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Evaluation of the mid-latitude ionospheric trough using high-resolution IGS ionospheric maps

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The ionospheric mid-latitude trough is a phenomenon which is characterized through an electron density depletion in the F-layer of the ionosphere at the sub-auroral zone. In this study, we identify and derive the mid-latitude ionospheric trough properties using high-resolution Global Ionospheric Maps (GIMs) from International GNSS Service (IGS), namely UQRG maps, which have a high temporal resolution of 15 minutes. Our study is based on an extensive database, which we obtained by detecting troughs between 1998 and 2022, including two complete solar cycles (23 and 24). We have analyzed essential factors that define the MIT, like the trough minimum position, width, depth, and occurrence probability. All these MIT parameters represent morphological characteristics of the midlatitude trough in dependence on the magnetic local time, geographic distribution, seasons, and solar and geomagnetic activity conditions, including solar wind plasma speed, interplanetary magnetic field components, and geomagnetic activity indices SYM-H and Hp30.

Since the MIT climatology and occurrence probability have not yet been included in widely used 3D electron density models like IRI, NeQuick, NEDM2020, etc., the discovered dependencies can be used to validate current MIT models and to develop new MIT models. The performance of the 3D electron density models might be enhanced by including an MIT model.