A three-dimensional numerical model to study the modulation of midlatitude E_s-layers

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We develop a three-dimensional numerical model to shed light on the generation, growth and diffusion mechanisms of the sporadic E layers in the midlatitude.

The Es layer is a high-density layer of plasma formed at around 100 kilometers high. It is affected by both the atmospheric waves generated in the troposphere and mesosphere, and the electromagnetic interaction between the E region and the F region, so that it is a very important phenomena to understand the physics of the upper atmosphere.

The mechanism of Es layer formation is described through the Windshear Theory. According to the theory, factors affecting the Es layer formation are zonal windshears and meridional windshears. Which one can make more effects depends on the altitude of Es layer.

Lately, there has been some new structures of the Es layer detected by several observations (e.g. Lidar observation). They cannot be explained only by Windshear Theory. It is considered that there are three factors of the structures: atmospheric waves, Kelvin-Helmholtz instability and Es layer instability. Several models have been developed to study each factor, but no model includes all three factors. Such a model is necessary to give a consistent explanation for which factor is the most effective for modulation of the Es layers.

Our model includes six kinds of ions of O^+, O_2^+, N^+, N_2^+, NO^+, Ca^+, and in both the transport process and the chemical process of ions in the uniform geomagnetic field solve. In addition, NRLMSISE-00 is used as a background field of neutral atmospheric density. This model uses three-dimensional polar coordinate system. Altitude coverage is from 85 km to 305 km and horizontal domain size is 5 degree ×5 degree in the longitude and latitude direction. The vertical and horizontal resolutions are 1 km and 0.1 degrees, respectively and the time resolution is 1 second.
By inputting latitude, longitude and UT into this model, it is possible to simulate ionosphere in midlatitude within the above calculation area.

In this presentation, as a pseudo-zonal and meridional neutral windshear, we employed a sinusoidal windsear in the vertical direction and reevaluated which component of the neutral windshear will affect more to form Es layers.
As a result, we obtained results consistent with the previous study that the influence of the zonal windshear is large at the low altitude and the influence of the meridional windshear is large at the high altitude.
Moreover, by incorporating the neutral winds of GSWM model and HWM14 model into ours, we examined the mechanism of generation of Es layer in the more real condition.

Based on these, we will introduce the future view in the presentation.

Keywords: sporadic E layer, midlatitude, simulation, ionosphere

