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# Coordinated observation between Reimei and EISCAT radar of N2+ emission and ion upflow in the polar topside ionosphere

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The upflow and outflow of heavy ions, such as N2+ and NO+, has been examined with immense interests since it is considered that heavy ions hardly escape from terrestrial gravity. It is considered that the generation process of N2+ outflow is the charge exchange between O+ and N2 at topside ionosphere. Recently, optical measurement data taken by a satellite showed N2+ 1st negative band emissions in the sunlit region suggesting the existence of N2+ upflow. To clarify the process of ion upflow, we carried out the coordinated observations between the Reimei satellite and the EISCAT/ESR radar during the winter solstice periods from 2005 to 2012, except for 2011 due to the problem on Reimei attitude system.

The field-of-view (FOV) of the multi-spectral auroral camera (MAC) on Reimei was directed toward the earth's limb in order to observe the height profile of N2+ emission intensity produced by resonant scattering. In this case, the altitude resolution and range in the image data obtained with Reimei/MAC are approximately 5 km and 300 km, respectively. N2+ emission image was taken with every 1 second. On the other hand, ion upflow speeds near the FOV of MAC are simultaneously observed by the EISCAT/ESR radar with the fast scan mode or fixed mode toward the magnetic zenith. In the scan mode, the azimuthal scan range is 120 degrees centering the geomagnetic north direction, and time resolution is about 3 min.

Using the Reimei data, we examined the relationship among N2+ 1st negative and OI green line emissions, ion upflow and geomagnetic activity. We found good correlation between N2+ emission intensities at 300 and 400km altitude and Kp indices. At these altitudes, N2+ emission intensities were 100-600R greater than OI intensities when Kp was greater than 3+. This suggests that N2+ density increase, or ion upflow occurs in the topside/upper ionosphere when geomagnetic activity increased.

From the statistical analysis based on the coordinated measurement data between Reimei and EISCAT/ESR radar, we found no significant relationship between ion up/down flow and and N2+ emission. Considering the fact that the dayside heating region (cusp/cleft and auroral oval) is expected to be shifted toward lower-latitudes, far from the ESR-site during the disturbed conditions, it is suggested that N2+ enhancement measured by Reimei was not generated locally at the field line threading Reimei, but may be transported from the dayside heating region. In this presentation, we will present the recent results on the coordinated observations, and give the future subject for the EISCAT-3D project.

Keywords: Reimei, EISCAT, ion upflow, aurora, ionosphere