Polar wind中において観測された光電子の特性

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Photoelectrons observed in the polar wind

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The polar wind is strongly controlled by solar radiation. Modeling studies suggested that escaping photoelectrons, which are produced by solar extreme ultraviolet radiation and originate from the polar cap ionosphere, drive the polar wind that includes heavy ions [e.g., Tam et al., 1998]. A photoelectron-driven polar wind model described by Wilson et al. [1997] indicated that a field-aligned potential drop (about 60 V), that reflects most of the escaping photoelectrons, exists at high-altitudes (about 7 R_E) to achieve zero net field-aligned current. Although presence of such a potential drop was reported for some cases based on observations of downgoing photoelectrons reflected at high altitudes [Winningham and Gurgiolo, 1982; Horwitz et al., 1992], the statistical characteristics of the potential drop (e.g., potential difference and occurrence frequency) have not been studied in detail.

We have statistically examined photoelectron spectra in the polar cap obtained by the electron spectrometer aboard the Fast Auroral SnapshoT (FAST) satellite at about 3800 km altitude during geomagnetically quiet periods at solar maximum. The geomagnetically quiet periods is defined as the times when the Kp index is less than or equal to 2+ for the preceding 3 hours and when the SYM-H index ranges from −10 to 40 nT. The polar cap is defined by the lack of energetic ions [Andersson et al., 2004]. The data obtained during geomagnetically quiet periods in July 2002 are used for the statistical study. In this period, the apogee of the FAST satellite located at high latitudes in the Northern (summer) Hemisphere. We found counter-streaming photoelectrons of up to more than 10 eV, indicating existence of a potential drop above the satellite altitude. Such distributions were frequently (more than 80%) observed in the polar cap. The estimated typical potential drop above the satellite is about 20 V, which is about a half of that predicted by photoelectron-driven polar wind models with a potential drop at high altitudes [Wilson et al., 1997; Su et al., 1998]. The net number flux of escaping photoelectrons negatively correlates with the magnitude of the potential drop. On the other hand, the net escape flux also negatively correlates with the number flux of upgoing photoelectrons. Since the flux of the escaping photoelectrons should be equal to the flux of the polar wind ions under the condition of the zero field-aligned current, this negative correlation indicates that the larger number flux of upgoing photoelectrons correspond to weaker polar wind. This fact seems to disagree with the idea that photoelectrons drive the polar wind, which was suggested by the modeling studies. These results imply that relation between photoelectrons and the polar wind is not as simple as that predicted by modeling studies.