Modeling low-latitude ionospheric variations

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Equatorial ionospheric anomaly (EIA) which originates from low-latitude region often expands as far as the southern part of Japan, where the F-region electron density is influenced by the EIA expansion in the daytime. In terms of space weather, the steep latitudinal gradient of electron density in EIA causes degrading of GPS positioning accuracy. Moreover, evening enhancement of vertical drift of low-latitude ionosphere is known as the leading factor of generating mechanism for plasma bubbles, which cause scintillations and degrade the quality of earth-to-satellite radio propagation. These low-latitude ionospheric phenomena vary day-to-day basis. Some observations have shown signatures of atmospheric wave effects on the ionospheric variations.

In order to investigate the day-to-day variations of low-latitude ionosphere, and to assist their prediction, we are developing an ionospheric numerical model that incorporates electrodynamics process, which is important since the atmospheric winds generate electric fields in the ionosphere through dynamo process.

Our preliminary results reproduce detail structures around the sunset, including a vortex-like structure of plasma drift with a strong vertical shear of zonal velocity, which are similar to some observations. Our results also show that tidal winds below the E-layer altitude directly affect F-layer electric field pattern which controls the EIA variations in the noon time, while almost do not affect the strength of evening enhancement. The latter is not consistent with some recent observations, although other numerical simulations have obtained similar results.