Three-dimensional ionospheric simulation of the Es layer: Physical mechanism of the sporadic appearance

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Physical mechanism of sporadic appearance of the mid-latitude sporadic E layer (Es layer) was studied by using a three-dimensional high precision numerical model. Es layer is a thin layer of metallic ion plasma appearing in the ionospheric E region. When the layer is observed from a point, it shows sporadic appearances. While it is widely accepted that the vertical wind-shear of the diurnal/semi-diurnal tide is responsible for the generation of the Es layer, the sporadic appearance of the Es layer cannot be explained by this tide-windshear theory. Recently, the self-consistent atmosphere-ionosphere model GAIA (Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy) has reproduced three-dimensional neutral wind fields containing both tidal and gravity waves. Consequently, it has become that the effect of tidal and gravity waves on structures of Es layer can be investigated at the same time.

We have developed a three-dimensional ionospheric numerical model. Three-dimensional neutral winds of the GAIA were used as an input in every 10 minutes for given day. The ionospheric model successfully reproduced the day-to-day variability of the Es layers that was observed by a Ca-ion lidar. Structures of Es layer reproduced in the neutral winds containing both tidal and gravity waves were circular or belt-like, and their scales were about 100-1000 km. As a result, we found that the structure of the Es layer was horizontally transported by the neutral wind, causing sporadic appearance of the Es layer.

Keywords: sporadic E layer, numerical simulation, ionosphere

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