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地磁気静穏時・弱擾乱時の極冠内における光電子の流出と高高度における反射
Photoelectron flows in the polar cap during geomagnetically quiet and weakly disturbed periods

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On the open magnetic field lines in the polar cap, downgoing electrons with energies lower than about 100 eV, which are considered to be photoelectrons reflected by a field-aligned potential drop above the satellite, had been identified in some case studies [e.g., Winningham and Gergiolo, 1982]. To examine the typical characteristics of the photoelectron flows and the field-aligned potential drop, we statistically investigated photoelectrons in the polar cap using the data obtained by the FAST satellite in an altitude range of 3000-3900 km in July 2002 (solar maximum) during geomagnetically quiet and weakly disturbed periods. In this period, the apogee of the FAST satellite located at high latitudes in the northern (summer) hemisphere. The geomagnetically quiet period 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, while the weakly disturbed period is defined as the times when the *Kp* index ranged between 4- and 5. The polar cap is defined by the lack of energetic ions [Andersson et al., 2004]. We found counter-streaming photoelectrons of up to more than 10 eV, indicating existence of a field-aligned potential drop (reflection potential drop) above the satellite altitude. Such distributions were frequently (quiet: 83%, weakly disturbed: 65%) observed in the polar cap. The estimated typical reflection potential drop above the satellite is about 20 V. In respect of the presence of a field-aligned potential drop at high altitudes, this result is consistent with the modeling results by Wilson et al. [1997] and Su et al. [1998], although the field-aligned distribution of the potential (e.g., presence of a potential jump) cannot be investigated from only the photoelectron observations in the present study. The typical observed reflection potential drop during geomagnetically quiet periods (about 22 V) is smaller than these modeling results by a factor of 2-3, while the median of net escaping electron number fluxes during geomagnetically quiet periods ($1.7 * 10^8$ /cm^2/s) is larger than these models by a factor of 2.8-3.5. During weakly disturbed periods, the net escaping electron number flux tends to increase (median: $2.8 * 10^8$ /cm^2/s), while the magnitude of the reflection potential drop tends to decrease (median: about 17 V), compared to those during geomagnetically quiet periods.

The net escaping electron number flux negatively correlates with the reflection potential drop. This relation corresponds to the fact that only high-energy photoelectrons can overcome the potential drop and escape when the reflection potential drop becomes large. On the other hand, the net escaping electron number flux, which should be nearly equal to the flux of the polar wind ions under small FAC conditions, negatively correlates with the upward electron number flux. This relation is contrary to the modeling results by Khazanov et al. [1997] and Tam et al. [1998]. An increase in downgoing electrons and their backscatter in the ionosphere with increasing reflection potential drop may explain the negative correlation. A potential drop at high altitudes, which was not considered by Khazanov et al. [1997] and Tam et al. [1998], would provide a polar wind system regulated by a negative feedback, and the most appropriate balance for polar wind ions would be achieved near the median of the reflection potential drop.

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