VARIATIONS OF METEOROLOGICAL AND ATMOSPHERIC ELECTRIC QUANTITIES UNDER THE INFLUENCE OF MESOSCALE CONVECTIVE SYSTEMS USING THE EXAMPLE OF THE CITY OF TOMSK

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Introduction

In the second half of the XX – beginning of the XXI centuries in the regions of Northern Eurasia, an increase in the proportion of convective clouds was noted. The most dangerous manifestations of convective cloudiness are mesoscale convective systems (MCSs), in particular, mesoscale convective complexes (MCCs) and squall lines (SLs). At the same time, in the south of Western Siberia, one of the centers of high-altitude recurrence of mesoscale convective systems is noted. Thus, the study of the MCS and related phenomena in this area seems to be very relevant.

Purpose of this work is to analyze the variations in meteorological and atmospheric-electrical quantities in Tomsk during the passage of mesoscale convective systems for the period 2017–2019.

1. Used data

The following data were used for the research:

1) satellite images according to the MODIS (Terra and Aqua satellites) and VIIRS (Suomi NPP satellite) spectroradiometers [https://worldview.earthdata.nasa.gov];
2) measurement data of the electric field potential gradient ($\nabla\varphi$) and meteorological quantities at the geophysical observatory of IMCES SB RAS;
3) coordinates of lightning discharges according to WWLLN (World Wide Lightning Location Network) [https://wwlln.net/].

2. Data processing and analysis

At the first stage, on the basis of satellite images in the visible part of the spectrum, obtained from the data of the daytime flights of the Terra, Aqua and Suomi NPP satellites, the cases of the passage of the MCC and LS through the city of Tomsk were deciphered. Total for the period for the period 2017–2019 12 cases of MCS passage were selected (Table 1).

Then, for the selected cases of MCS passage, intervals with the data of measurements of $\nabla\varphi$ and various meteorological quantities at the IMCES SB RAS were allocated, and the intensity of a thunderstorm (the number of lightning strikes for a period of 10 min) was calculated in the near zone of the monitoring point (radius 20 km). On the basis of the prepared data, thematic figures were constructed, which are complexes of time-synchronized graphs of variations of the analyzed quantities (for example, figures 1 and 2).

Table 1 - Data on the passage of the MCC and squall lines over Tomsk

№	Year	Month	Day	Time of passage, local (h.)	MCS type
1	2017	6	11	17:30–20:00	Squall Line
2	2017	6	25	16:10–18:10	MCC
3	2017	6	28	04:00–08:00	Squall Line
4	2017	7	22	10:45–13:30	MCC
5	2017	7	22	14:20–16:00	MCC
6	2018	6	10	21:30–23:45	MCC
7	2018	6	19	19:45–21:10	MCC
8	2018	6	24	01:00–03:00	MCC
9	2018	6	28	01:12–05:00	MCC
10	2019	6	13	15:30–18:30	Squall Line
11	2019	7	3	01:00–03:30	MCC
12	2019	7	9–10	23:30–02:00	Squall Line

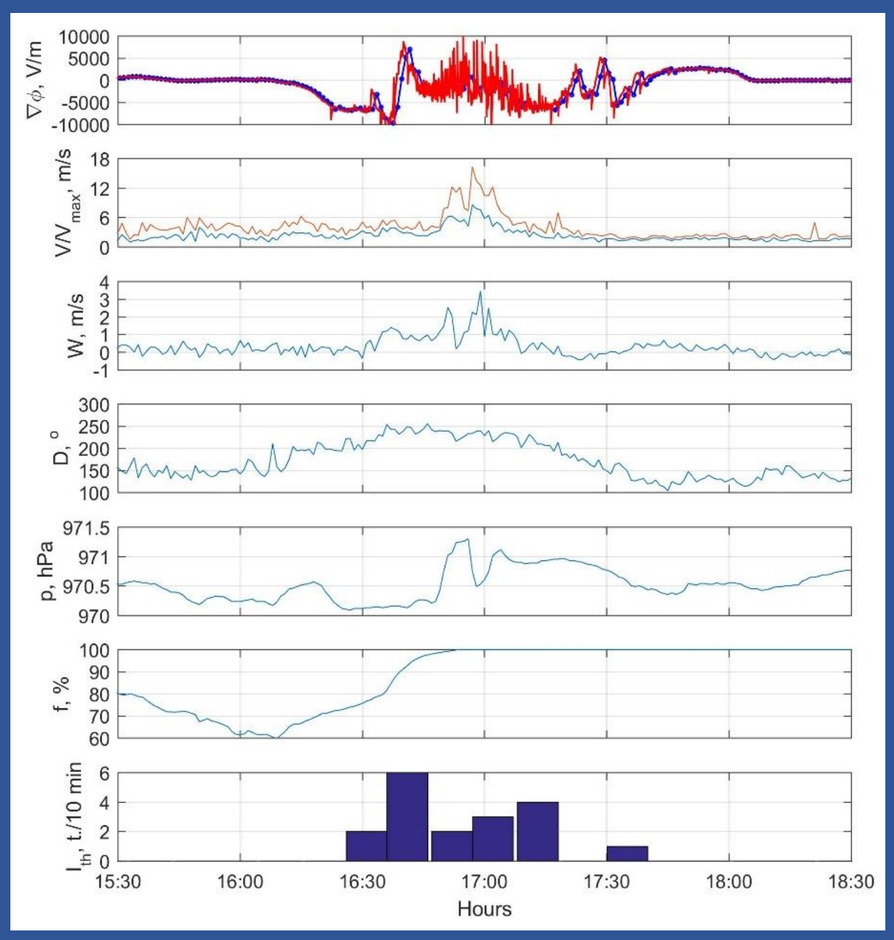

Figure 1 – Variations in the gradient of the electric field potential ($\nabla\varphi$; red line – instantaneous values, blue – mean-minute), average (V) and maximum (V_{max}) values of the horizontal wind component, average values of the vertical wind component (W), horizontal wind direction (D), air pressure (p), relative humidity (f) and thunderstorm intensity (I_{th}) during the passage of the MCC 25.06.17

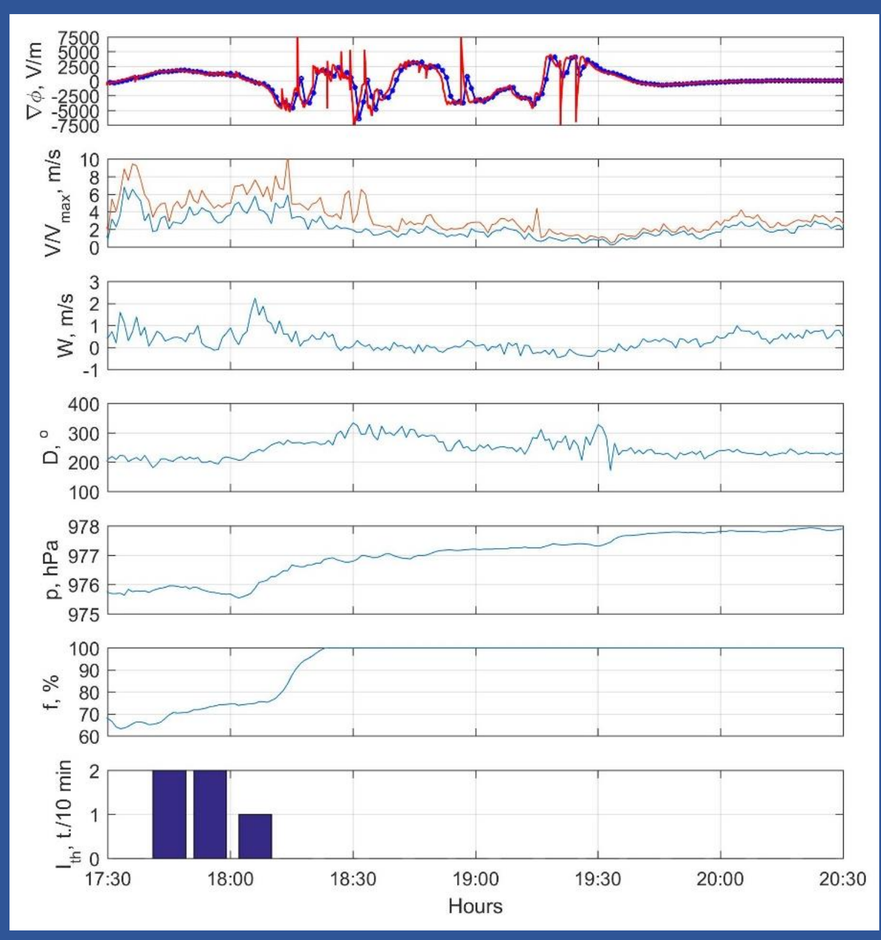

Figure 2 – Variations in the gradient of the electric field potential ($\nabla\varphi$; red line – instantaneous values, blue – mean-minute), average (V) and maximum (V_{max}) values of the horizontal wind component, average values of the vertical wind component (W), horizontal wind direction (D), air pressure (p), relative humidity (f) and thunderstorm intensity (I_{th}) during the passage of the SL 11.06.17

3. Main results

Based on the research, the following characteristics of variations in electrical and meteorological values during the passage of the MCSs are noted:

–the duration of the "slow variations" $\nabla\varphi$ – from 2 h 10 min to 4 h 15 min;
–extreme average minute values $\nabla\varphi$ – 5÷19 kV/m;
–the number of Cloud-to-ground lightning's – 1÷57;
–maximum speed of the horizontal component of the wind – 4÷16 m/s;
–maximum speed of the vertical component of the wind – 0,9÷3,3 m/s;
–the duration of rainfall – from 25 min to 1 h 20 min;
–total amount of precipitation – 0,5÷8,8 mm;
–maximum intensity of precipitation – 0,09÷0,65 mm/min.

Comparison of the duration of "slow variations" of electric fields and extremes of the mean-minute $\nabla\varphi$ indices recorded during the passage of mesoscale convective systems with similar characteristics of single cumulonimbus clouds showed that they exceed the characteristics of the latter by 6 and 4 times, respectively.