Multi-instrumental investigation of extreme space weather events in September 2017: Data and modeling

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Strong Solar activity during September 2017, despite being in the declining phase of cycle 24, produced several solar flares, accompanied by a series of coronal mass ejections that led to complex and geoeffective plasma structures in the heliosphere (Luhmann et al., 2020). These events, involving interactions between plasma structures (Albert et al., 2020), as well as their influence on Earth's environment are very difficult to forecast.

A number of studies used different approaches to analyze influence of Solar activity on particular phenomena either in heliosphere (Kozev et al., 2022, Savić et al., 2023) or ionosphere responses (Kolarski et al., 2022, Srećković at al., 2021). Recently, several investigations based on multi-instrumental measurements and numerical simulations show more comprehensive insight into the ionospheric responses and change of primary cosmic rays' flux due to the extreme Solar activity (Kolarski et al., 2023, Barta et al., 2022).

The focus of this research is to investigate the phenomena induced by the extreme event in near-Earth space and Earth's atmosphere during September 2017, with an emphasis on studying and modeling the variations in cosmic ray flux and disturbances in the lower ionosphere in correlation with Solar activity. The investigation is based on ground-based measurements such as from neutron monitors, very low-frequency (VLF) radio wave stations, and cosmic ray detectors, as well as in situ measurements from different space probes.

The results of this study show that the ionospheric atomic and molecular data like sharpness and effective reflection height and electron density obtained from Belgrade VLF data measurements, are in correlation with incident X-ray flux while time series of cosmic rays' flux measured at Belgrade muon station correspond to disturbance of near-Earth heliospheric conditions.

The multi-instrumental approach accompanied with numerical modeling of specific space weather events additionally contribute to better understanding of solar-terrestrial coupling processes.

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