

## ANNUAL REPORT OF THE OBSERVED GEOMAGNETIC ACTIVITY IN PANAGJURISHTE OBSERVATORY FOR 2015

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**Abstract.** Presently, in the era of Internet communication the preliminary time series (INTERMAGNET's reported data) acquired in geomagnetic observatories are available in near-real time, while the final absolute time series (definitive data) are disseminated with many months delay, being subject to many checks. This paper reports the definitive geomagnetic data obtained in Panagjurishte observatory in 2015, prepared in the form of local geomagnetic indices and absolute time-series of daily mean values plots. Calculated indices show that 2015 has quite disturbed geomagnetic field reaching  $K=8$ . This is reasonable due to the fact that it is in the middle of the 24th So;ar cycle when the Sun is in its most active period. Verification of data quality is performed according to "IAGA guide for magnetic measurements and observatory practice".

**Key words:** PAG observatory, geomagnetic variations, geomagnetic activity, local geomagnetic indices, daily mean values, 2015.

### Introduction

The Geomagnetic observatory in Panagjurishte (PAG) is established in 1937 – first on the Balkan Peninsula and unique in Bulgaria and during more than 80 years performs absolute measurements of the geomagnetic field elements and continuous registration of their variations (Buchvarov, 2006). In 2007 PAG observatory was equipped with digital systems for the recording of geomagnetic field element's variations. Thus, the observatory implemented the technical requirements and was joined to the INTERMAGNET (International Real-time Magnetic Observatory Network), which establishes a global network of cooperating digital magnetic observatories, and facilitate data exchanges and

geomagnetic products in close to real time. Preliminary recorded time series and local geomagnetic k-indices are published on the NIGGG web page ([http://data.niggg.bas.bg/magn\\_data1/dailymag\\_bg.php](http://data.niggg.bas.bg/magn_data1/dailymag_bg.php)) and automatically reported to INTERMAGNET. The present paper provides quasi-definitive geomagnetic data which are checked and processed to comply with the IAGA standards for observatory practices.

### **Local geomagnetic indices ( $K$ , $A_K$ , $\Sigma K$ ) calculated at PAG observatory.**

The K-index is often used as a quantitative measure of local magnetic activity. It is a 3-hour quasi-logarithmic scale developed to measure magnetic activity ranging from 0 to 9, with 0 indicating completely quiet conditions and 9, representing extreme magnetic activity. It is intended to measure geomagnetic disturbances outside the normal diurnal quiet time variations. In order to have a somewhat consistent scale of magnetic activity between observatories at high latitudes, where field variations can be quite large in amplitude, and those at low latitudes, each observatory is assigned its own set of amplitude ranges corresponding to the various K-index levels. Thus, for example, a K-index of 5 at College (TCO) observatory (212.4°E, 64.87°N) corresponds to a lower limit of magnetic activity range of 350 nT over the 3-hour interval, while at San Juan (SJJ) observatory (293.85°E, 18.117°N) this same K-index level corresponds to a lower limit of magnetic activity of 40 nT. The idea is to have K-index compensation for the influence of latitude on magnetic activity, so that a K-index of 7 at College and San Juan would represent the same magnetic storm intensity despite the actual differences in the range of magnetic fluctuation amplitudes at the two latitudes.

The ranges of the individual  $K$  numbers in PAG observatory (24.177°E, 42.515°N) are defined as follows:

Deviation from the normal $Sq$ variation [nT]	<5	5 -10	10 - 20	20 - 40	40 - 70	70 - 120	120 -200	200-330	330-500	> 500
$K$	0	1	2	3	4	5	6	7	8	9

The eight three-hourly K numbers (after Bartels) are calculated by a computer code (FMI method, Sucksdorff et al., 1991) from the digital recordings of three component flux-gate variometer FGE.

The local equivalent daily amplitude index  $Ak$  [nT] which is determined by converting  $K$  -indices into eight 3-hour equivalent linear amplitudes  $a_k$ , and calculating the mean value. The 3-hour equivalent amplitude  $a_k$  is assigned for each K value using the following table:

$K$	0	1	2	3	4	5	6	7	8	9
$a_{K[nT]}$	0	3	7	15	27	48	80	140	240	400

$\Sigma K$  is the daily sum of the eight  $K$  numbers.

The calculated local geomagnetic indices ( $K$ ,  $A_k$ ,  $\Sigma K$ ) at PAG observatory for 2015 are presented in Table 1.

**Table 1.** Local geomagnetic indices ( $K$ ,  $A_k$ ,  $\Sigma K$ ) calculated at PAG observatory in 2015.

Activity Indices										
Day	$K$								$A_k [nT]$	$\Sigma K$
01-Jan-15	2	1	1	2	1	2	2	3	7	14
02-Jan-15	3	1	2	2	2	3	4	5	16	22
03-Jan-15	5	3	2	3	2	1	1	0	12	17
04-Jan-15	1	1	1	3	3	5	4	5	20	23
05-Jan-15	5	3	2	3	2	2	3	3	16	23
06-Jan-15	2	3	3	4	2	3	4	1	15	22
07-Jan-15	2	3	6	5	3	2	2	4	26	27
08-Jan-15	3	3	3	3	3	3	2	3	14	23
09-Jan-15	2	2	2	3	2	2	2	2	8	17
10-Jan-15	2	3	2	2	2	4	2	1	10	18
11-Jan-15	3	1	3	2	2	2	2	3	10	18
12-Jan-15	1	1	2	2	3	2	3	2	8	16
13-Jan-15	1	2	2	2	2	3	2	2	8	16
14-Jan-15	2	1	2	2	3	2	3	1	8	16
15-Jan-15	0	0	1	2	3	2	0	1	4	9
16-Jan-15	2	2	2	2	2	1	2	1	6	14
17-Jan-15	2	2	1	2	1	0	1	3	6	12
18-Jan-15	1	1	1	1	2	2	2	3	6	13
19-Jan-15	2	1	1	1	0	1	2	3	5	11
20-Jan-15	2	0	1	1	1	0	1	2	3	8
21-Jan-15	2	2	3	2	2	4	4	3	14	22
22-Jan-15	4	2	1	3	3	1	3	2	12	19
23-Jan-15	3	2	2	2	1	2	2	1	7	15
24-Jan-15	1	1	1	1	2	2	3	2	6	13
25-Jan-15	2	2	1	1	1	2	2	3	7	14
26-Jan-15	3	2	3	3	2	3	3	2	12	21
27-Jan-15	3	3	3	2	2	3	2	4	14	22
28-Jan-15	3	2	2	2	1	1	2	2	7	15
29-Jan-15	2	1	1	2	2	3	5	3	13	19

30-Jan-15	3	2	2	2	1	2	4	4	13	20
31-Jan-15	1	2	2	2	2	2	3	4	10	18
01-Feb-15	4	3	3	3	2	3	4	5	21	27
02-Feb-15	4	4	3	3	2	4	4	3	20	27
03-Feb-15	3	3	2	2	3	3	3	3	13	22
04-Feb-15	2	2	1	2	3	3	2	2	9	17
05-Feb-15	1	2	2	2	3	4	3	2	11	19
06-Feb-15	0	1	2	3	1	1	1	1	5	10
07-Feb-15	1	1	2	3	2	3	3	2	9	17
08-Feb-15	2	2	2	2	1	2	3	3	9	17
09-Feb-15	3	2	1	1	2	2	2	3	8	16
10-Feb-15	0	2	1	1	1	1	2	3	5	11
11-Feb-15	1	3	2	2	2	1	0	1	6	12
12-Feb-15	2	2	1	1	2	1	2	2	6	13
13-Feb-15	0	0	1	1	1	1	1	1	2	6
14-Feb-15	0	1	1	1	0	0	0	1	2	4
15-Feb-15	1	2	2	2	3	2	2	2	8	16
16-Feb-15	1	1	1	2	2	2	3	4	9	16
17-Feb-15	3	3	2	3	3	3	5	4	20	26
18-Feb-15	5	3	3	3	2	2	3	3	17	24
19-Feb-15	3	2	2	2	1	2	3	2	9	17
20-Feb-15	1	2	2	2	2	1	1	2	6	13
21-Feb-15	2	1	1	1	1	2	2	3	6	13
22-Feb-15	3	2	1	2	2	1	1	3	8	15
23-Feb-15	3	2	3	3	3	4	4	4	19	26
24-Feb-15	5	4	3	3	2	1	1	3	17	22
25-Feb-15	1	1	3	2	3	3	3	0	9	16
26-Feb-15	2	1	1	2	1	0	1	1	4	9
27-Feb-15	1	1	1	2	1	2	1	2	5	11
28-Feb-15	1	2	2	2	2	3	4	4	13	20
01-Mar-15	5	4	4	3	1	2	3	3	20	25
02-Mar-15	3	3	4	4	3	4	3	3	20	27
03-Mar-15	3	3	2	2	1	2	3	4	12	20
04-Mar-15	2	2	2	4	4	1	2	3	13	20
05-Mar-15	1	1	1	2	2	3	2	2	7	14
06-Mar-15	1	2	3	2	1	2	3	4	11	18
07-Mar-15	3	3	3	3	3	4	4	4	20	27
08-Mar-15	2	2	2	3	3	3	2	1	10	18
09-Mar-15	3	2	1	0	1	1	1	1	5	10
10-Mar-15	1	1	2	1	1	0	1	0	3	7
11-Mar-15	0	3	2	2	2	2	3	1	8	15

12-Mar-15	1	3	2	2	2	2	1	0	6	13
13-Mar-15	1	0	1	3	4	1	1	1	7	12
14-Mar-15	1	2	2	2	2	0	1	3	6	13
15-Mar-15	3	2	2	2	2	2	3	2	9	18
16-Mar-15	2	3	4	3	3	3	2	1	13	21
17-Mar-15	2	5	5	6	7	7	5	7	81	44
18-Mar-15	5	4	3	4	6	5	5	4	40	36
19-Mar-15	4	3	3	4	4	3	3	4	21	28
20-Mar-15	4	3	4	3	3	3	4	5	24	29
21-Mar-15	4	2	2	3	3	2	2	2	12	20
22-Mar-15	2	3	5	5	3	1	2	1	18	22
23-Mar-15	3	3	2	3	5	3	3	4	20	26
24-Mar-15	1	1	1	3	3	4	2	2	10	17
25-Mar-15	2	2	2	4	4	3	4	2	16	23
26-Mar-15	3	2	2	1	2	2	2	4	10	18
27-Mar-15	3	2	2	2	3	2	1	2	9	17
28-Mar-15	1	2	3	2	2	3	2	3	10	18
29-Mar-15	3	3	2	2	2	2	2	2	9	18
30-Mar-15	2	1	1	2	0	1	1	2	4	10
31-Mar-15	1	1	2	3	3	3	3	2	10	18
01-Apr-15	1	1	2	2	1	3	3	3	9	16
02-Apr-15	1	2	2	2	2	2	3	4	10	18
03-Apr-15	3	3	2	3	3	3	2	3	13	22
04-Apr-15	3	2	2	3	3	4	3	2	14	22
05-Apr-15	2	1	1	1	1	2	2	3	6	13
06-Apr-15	2	1	1	1	1	1	1	1	4	9
07-Apr-15	2	2	2	1	1	1	2	1	5	12
08-Apr-15	2	0	1	1	1	1	2	1	4	9
09-Apr-15	2	2	3	3	2	2	3	3	11	20
10-Apr-15	4	4	4	3	4	3	3	2	20	27
11-Apr-15	4	3	2	2	2	4	3	1	14	21
12-Apr-15	0	1	1	1	1	1	2	1	3	8
13-Apr-15	2	2	2	1	1	2	2	1	6	13
14-Apr-15	0	1	2	2	3	4	5	4	17	21
15-Apr-15	2	3	2	4	4	4	5	3	22	27
16-Apr-15	4	3	3	4	3	3	5	5	26	30
17-Apr-15	4	3	3	3	2	3	3	2	15	23
18-Apr-15	2	1	3	3	2	3	4	3	13	21
19-Apr-15	2	1	1	2	1	2	3	3	8	15
20-Apr-15	3	2	2	2	2	2	3	4	12	20
21-Apr-15	3	3	3	4	4	4	3	3	20	27

22-Apr-15	2	2	3	3	2	2	2	3	10	19
23-Apr-15	1	2	1	2	1	1	1	2	5	11
24-Apr-15	1	2	1	2	0	1	1	0	3	8
25-Apr-15	0	0	1	1	0	1	1	1	2	5
26-Apr-15	1	1	1	1	1	1	1	1	3	8
27-Apr-15	0	1	2	2	1	2	2	2	5	12
28-Apr-15	2	1	2	2	2	2	2	1	6	14
29-Apr-15	1	1	1	1	2	2	1	1	4	10
30-Apr-15	3	1	1	1	1	1	2	1	5	11
01-May-15	1	2	1	1	1	2	2	2	5	12
02-May-15	2	2	1	2	2	2	3	3	9	17
03-May-15	3	2	2	2	1	2	2	1	7	15
04-May-15	1	1	2	2	2	2	2	1	6	13
05-May-15	1	1	1	2	2	2	2	2	6	13
06-May-15	3	2	3	4	4	5	5	2	24	28
07-May-15	2	2	2	2	2	3	2	2	8	17
08-May-15	2	2	2	2	1	1	1	1	5	12
09-May-15	1	1	1	3	2	3	3	3	10	17
10-May-15	1	2	2	3	3	1	3	2	9	17
11-May-15	3	3	2	2	3	2	2	4	13	21
12-May-15	2	2	2	3	3	3	3	3	12	21
13-May-15	4	5	5	4	3	4	4	4	31	33
14-May-15	2	2	2	2	2	1	2	2	7	15
15-May-15	1	2	2	2	2	1	2	2	6	14
16-May-15	1	2	1	1	2	1	1	2	5	11
17-May-15	2	2	1	1	2	2	2	1	6	13
18-May-15	2	2	2	3	3	2	3	4	13	21
19-May-15	5	3	2	2	2	2	2	1	13	19
20-May-15	2	3	2	1	2	2	1	0	6	13
21-May-15	1	1	0	1	1	1	1	1	3	7
22-May-15	1	2	0	1	1	0	0	0	2	5
23-May-15	0	1	1	2	1	1	2	1	4	9
24-May-15	2	2	1	1	1	1	1	1	4	10
25-May-15	0	1	1	1	1	0	1	1	2	6
26-May-15	1	2	2	1	2	3	2	1	7	14
27-May-15	1	2	1	1	3	2	1	2	6	13
28-May-15	2	3	1	2	2	2	2	1	7	15
29-May-15	1	3	1	2	2	2	2	2	7	15
30-May-15	1	2	1	1	2	1	1	2	5	11
31-May-15	1	1	1	1	1	2	2	2	5	11
01-Jun-15	3	2	1	2	1	1	2	1	6	13

02-Jun-15	2	2	0	1	1	1	2	1	4	10
03-Jun-15	2	2	1	2	1	1	2	1	5	12
04-Jun-15	1	2	1	1	1	1	1	0	3	8
05-Jun-15	0	1	1	1	1	1	1	1	3	7
06-Jun-15	1	2	1	2	2	1	0	1	4	10
07-Jun-15	1	2	2	2	2	2	3	3	9	17
08-Jun-15	3	5	6	5	3	4	3	4	34	33
09-Jun-15	3	3	3	2	3	3	3	2	13	22
10-Jun-15	3	2	3	3	2	2	2	2	10	19
11-Jun-15	2	2	2	2	2	3	2	1	8	16
12-Jun-15	1	2	1	1	3	2	2	2	7	14
13-Jun-15	3	2	3	3	1	2	2	2	10	18
14-Jun-15	4	2	3	4	3	3	2	3	16	24
15-Jun-15	2	2	2	3	3	3	3	3	12	21
16-Jun-15	3	2	2	1	2	3	3	2	10	18
17-Jun-15	3	3	2	2	3	3	1	1	10	18
18-Jun-15	2	1	1	2	2	3	2	1	7	14
19-Jun-15	2	1	1	1	1	0	1	0	3	7
20-Jun-15	1	1	1	1	0	1	1	1	3	7
21-Jun-15	1	1	1	1	1	4	3	3	9	15
22-Jun-15	1	3	4	3	5	5	8	5	56	34
23-Jun-15	6	5	5	4	4	3	4	4	37	35
24-Jun-15	3	2	3	2	3	3			9	16
25-Jun-15									0	0
26-Jun-15					1	1	1	2	2	5
27-Jun-15	2	3	2	2	2	2	2	2	8	17
28-Jun-15	3	3	3	2	3	2	3	2	12	21
29-Jun-15	2	2	2	2	2	2	1	0	6	13
30-Jun-15	1	2	2	1	1	1	2	3	6	13
01-Jul-15	2	2	1	2	2	2	1	0	5	12
02-Jul-15	1	2	2	1	1	0	0	0	3	7
03-Jul-15	1	1	1	1	0	1	0	0	2	5
04-Jul-15	1	2	2	2	3	3	4	4	14	21
05-Jul-15	4	4	2	3	2	3	3	3	16	24
06-Jul-15	3	3	2	2	1	1	3	2	9	17
07-Jul-15	2	2	1	2	1	1	2	2	6	13
08-Jul-15	0	1	1	2	2	2	2	1	5	11
09-Jul-15	1	2	1	1	1	1	2	1	4	10
10-Jul-15	1	2	1	1	0	2	2	5	10	14
11-Jul-15	4	3	3	3	2	2	3	3	15	23
12-Jul-15	2	3	2	3	2	2	3	3	11	20

13-Jul-15	4	4	4	3	3	3	5	3	24	29
14-Jul-15	3	2	2	2	2	2	3	2	9	18
15-Jul-15	1	2	1	2	3	2	1	2	7	14
16-Jul-15	3	2	2	2	2	2	2	1	8	16
17-Jul-15	1	2	1	2	1	1	0	0	3	8
18-Jul-15	1	1	1	1	1	1	2	1	4	9
19-Jul-15	1	1	2	1	0	1	0	0	2	6
20-Jul-15	0	0	1	1	1	1	1	1	2	6
21-Jul-15	3	3	3	2	2	2	2	2	10	19
22-Jul-15	2	2	1	1	2	3	2	2	7	15
23-Jul-15	3	3	3	3	3	2	3	3	14	23
24-Jul-15	2	2	1	2	2	2	2	3	8	16
25-Jul-15	2	2	3	3	2	1	2	3	10	18
26-Jul-15	3	2	1	2	1	2	2	2	7	15
27-Jul-15	2	2	2	3	2	2	2	2	8	17
28-Jul-15	2	2	2	3	2	1	2	1	7	15
29-Jul-15	1	1	2	2	2	2	2	1	6	13
30-Jul-15	2	2	1	2	2	3	4	5	15	21
31-Jul-15	3	2	2	2	3	4	3	3	14	22
01-Aug-15	3	2	1	2	2	3	3	2	10	18
02-Aug-15	3	2	2	1	3	2	2	2	9	17
03-Aug-15	2	3	2	1	2	2	1	2	7	15
04-Aug-15	1	2	2	1	2	1	2	4	8	15
05-Aug-15	2	2	1	2	2	2	1	2	6	14
06-Aug-15	2	2	2	3	3	2	2	2	9	18
07-Aug-15	2	3	4	3	4	4	3	2	18	25
08-Aug-15	2	2	2	3	3	1	3	3	11	19
09-Aug-15	2	2	2	3	2	3	2	3	10	19
10-Aug-15	3	2	3	2	2	2	3	2	10	19
11-Aug-15	3	3	2	2	1	1	2	2	8	16
12-Aug-15	2	2	2	1	2	3	3	3	10	18
13-Aug-15	3	4	2	2	2	1	1	1	9	16
14-Aug-15	1	1	1	2	1	1	1	2	4	10
15-Aug-15	3	2	4	5	5	4	3	3	25	29
16-Aug-15	4	3	5	4	3	4	3	4	25	30
17-Aug-15	3	3	3	3	4	4	4	2	19	26
18-Aug-15	3	3	3	1	1	2	1	2	9	16
19-Aug-15	4	3	3	2	3	3	3	3	16	24
20-Aug-15	2	3	2	3	4	3	2	3	14	22
21-Aug-15	1	2	2	1	2	1	1	1	5	11
22-Aug-15	2	1	2	3	3	2	3	2	10	18



23-Aug-15	3	3	4	3	4	3	4	2	19	26
24-Aug-15	2	2	2	3	2	1	2	1	7	15
25-Aug-15	2	2	1	2	1	2	3	2	7	15
26-Aug-15	3	3	2	4	3	5	5	5	28	30
27-Aug-15	4	5	4	4	3	4	4	6	35	34
28-Aug-15	5	3	2	2	4	5	5	4	28	30
29-Aug-15	3	2	2	3	2	3	3	2	11	20
30-Aug-15	1	2	1	1	1	2	2	2	5	12
31-Aug-15	2	1	2	2	2	2	2	2	7	15
01-Sep-15	2	1	1	1	1	1	1	3	5	11
02-Sep-15	2	2	2	1	2	3	3	3	10	18
03-Sep-15	2	2	2	2	1	2	2	3	8	16
04-Sep-15	3	4	4	3	3	2	3	3	17	25
05-Sep-15	2	2	3	2	3	5	4	2	17	23
06-Sep-15	2	2	2	2	4	2	5	3	16	22
07-Sep-15	2	2	2	2	4	5	5	5	25	27
08-Sep-15	6	4	3	2	3	2	2	4	23	26
09-Sep-15	4	5	4	4	4	4	5	5	35	35
10-Sep-15	3	1	2	1	2	4	5	4	17	22
11-Sep-15	3	3	6	6	5	6	3	3	44	35
12-Sep-15	4	2	4	3					10	13
13-Sep-15									0	0
14-Sep-15					1	5	5	3	14	14
15-Sep-15	4	3							5	7
16-Sep-15									0	0
17-Sep-15									0	0
18-Sep-15			4	2	2	2	3	3	10	16
19-Sep-15	3	4	4	3	2	0	2	3	14	21
20-Sep-15	3	4	6	5	4	5	3	3	34	33
21-Sep-15	2	2	1	3	2	2	1	2	7	15
22-Sep-15	3	2	3	2	3	2	2	2	10	19
23-Sep-15	1	2	3	3	3	4	4	2	15	22
24-Sep-15	2	2	2	1	1	2	3	3	8	16
25-Sep-15	1	2	2	2	3	2	1	2	7	15
26-Sep-15	1	1	1	1	1	2	2	2	5	11
27-Sep-15	1	1	2	1	1	1	1	2	4	10
28-Sep-15	1	1	2	1	1	1	2	2	5	11
29-Sep-15	2	2	2	1	1	1	1	1	5	11
30-Sep-15	1	0	1	1	2	1	1	1	3	8
01-Oct-15	1	1	1	2	3	4	4	5	17	21
02-Oct-15	2	2	3	2	2	2	3	2	9	18

03-Oct-15	2	2	2	1	2	3	2	3	9	17
04-Oct-15	3	3	3	2	3	2	3	5	17	24
05-Oct-15	4	3	3	4	4	2	3	3	19	26
06-Oct-15	3	3	3	1	3	4	5	5	23	27
07-Oct-15	4	4	4	5	4	6	6	5	46	38
08-Oct-15	3	5	5	4	4	5	5	4	36	35
09-Oct-15	3	2	2	3	4	4	5	4	22	27
10-Oct-15	2	2	3	1	2	4	2	2	10	18
11-Oct-15	3	2	1	2	2	3	4	4	14	21
12-Oct-15	1	2	2	3	2	5	5	4	20	24
13-Oct-15	2	3	3	4	2	4	4	5	22	27
14-Oct-15	3	4	3	3	3	3	4	2	17	25
15-Oct-15	2	2	1	2	2	2	3	3	9	17
16-Oct-15	2	2	1	1	2	1	1	1	5	11
17-Oct-15	2	3	2	2	3	2	4	2	12	20
18-Oct-15	3	2	3	4	3	3	3	3	16	24
19-Oct-15	0	1	1	2	1	1	1	2	4	9
20-Oct-15	1	1	2	2	2	3	4	3	11	18
21-Oct-15	1	2	2	4	4	2	2	2	12	19
22-Oct-15	1	1	2	2	1	2	3	2	7	14
23-Oct-15	2	1	1	2	2	2	2	3	7	15
24-Oct-15	2	2	2	1	1	1	4	3	9	16
25-Oct-15	2	1	2	2	3	2	1	1	7	14
26-Oct-15	1	0	1	2	1	0	0	0	2	5
27-Oct-15	0	0	1	1	1	0	1	3	3	7
28-Oct-15	0	1	1	2	0	1	1	0	2	6
29-Oct-15	1	0	1	2	1	0	1	3	4	9
30-Oct-15	2	1	1	2	2	3	2	3	8	16
31-Oct-15	0	0	1	2	2	2	2	3	6	12
01-Nov-15	1	2	2	1	2	2	3	2	7	15
02-Nov-15	1	0	1	1	3	3	1	2	6	12
03-Nov-15	3	3	5	4	4	4	5	4	29	32
04-Nov-15	4	5	4	3	5	3	3	3	26	30
05-Nov-15	3	1	3	3	3	4	3	4	17	24
06-Nov-15	4	2	2	2	2	2	5	4	17	23
07-Nov-15	4	5	5	4	3	3	4	2	27	30
08-Nov-15	2	1	1	2	4	4	5	5	21	24
09-Nov-15	4	2	3	3	3	4	5	5	25	29
10-Nov-15	4	3	3	5	5	4	4	4	29	32
11-Nov-15	4	2	3	2	4	5	4	2	21	26

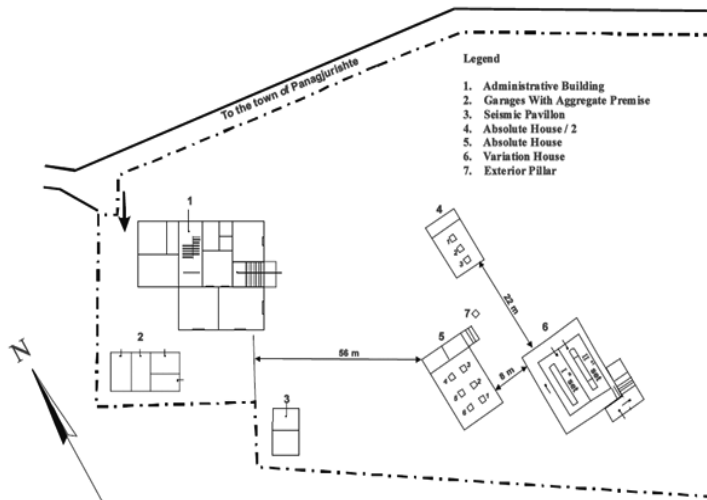
12-Nov-15	1	1	1	1	1	2	1	1	4	9
13-Nov-15	1	1	1	2	4	4	4	4	16	21
14-Nov-15	3	1	2	2	3	1	2	2	8	16
15-Nov-15	2	2	1	2	1	2	3	3	8	16
16-Nov-15	3	2	2	3	3	2	3	3	12	21
17-Nov-15	1	2	1	2	1	3	3	2	8	15
18-Nov-15	1	3	2	2	2	3	5	4	16	22
19-Nov-15	3	2	1	3	1	1	1	1	7	13
20-Nov-15	1	1	3	2	0	1	0	1	4	9
21-Nov-15	2	1	0	1	0	0	1	1	2	6
22-Nov-15	1	1	1	1	1	1	1	1	3	8
23-Nov-15	1	1	1	1	1	0	0	0	2	5
24-Nov-15	1	0	1	1	0	0	0	0	1	3
25-Nov-15	0	0	1	0	0	0	0	0	0	1
26-Nov-15	0	0	1	1	0	0	2	2	3	6
27-Nov-15	3	3	2	2	2	2	2	2	9	18
28-Nov-15	2	1	1	2	2	2	3	3	8	16
29-Nov-15	1	1	2	2	3	2	3	4	11	18
30-Nov-15	3	2	4	3	2	1	3	3	13	21
01-Dec-15	2	2	1	2	4	4	3	4	15	22
02-Dec-15	2	2	2	1	3	2	2	2	8	16
03-Dec-15	1	1	1	1	1	1	1	2	4	9
04-Dec-15	1	1	1	1	1	1	1	2	4	9
05-Dec-15	2	1	3	3	3	5	4	3	18	24
06-Dec-15	2	3	2	4	4	4	4	4	21	27
07-Dec-15	3	3	2	3	4	4	4	2	18	25
08-Dec-15	3	2	2	3	3	1	2	3	11	19
09-Dec-15	2	1	0	1	2	3	4	2	9	15
10-Dec-15	3	4	3	3	3	4	4	4	21	28
11-Dec-15	4	3	2	3	3	5	4	4	23	28
12-Dec-15	2	2	2	2	2	3	3	2	9	18
13-Dec-15	2	2	2	2	2	1	1	1	6	13
14-Dec-15	2	2	1	1	4	5	5	5	24	25
15-Dec-15	4	3	2	2	3	4	3	3	16	24
16-Dec-15	3	2	1	1	0	0	1	1	4	9
17-Dec-15	1	1	1	1	2	2	4	2	8	14
18-Dec-15	2	1	1	1	1	0	1	3	5	10
19-Dec-15	1	1	1	1	1	4	5	5	17	19
20-Dec-15	4	5	5	3	5	6	6	6	53	40
21-Dec-15	6	4	4	3	2	2	2	3	23	26

22-Dec-15	3	2	3	4	3	1	3	2	13	21
23-Dec-15	2	2	1	2	3	2	3	4	11	19
24-Dec-15	2	2	3	2	2	2	3	2	9	18
25-Dec-15	3	2	2	2	2	2	2	2	8	17
26-Dec-15	2	2	2	2	4	4	3	5	18	24
27-Dec-15	3	2	2	2	3	3	3	2	11	20
28-Dec-15	1	1	2	2	2	1	0	2	5	11
29-Dec-15	2	0	2	1	2	2	3	3	8	15
30-Dec-15	0	0	1	1	1	1	1	2	3	7
31-Dec-15	4	3	3	5	5	6	5	4	39	35

### **Definitive daily mean values of the Declination (D), Inclination (I), Horizontal (X and Y), and Vertical (Z) field components.**

Presently, daily mean values are obtained from the hourly means (HMVs) which in turn comes from the minute mean values (MMVs), based on the digital recordings of the three-component fluxgate magnetometer FGE. The baseline of this magnetometer is determined from absolute measurements with a DI-flux theodolite and an Overhauser proton magnetometer.

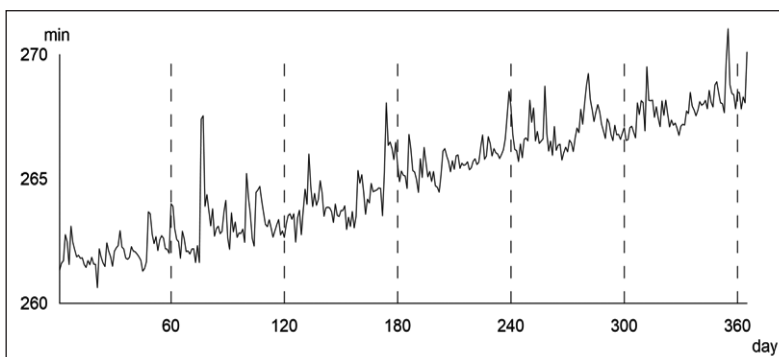
Positions of the Variation house where the three-component fluxgate magnetometer FGE is installed and the Absolute house where absolute geomagnetic measurements are performed are given in the Fig. 1.



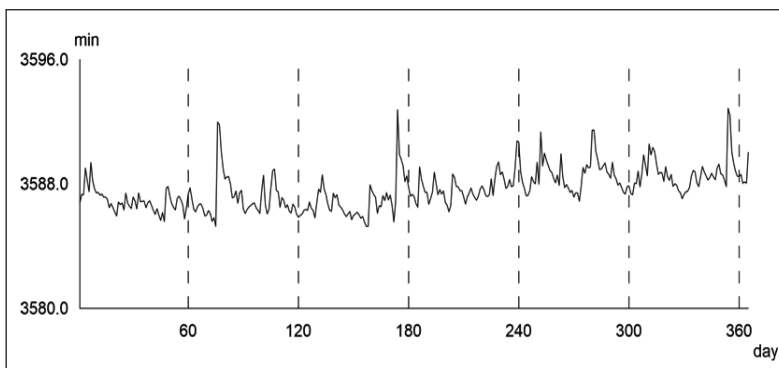
**Fig. 1.** Ground plan of the Panagjurishte observatory (after Kostov and Nozharov, 1987)

Before calculating of MMVs, inspection and verification of the reported data is performed. The reported data (available in near real time) are usually used in applications where the reliable representation of higher-frequency magnetic field variations is more important rather than absolute levels or secular variation. This concerns, e.g. the forecast of magnetic activity, radio-wave propagation, or space weather. In the case of reported data it is not possible to verify them prior to dissemination. Careful monitoring of the automatically transmitted data and the present-day computer technologies enable us to improve the quality of data and reduce the number of gaps in the records. After the quality control procedures have been applied to the 2015 reported data, we obtained the definitive minute mean values and calculated the HMMVs and DMVs. Due to technical problems there are gaps in the data records in February and March.

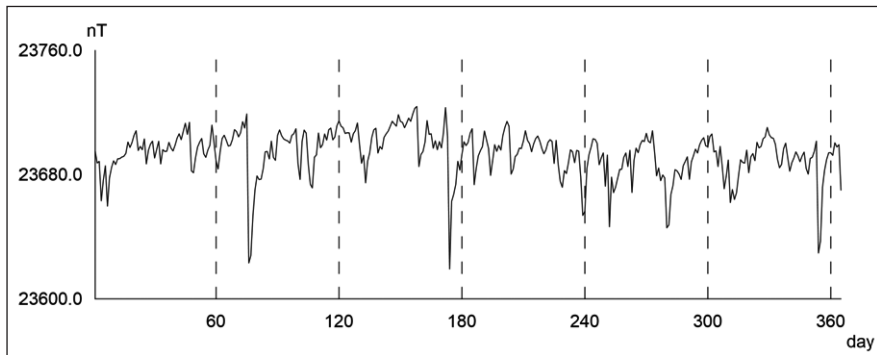
Daily mean values of the Declination (D), Inclination (I), Horizontal (X and Y), and Vertical (Z) field components for 2014 are plotted in the next figures:



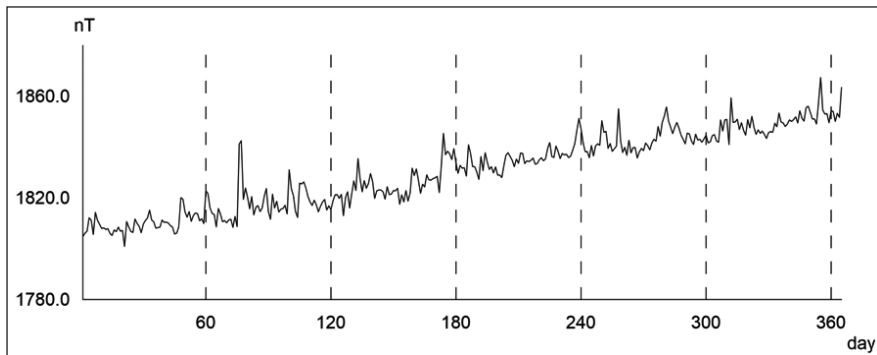
**Fig. 2.** Plot of the daily mean values of the **Declination (D)** registered in PAG observatory in 2015.



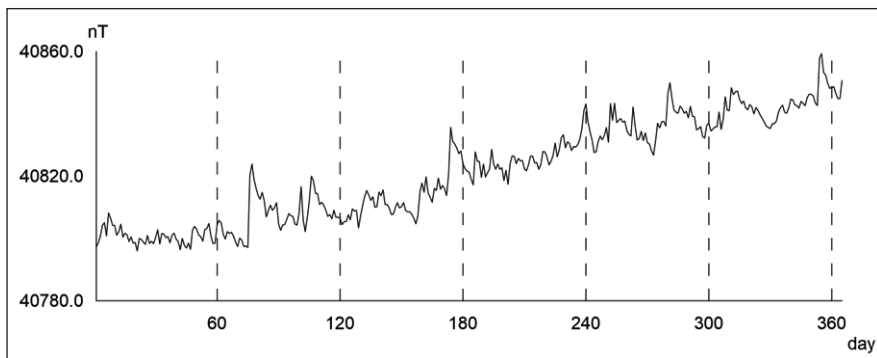
**Fig. 3.** Plot of the daily mean values of the **Inclination (I)** registered in PAG observatory in 2015.



**Fig. 4.** Plot of the daily mean values of the **North geomagnetic field component (X)** registered in PAG observatory in 2015.



**Fig. 5.** Plot of the daily mean values of the **East geomagnetic field component (Y)** registered in PAG observatory in 2015.



**Fig. 6.** Plot of the daily mean values of the **Vertical geomagnetic field component (Z)** registered in PAG observatory in 2015

## Conclusions

Continuous registration of the geomagnetic field components gives the sum of all field contributions from the internal and external to the Earth sources. A straightforward separation of the individual contributions is impossible and many scientific studies deal with different aspects of this problem (Mandea and Korte, 2010). Approximate description of the strength of different external variations however, are provided by geomagnetic indices. A quantitative measure of 2015 local geomagnetic activity in the form of 3 hour *K*-index is published here, based upon the range of fluctuations in the PAG observatory records. Table 1 shows that 2015 has disturbed geomagnetic field with 67 disturbed days. The most active period are recorded in September, October, November and December each of them having at least 7 days with recorded geomagnetic storm. The most strong events during 2015 are two – between 17-23 March with largest  $K=7$  and 22-23 June when  $K=8$  was reached. The observed activity is quite reasonable because 2015 is in the middle of the 24<sup>th</sup> Solar cycle. with 6 days having  $K$ -index  $\geq 5$  and 1 with  $K=6$ . Annual variations of the geomagnetic field components are plotted in form of daily mean values. Data are checked and verified according to IAGA requirements (Jankowski and Sucksdorff, 1996).

## References

- Buchvarov, I., 2006. Field and observatory geomagnetic measurements in Bulgaria. in Rasson and Delipetrov (eds.) *Geomagnetics for Aeronautical Safety*, Springer, p. 61-62.
- Jankowski, J., Sucksdorff, C., 1996. *Guide for magnetic measurements and observatory practice.*, International Association of Geomagnetism and Aeronomy, Warsaw, Poland.
- Kostov, K. and P. Nozharov. Absolute magnetic measurements in Bulgaria 1787-1997, Sofia, 1987, pp. 72.
- Mandea, M., Korte, M. (eds), 2010. *Geomagnetic observation and models*, IAGA Special Sopron Book Series 5, Springer.
- Sucksdorff, C., Pirjola, R. and Häkkinen, L., 1991. Computer production of *K*-values based on linear elimination, *Geophysical Transactions*, 36, 333-345.

## Годишен доклад за наблюдаваната геомагнитна активност в Обсерватория Панагюрище през 2015

М. Методиев, П. Трифонова

**Резюме:** Понастоящем, в ерата на интернет комуникациите, записите от геомагнитните обсерватории се предоставят на заинтересованите потребители почти в реално време, докато обработените времеви серии (окончателни данни) са обект на много проверки и се разпространяват с месеци закъснение. Статията представя дефини-

тивните геомагнитни данни, получени в Обсерватория Панагюрище през 2015 г., дадени под формата на локални геомагнитни индекси и графики на среднодневните стойности на компонентите на магнитното поле. Изчислените индекси показват, че 2015 г. има доста смутено геомагнитно поле, достигащо  $K = 8$ . Това е очаквано и разбираемо поради факта, че годината се намира в средата на 24-ия Слънчев цикъл, когато Слънцето е в най-активния си период.