Three-dimensional distribution of H+ and O+ ions in the Earth's magnetosphere based on the Cluster observation

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We introduce a three dimensional, in radial distance (Earth radii, R_E), magnetic latitude (theta), and magnetic local time (MLT), statistical distributions of ion moments in the magnetosphere on the basis of data from the Cluster Ion Spectrometry experiment (CIS) instrument aboard the Cluster spacecraft. Previous observations have showed that the energy density of O+ ions, which are often used as a proxy of terrestrial origin, increases both in the ring current and near-Earth plasma sheet with geomagnetic activity especially during geomagnetic storms [e.g., Nose et al., 2005]. There are many studies on upflow/outflow from the ionosphere during the geomagnetic storms and detailed/statistical distribution of such heavy ions in the plasma sheet (from the outer close to the lobe interface to the center, in radial sense from close to the inner magnetosphere to the long-distance tail region). However, the linkage between the ionosphere as a source of O+ and the plasma sheet, i.e. the plasma transport and the intermediate energization processes are still unclear. In this study, the moments of ions (H+ and O+) are calculated based on three-year observations by Cluster/CIS in 2001-2003 during the former Solar Maximum. Since Cluster is orbiting L greater and equal to 4 and radially R greater and equal to 4 and smaller and equal to 20 R_E in the geocentric distance, surveying coverage in the inner magnetosphere is limited. However, the resultant statistical distribution (in the future, an emripical model is expected) covers the plasma dynamics of medium-distance magnetosphere containing near-Earth plasma sheet. Cluster/CIS can measure the energy range of ions between ˜10 eV and 38 keV. The statistical distribution is built for different geomagnetic activity in different locations and time-scale. With this distribution, one can obtain the global distribution of pre-energized (prior to entry to the plasma sheet and the subsequent injection to the inner magnetosphere) outflowing ions along a flux tube. Furthermore, we can screen and scope dynamic distributions of magnetospheric ions on some occasions. We will report on what this statistical distribution indicates in terms of magnetospheric plasma (both ionospheric and solar wind origin) dynamics in association with the former Solar Maximum.