Molecular ion outflow mechanism from the deep ionosphere observed by EISCAT radar in conjunction with the Arase (ERG) satellite.

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Molecular ions (N_2^+,O_2^+,NO^+) in the inner magnetosphere were first observed by AMPTE/IRM [Klecker et al., 1986] and also recently observed by Arase during geomagnetically active periods. It is considered that these molecular ions have been transported upward by some heating processes in the ionosphere [e.g., Kosch et al., 2010]. However, in order to achieve heavy molecular ions outflow from the deep ionosphere around the altitude of ˜300 km by the heating process, the rapid upward transport is required. In this study, we aim at quantitative assessment of the outflow process of the molecular ions from the deep ionosphere by using data of EISCAT ultra high frequency radar in conjunction with the Arase (ERG) satellite.

We here focus on the magnetic storm event started on the September 7, 2017. During the storm, the Arase satellite and EISCAT radar have simultaneous observations from 16:00 to 20:00 UT on September 8, 2017. The minimum Dst index of the magnetic storm was -125 nT. During the period, the MEPi instrument onboard the Arase satellite detected high-energy (>20 keV) molecular ions (N_2^+,O_2^+,NO^+) in the ring current and EISCAT radar observed strong upward flow of ˜100 m/s and ion heating which made the ion temperature higher than 2000 K. The EISCAT data and models of the ionosphere (IRI) and neutral upper atmosphere (MSISE-90) enabled us to discuss the heating and outflow mechanisms. We evaluated each term of the equation of motion about molecular ions quantitatively. The results suggest that the most important part of these processes is the acceleration mechanism driven by pressure gradient of ions itself. We also estimated the electric field strength at ˜110 km based on the statistical study by EISCAT radar [Davies and Robinson, 1997], and found that there was enhancement of the electric field by a factor of 2 in the deep ionosphere during the period.

References:

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