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Solar zenith angle and solar activity dependences of electron number density distribution in the nightside auroral region

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Solar zenith angle and solar activity dependences of electron number density distribution in the nightside auroral region from the topside ionosphere to the magnetosphere within a geocentric radial distance of 2.6 RE were statistically investigated based on 7-years plasma wave data obtained by the Akebono (EXOS-D) satellite. Electron number density Ne is derived from the upper limit frequency of whistler-mode auroral hiss, which is almost equal to plasma frequency fpe in the polar region. In order to focus on the nightside auroral region, the datasets obtained in a sector from 2100 to 0300 MLT were selected for the analyses in this study. In order to investigate seasonal and solar activity dependence of electron number density, the selected datasets were divided into 12 sub-datasets depending on solar zenith angle (SZA) and phase of the solar cycle. In this study, the periods from April, 1989 to March, 1992, and from July, 1993 to June, 1997 are defined as solar maximum, solar minimum, respectively. For each sub-dataset, the average electron number density in each spatial bin with 500 km square in the meridian plane. The results are summarized as follows: (1) Electron number density Ne changes depending on SZA and solar activity: Ne in sunlight is about 3 times larger than that in darkness, and Ne during solar maximum is about 10 times larger than that during solar minimum. (2) The polar low density region with an Ne range below 100/cc during solar maximum is wider than that during solar minimum. The plasmapause is at L=3.5 during solar maximum while it becomes at L=4.5 during solar minimum. (3) Vertical Ne profile varies depending on SZA and solar activity. The low density region with an Ne range below 100/cc is distributed in an altitude range above 8500 km in a SZA range from 60 degrees to 70 degrees during solar maximum while it becomes distributed in an altitude range above 2500 km in a SZA range from 110 degrees to 120 degrees during solar minimum. The vertical Ne profile during solar minimum is quite similar to the empirical model proposed by Kletzing et al. [1998]. The coincidence is probably because the model is based on the S3-3 datasets obtained mainly in 1976, or during solar minimum. Vertical Ne profiles obtained in the previous studies were also summarized by Hilgers [1992]. In Fig. 2 of Hilgers [1992], the vertical Ne profile obtained by DE-1 is 3-10 times larger than that obtained by Viking. DE-1 dataset was obtained in a period from 1981 to 1982 [Persoon et al., 1983], or during solar maximum. On the other hand, Viking dataset was obtained in a period from 1986 to 1987, or during solar minimum. The difference of Ne is probably due to the solar activity dependence obviously shown in this study. The Ne distribution in the meridian plane, shown in this study, will be useful for studies such as ray tracing of radio waves in the polar region and simulations of field line resonance along the auroral field lines, which highly depend on the background plasma density models. In those studies, the SZA and solar activity dependence of Ne shown in this study should be taken into consideration in future.