Ionospheric anomalies during magnetic storms in 2015-2017: features, intensity and dynamics

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The strong irregular changes are observed in the ionosphere during solar events and magnetic storms and lead to the formation of irregularities and occurrence of positive and negative ionospheric storms [1, 2]. Ionospheric irregularities have a complex space-time distribution and a random nature, many aspects of which have not been sufficiently studied [ex. 1]. The problem of prediction and timely detection of irregularities that have a negative impact on modern technical systems is also a very relevant [1, 2]. In spite of the intensive development of data analysis methods and information technologies, an effective solution of this problem has not been currently found [ex. 2].

In this paper, the ionospheric parameter variations were studied during strong and moderate magnetic storms from 2015 to 2017. The ionospheric data of Paratunka (Russia, Kamchatka), Wakkanai (Japan) and Norfolk (Australia) were analyzed (http://spidr.ionosonde.net/spidr and http://wdc.nict.go.jp). The research is based on the application of new methods for modeling and analysis of ionospheric data, described in the paper [3]. As distinct from the traditional approaches and techniques [4, 5] (median methods, IRI model), these methods allow us to more efficient detect anomalous changes in the ionospheric parameters and estimate their characteristics.

In the course of the investigation, ionospheric disturbances occurring on the eve and during magnetic storms were detected in the analyzed areas (fig. 1). Their features, dynamics and intensity were studied. The study results showed high probability of the occurrence of long-term (from 10-15 hours to one and a half day) increases in the ionospheric parameters (positive ionospheric storms) on the eve of magnetic storms, which agrees with the numerous observations described in the paper [1]. The comparison of the obtained results with the space weather data indicates solar nature of detected anomalous changes in the ionosphere. In this case, these effects can be used as precursors of magnetic storms (as an additional factor), which determines their applied significance. During the main phase of magnetic storms, the ionospheric process dynamics significantly changes and a long-time decrease (from 12 hours to several days) in the electron concentration (negative ionospheric storms) are observed.

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