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Observations of escaping and reflected photoelectrons by the FAST satellite in the polar cap magnetosphere

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The polar wind process is strongly controlled by solar radiation. Modeling studies suggested that escaping photoelectrons, which are produced by solar extreme ultraviolet radiation, originating from the polar cap ionosphere drive the polar wind which includes heavy ions. A photoelectron driven polar wind models described by Wilson et al. [1997] indicated that a potential drop (about 60 V), which reflects most of the escaping photoelectrons, exists at high-altitudes (about 7 R_E) to achieve zero field-aligned current. Although presence of such a potential drop was reported for some cases [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 the photoelectron spectra obtained by the electron spectrometer aboard the Fast Auroral Snapshot (FAST) satellite at about 3800 km altitude during geomagnetically quiet periods near solar maximum. The data obtained from 2 to 16 July 2002 (quiet-time: about 50 orbit passes) are used for the statistical study. In this period, the apogee of the FAST satellite located at high latitudes in the Northern (summer) Hemisphere. Magnetic field data are used to estimate field-aligned currents. The reflected photoelectrons, which were likely reflected by a potential drop, were almost always (about 90%) observed in the region of a weak field-aligned current (-1.6$*10^{-7}$-1.6$*10^{-7}$ A/m^2 mapped to 1000 km altitude). The typical potential difference estimated in the present study is about 20 V, which is about a half of that predicted by photoelectron driven polar wind models [Wilson et al., 1997; Su et al., 1998]. When the potential difference are above 20 V, the typical number flux of the reflected photoelectrons with energy below the potential difference is about 90% of that of the escaping photoelectrons in the same energy range. The high reflection rate supports the presence of field-aligned electric fields.

Keywords: ion outflow, polar wind, potential drop