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Increase of electron densities in the nighttime D-region ionosphere during magnetic storms estimated from tweek atmospherics

Hiroyo Ohya[1]; Kazuo Shiokawa[2]; Yasuhiro Murayama[3]; Yoshizumi Miyoshi[4]; Masanori Nishino[5]

[1] Electronics and Mechanical Eng.,Chiba Univ; [2] STELAB, Nagoya Univ.; [3] NICT; [4] STEL, Nagoya Univ.; [5] STE Lab. Nagoya Univ

We have estimated reflection heights of tweek atmospherics in the D-region ionosphere during three magnetic storms. We found that nighttime tweek reflection heights became lower during the storm main phase than those before the storm and in the storm recovery phase This means that nighttime electron densities in the D-region ionosphere increased in a wide range of low-mid latitudes during the main phase.

The objective of this study is to know main causes of descent of tweek reflection- heights during the main phase. Several possibilities of the descent are considered, i.e., ExB drift by westward electric field and enhancements of D-region electron density due to energetic particle precipitation from the magnetospheric radiation belt and plasma sheet and due to an increase of cosmic ray flux.

To estimate cut-off frequency of the first-order mode tweeks, horizontal propagation distance, and propagation time, we have fitted theoretical model-curves to dynamic spectra of tweeks. The tweek reflection height and electron density at the reflection height are calculated from the cut-off frequency.

We have used routine-based data of nighttime tweeks during two minutes each hour observed at Moshiri and Kagoshima, Japan. We cannot estimate these parameters for daytime tweeks, because attenuation in tweek propagation is larger in daytime than that in nighttime.

We estimated variations of the tweek reflection-heights for three magnetic storms. The peak Dst-indices of these storms were larger less than -200 nT. In the main phases of the all storms, the tweek reflection heights descended to 80 km transiently comparing the average tweek reflection-height of ~88 km before and after the main phase. The cause of the descent may be different between each storm. In this paper we discuss the variations during the storm of October 2-12, 2000.

For the storm of October 2-12, 2000, the mean tweek reflection heights descended transiently at 1550-1650 UT on October 2 and at 1250 UT on October 3 at the both stations. The timing of the reflection-height descent might be related to their relevant substorms, which were identified by ground magnetic field data in high latitudes.

While the tweek height became very low at 1550-1650 UT on October 2, the MF radars at Wakkanai near Moshiri and at Yamagawa near Kagoshima observed enhancements of electron density at 1500-1600 UT. At 1600-1700 UT on October 2, the h'F values obtained from the ionograms at Kokubunji, Japan, and Anyang, China, were lower than those from monthly mean quiet value. At 1300 UT on October 3, however, they were higher than the quiet value. This may indicate that westward and eastward electric fields dominated at 1600-1700 UT on October 2 and at 1300UT on October 3, respectively.

For the descent of the reflection height on October 2, we have an idea that the westward electric fields might push down entirely the ionosphere by ExB drift. From the h'F variations, we also predict that westward electric field might impose during more than two hours.

The descent of tweek reflection-height on October 3 may be related with a Large Scale Traveling Ionosphere Disturbance (LSTID), which was detected by a GPS network over Japan. At 1300 UT on October 3, when the tweek reflection heights descended, a LSTID propagated equatorward and then was situated at southwestern part of Japan.

On the other hand, we consider a possibility of ionization by energetic particle precipitation in the nighttime low-mid latitude D-region associated with the storm-time substorms. At night, ionization production rate below 100 km height by energetic particle precipitation is estimated to be 10^(-2)-10 cm^(-3)*s^(-1). In the presentation, we will discuss a possibility of the energetic particle precipitation as the cause of the reflection-height descent.