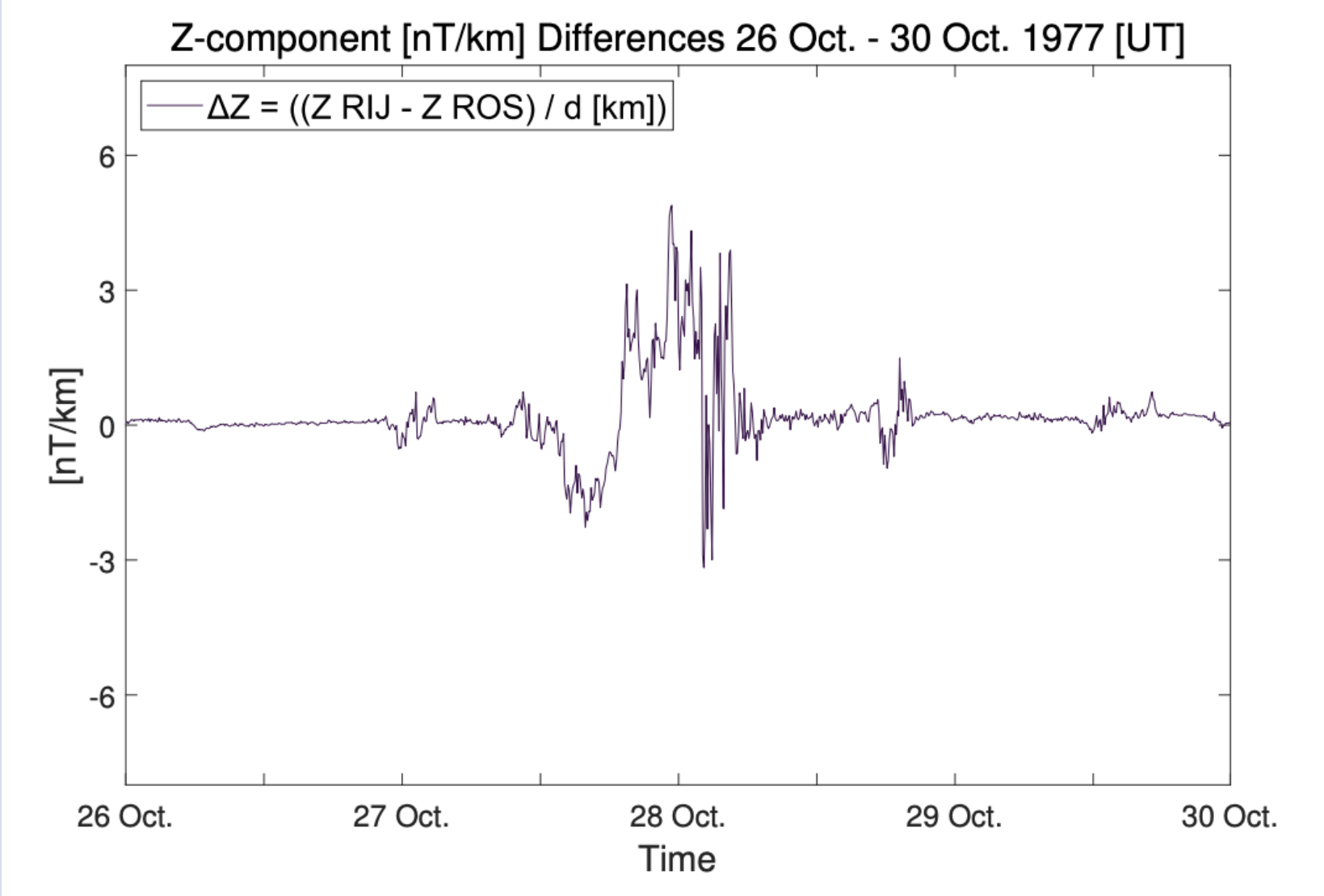
- When the magnetosphere is in the normal state, the differences are inconsiderable

- During the magnetic storm the differences are large



- The magnitude of the vertical component can change very rapidly

- The difference is at most approximately 5 nT/km



♦The figure shows the highest hourly time derivative of the H-component during the magnetic storm

♦The disturbance seems to come from geographic northeast and intensify at all the stations