Solar cycle variations of tweek reflection height in the D- and lower E-region ionosphere

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The purpose of this study is to reveal solar cycle variations of tweek reflection height during Solar Cycle 21-23. Tweek atmospherics are reflected typically at a height where the equivalent electron densities are ˜20 - 30 cm^{-3}. Descent (rise) of the reflection height corresponds to increase (decrease) in electron density in the D- and lower E-region ionosphere. It is well known that electron density in these sub-ionosphere depends on solar activities, although the detailed investigation for nighttime lower ionosphere has not been sufficiently performed yet. An advantage of using tweeks is to be able to monitor variations of electron density less than 10^2 cm^{-3} along long propagation paths (several thousands of kilometers). From cut-off frequency of the first order mode on dynamic spectrum, we can estimate the reflection height. We analyzed 98463 tweeks obtained at Kagoshima (31.5N, 130.7E), Japan, on magnetically quiet days during Solar Cycle 21-23 from April 1976 to December 2009 by using an automatic procedure that we developed. In the entire trend, the tweek reflection height was high (low) at solar maximum (minimum). This means that the nighttime electron density in the D- and low E-region ionosphere increases (decreases) at solar minimum (maximum). This negative correlation between the bottomside ionospheric density and the solar activity is opposite to those reported by Wakai [1971, using ionosonde specially designed with a frequency range extending down below 1 MHz] and Kurschner and Jacobi [2002, using LF radio waves from transmitter], but is consistent with those obtained by the high-latitude rocket measurements by Friedrich and Torkar [1995]. The main causes of the reflection height (the electron density) variations at night associated with solar activities are considered as follows: 1. the precipitation of energetic particles from the radiation belts into the low latitudes, 2. changes of geocorona emission or cosmic rays, and 3. changes of neutral atmosphere. In the presentation, we discuss the possible causes of these variations of tweek reflection height.