太陽活動極大期の地磁気静穏時における極域電子密度高度分布の太陽天頂角依存性

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Solar zenith angle dependence of the electron density profile in the polar region during geomagnetically quiet periods

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We have developed empirical models of the solar zenith angle (SZA) dependence of the electron density profile in the polar region. The electron density data used in the present study are obtained from 63 months of plasma wave observations by the Akebono satellite in an altitude range of 500-10,500 km during geomagnetically quiet periods in the solar maximum (monthly-averaged $F_{10.7}$ larger than 170). Electron density profiles at low altitudes are well fitted by exponential functions, while those at higher altitudes are well described by power law functions. A transition of the density profile is identified in an altitude range of 1700-4500 km.

The largest variation in the electron density with SZA is identified at 2200 km altitude, where the electron density varies by a factor of 101 from $1.16*10^4$ cm^{-3} at an SZA of 50 deg to $1.15*10^2$ cm^{-3} at an SZA of 130 deg in the polar cap. Above 5500 km altitude, the variation of the electron density is within a factor of 30. The electron density, scale height and transition height decrease drastically with increasing SZA in an SZA range of 90-120 deg. The scale height and transition height at an SZA of 120 deg (223 and 1800 km) are less than half of that at an SZA of 90 deg (623 and 4400 km).

Furthermore, in order to compare the change in the ionospheric plasma temperatures with that in the scale height at low altitudes of the empirical models, we have investigated the SZA dependence of the electron and ion temperatures in the ionosphere using 19 months of data derived from EISCAT Svalbard Radar, located at an invariant latitude of 75.2 deg, in an altitude range of 300-900 km during geomagnetically quiet periods in the solar maximum. The ion temperature above about 600 km altitude and the electron temperature in the altitude range of 300-900 km decrease most drastically with increasing SZA in an SZA range of 90-110 deg, which is near the terminator in the ionosphere. The drastic decrease in the ionospheric temperatures strongly suggests the dominant role of heating and photo-ionization processes by solar radiation in determining the electron density up to about 2000 km in the polar cap during geomagnetically quiet periods. Above about 2000 km altitude, the ionospheric control of the electron density gradually diminishes with increasing altitude. We expect that the statistical SZA dependence models of the electron density in the polar cap and auroral zone derived in the present study will make an important contribution to the investigations of the polar wind, ion outflow, and auroral acceleration.