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Tidal effect of the neutral atmosphere in the lower thermosphere on the movement of sporadic E at midlatitude

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Introduction

Sporadic *E* is a highly ionized plasma patch unpredictably appears at an altitude of ˜100 km in the *E*-region of the ionosphere. At midlatitudes, occurrences maximize in local summer (Whitehead, 1989 and references there in), and in the Far East region including Japan (Wu et al., 2005; Arras et al., 2008). Ground-based radar observations and rocket experiments have been the two primary methods of sporadic *E* observations. Since their spatial and temporal resolutions are restricted, two-dimensional (2-D) and/or continuous observations of sporadic *E* plasma patches and their movements have been difficult. Maeda and Heki [2014] have performed 2-D observations of midlatitude sporadic *E* by using dual-frequency Global Navigation Satellite System (GNSS) satellites and a dense array of GNSS receivers in Japan (GEONET) composed of ˜1200 GNSS staions. Sporadic *E* can be observed as positive total electron content (TEC) anomaly in the GNSS-TEC observations. Mapping these anomalies revealed 2-D horizontal structure of sporadic *E* plasma patches and time sequences of TEC maps showed temporal evolution of the plasma structure, including their movements.

Analyses

In the present study, we use GNSS-TEC observations with GEONET receivers. We focus on the movement of sporadic *E* patches. Typically sporadic *E* plasma patches form frontal structure that elongates 50-500 km in the east-west (E-W) direction [Maeda and Heki, 2014]. Since the movements in the E-W direction cannot be distinguished from the development of elongation, here we only study movements in the N-S directions. 5 min TEC maps are generated to study temporal evolution of plasma patches. Direction and speed of movements are manually read by 20-30 min interval. In total, 27 cases of sporadic *E* movements over Kanto region are analyzed.

Results and Discussion

We counted the number of northward and southward movements, respectively, and plotted in the local time (LT) order. The histogram shows LT dependence of N-S movements, i.e., northward and southward movements concentrates in the 10-12 LT and 18 LT, respectively. In between the two peaks, there is a silent period, i.e., the minimum of the number of movements at 15 LT. These results are consistent with those reported by Tanaka [1979] who conducted backscatter radar observations in Kanto region (the same study area as ours). Tanaka [1979] showed that the westward movement peaks around 15 LT. Since we ignored the E-W movements, the silent period in the N-S movements can be interpreted as the results of rotation of movement directions of plasma patches possibly governed by atmospheric tide. Thus, GNSS-TEC observations of sporadic *E* plasma patches may be useful to infer the dynamics of the neutral atmosphere in the lower thermosphere.

Keywords: sporadic-E, GPS, TEC, atmospheric tide