GEOTAIL OBSERVATIONS OF PLASMA SHEET ION COMPOSITION OVER 16 YEARS: ON VARIATIONS OF AVERAGE PLASMA ION MASS AND SUBSTORM TRIGGERING

M. NOSÉ 1, A. IEDA 2, S. P. CHRISTON 3

1 Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University, Japan
2 Solar-Terrestrial Environment Laboratory, Nagoya University, Japan
3 Focused Analysis and Research, Maryland, USA

We examined long-term variations of ion composition in the plasma sheet, using energetic (9.4-212.1 keV/e) ion flux data obtained by the suprathermal ion composition spectrometer (STICS) sensor of the energetic particle and ion composition (EPIC) instrument onboard the Geotail spacecraft. EPIC/STICS observations are available from 17 October 1992 for more than 16 years, covering the declining phase of solar cycle 22, all of solar cycle 23, and the early phase of solar cycle 24. This unprecedented long-term data set revealed that (1) the He^+/H^+ and O^+/H^+ flux ratios in the plasma sheet were dependent on the F10.7 index; (2) the F10.7 index dependence is stronger for O^+/H^+ than He^+/H^+; (3) the O^+/H^+ flux ratio is also weakly correlated with the $\sum$Kp index; and (4) the He^{2+}/H^+ flux ratio in the plasma sheet appeared to show no long-term trend. From these results, we derived empirical equations related to plasma sheet ion composition and the F10.7 index, and estimated that the average plasma ion mass changes from ~1.1 amu during solar minimum to ~2.8 amu during solar maximum. In such a case, the Alfvén velocity during solar maximum decreases to ~60% of the solar minimum value. Thus, physical processes in the plasma sheet are considered to be much different between solar minimum and solar maximum. We also compared long-term variation of the plasma sheet ion composition with that of the substorm occurrence rate, which is evaluated by the number of Pi2 pulsations. No correlation or negative correlation were found between them. This result contradicts the O^+ triggering substorm model, in which heavy ions in the plasma sheet increase the growth rate of the linear ion tearing mode and play an important role in localization and initiation of substorms. In contrast, O^+ ions in the plasma sheet may prevent occurrence of substorms.

Plasma sheet ion composition, Ionospheric ion outflow, Substorm

Masahito Nosé, Data Analysis Center for Geomagnetism and Space Magnetism, Graduate School of Science, Kyoto University, Oiwake-cho, Kitashirakawa, Sakyo-ku, Kyoto, 606-8502 Japan;
Tel: +81-75-753-3959, Fax: +81-75-722-7884, E-mail: nose@kugi.kyoto-u.ac.jp