# Response of the low-middle latitude D-region ionosphere to magnetic storms by tweek atmospheric observations

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A lot of previous studies have revealed that the storm-time lower ionosphere changes in complicated physical and chemical process. Because of the complexity, however, the response of the D-region ionosphere to magnetic storms is still far beyond being fully understood, in spite that the lower ionospheric research is the oldest field in aeronomy. We have proposed a new method to estimate nighttime electron density variations at the bottom of the ionosphere by tweek atmospherics. This study aims to examine the response of the D-region ionosphere to major magnetic storms by the tweek method.

Tweeks are pulse signals that ELF/VLF electromagnetic waves originated from lightning discharges show the cut-off frequency characteristics due to long-distance propagation by the Earth-ionosphere wave-guide mode. We developed a method estimating tweek reflection heights (equivalent electron densities) in the low-middle latitude D-region ionosphere by an accurate measurement of their first-order mode cut-off frequency. Tweek reflection heights (equivalent electron densities) show average values integrated along the propagation paths. This method is available only for nighttime data, because the frequency-time dispersion of tweeks cannot be found in daytime data. Namely, the tweek method is suited for a monitor of nighttime D-region electron density variations in wide area at low-mid latitudes, in particular, over oceans, as an inexpensive instrument.

Tweeks are routinely observed at Moshiri (44.37 N, 142.27 E in geographic coordinates) and Kagoshima (31.48 N, 130.72 E). In this study, we present response in reflection height of the D-region ionosphere to the major magnetic storm in October 2000 by tweek observations; transient lowering/rising in the small bay Dst-variation and rising near the maximum depression of the major bay Dst-variation. In the main phase of the small-bay, tweek reflection heights significantly fell down twice to about 80 km height, although it is usually about 89 km heights.

We compared the response in the equivalent electron densities (tweek reflection heights) with intensities of the 40 kHz radio-wave signals, electron density profiles by the IRI-2001 model and measured by the MF radars, and the ionospheric F-region parameter (h'F) by the ionosonde. We have found that the equivalent electron densities were almost underestimated comparing with IRI-2001 profiles and measurements by MF radar. We have also found two cases that the lowering/rising of the D-region is coupled and not coupled with the vertical motion of the F-region. By discussions using simultaneous TEC (Total Electron Content) perturbation data we suggest possible mechanisms for the two cases; ExB vertical plasma drift due to ionospheric electric fields and the LSTIDs (Large Scale Traveling Ionospheric Disturbances) propagating from auroral to low-latitude ionosphere, respectively.

It is mentioned for the ionospheric electric fields that electrodynamics of the low latitude ionosphere is strongly affected by zonal electric fields: There are two kinds of large-scale disturbed electric fields in the equatorial region and low latitude ionosphere. First, disturbed electric fields at high latitudes promptly penetrate to equatorial region and low latitudes. Second, electric field perturbations are associated with ionospheric disturbance dynamo effects. There have been few studies of the electric field effect and wave-like disturbance effect on the D-region in storm-time. In this presentation, we will discuss these mechanisms.