Extreme Ionospheric Response to a Minor Magnetic Storm in Deep Solar Minimum Revealed by Data Assimilation Results of FORMOSAT-7/COSMIC-2 and GNSS Total Electron Content

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Global ionosphere specification (GIS) analysis results, wherein radio occultation total electron content (TEC) measurements of recently launched FORMOSAT-7/COSMIC-2 (F7/C2) constellation and ground-based global navigation satellite system TEC are assimilated, are used to examine ionospheric responses to a minor magnetic storm on 5 August 2019. The GIS gives three-dimensional global electron density specification at the top of every hour, assimilating these TEC data hourly by the Gauss-Markov Kalman filter with the initial state specified by the international reference ionosphere model. The assimilation analysis results reveal more than 300% electron density enhancements within the equatorial ionization anomaly crest, mostly appearing in the 200–300 km altitude range. Localized density enhancements are also seen to develop over the European longitude sector. The GIS outputs generated with the new low-latitude measurements by F7/C2 satellites show unexpected extreme ionosphere variations in response to a minor magnetic storm during deep solar minimum conditions when the background electron density is very low. During solar active periods, it normally requires larger geomagnetic storms to elevate the ionospheric electron density by more than 200%. The vertical ionospheric structures given by the GIS indicate the role of an enhanced fountain effect and storm-induced equatorward circulations in producing the observed positive storm responses.

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