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Occurrence characteristics of the cleft ion fountain

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The Suprathermal Ion Mass Spectrometer (SMS) on Akebono satellite has been continuously observing ion outflow in the polar ionosphere for more than 15 years. These data enable us to investigate the ion outflow from various viewpoints such as the solar activity dependence, seasonal variation, IMF dependence, and the geomagnetic activity influence. In this presentation, we discuss occurrence characteristics of the cleft ion fountain, which is known to be one of the important ion outflow processes from the cusp/cleft region, on the basis of long-term observations by the SMS on Akebono.
The cleft ion fountain was first identified with observations by the retarding ion mass spectrometer on Dynamics Explorer 1, and it is generally known as low-energy O+ ions originating from the cusp or cleft and falling back into the ionosphere due to the fact that the ions were not sufficiently energetic to overcome gravitation. In contrast, light ions cannot have the downward velocity because the upward acceleration due to the ambipolar electric field is dominant compared to gravitation and collisions.
Our statistical analysis of the thermal ion outflow from the cusp/cleft and polar cap indicates that the downgoing O+ ions become predominant in the nightside polar cap during the high solar activity periods. It is also confirmed that the O+ downward flow on the nightside is more frequently observable on the negative IMF Bz condition. The solar activity dependence of the cleft ion fountain can be mostly interpreted by considering thermal process and variation of the vertical plasma distribution according to the solar activity. The cause of the IMF Bz dependence may be due to 1) the fact that anti-sunward convection on the negative Bz helps to bring ions into the nightside polar cap, and 2) high electron temperature on the negative Bz can increase the ambipolar electric field which accelerates ions upwardly.
We discuss occurrence situation of the cleft ion fountain as well as its dependence on the solar and geomagnetic activity for the sake of inherent understanding of ion outflow and downflow in the polar ionosphere.

Keywords: ion outflow, polar ionosphere, cusp, satellite observation