Work out of a substorm catalog based on the ground based magnetic data at the Panagjurishte station, Bulgaria

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Introduction

The development of an original catalog of the midlatitude positive bays (MPB) registered at the Bulgarian station Panagjurishte (~37° GMLat, ~97° GMLon) is one of the basic tasks of the project **"Investigation of the geomagnetic disturbances propagation to midlatitudes and their interplanetary drivers identification for the development of midlatitude space weather forecast" -** a bilateral project Bulgaria – Russia 2019 – 2020, financed by the National Science Fund (project number КП-06-Русия/15)

The study the MPB behavior could be one of the important tools of the investigation of the solar-magnetosphere coupling during the substorm progress because, as it is generally accepted, a MPB represents the midlatitude effect of the substorm current wedge (SCW) development and could be a proxy of the dipolarization process in the magnetotail.

Data for the Panagjurishte station substorms catalog

Data derived by the Panagjurishte magnetic measurements

Concomitant data for the substorm days

- Sign conversion latitude of the X bay (-/+);
- Structures in the solar wind for the day;
- Presence/No presence of geomagnetic storm, if Yes: Ap, SYM/Hmin, onset, storm phase during which the substorm originates;
- Average, max Kp for the day.

List of substorm dates, number for the day

Data about every substorm

Every day data

Parameters:

- Date;
- ΔT=UT-LT;
- Sunrise and sunset in UT;
- MLT at the onset;
- Substorm onset, UT;
- MPB maximum, UT;
- MPB amplitude, nT;
- Positive bay end, UT.

Files data:

- UT, LT, processed X, processed Y, horizontal power.

Figures:

- processed X/(UT/LT);
- processed Y/(UT/LT);
- horizontal power (MPB)/(UT/LT);

Scheme of the structure of the Panagjurishte substorm catalog.

Structure of the substorm catalog

Index of /Catalog_MPB/Stations/Panagjurishte

Name	Last modified	Size	Description
Parent Directory		-	
Magnetic field data/	2021-08-05 11:44	-	
Substorm data/	2021-08-05 11:43	-	

Index of /Catalog_MPB/Stations/Panagjurishte/Magnetic field data

Name	Last modified	Size	Description
Parent Directory			
Years/	2021-0		

Index of /Catalog_MPB/Stations/Panagjurishte/Magnetic field data/Years

Name	Last modified	Size	Description
Parent Directory			
2007/	2021-07-18 22:17		
2008/	2021-07-18 22:17		
2009/	2021-07-18 22:17		
2010/	2021-07-18 22:17		
2011/	2021-07-18 22:17		
2012/	2021-07-18 22:17		
2013/	2021-07-24 21:43		
2014/	2021-07-24 21:36		
2015/	2021-07-24 21:36		
2016/	2021-07-24 21:36		
2017/	2021-07-25 14:23		
2018/	2021-08-03 11:11		
2019/	2021-08-03 11:11		
2020/	2021-07-25 14:05		
2021/	2021-07-20 14:11		

Index of /Catalog_MPB/Stations/Panagjurishte/Magnetic field data/Years/2013/2 February

Name	Last modified	Size	Description
Parent Directory			
20130201/	2021-08-03 10:46		
20130202/	2021-08-03 10:46		
20130203/	2021-08-03 10:46		
20130204/	2021-08-03 10:46		
20130205/	2021-08-03 10:46		
20130206/	2021-08-03 10:47		
20130207/	2021-08-03 10:47		
20130208/	2021-08-03 10:47		
20130209/	2021-08-03 10:46		
20130210/	2021-07-24 21:48		
20130211/	2021-08-03 10:47		
20130212/	2021-08-03 10:47		
20130213/	2021-08-30 15:31		
20130214/	2021-08-03 10:48	-	
20130215/	2021-08-03 10:48	-	
20130216/	2021-08-03 10:48	-	
20130217/	2021-08-03 11:08	-	
20130218/	2021-08-03 11:08	-	

Index of /Catalog_MPB/Stations/Panagjurishte/Magnetic field data/Years/2013/2 February/20130202

Name	Last modified	Size	Description
Parent Directory		-	
PAG_MPB_2013_02_02.gif	2021-08-30 18:43	8.5K	
PAG_Magn._data_2013_..>	2021-08-30 18:43	95K	
PAG_X-comp._2013_02_..>	2021-08-30 18:43	10K	
PAG_Y-comp._2013_02_..>	2021-08-30 18:43	12K	

Consecutive windows to look at the graphs and the data file for a given day.

Every day data

To construct the catalog, first the magnetic field data have to be processed. In this purpose, special processing tools were developed. The processing includes:

- Construction of a long array of 36000 data points spaced in minutes for an interval of 25 days, centered on the day under consideration;
- Preprocessing, including gaps and peaks detection and removal;
- Estimation and subtraction of the main field;
- Removing of the very disturbed days (outliers);
- Determination and subtraction of the mean field under solar quiet conditions;
- High-pass filtration of the obtained X and Y component variations;
- Computing of the horizontal power.

In the catalog, data files and graphics of some results for every day are included.

Every day files comprise:

- one minute data for the processed X and Y magnetic components;

- the horizontal power of the magnetic field (main field and mean Solar quiet magnetic variations (Sq) removed).
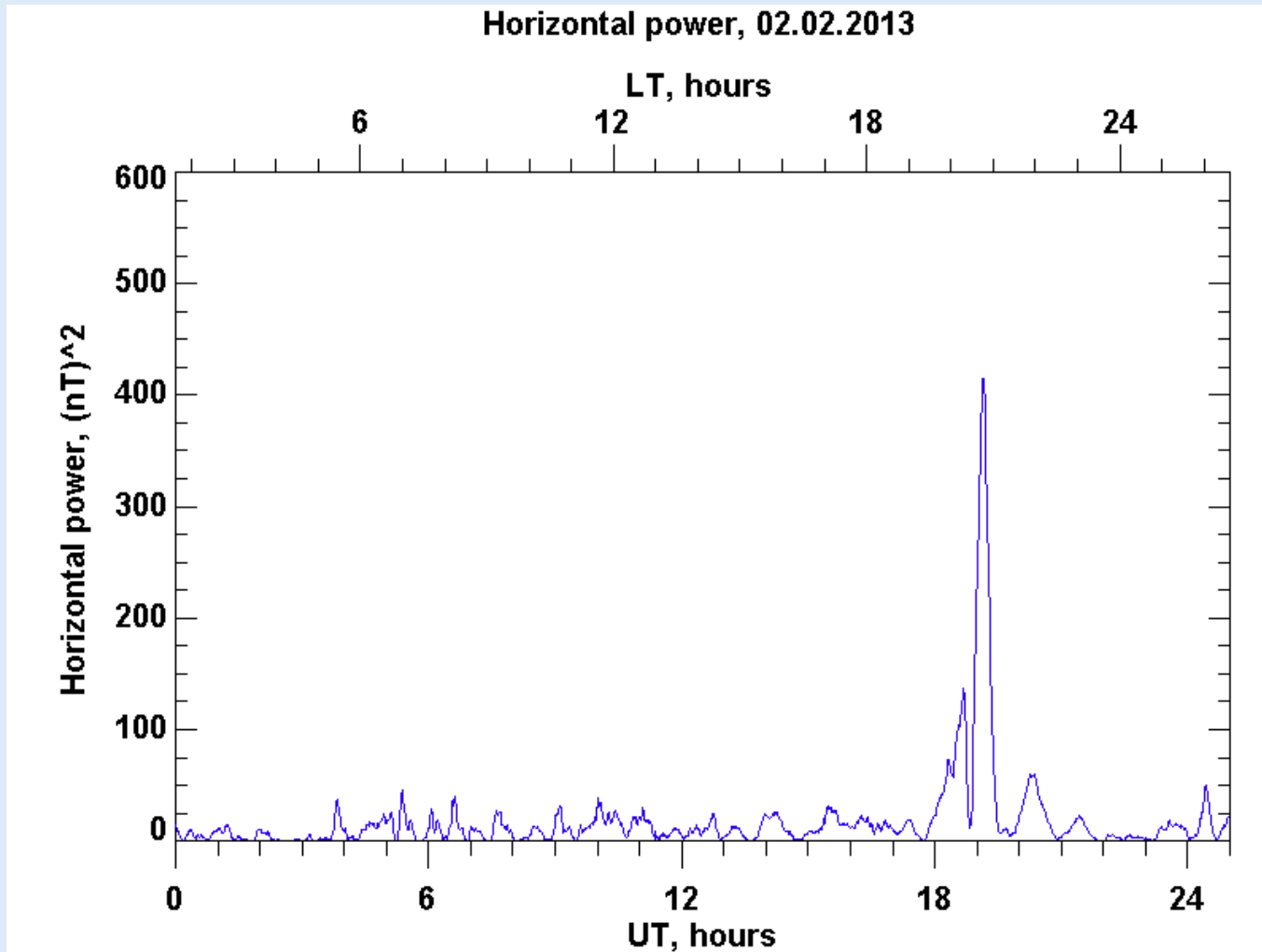
The graphics present:

- the processed X component;

- the processed Y component;

- the horizontal power of the magnetic field.

Every day figures

Filtered delta X-comp., 02.02.2013

Filtered delta Y-comp., 02.02.2013
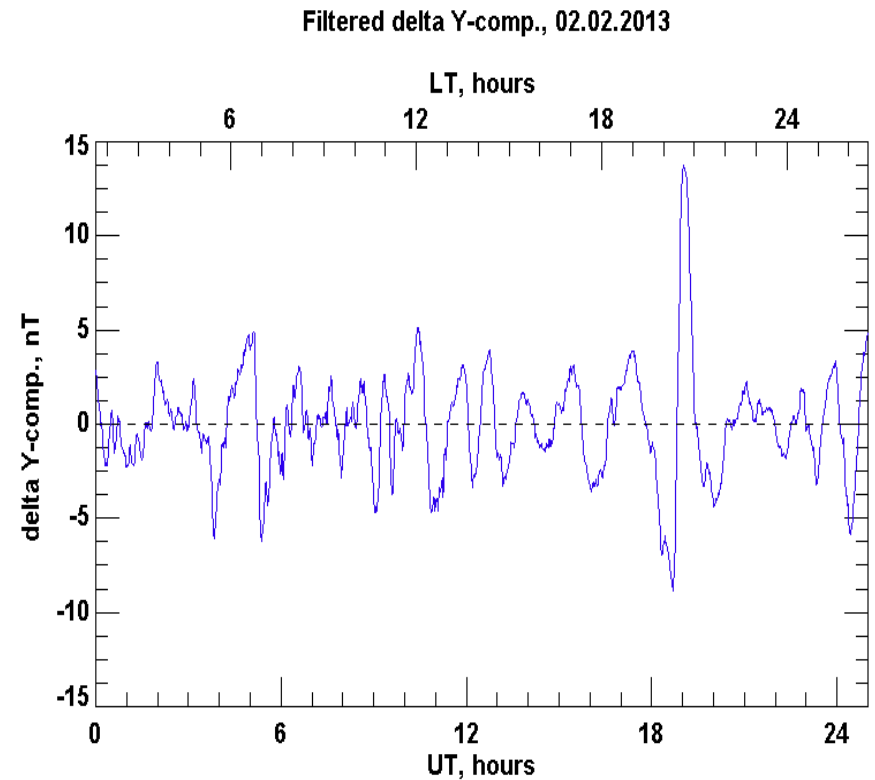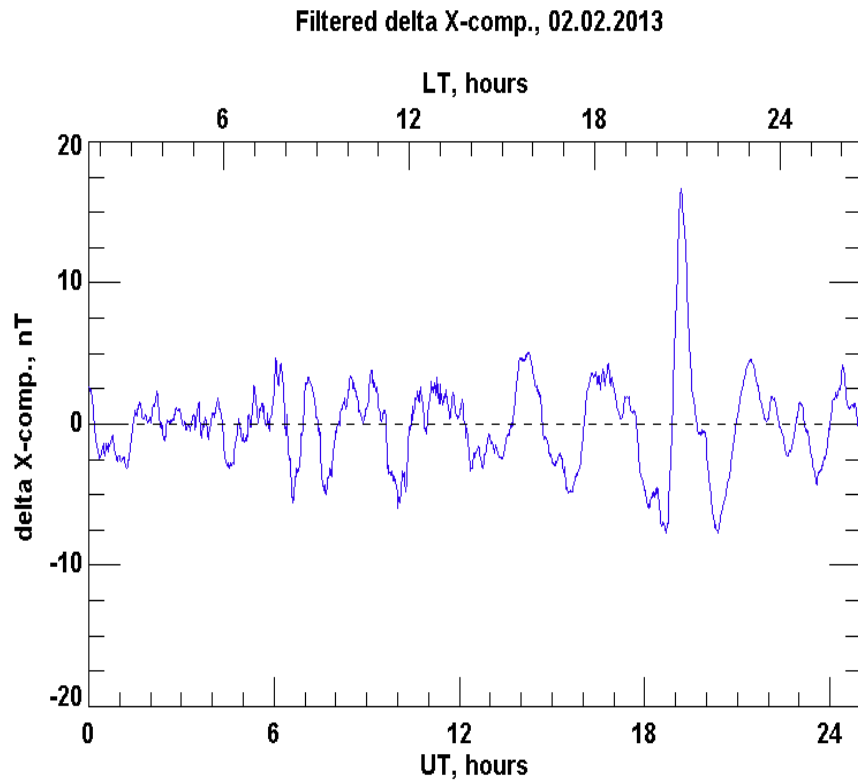
Processed X (left panel) and Y (right panel) components of the magnetic field, measured on 02 February 2013 at the Panagjurishte station.

Horizontal power, 02.02.2013

Horizontal power of the magnetic field perturbations on 02 February 2013 at Panagjurishte.

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Magnetic field processed X and Y components and the resulting horizontal power
Calculated at Space Research and Technology Institute, Sofia, Bulgaria

Station: PAG
Observation Data: 02.02.2013


     Time in UT        delta X-com.      delta Y-comp.       Power
     min    hours          nT                nT               nT
     --------------------------------------------------------------
      1    0.017          2.63              2.84             14.99
      2    0.033          2.50              2.45             12.25
      3    0.050          2.37              1.96              9.45
      4    0.067          2.44              1.77              9.09
      5    0.083          2.21              1.18              6.29
      6    0.100          1.99              1.09              5.14
      7    0.117          1.66              0.80              3.40
      8    0.133          1.24              0.61              1.91
      9    0.150          0.91              0.03              0.83
     10    0.167          0.49             -0.06              0.24
     11    0.183          0.07             -0.04              0.01
     12    0.200         -0.45              0.07              0.21
     13    0.217         -0.67             -0.51              0.71
     14    0.233         -1.09             -1.19              2.61
     15    0.250         -1.51             -1.57              4.75
     16    0.267         -1.63             -1.75              5.72
     17    0.283         -1.74             -1.83              6.39
```

Magnetic field data file for 02.02.2013.

Structure of the substorm catalog

Consecutive windows to look at the substorm data.

Substorm data

Substorm detection – in the auroral zone, on the IMAGE meridional chain PPN-NAL.

Use of INTERMAGNET and SuperMAG stations data in the longitudinal band 90°-104° GMLon (near the longitude of the PAG station (~97° GMLon), to follow the substorms development.

Time period – January and February 2013. During this time 75 substorms were identified; this number includes all observed substorms.

For each substorm in the auroral zone its midlaltitude display – positive bay – at the station PAG (Bulgaria) was examined and a file with chosen parameters was created.

In the beginning of every file the date and the difference between local and universal time (LT-UT) for Panagjurishte are written, the UT for the sunrise and sunset at Panagjurishte for the substorm day, and the MLT at the substorm onset.

MPB parameters
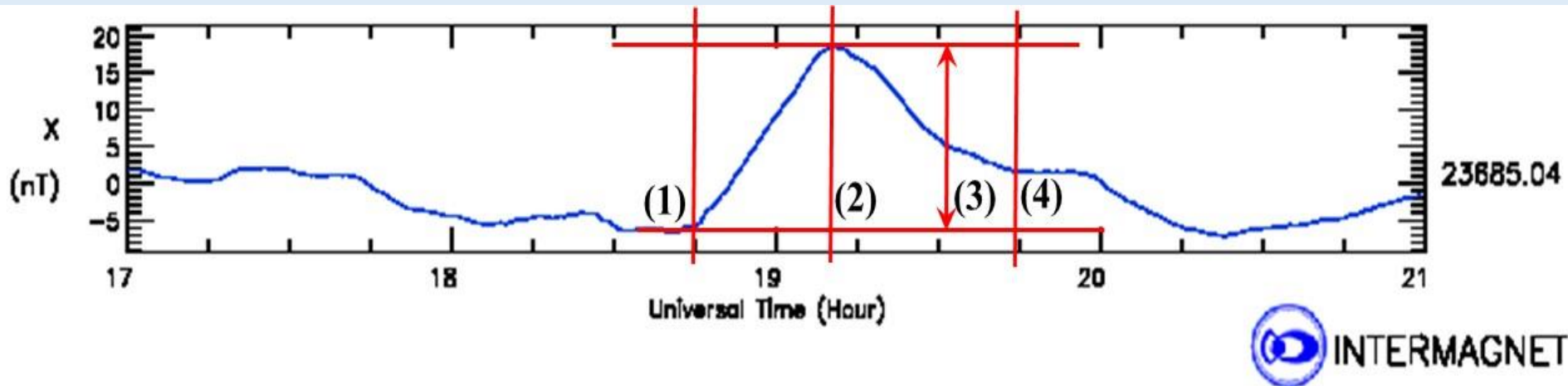
An example of the determination of the MPB parameters. We have chosen an isolated substorm, namely the one at 18:43 UT on 02 February 2013. The way of estimation the MPB parameters, included in the catalog, is presented in the plot from INTERMAGNET by straight lines, enumerated as follows:

(1) time of the substorm onset;
(2) time of the positive bay maximum;
(3) amplitude of the X-component;
(4) time of the positive bay end.

Summary

A substorms catalog including the X and Y components variations and the horizontal power of the magnetic field, main field and the mean field under solar quiet conditions subtracted, and the positive bays characteristics by data of the midlatitude Bulgarian station Panagjurishte (PAG) is under construction. The catalog is FTP positioned with preliminary address https://magnetic.nuclearmodels.net/Catalog_MPB/Stations/Panagjurishte/. Tools for data preprocessing and processing have been developed. The substorms during January and February 2013 have been identified. The PAG magnetic data for these two months have been processed. The characteristics of the positive bays were determined. The obtained results have been uploaded in the catalog.

Future work and usefulness of such catalog

In the future work we intend to process in such a way all one minute magnetic data from Panagjurishte (since 2007) and to complete the substorm catalog. We plan also to implement permanent processing of the newly registered data and thus to keep the catalog up to date.

Such catalog is being made for the first time. This work could be useful for further studies.

The processing tools could be used for other European stations data to form a dataset and to obtain the midlatitude positive bay (MPB) index. This will allow to implement a complex analysis of the space-temporal characteristics of the magnetic substorms at midlattitudes and auroral latitudes in order to reveal the peculiarities of the spreading of the geomagnetic disturbances to midlattitudes depending on the conditions of the near-Earth space weather.

Thank You for your attention!

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