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Oxygen Ion Outflow Response to the Solar Wind Condition derived from the Extreme Ultraviolet Imaging on SELENE

Naoki Aso[1], Atsushi Yamazaki[2*], Ichiro Yoshikawa[3], Makoto Taguchi[4], Kikuchi Masayuki[5], Wataru Miyake[6], Masato Nakamura[2]

[1]EPS, Tokyo Univ., [2]ISAS/JAXA, [3]Univ. of Tokyo, [4]Rikkyo Univ., [5]NIPR, [6]Tokai Univ.

In 1960s, H+, He+, and electrons generated in the ionosphere are theoretically thought to outflow into the magnetosphere from the earth due to the pressure gradient in the polar cap region where the magnetic field connects to interplanetary space, what is called open field lines. In 1980s and 19 90s, the existence of these plasma outflows was verified from the plasma in-situ observation operated by polar orbit satellites such as Dynamic Explorers and Akebono. Additionally, O+ outflow was observed much more than expected amount even though it was thought few O+ would outflow because of its heavy mass. In previous studies, great amount of O+ outflow was discovered at the cleft region and the auroral region or in the polar wind at the polar cap region and energization mechanism caused by ambipolar electric field and wave-particle interaction are introduced. However, it is not yet obvious when and how much outflow ions are produced and it is difficult to solve this problem only by the in-situ observation.
To solve this problem, it is important to conduct in-situ observations and imaging observations at the same time so as to observe ions comprehensively. In order to observe circum-terrestrial plasma from moon orbit, Upper Atmosphere and Plasma Imager - Telescope of Extreme ultraviolet (UPI-TEX) on board the lunar orbiter, SELENE (KAGUYA) operated imaging observations of the resonance scattering emission from O+ and He+. Since it can observe both temporal and spatial variations of circum-terrestrial plasma comprehensively, it can be a significant measurement to understand the mechanism of the outflow. UPI-TEX took images of O+ outflow where the magnetic field is open and several Re far from the earth every 2 hours so that it is possible to understand the temporal variation of outflow ions amount result from the magnetospheric variation of a few hours scale.
The purpose of this study is to evaluate the temporal variation of the outflow ions amount depending on the solar wind condition and understand what produce the outflow ions and when the outflow ions are produced. In this analysis, I focused on the relationship between solar wind condition and geomagnetic activity and the amount of outflow O+. Since the UPI-TEX instrument observes the resonance scattering emission from O+ to take 2-dimensional images, I can see comprehensive variation of the O+ outflow from the polar region of the earth. However, there are contaminations of the emission from hydrogen atoms called geocorona near the wavelength of the resonance scattering emission from O+. Especially, the emission of Lyman beta 102.5 nm is detected comparable to the resonance scattering emission from O+ outflow. In this study, I assume atomic hydrogen distribution as spherically symmetric Chamberlain model to calculate the intensity from atomic hydrogen by solving radiative transfer equations and subtracted the counts from the obtained image. In the obtained images, I calculate the averaged intensity of the O+ resonance scattering emission in the area O+ outflow can exist along the open magnetic field derived from the Tsyganenko 96 model. The variation of the averaged intensity resulted from the variation of the integrated area is normalized theoretically. The variation of the averaged intensity is compared with the solar wind parameters and geomagnetic activity. As a result, the timing of the peak of the normalized averaged intensity was coincident with that of solar wind dynamic

pressure pulse. VSWBIMF and the solar wind speed highly correlated with the intensity. The time delay between the changes in the solar wind and that in the intensity was not found in this study. Those results are consistent with previous studies. I conclude that solar wind dynamic pressure, VSWBIMF, and the solar wind speed seem to cause ionospheric O+ to outflow to the magnetosphere.

Keywords: Oxygen ion outflow, Resonance scattering emission, SELENE satellite, Solar wind