Sadovsky Institute of Geosphere Dynamics of
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VARIATIONS OF ELECTRICAL CHARACTERISTICS OF NEAR-SURFACE ATMOSPHERE OF THE EARTH DURING MAGNETIC STORM

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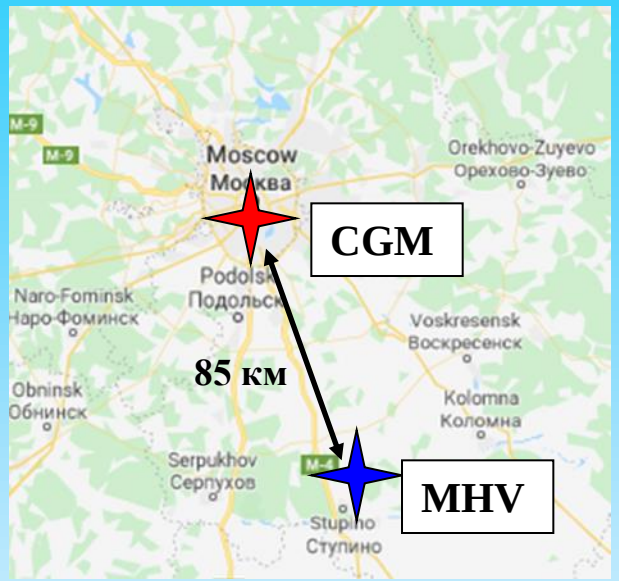
Temporal variations of the electric field in near-surface layer of the Earth are determined by many factors, among which strong disturbances of the magnetic field should be especially noted. Magnetic storms cause an increase in the ionospheric electric field, which leads to variations in the gradient of the electric field potential near the Earth's surface.

The literature on the effects of geomagnetic storms on the atmospheric electricity of high and middle latitudes is rather voluminous. Unfortunately, these results are limited and rather contradictive. This can be connected not only with the particularities of the physical processes in the near Earth's atmosphere for individual geomagnetic storms but also with the choice of, e.g., detection location, zero day in the method of superposed epochs, intervals of data averaging (from minutes to days), as well as with the state of the atmosphere before a storm and after it. The proposed possible mechanisms of these effects are contradictory to the same extent.

Research purpose

We consider the effect of magnetic storms in variations in the electrical characteristics of the atmosphere at Geophysical observatory Mikhnevo of Sadovsky Institute of Geosphere Dynamics of Russian Academy of Sciences (54.94° N; 37.73° E) and at Center for geophysical monitoring of Moscow of Sadovsky Institute of Geosphere Dynamics of Russian Academy of Sciences (55.70° N; 37.57° E).

Initial data

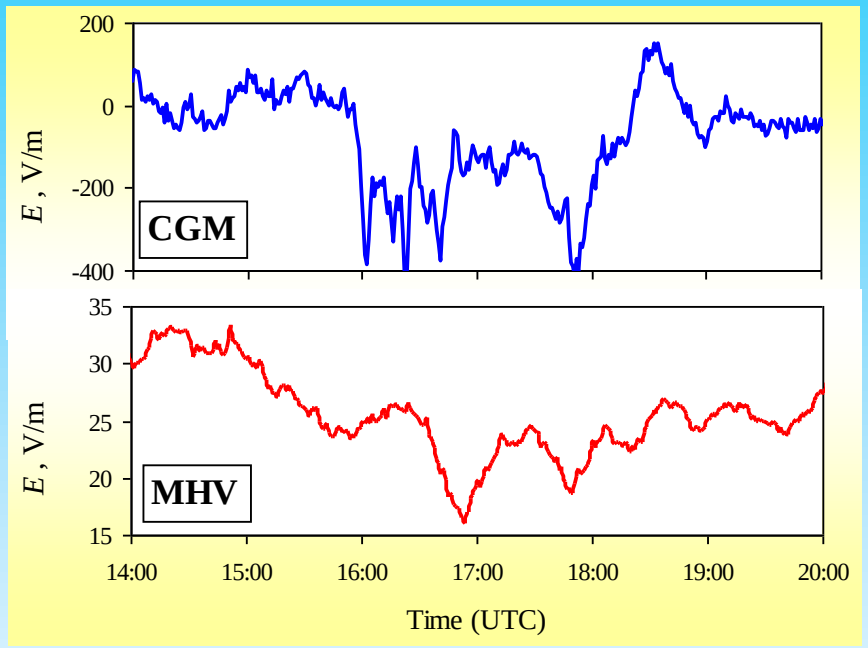


We used data from the continuous recording of three components of the magnetic field by LEMI-018 flux-gate digital magnetometer; the vertical components of the atmospheric electric field strength *E* by INEP electrostatic fluxmeter and the atmospheric current *I* by a compensation current recorder at observatory Mikhnevo, as well as the vertical components of the atmospheric electric field strength *E* by INEP electrostatic fluxmeter at Center for geophysical monitoring of Moscow of Sadovsky Institute of Geosphere Dynamics of Russian Academy of Sciences. The data for the period 2016-2019 in “fair weather conditions” were analyzed.

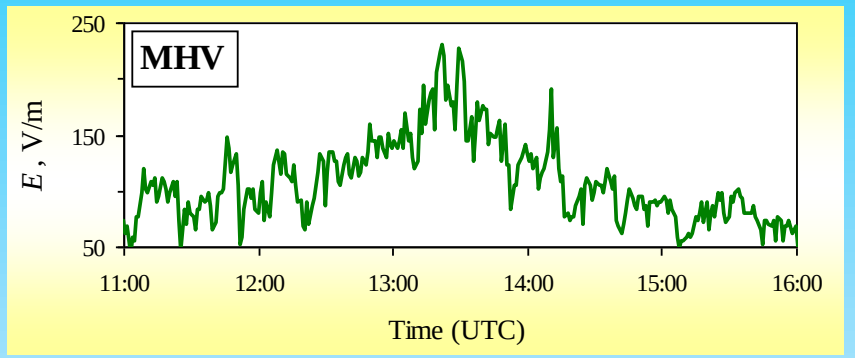
Magnetic storm list

№	Date dd.mm.yyyy	Time of Day, UT	Max value of *K*-index	№	Date dd.mm.yyyy	Time of Day, UT	Max value of *K*-index
1	21.01.2016	15-18	5	**30**	27.03.2017	21-24	6
2	24.01.2016	15-24	5	**31**	31.03.2017	15-18	5
3	06.03.2016	18-24	5	**32**	01.04.2017	15-18	5
4	07.03.2016	18-24	5	**33**	22.04.2017	15-18	6
5	11.03.2016	12-15	5	**34**	23.04.2017	12-15	5
6	15.03.2016	18-21	5	**35**	03.06.2017	15-18	5
7	12.04.2016	09-12	6	**36**	09.07.2017	9-12	5
8	05.06.2016	12-15; 21-24	5	**37**	16.07.2017	12-18	6
9	29.09.2016	15-18	6	**38**	17.07.2017	15-18	5
10	30.09.2016	18-21	6	**39**	31.08.2017	12-15	5
11	13.10.2016	15-21	6	**40**	08.09.2017	12-15; 18-21	7
12	25.10.2016	12-18	7	**41**	14.09.2017	15-18	5
13	27.10.2016	15-18	5	**42**	17.09.2017	12-15	5
14	24.11.2016	12-15	5	**43**	27.09.2017	18-24	6
15	25.11.2016	15-18	5	**44**	30.09.2017	12-15	5
16	07.12.2016	18-21	5	**45**	13.10.2017	12-15	5
17	08.12.2016	15-21	5	**46**	24.10.2017	12-18	6
18	09.12.2016	18-21	5	**47**	08.11.2017	12-15	5
19	22.12.2016	18-21	5	**48**	21.11.2017	15-18	5
20	07.01.2017	12-15	5	**49**	05.12.2017	12-18	5
21	26.01.2017	15-21	5	**50**	12.12.2017	18-21	5
22	31.01.2017	12-15	5	**51**	22.02.2018	18-21	5
23	01.02.2017	15-18	6	**52**	27.02.2018	0-3	5
24	02.02.2017	15-18	5	**53**	18.03.2018	18-24	5
25	17.02.2017	15-18	5	**54**	20.04.2018	18-21	5
26	01.03.2017	12-18	5	**55**	01.10.2018	12-15	5
27	02.03.2017	12-15; 18-21	5	**56**	07.10.2018	15-21	5
28	03.03.2017	15-18	5	**57**	28.02.2019	12-15; 18-21	5
29	06.03.2017	12-15	5	**58**	01.03.2019	15-18	5

Variations in vertical component of electric field strength during periods of magnetic storms

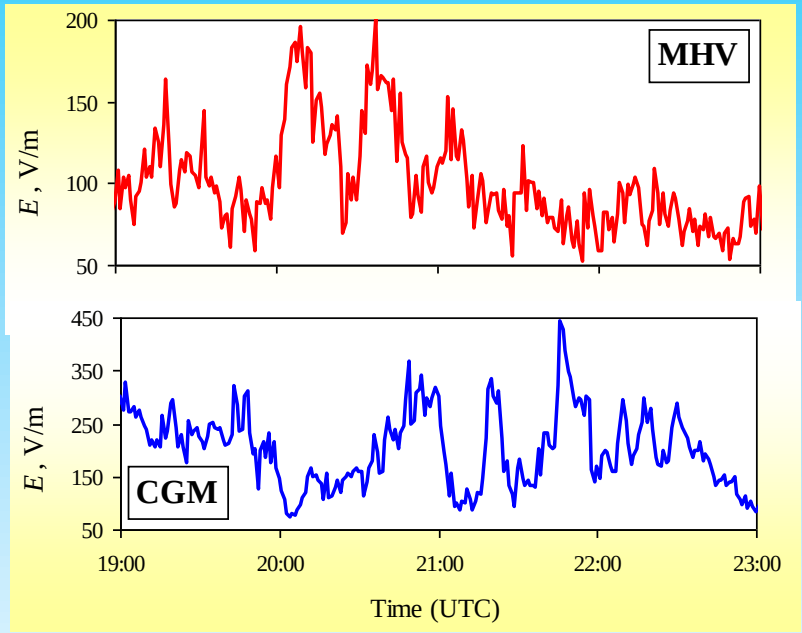


Variations of the vertical component of the electric field strength *E* in the surface atmosphere during the magnetic storm on December 12, 2017 at observatory Mikhnevo (MHV) and Center for geophysical monitoring of Moscow (CGM)



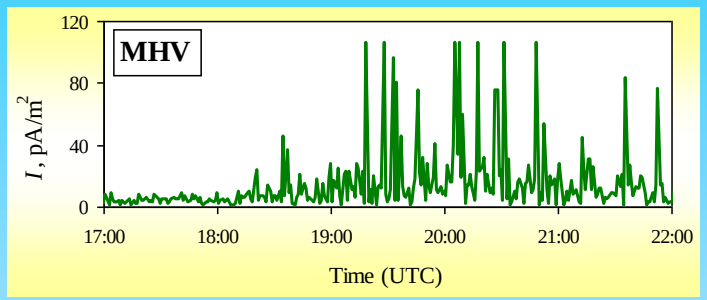
Variations of the vertical component of the electric field strength *E* in the surface atmosphere during the magnetic storm on February 28, 2019 at observatory Mikhnevo (MHV)

Variations in vertical component of electric field strength during periods of magnetic storms

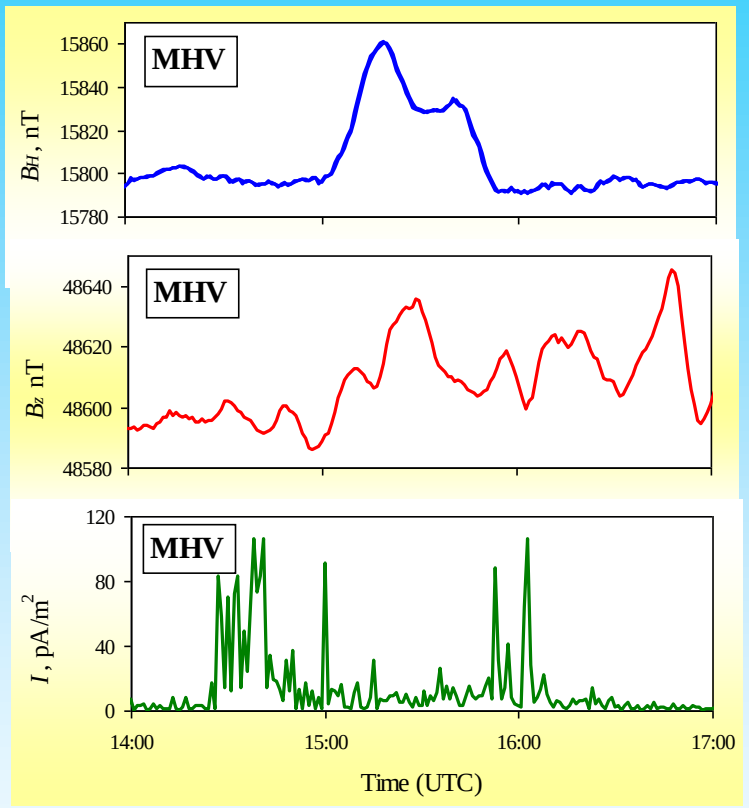


Variations of the vertical component of the electric field strength *E* in the surface atmosphere during the magnetic storm on March 7, 2016 at observatory Mikhnevo (MHV) and Center for geophysical monitoring of Moscow (CGM)

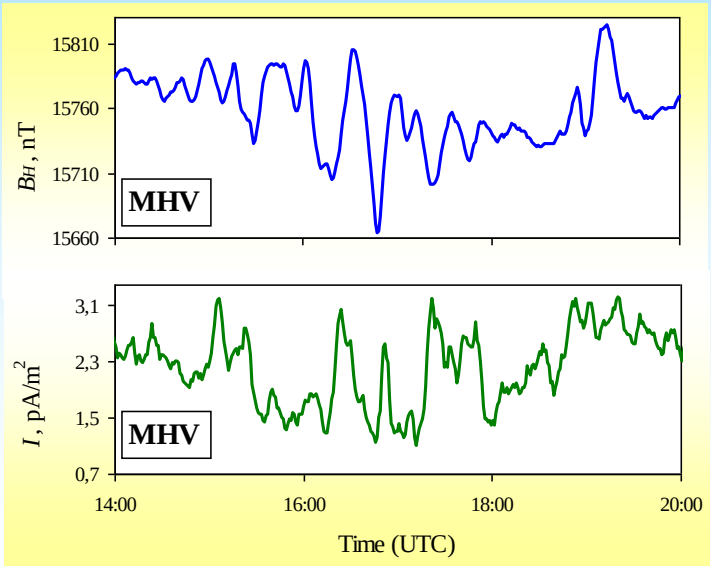
Variations of the vertical atmospheric current during periods of magnetic storms



Caused variations in vertical atmospheric current during the magnetic storm on December 7, 2016 at observatory Mikhnevo (MHV)



March 31, 2017



October 13, 2016

Caused variations in vertical atmospheric current and variation of components of geomagnetic field during the magnetic storms at observatory Mikhnevo (MHV)

Conclusion

Experimental data processing and analysis show that accompanying magnetic storms with geomagnetic *K*-index more or equal 5 increased variations in the electric field and vertical atmospheric current are characterized by different morphological structures. Basically (in 50% of the considered cases), during periods of strong magnetic storms, alternating variations in the electric field strength are observed. In 33% of cases we register a bay-shaped negative change in *E*, in 17% of cases we observe a bay-shaped change in *E* in the direction of positive values.

It is currently difficult to interpret the data. Nevertheless, the research results can be of great help in the development and verification of theoretical and computational models for generating variations in the electric field as a result of strong geomagnetic disturbances.