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Pre-storm electron density enhancements at middle latitudes

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Geomagnetic storm-induced ionospheric disturbances have been studied for several decades. Nevertheless, some features of these ionospheric disturbances are still not clear and hardly predictable. Substantial increases of foF2 a day or so before the storm onset belong to less known among them. Here we study such increases of electron density for 65 strong geomagnetic storms of the current solar cycle, as they were observed above middle latitudes. 15 out of 65 events were accompanied by significant ($>$20%) increases of foF2 before the storm onset over European area. We discuss occurrence, latitudinal and longitudinal extent and dependence, as well as height profile and possible origin of such enhancements. All observed pre-storm changes of foF2 exhibited positive deviation from the median mostly in the range of 25% to 40 %. Seasonally, the pre-storm enhancement occurrence peaks in summer and is minimum in winter. The enhancements tend to occur more often at decay branch of solar cycle. Potential sources/mechanisms of the phenomenon will be briefly discussed.