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Observations of N2+ emission height distribution in the polar ionosphere by Reimei satellite

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Field-aligned ion upflow is often observed in association with transient plasma heating in the polar topside ionosphere. Although velocities of ion upflow are always smaller than the escape velocity, ion upflow must play an important role as a source of ion outflow. It has been confirmed that low energy electron precipitation is the dominant mechanism to produce ion upflow.

Ion upflows have been observed by using EISCAT radar or in situ observations of satellites, but Romick et al. [2005] suggested optical observations of ion upflows and in the topside ionosphere. Recent MSX and Coriolis measurement data showed the existence of molecular nitrogen ion emission which is produced by resonant scattering in the sunlit region, and its strong dependence on geomagnetic activities.

Reimei was launched successfully in August 2005 by Russian Dnepr rocket as a piggyback satellite into a noon-midnight polar-orbit at an altitude of 610-670km. Auroral images at emissions of N_2^+(427.8 nm), OI(557.7 nm), N_2(670 nm) are obtained by three independent channels of the Multi-spectral Auroral Camera(MAC) with maximum time and spatial resolutions of 2 km and 120 msec, respectively. MAC observes auroras mainly in the two modes as follows: 1) simultaneous observation between plasma particles and auroras around the magnetic footprint (Mode-S), 2) observation of auroral height distribution in the limb direction (Mode-H). In this study, in order to observe molecular nitrogen ion emission in the topside ionosphere, the field-of-view of MAC was directed toward the earth's limb with the Mode-H.

We analyzed imaging data sets obtained at Aug 20th, 2006 during period of Kp=5+. In this observation, 427.8nm emission enhancement was observed above shadow height of 250km. The intensities were about 1kR at 300km altitude and about 300R at 400km altitude. Moreover, the emissions had horizontal structures with a size of about 20-100km.

Since there are excitation processes to N_2^+ B state other than resonant scattering in the polar atmosphere, we estimated N_2^+ 1st negative band emission intensity by using aurora emission model [Ono, 1993] and GLOW model. Estimated intensity agreed well with observed intensity at 260-290km altitude, while emissions above 290km altitude are grater than estimated intensity. This indicates increase of N_2^+ density at the topside ionosphere.

Moreover, correlation between geomagnetic activity and emission intensities at N_2^+(427.8nm) and OI(557.7nm) in the topside ionosphere was studied by using 87 imaging data sets. As a result, it is found good correlation between N_2^+ emission intensities at 300 and 400km altitude and Kp index. At these altitudes, N_2^+ 1st negative band(427.8nm) emission intensities were 100-600R greater than OI(557.7nm) intensities when Kp was greater than 3+. This suggests that N_2^+ density increase, or ion upflow occurs morve frequently when geomagnetic activity increased. Akebono satellite observations at 5000-10000km reported by Yau et al.[1993] showed density enhancement when Kp was greater than 4. Compared with our statistical result, such dependence on geomagnetic activity is very similar but there is a large difference in altitude. This suggests that ionization of N_2 at 260-290km altitude and ion upflow is important for N_2^+ ion outflow into the magnetosphere.