Scientific & Educational Centre NEVOD

Analysis of the dynamics of the time series of muon hodoscope URAGAN muonographs during geoeffective coronal mass ejections

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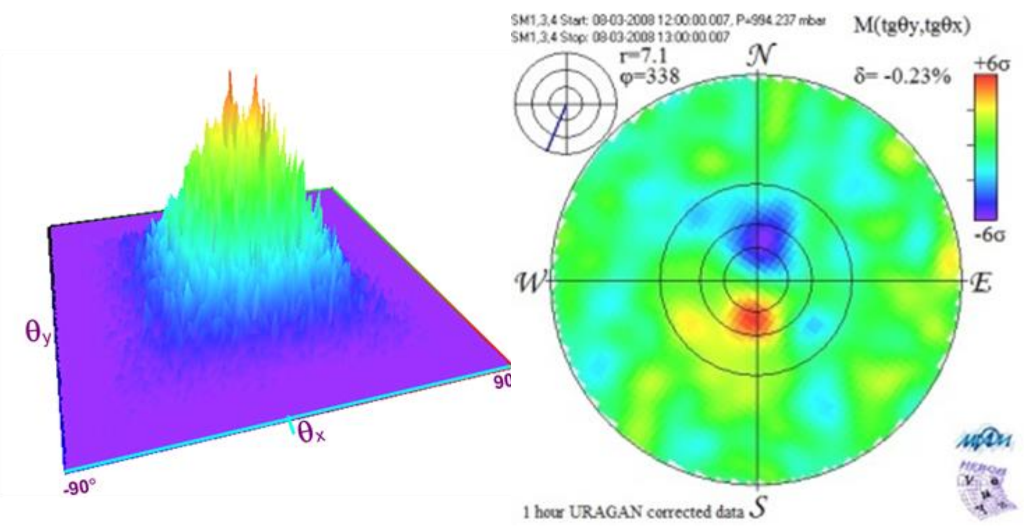
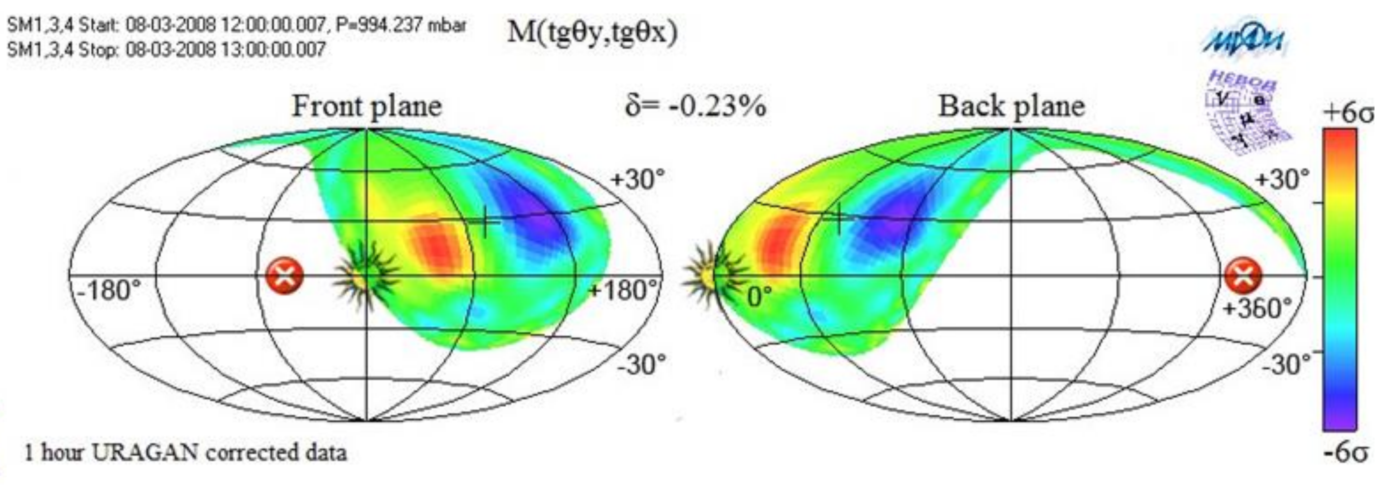
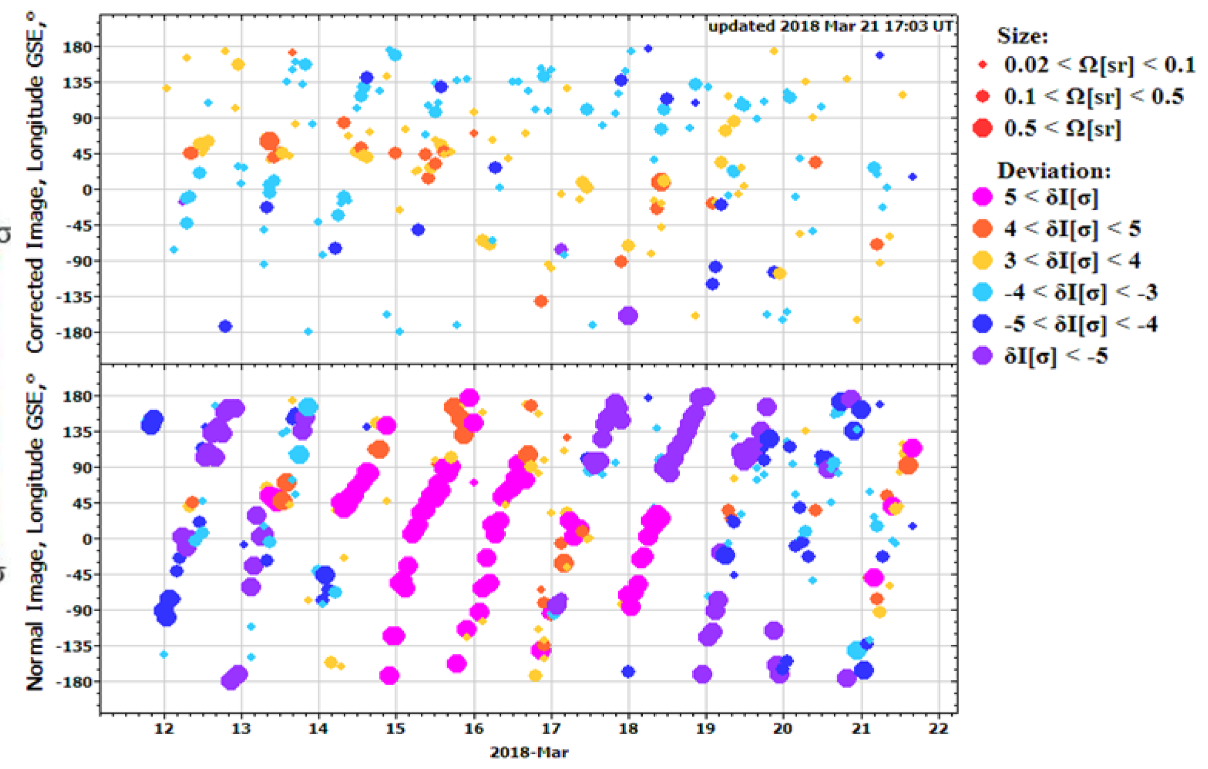
MUON HODOSCOPE URAGAN

Muon hodoscope (MH) URAGAN is a large-aperture coordinate-tracking detector capable to detect muons in a wide range of zenith angles (0°-80°). It is used to study characteristics of the muon flux spatial-angular variations . Hodoscope consists of four supermodules (SMs) with a total area of ~ 46 m^2 and has high spatial (~ 1 cm) and angular (~ 1°) accuracies. SM consists of eight layers of streamer tubes equipped with a two-coordinate system of external readout strips. Each registered muon with reconstructed arrival direction is recorded in a two-dimensional angular matrix which represents an image of the upper hemisphere in the flux of muons with an exposition of 1 minute.

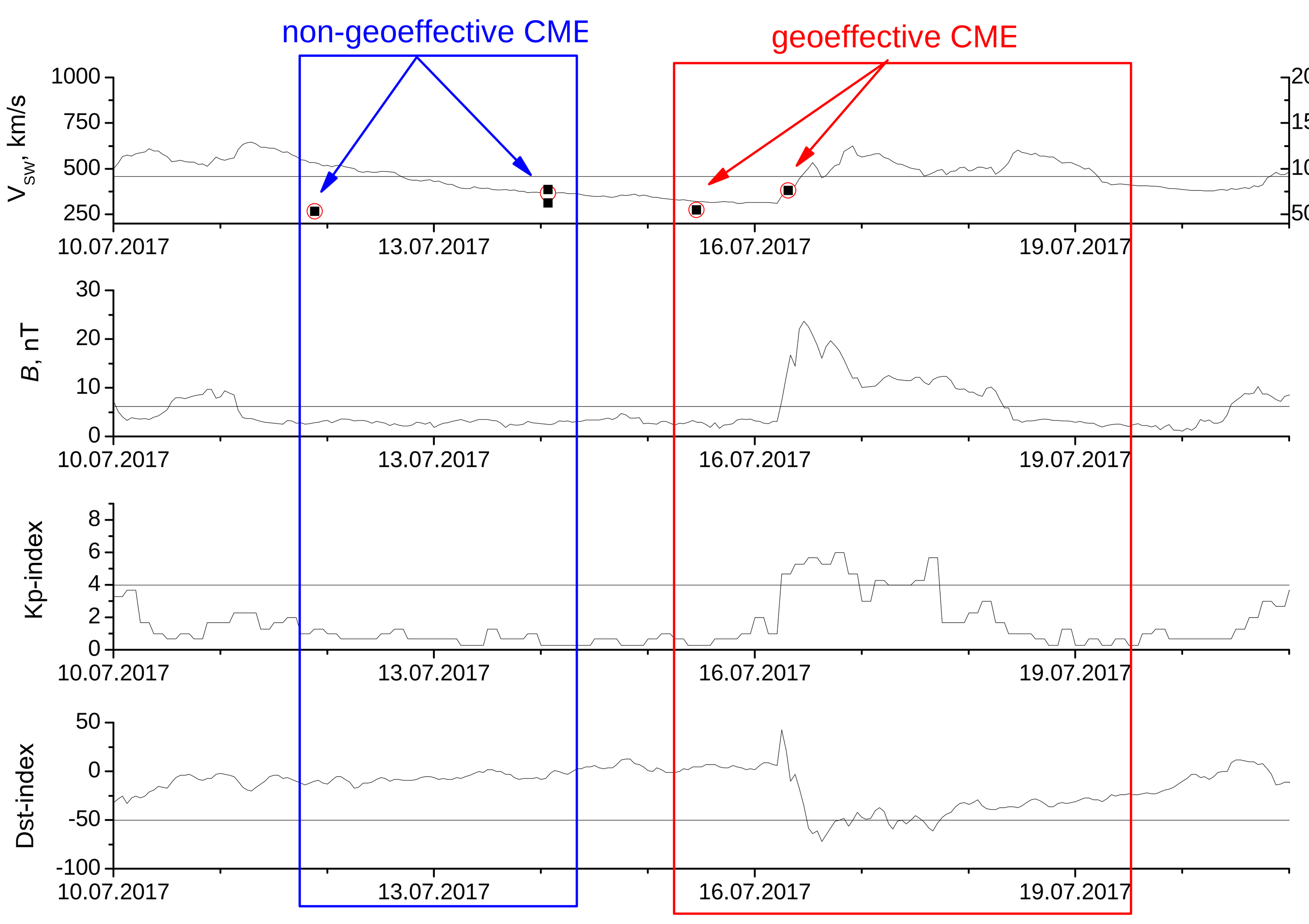


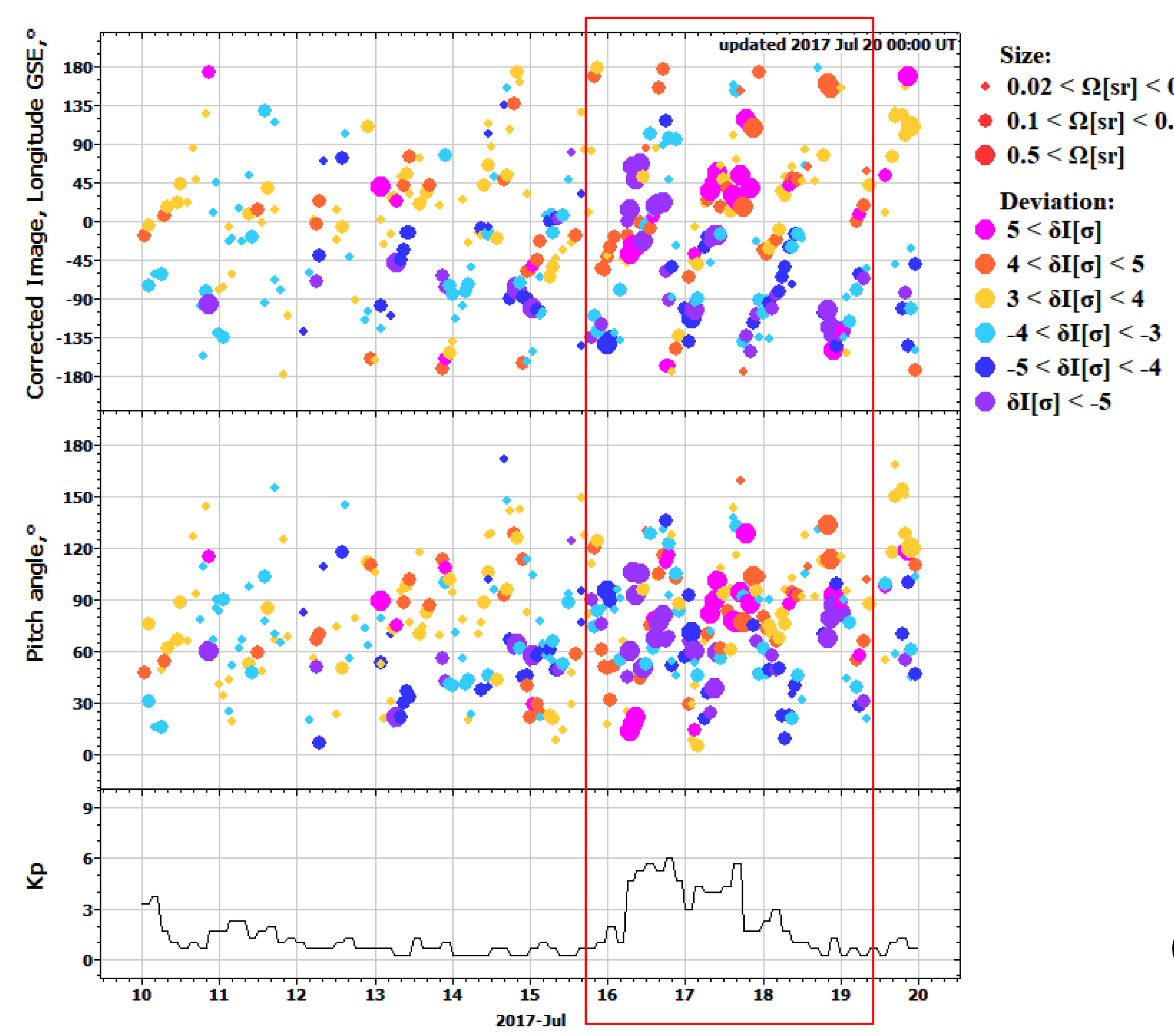


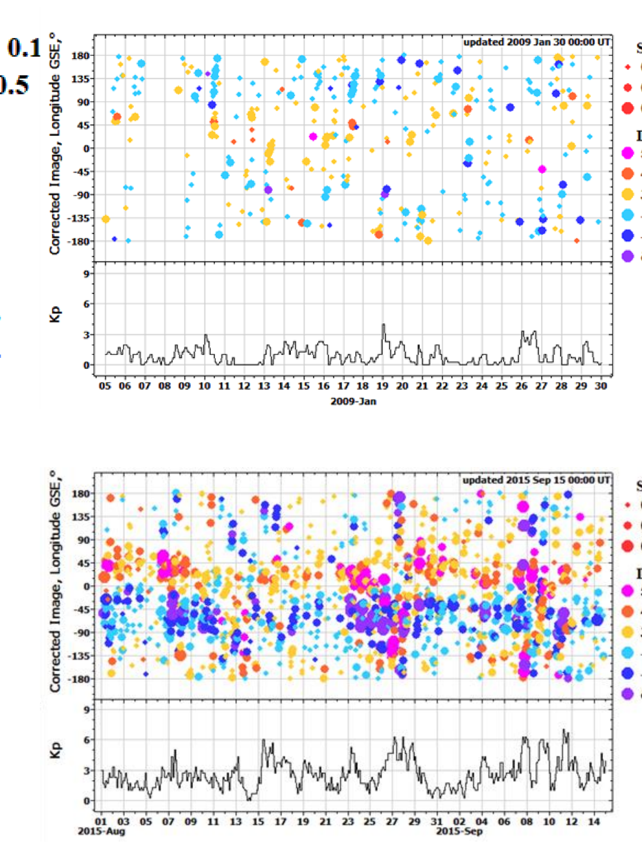


ANALYSIS OF CORONAL MASS EJECTIONS

Geoeffective events are the events which have a direct impact on the radiation, geomagnetic and electromagnetic environment in the near-Earth space.

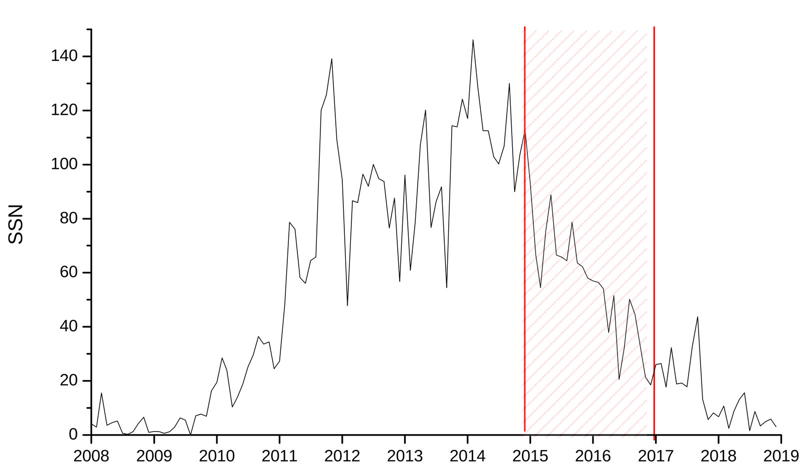






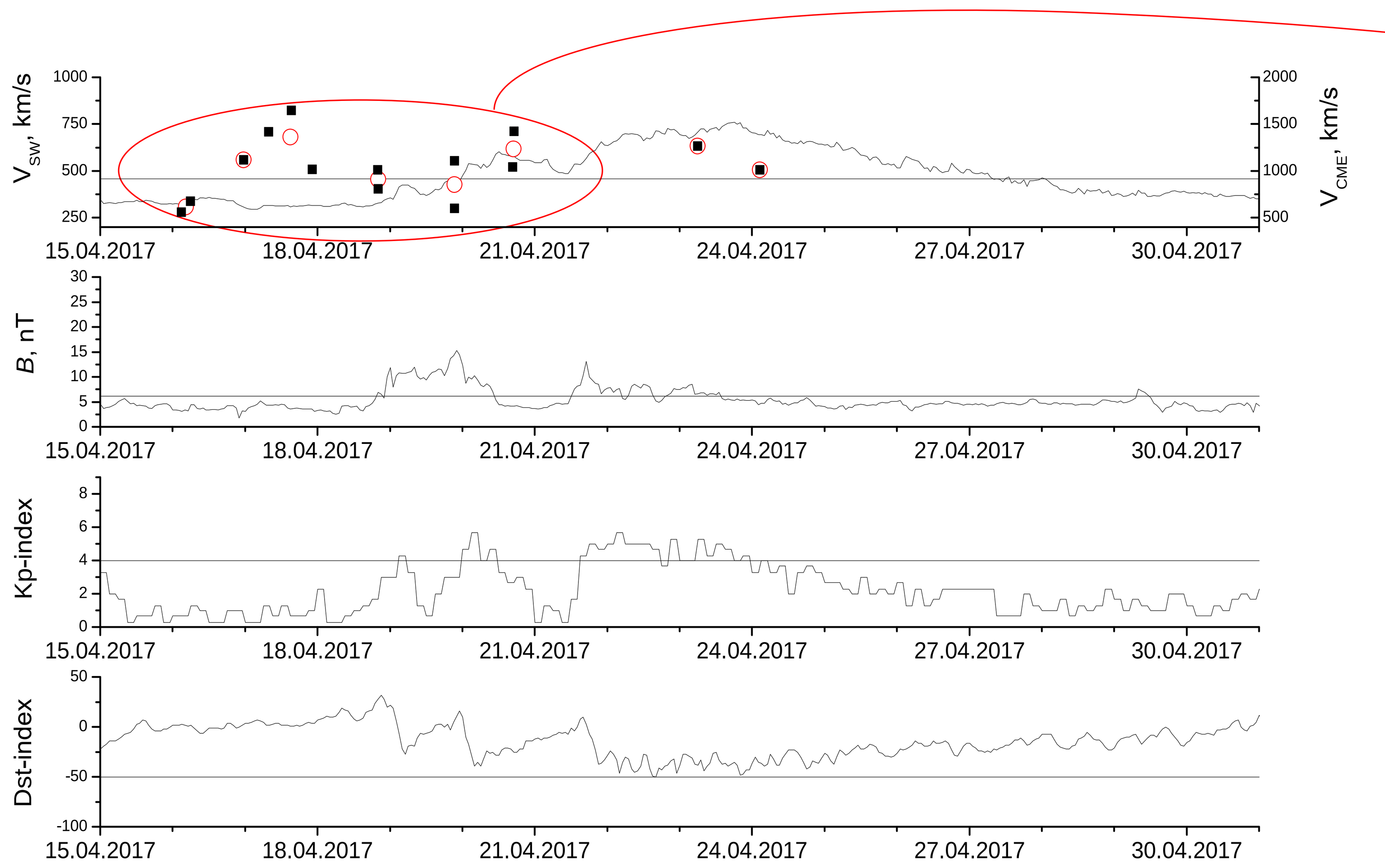
GSE-maps in the periods of minimum (January, 2009) and maximum (August-September, 2015) of solar activity

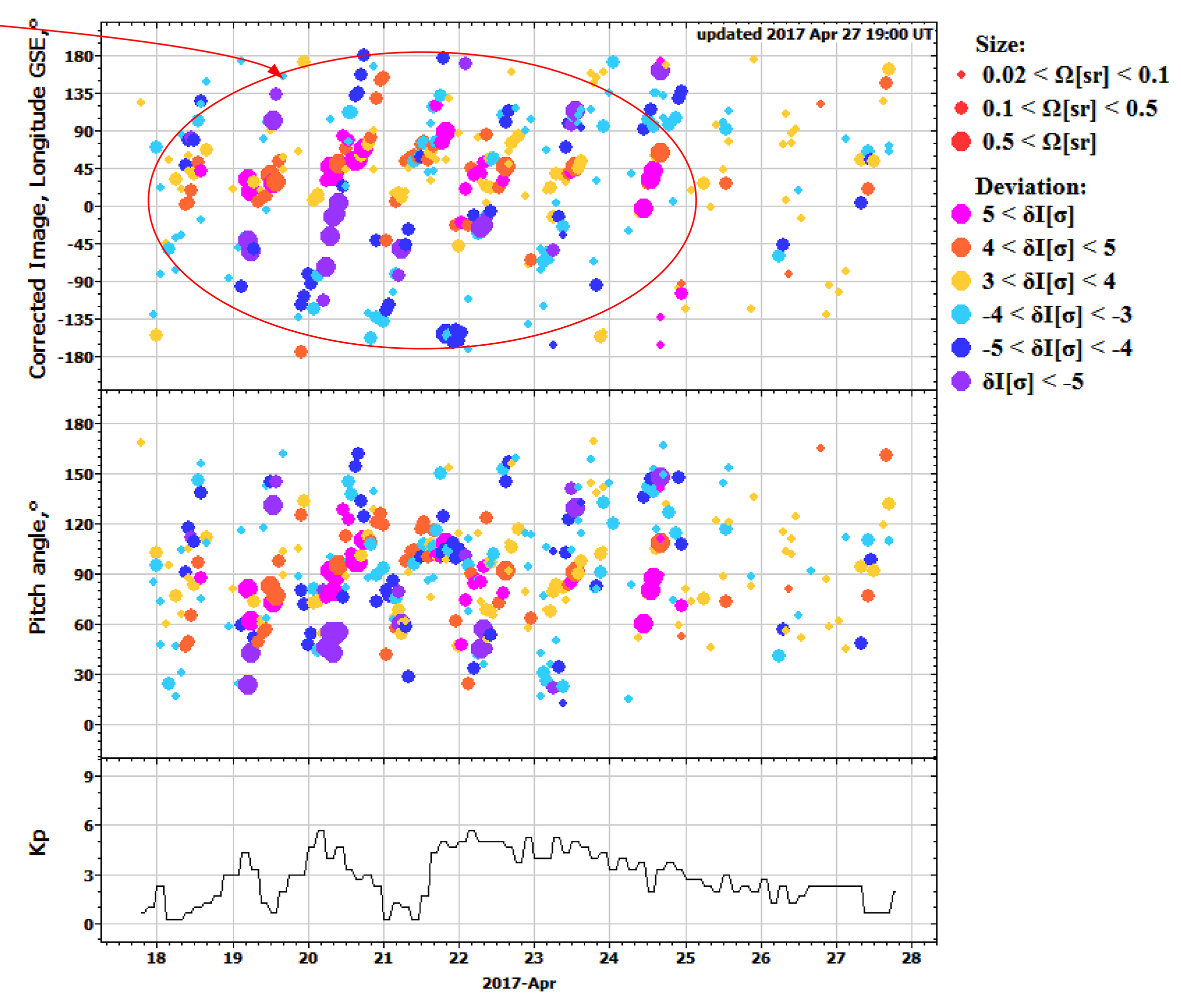
In 2016-2018, 100 geoeffective coronal mass ejections were observed



	CME	Geoeffective
2016	102	59
2017	55	36
2018	8	5

In April 2017, a series of CMEs produced small disturbances in the magnetosphere of the Earth (Kp=5)





- The CR flux density increase (compared to the mean value) by 4σ occurs at longitudes from 0° to 45° in 88% ± 2% of cases, at longitudes from 45° to 90° in 55% ± 3%, at longitudes from 90° to 135° in 19% ± 2%, at longitudes from - 45° to - 90° in 34% ± 3%, at longitudes from - 90° to - 135° in 17% ± 2%.
- Increase of the flux density by 5σ occurs at longitudes from 0° to 90° in 88% ± 2% of cases, at longitudes from 90° to 135° in 55% ± 3%.
- Decrease of the flux density by 4σ occurs at all longitude values except 0° - 45°, at these longitudes it is observed only in 7% ± 1% of cases.
- Decrease of the flux density by 5σ practically does not occur at longitudes from 0° to 90°, it occurs at longitudes from 90° to 135° in 55% ± 3% of cases, at longitudes from 135° to 180° in 89% ± 2% of cases, at longitudes from - 45° to - 90° in 54% ± 3%, at longitudes from - 90° to - 180° in 93% ± 2%.

[https://omniweb.gsfc.nasa.gov]
[http://www.sidc.be/cactus]

CONCLUSION

For the considered geoeffective events, an increase of the cosmic ray flux intensity by 5σ is observed at longitudes 0° - 135° within the interval of 3-5 days after the emission. Also, the most frequent increase of the cosmic ray flux intensity by 3σ - 4σ occurs at the same longitudes. The decrease of the cosmic ray flux intensity by -5σ occurs at longitudes from 0° to -180° and at longitudes from 135° to 180°.

During the periods of low solar activity, the response to geoeffective events is most obvious, the density of deformation areas increases in a short period of time (2 days). The increases and decreases of the cosmic ray flux are divided by longitude.

The work was performed in the Scientific and Educational Center NEVOD (National Research Nuclear University MEPhI) with the support of the Russian Science Foundation (grant no. 17-17-01215).