Spatial distribution of increase of energetic particles observed in the upstream region and in the magnetosheath

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Increase of high energy (larger than 50keV) particle flux lasting from minutes to hours is observed in the upstream region of the Earth's bow shock and in the magnetosheath. This flux increase is called an upstream event. The upstream events are attributed to particles accelerated at the bow shock or in the magnetotail. Ions accelerated in the magnetotail (i.e., ions of magnetospheric origin) drift duskward in the near-Earth magnetosphere and leak out from the duskside of the magnetopause. Then the ions stream along interplanetary magnetic field (IMF) toward the upstream region through the magnetosheath. (Electrons drift dawnward and leak out from the dawnside of the magnetopause.) However, there still remain many questions about the upstream events, such as their spatial distribution. In this study we examined spatial distribution of the upstream events in order to determine in what degree particles of magnetospheric origin are dominant in the upstream events. We used energetic ion flux data obtained by the ion composition system (ICS) sensor of the EPIC instrument on board the Geotail spacecraft. The ICS sensor covers energy range over 58.1 keV for protons.

Using the particle flux data of 58.1-77.3 in the period of June to November 1999, we visually identified 484 events in the upstream region defined by X(GSE) larger than 0 and r ((X(GSE)**2+Y(GSE)**2)**0.5) larger than 15 Re. The satellite stayed 2828.5 hours in the upstream region during the six months. We divided the upstream region into 10 Re x 10 Re meshes and calculated the occurrence probability (number of events/hours of satellite observations) in each mesh. The result showed a slight dawn-dusk asymmetry: the occurrence probability was 0.3 event/hour in the dawnside and 0.1 event/hour in the duskside.

We also analyzed dependence of the spatial distribution of the upstream events on the Dst index. Since the Dst index is thought to indicate geomagnetic storm activity, we can expect to clarify characteristics of particles of magnetospheric origin. The occurrence probability was almost the same in all meshes when Dst was larger than zero, while the probability was larger in the dawn sector than in the dusk sector when Dst was below -50 nT. This result suggests that particles of magnetospheric origin are leaking out from the duskside of the magnetopause and streaming along the IMF toward the dawnside of the upstream region.

In addition to the above results, we will report how spatial distribution of upstream events depends on energy of particles and the Kp index by using objective (not visual) definition of the events.