ROLE OF CORONAL MASS EJECTIONS AND HIGH-SPEED SOLAR STREAMS IN THE OCCURRENCE OF IONOSPHERIC DISTURBANCES

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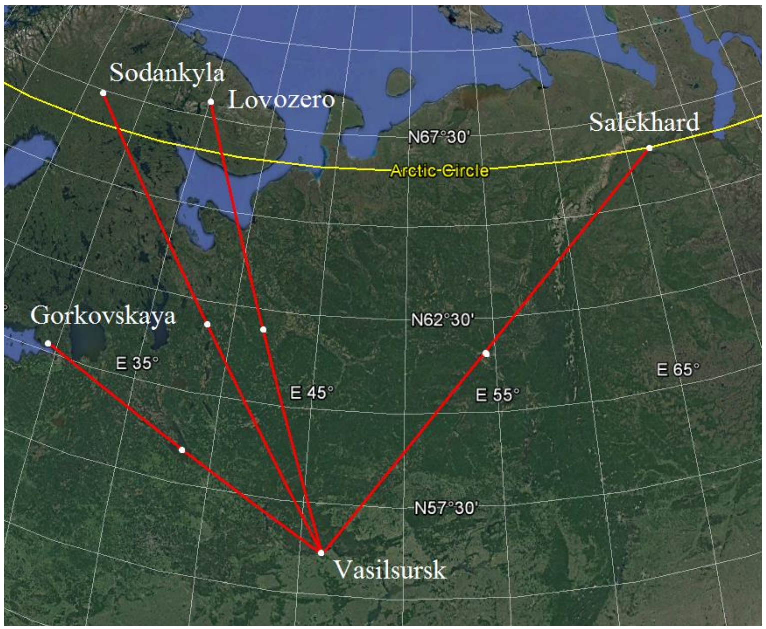
Data and Method

The study uses **vertical** and **oblique sounding** data of the ionosphere obtained in May, September 2017 during the observations of the maximum observed frequency (MOF, in MHz) of ionospheric channels on three subauroral (Lovozero-Vasilsursk, Sodankyulya-Vasilsursk and Salekhard-Vasilsursk) and one mid-latitude (Gorkovskaya, Leningrad region-Vasilsursk) paths, as well as the critical frequency of the ionospheric layer *f*0F2 from the mid-latitude ionosphere station Vasilsursk.

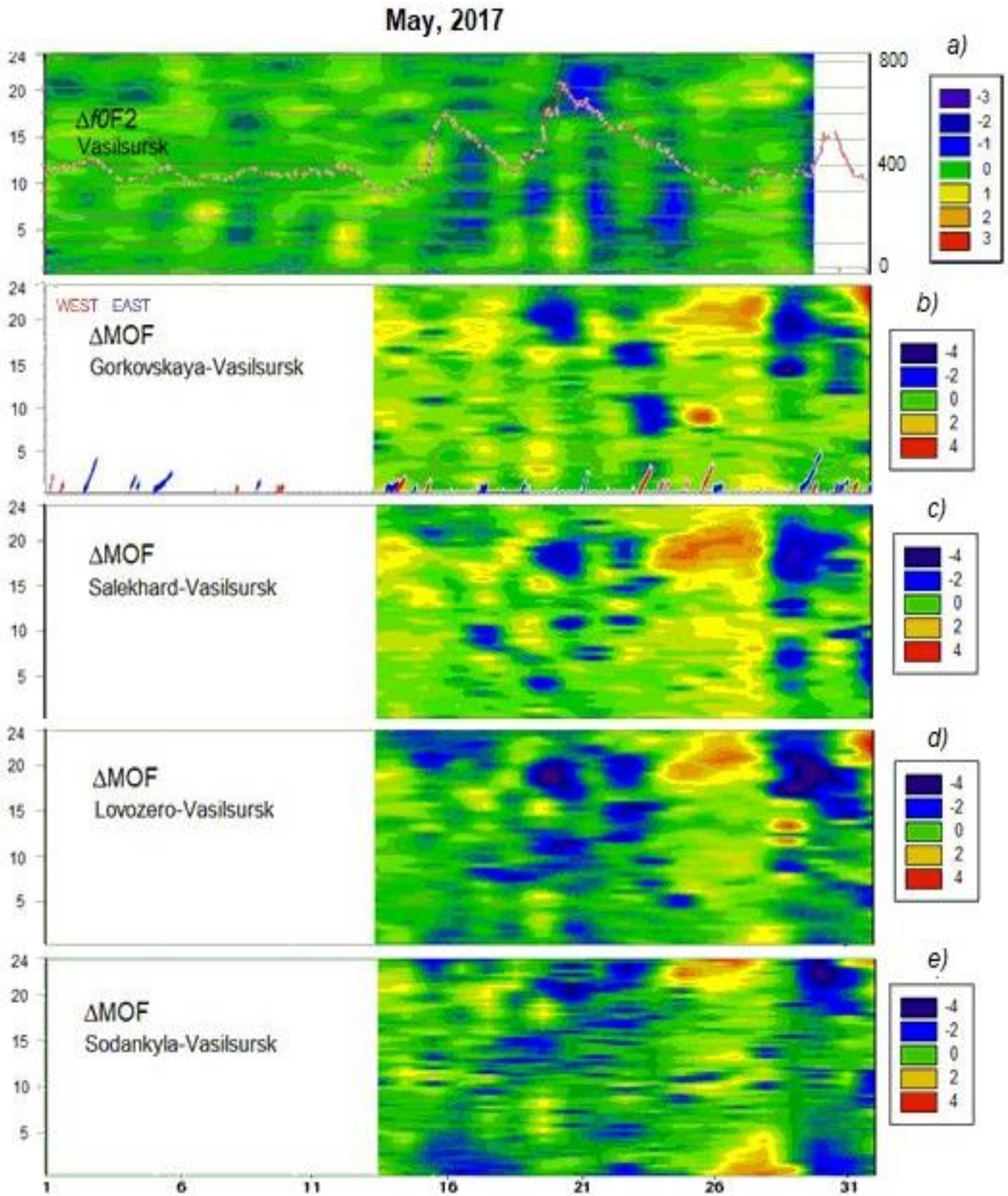


Paths	Length, km	Coordinates of chirp transmitting stations
Lovozero – Vasilsursk	1767	68.00°N, 35.02°E
Sodankyla – Vasilsursk	1236	67.4°N, 26.6°E
Salekhard – Vasilsursk	1581	66.52°N, 66.37°E
Gorkovskaya – Vasilsursk	1500	60.27°N, 29.38°E

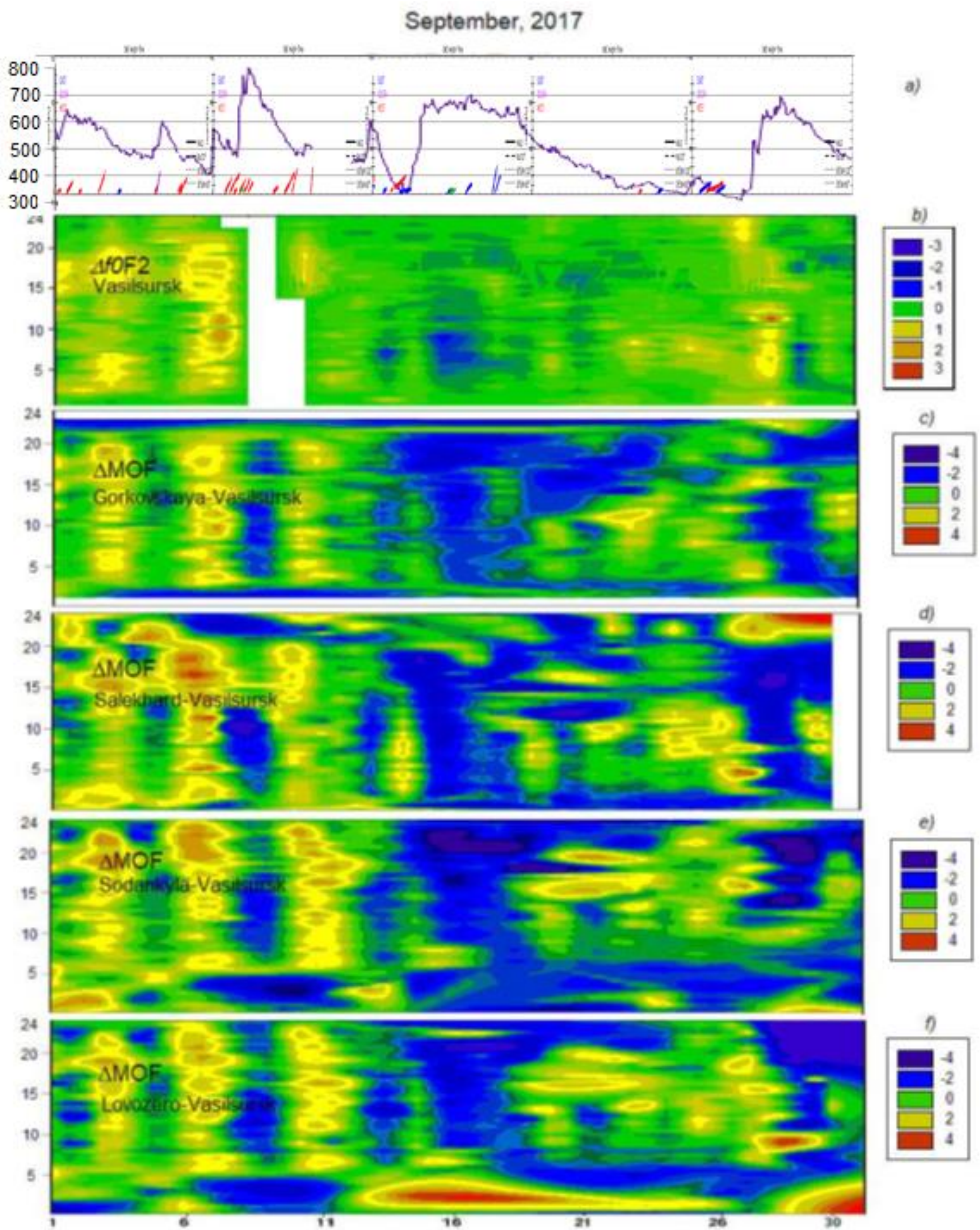
The study of disturbances in vertical and oblique sounding data is based on the **deviation** of the critical frequency of the ionospheric layer F2 (Δ*f*0F2) and maximum observed frequency (ΔMOF) for oblique sounding trajectories:

$$\Delta f0F2_{jk} = f0F2_{jk} - \overline{f0F2_{j}} \qquad \overline{f0F2_{j}} = \sum_{k=1}^{N} f0F2_{jk} / N$$

Where *f*0F2*jk* – each measured point, *j* is the point number during the day, *k* is the day number in the month. *N* is number of days in a month. A similar procedure is used for ΔMOF.



As can be seen from the Figure, the response of the ionosphere to high-speed solar wind streams (HSS) and coronal mass ejections (CME) is ambiguous. A strong decrease in Δf0F2 and ΔMOF on May 20-22 (blue) is observed when there is a high HSS speed (about 700 km/s), while a strong decrease in Δf0F2 and ΔMOF on May 28-30 is observed at a moderate HSS speed, about 300 km/s . Comparison with the CME' registration time suggests that an increase by several MHz in the instantaneous values of Δf0F2 or ΔMOF may be associated with the aftereffect of several non-loop type CMEs that occurred on May 23.



The strong decrease in ΔMOF observed on Sept 8 is a reaction to the arrival of CMEs associated with powerful X flare propagating from the Sun on Sept 6 (Halo) and/or Sept 7 (red segments), and HSS with a high speed - up to 800 km/s. The most interesting time interval is Sept 12–30, when there was no registration of flare activity in X-rays. At the same time, on all paths and in instantaneous vertical sounding, there is a strong decrease by several MHz in the values of ΔMOF and Δf0F2 during the passage of the HSS at a speed of about 700 km/s. CMEs ejected from the Sun on Sept 10 or Sept 12 also contributed to the decrease in ΔMOF and Δf0F2 on Sept 16. A sharp decrease in ΔMOF and Δf0F2 on all paths on Sept 28, 29 is also associated with CMEs and HSS.

The results of studies of the influence of coronal mass ejections (CME) and high-speed solar wind streams (HSS) on the characteristics of the ionosphere showed that CME and HSS have approximately the same effect on the parameters characterizing the state of the ionosphere.

Thank you for attention!