



Eighth Workshop “Solar influences on the magnetosphere, ionosphere and atmosphere”

Substorms over Apatity during 2014/2015 observational season

V. Guineva¹, I. V. Despirak², B. V. Kozelov²

*¹Space Research and Technology Institute (SRTI),
Stara Zagora Department, Bulgaria*

²Polar Geophysical Institute, Apatity, Russia



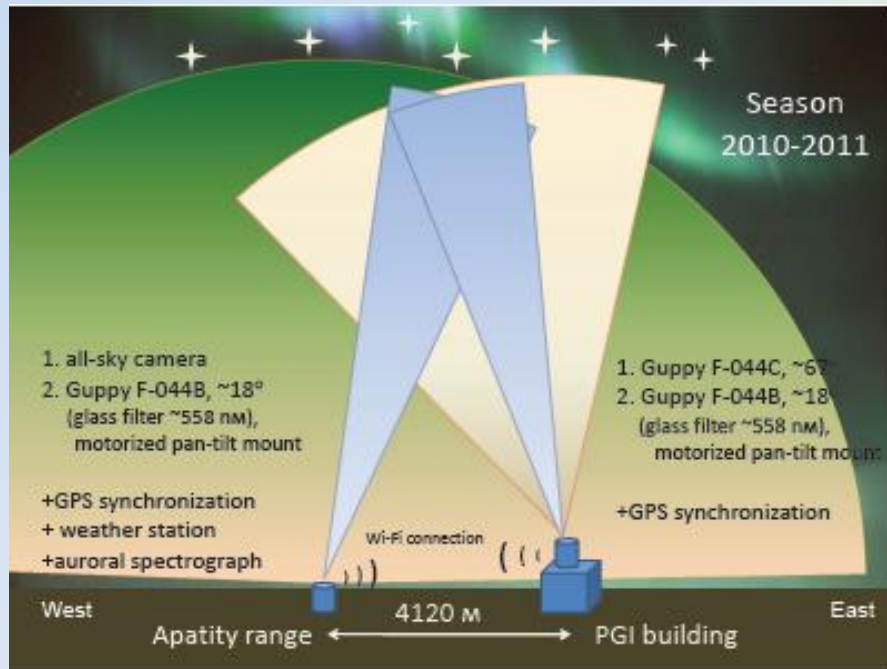
May 30– June 3, 2016, Sunny Beach, Bulgaria

Instrumentation and data used

Goal: to study substorm developments during different geomagnetic conditions: in non-storm time and during different phases of geomagnetic storms.

- Measurements from **MAIN** (**M**ultiscale **A**urora **I**maging **N**etwork) in Apatity during 2014/ 2015 observational season have been used.
- Solar wind and interplanetary magnetic field parameters were taken from the 1-min sampled OMNI data base (spacecraft-interspersed, near Earth data) of the Coordinated Data Analysis Web (<http://cdaweb.gsfc.nasa.gov/cgi-bin/eval2.cgi>).
- K_p indices were taken from NOAA National centers for environmental information:
http://www.ngdc.noaa.gov/stp/GEOMAG/kp_ap.html via ftp.
- Substorms onset was verified by the 10-sec sampled ground-based data of IMAGE magnetometers network, and the substorms development was studied by data of Apatity all-sky and GC cameras.

Instrumentation and data used



Stations coordinates

MAIN (Multiscale Aurora Imaging Network) in Apatity

Location of the cameras during winter seasons

Apatity is situated at auroral latitudes, and the IMAGE stations closest to it are Muonio, Lovozero and

Pello, and by CGM lat. the closest station is Pello.

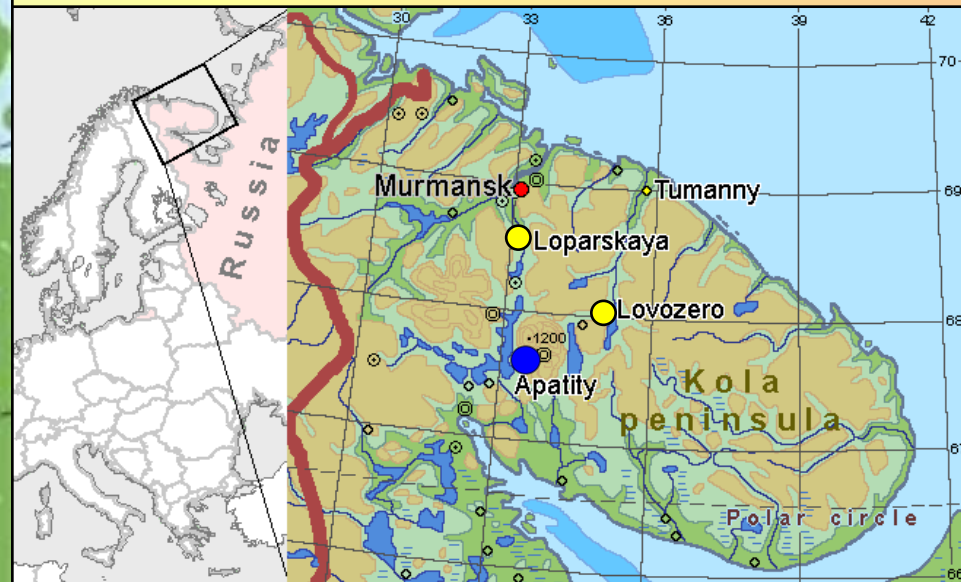
Abbrev.	name	geogr. lat., N	geogr. long., E	CGM lat., N (2014)	CGM long., E (2014)	UT at 00 MLT (2014)
MUO	Muonio	68.02	23.53	64.99	104.24	21.35
LOZ	Lovozero	67.97	35.08	64.62	113.80	20.72
APT	Apatity	67.58	33.31	64.27	112.10	20.83
PEL	Pello	66.90	24.08	63.82	104.03	21.37

Instrumentation and data used

Image magnetometer set

- Apatity location
- Stations from the TAR-NAL chain
- Meridional stations nearer Apatity
- Loparskaya and Lovozero stations
- Other IMAGE stations

Apatity region map



Presented substorms:

Substorms during the geomagnetic storm on 23

December 2014:

24.12.2014, 16:43:20 UT

- SYM/H = -28 nT, recovery phase;

24.12.2014, 19:22:50 UT

- SYM/H = -38 nT, recovery phase;

26.12.2014, 19:33 UT

- SYM/H = -33 nT, recovery phase.

A substorm during quiet conditions:

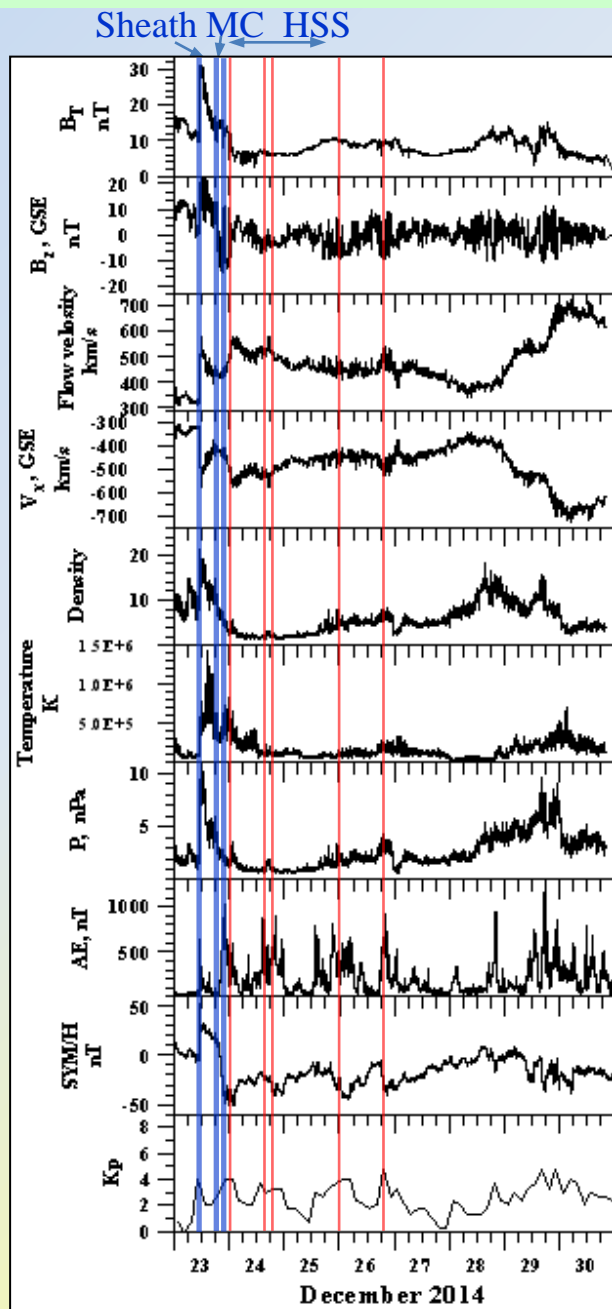
27.03.2015, 21:51:30 UT

- No geomagnetic storm;
- No structures in the solar wind;
- Weak substorm to the North from Apatity.

Data from the all-sky camera (images and keograms) and Guppy F-044C (GC) camera with field of view $\sim 67^\circ$ (keograms) are shown. The keograms were constructed in direction magnetic North (up). The zero angle coincides with zenith.

Interplanetary conditions, 23-30.12.2014

Overview of the interplanetary conditions during 23 - 30 December 2014



Sheat: from 11:10 UT to 18:45 UT, 23.12.2014

MC: from 18:45 UT to 21:00 UT, 23.12.2014

HSS: after 21:00 UT, 23.12.2014

The boundaries of the structures in the solar wind are marked by blue vertical lines.

The times of the observed substorms are indicated by red vertical lines.

Geomagnetic storm: SYM/H_{min} = -52 nT at 01:38 UT on 24.12.2014 (3 consecutive minima, long lasting and structured recovery phase).

Substorms:

- 1) 00:29:30 UT, 24.12.2014, during the structured minimum, SYM/H = -45 nT;
- 2) 16:43:20 UT, 24.12.2014, rec. phase, SYM/H = -28 nT;
- 3) 19:22:50 UT, 24.12.2014, SYM/H = -38 nT, rec. phase;
- 4) 00:40 UT, 26.12.2014, SYM/H = -33 nT;
- 5) 19:33 UT, 26.12.2014, SYM/H = -33 nT.

Magnetic field data, 24.12.2014

IMAGE magnetometer network 2014-12-24

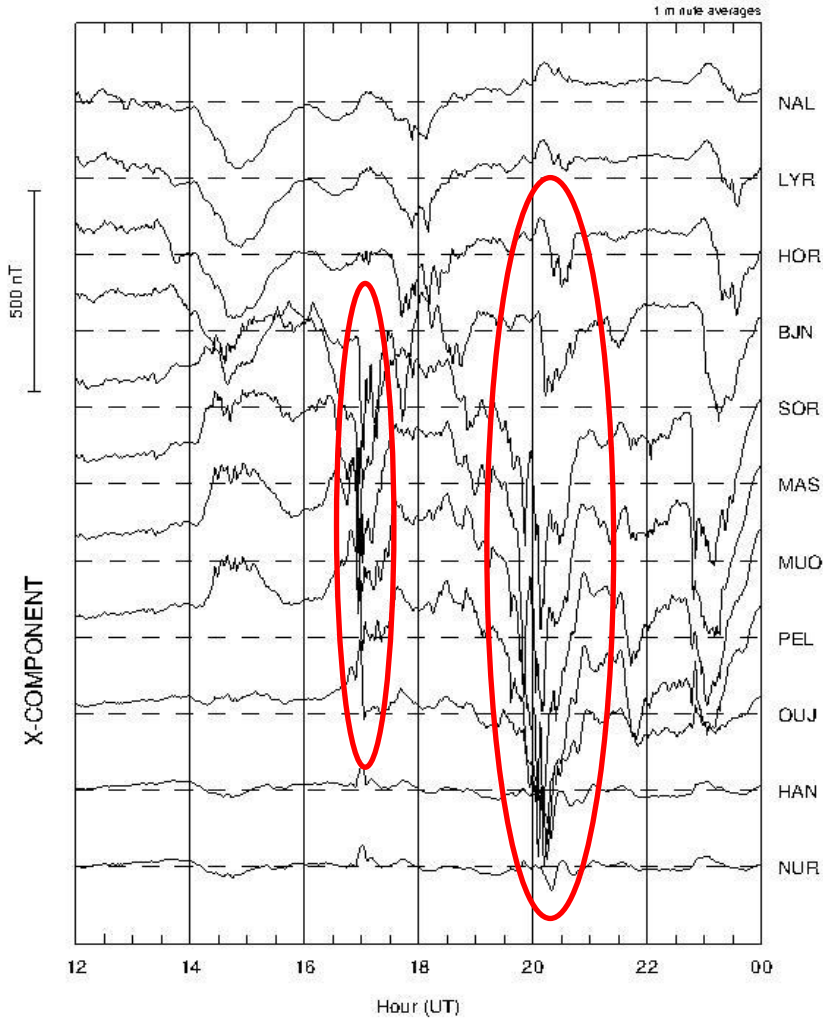
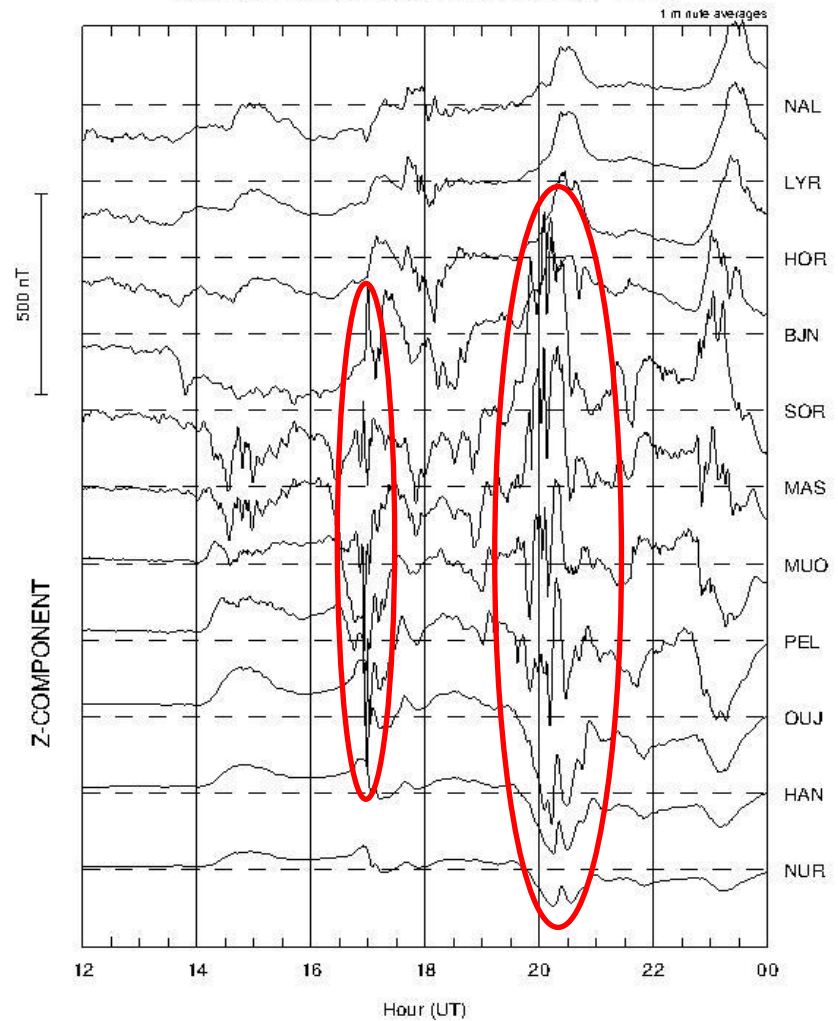
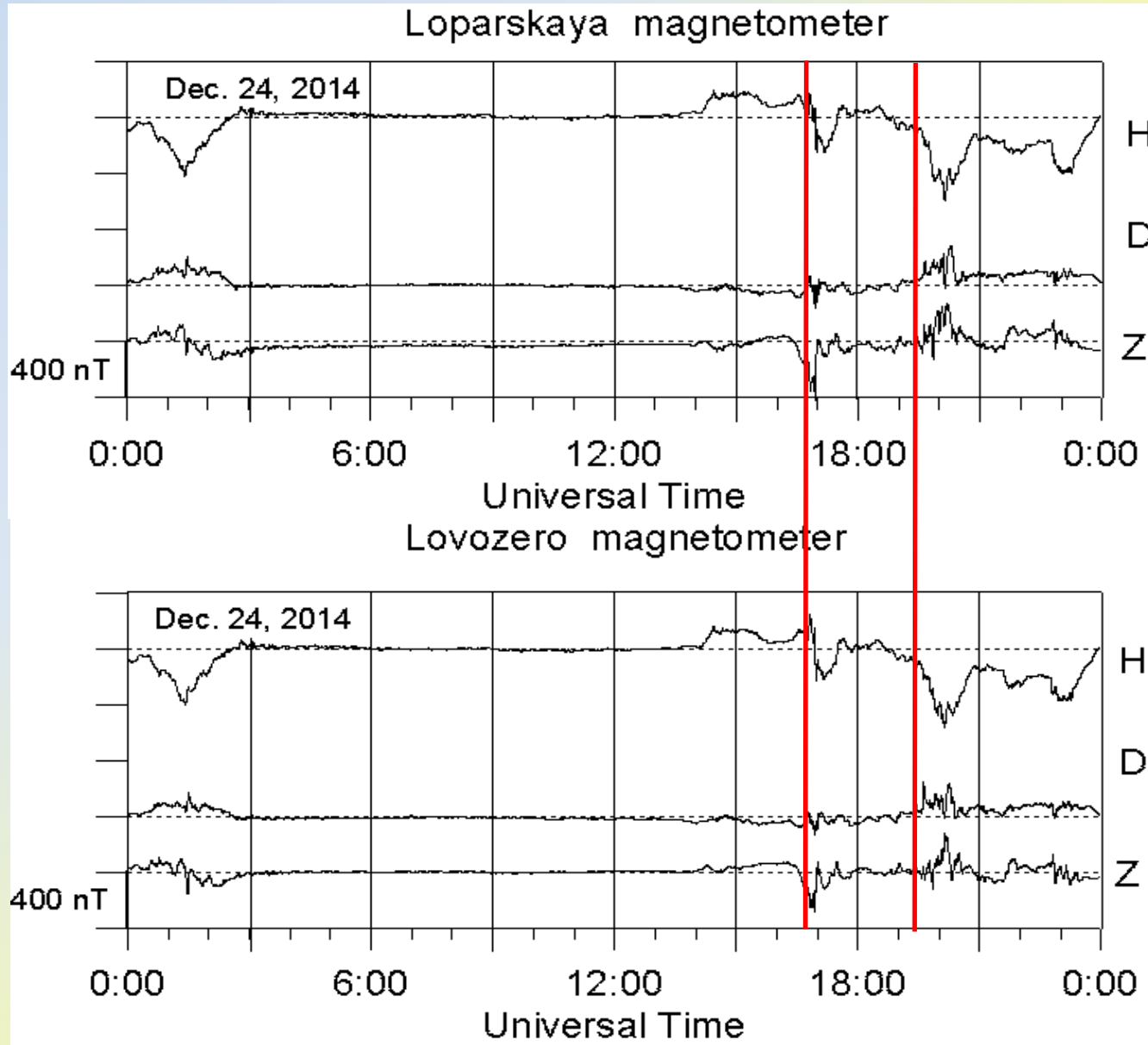


IMAGE magnetometer network 2014-12-24

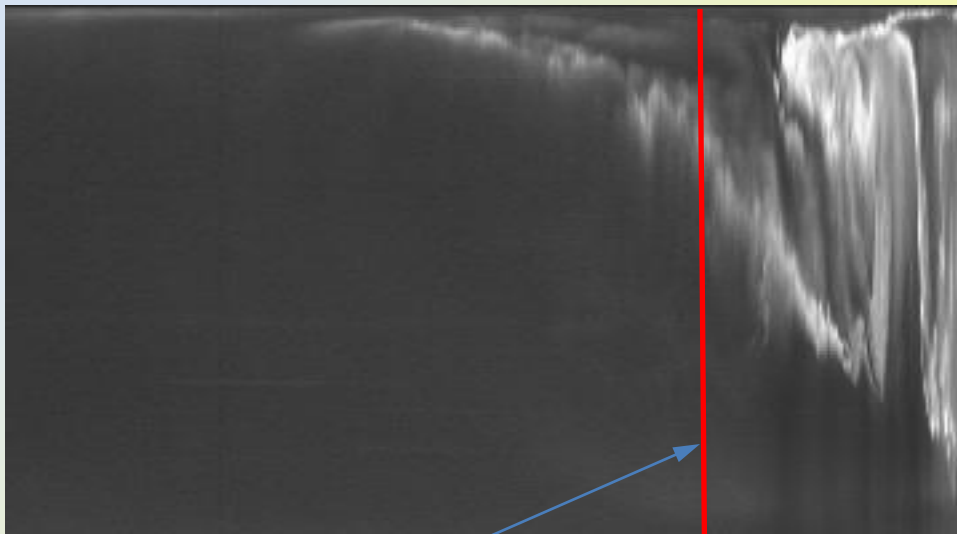
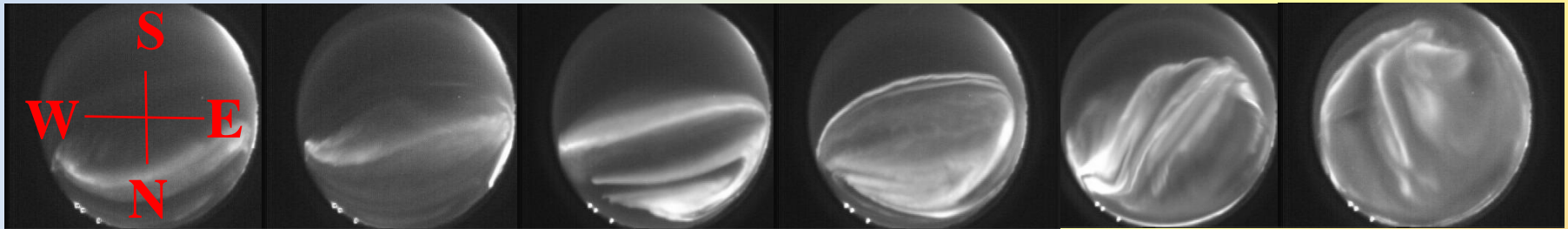


Magnetic field data, 24.12.2014

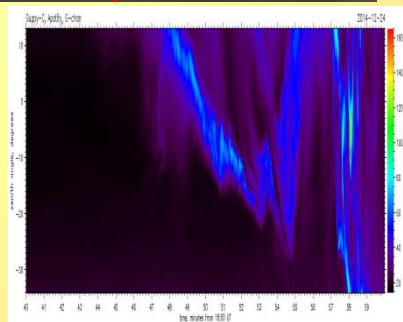


All-sky and GC cameras data, 24.12.2014

UT: 16:43:20 16:46:20 16:49:00 16:52:20 16:57:20 16:59:00

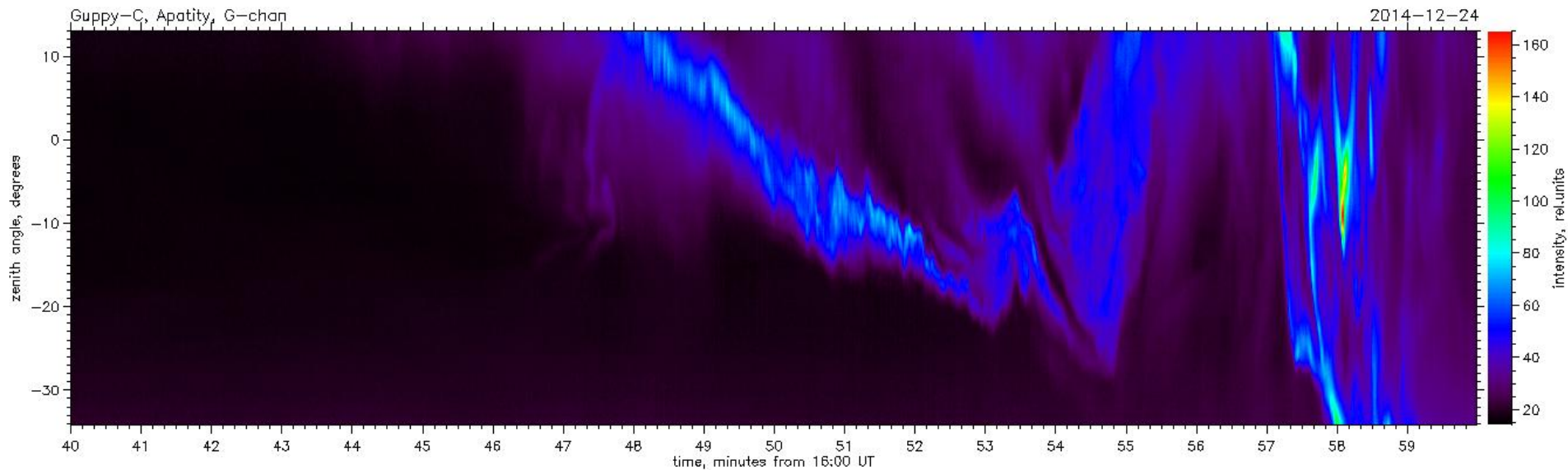


16:43:20



The substorm is seen first in the all-sky images at 16:43:20 UT to the North from the station zenith. The movement of substorm auroras to South is observed till the occupation of the whole field of view by auroras after 16:59:00 UT.

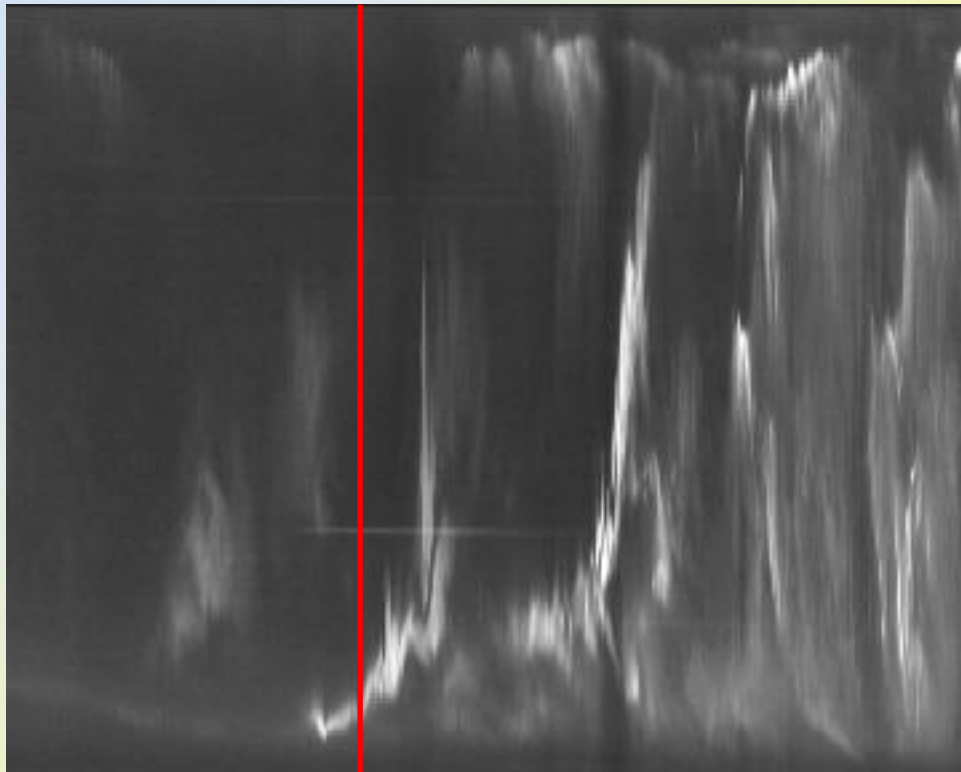
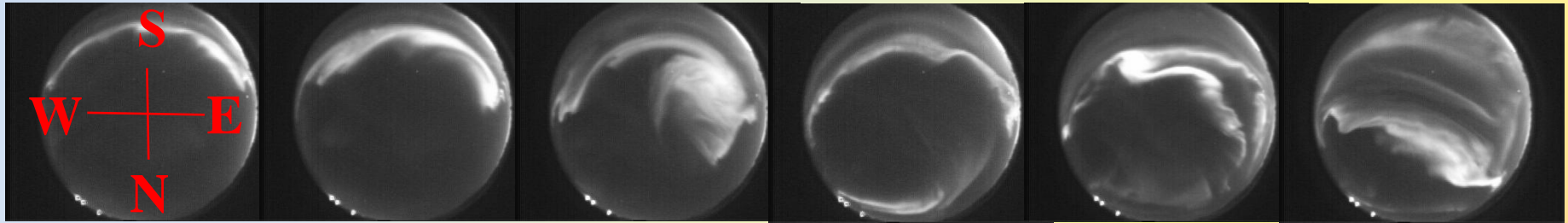
All-sky and GC cameras data, 24.12.2014



Substorm development by the GC keogram from 16:40 UT to 17:00 UT. The bright substorm auroras reached the GC camera field of view (15°N) at 16:48 UT. The maximal relative intensity in the field of view is 160 rel. units.

All-sky and GC cameras data, 24.12.2014

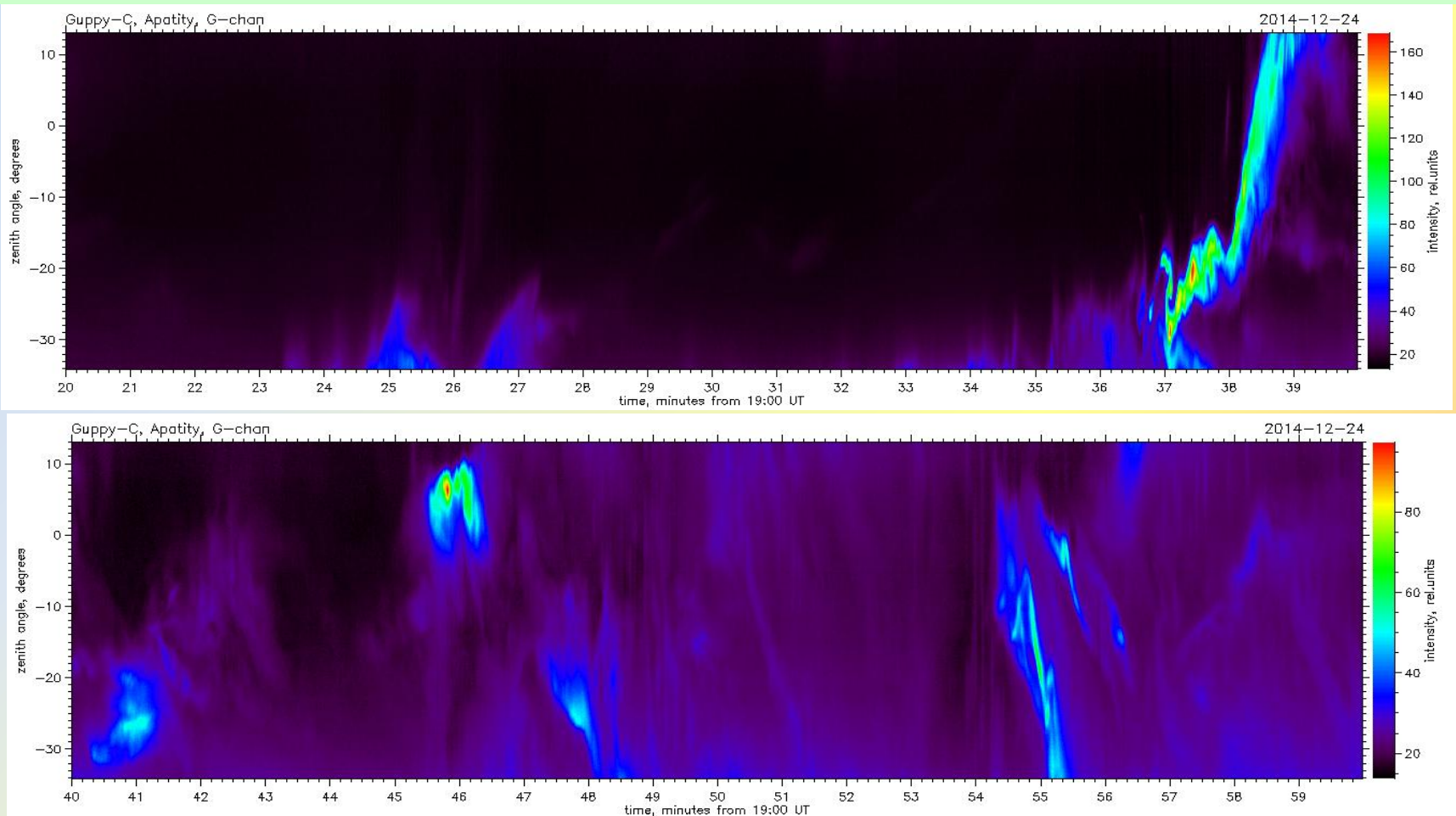
UT: 19:22:50 19:24:20 19:26:20 19:34:20 19:37:00 19:39:30



19:22:50

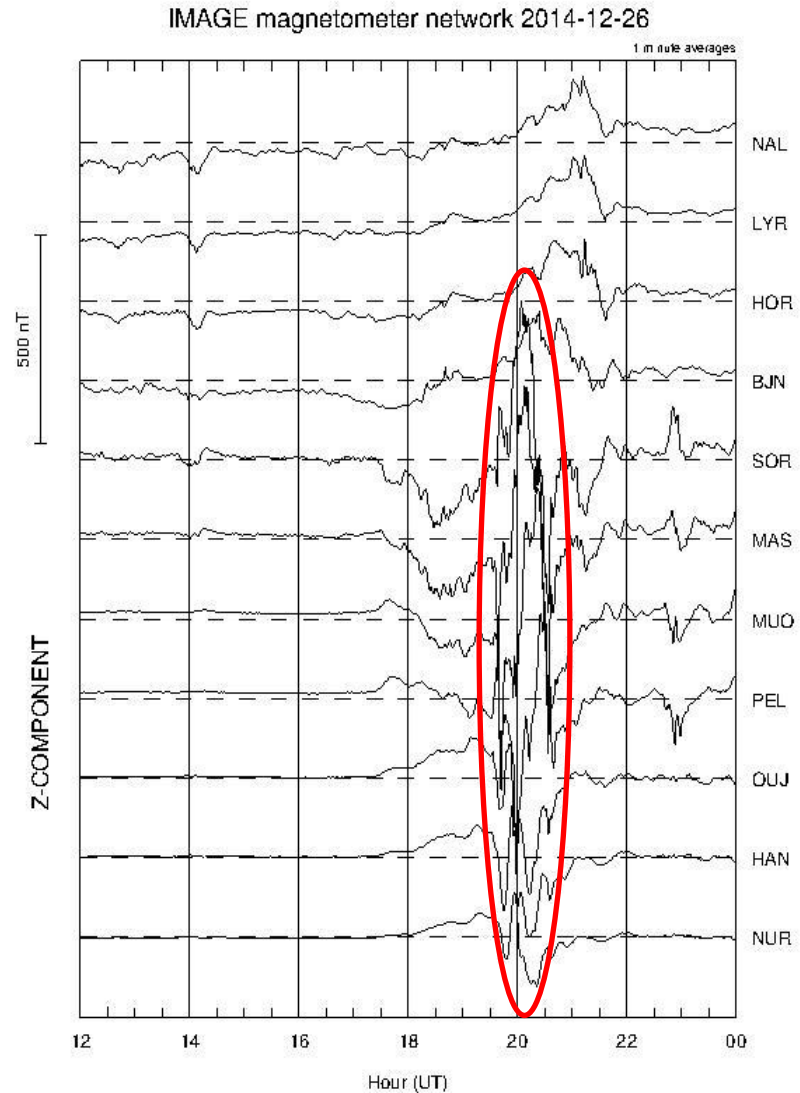
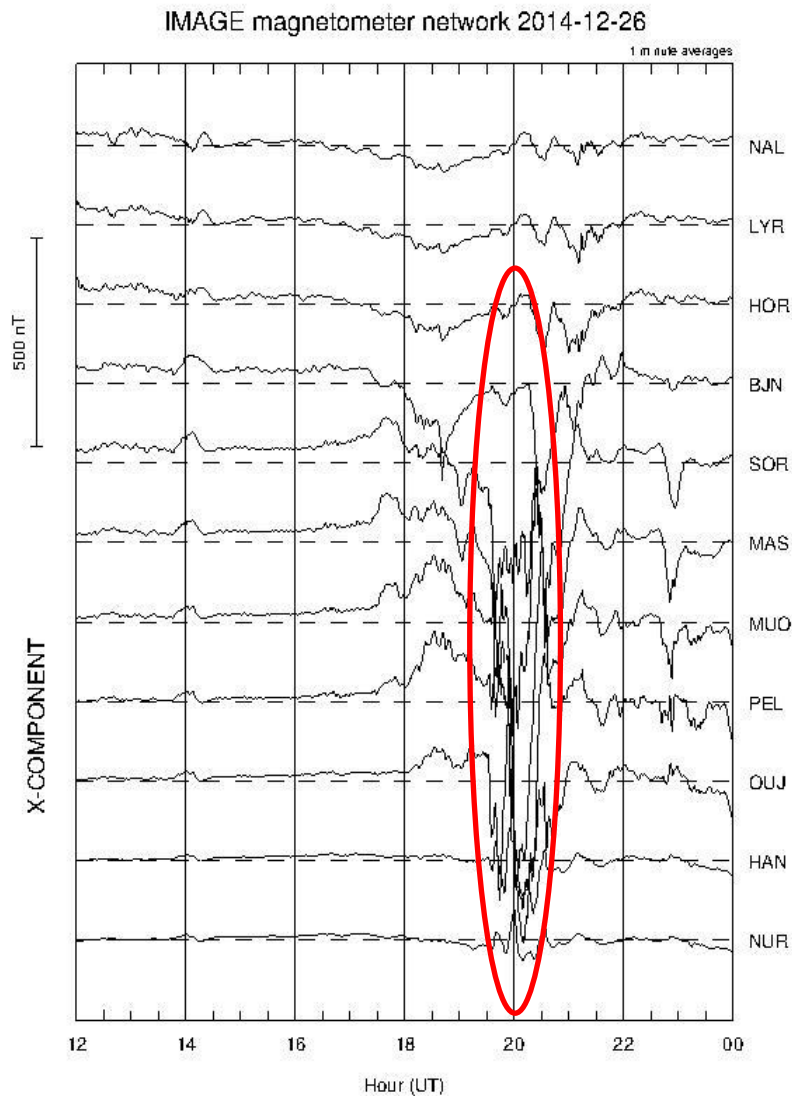
Development of the substorm at 19:22:50 UT. The substorm onset was to the South from Apatity. The auroras travelled Northward, surpassed the station zenith and covered the whole field of view.

All-sky and GC cameras data, 24.12.2014

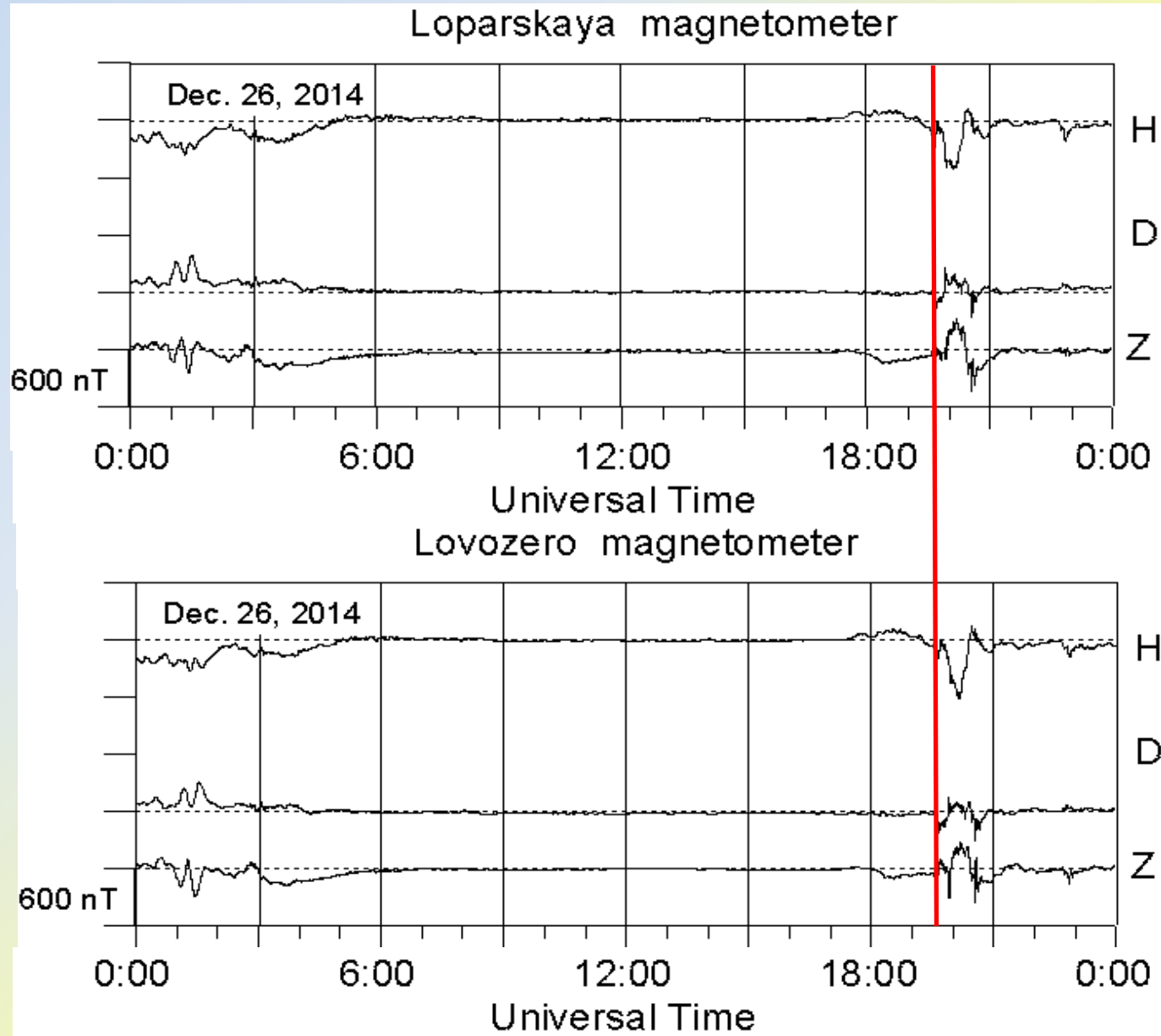


The substorm development by the GC camera keograms 19:20 – 19:40 UT and 19:40 – 20:00 UT. In the GC keograms the substorm auroras are seen first in 19:24:40 UT. The maximal relative intensity in the GC camera field of view is 160 rel. units.

Magnetic field data, 26.12.2014

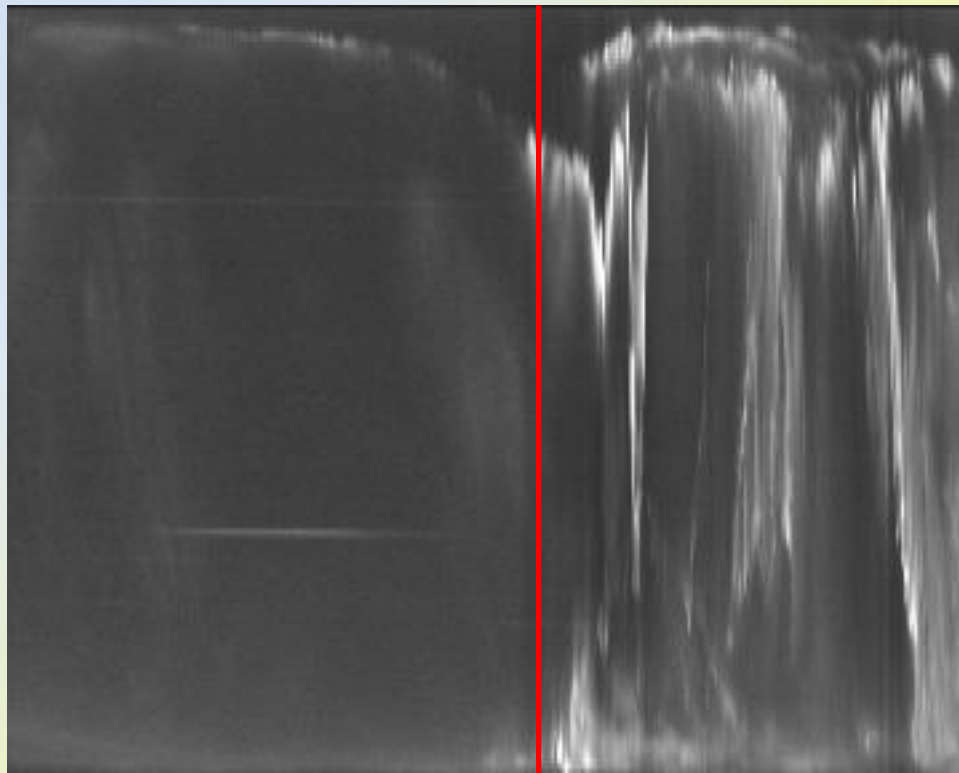
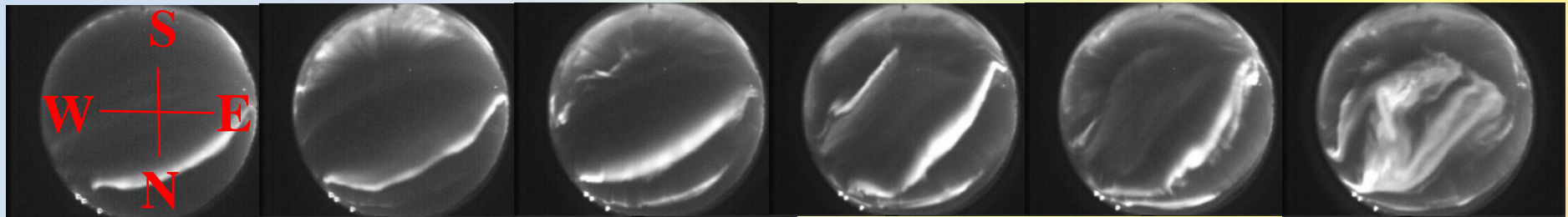


Magnetic field data, 26.12.2014



All-sky and GC cameras data, 26.12.2014

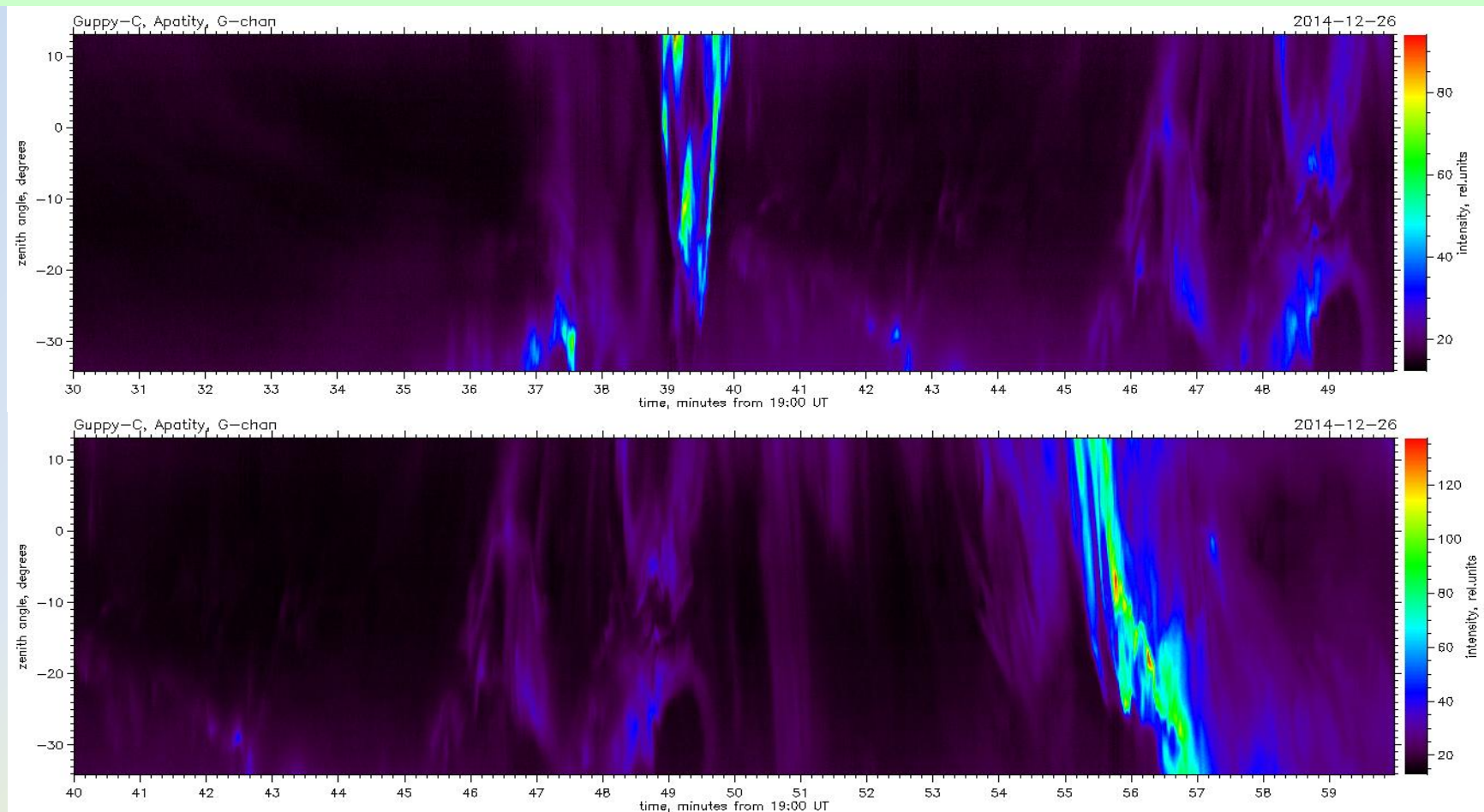
UT: 19:33:00 19:35:20 19:36:30 19:37:40 19:38:20 19:39:20



19:33

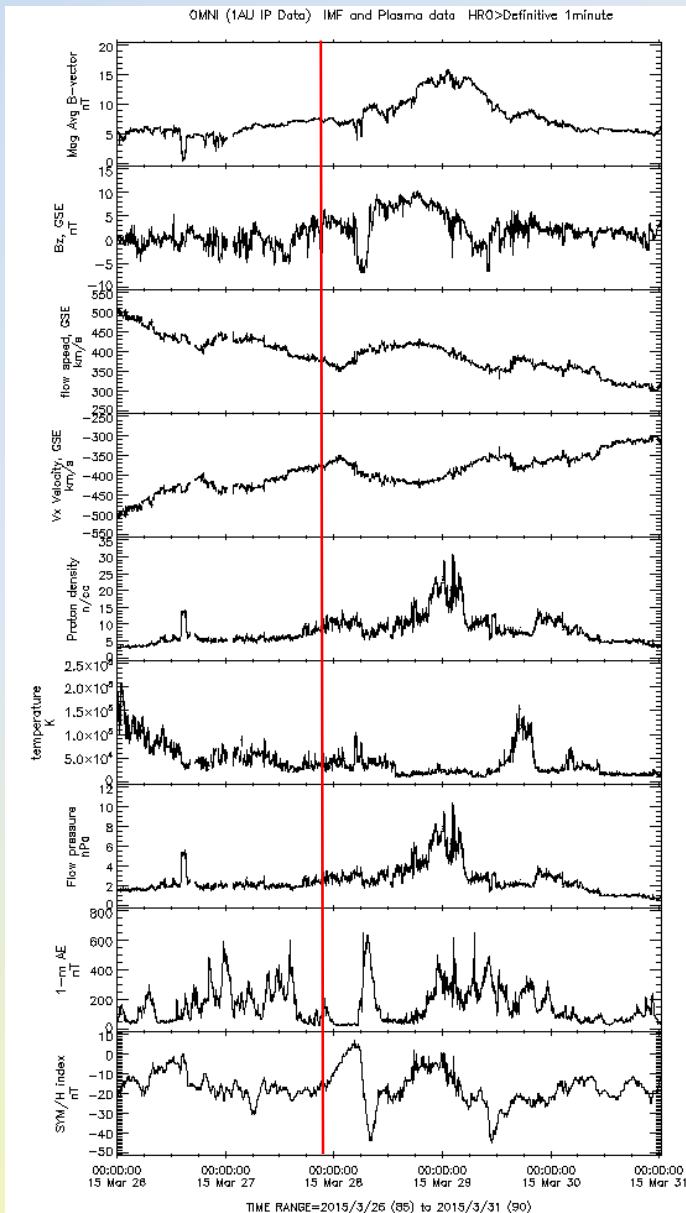
Development of the substorm at 19:33 UT on 26.12.2014. First a bright arc appeared to the North from the station zenith and moved slowly to South. After that bright auroras arised in the South part of the field of view and after 19:37:40 the whole field of view was occupied by substorm auroras.

All-sky and GC cameras data, 26.12.2014



The substorm development by the GC camera keograms 19:30 – 19:50 UT and 19:40 – 20:00 UT. In the GC keograms the substorm auroras are seen first at 19:35:30 UT at 35° to the South from zenith. The auroras from North are seen at 19:37 UT at 15°N.

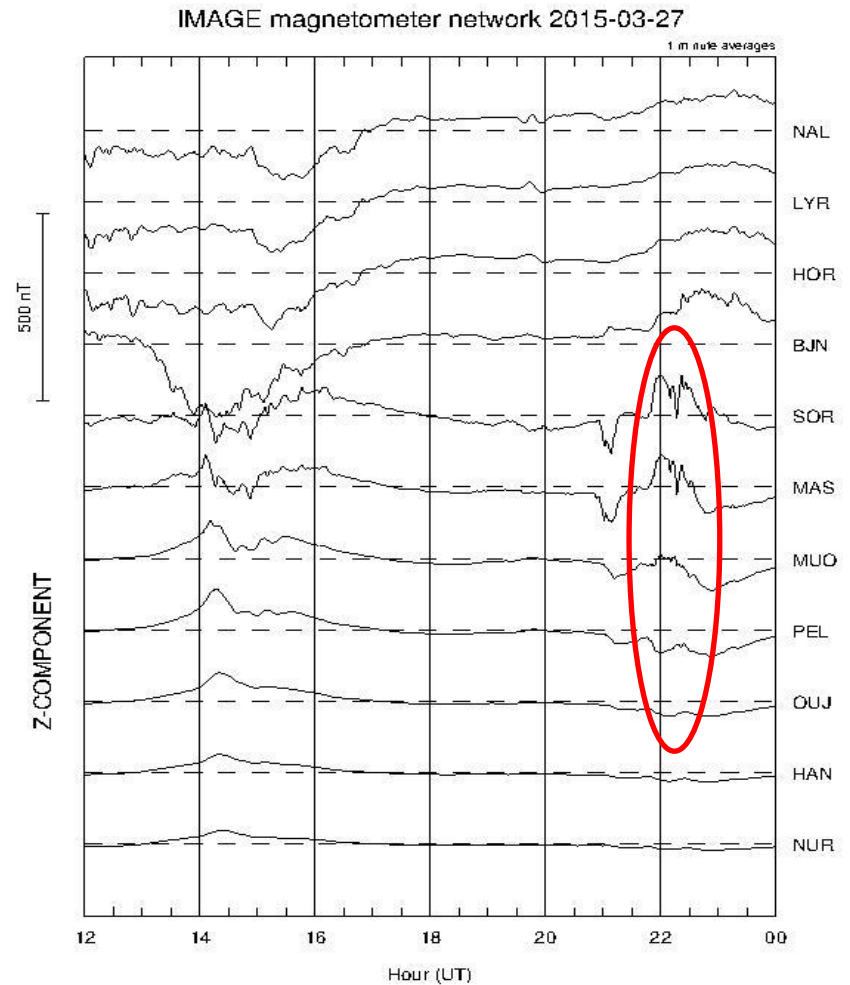
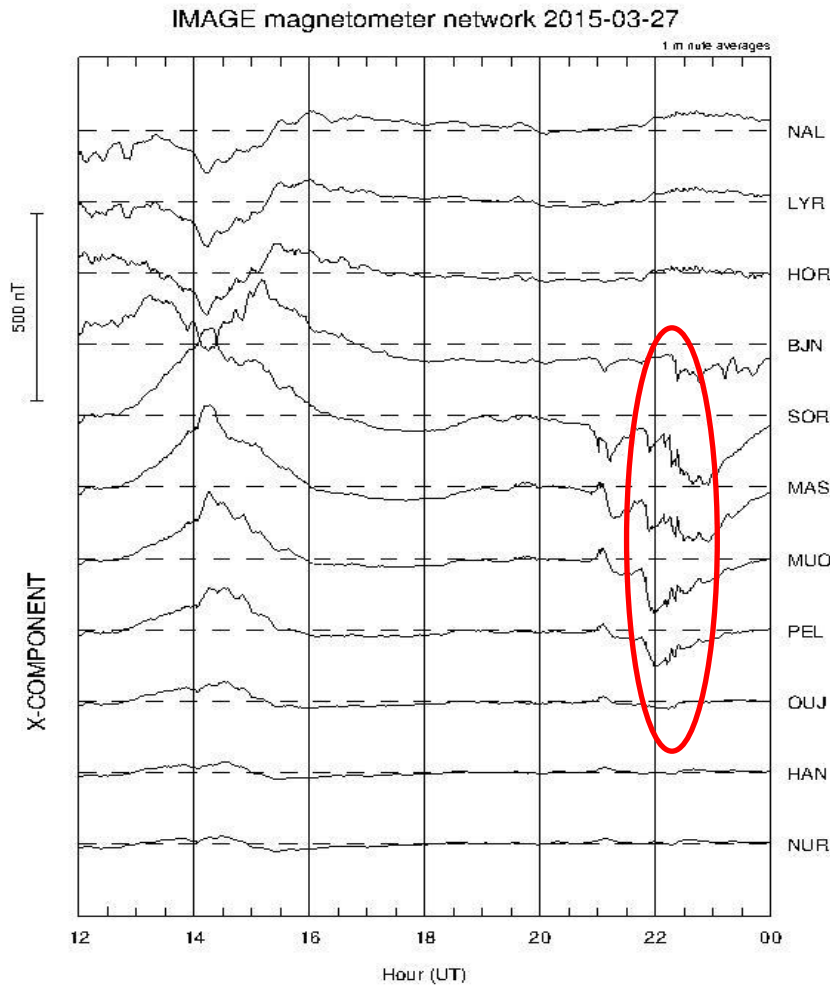
Interplanetary conditions, 26-31.03.2015



Please acknowledge data provider, J.H. King, N. Papatashvili
at AdnetSystems, NASA GSFC and CDAWeb when using these data.
Generated by CDAWeb on Sun May 29 02:46:24 2016

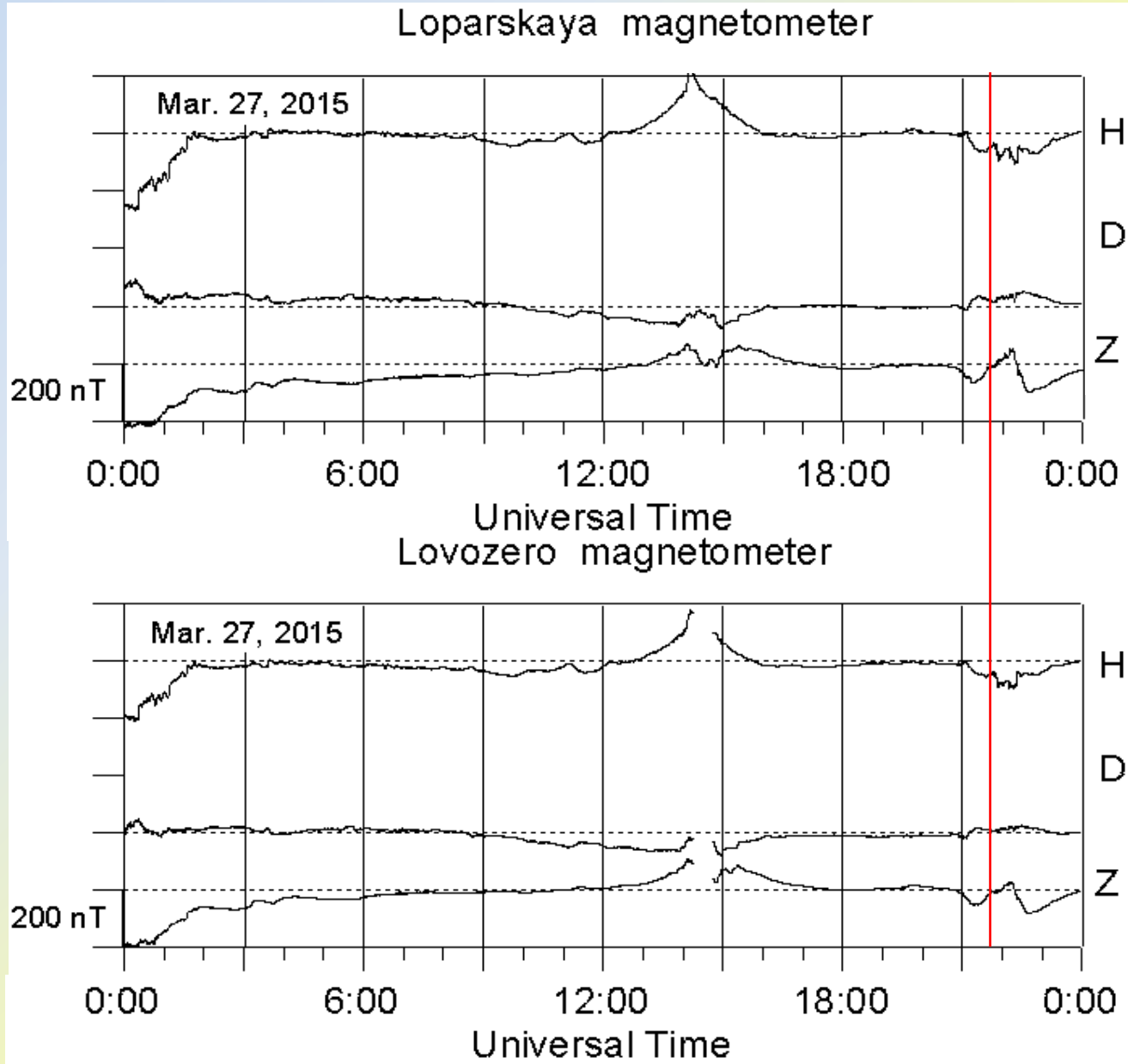
The substorm on 27 March 2015 occurred under quiet conditions, after the great disturbances on 17 March 2015 (the so-called St.Patrick day), when a MC followed by a HSS passed by the Earth and another MC on 22 March 2015 reached the Earth. On 27 March 2015 no sizable disturbances in the interplanetary and geomagnetic medium were registered. The substorm time is marked by red vertical line.

Magnetic field data, 27.03.2015



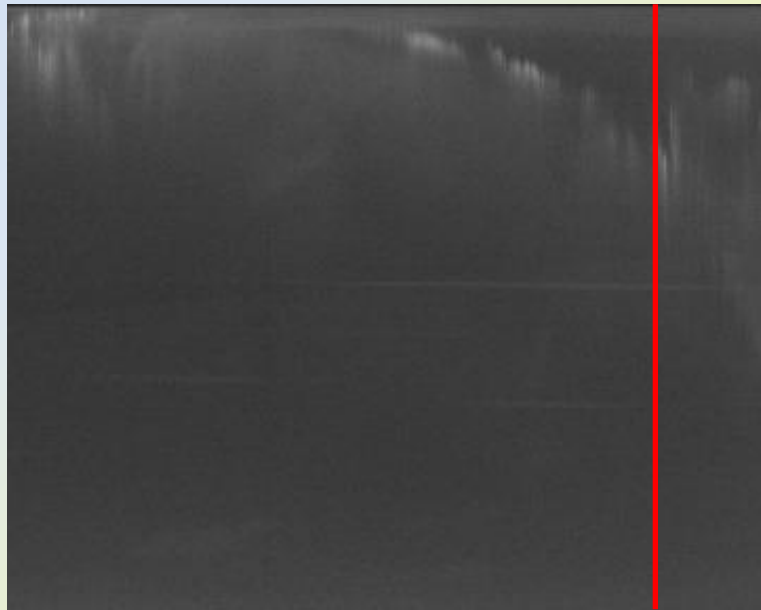
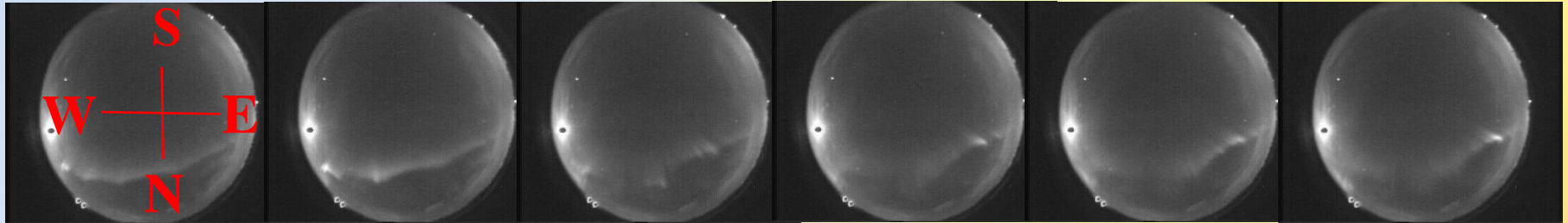
The magnetic disturbance spread over a narrow latitudinal range including only 5 stations from the meridional chain located at auroral latitudes.

Magnetic field data, 27.03.2015



All-sky camera data, 27.03.2015

UT: 21:51:30 21:51:50 21:52:20 21:52:40 21:52:50 21:53:00



21:51:30

Hourly AS keogram for 21:00-
22:00 UT on 27.03.2015.

The substorm onset over Apatity occurred at 21:51:30 UT on 27.03.2015 to the North from Apatity. The auroras stayed in the Northern part of the field of view.

Results and conclusions

We studied the substorms registered during the 2014/2015 observational season. From September 2014 to April 2015 **49 substorms** were identified during which measurements have been performed.

Substorms during geomagnetic storms (22)

Main phase	8
Near recovery phase	7
Late recovery phase	3
Structured recovery phase	4

Substorms during non-storm conditions (27)

Quiet conditions	7
Structures in the solar wind:	
CIR	1
Just before HSS	2
HSS	5
Just after HSS	8
During MC + HSS	4

Results and conclusions

Substorms in non-storm conditions:

- **The substorms generated under quiet interplanetary and geomagnetic conditions, occurred to the North from Apatity (64.27°N CGM Lat. by 2014). The substorm expansion was seen, but substorm auroras stayed in the Northern part of the field of view;**
- **Substorms, connected to structures in the solar wind as CIR, HSS, Sheath or MC, which provoked some disturbances, but a geomagnetic storm was not generated, may originate to the North from Apatity, over the station zenith or to the South from Apatity;**

Results and conclusions

Substorms during geomagnetic storms:

- Substorms, originated during the main storm phase or near the SYM/H minimum in the recovery phase, occurred to the South of Apatity (64.27°N CGM Lat. by 2014), and substorm auroras expansion to North was observed;
- For substorms during the recovery phase or the late recovery phase, auroras were observed near the station zenith or to the North of the Apatity station, and their motion from North to South was registered;
- The boundary between both types of substorms in terms of SYM/H index is in the range 35-50 nT;
- The maximal relative intensity of the substorm features in the GC camera field of view is considerably larger during the substorms, arising to the South from Apatity.

Thanks for the attention!