Cause and consequence of strong ionospheric heating: Simultaneous observations by Arase(ERG) satellite and EISCAT radar

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Observations have shown that the terrestrial plasma contribution, especially that of heavy ions originating from the Earth’s ionosphere increases with increasing geomagnetic activities. Particularly in the inner magnetosphere during large geomagnetic storms, contribution of terrestrial heavy ions to the ring current can be comparable to or exceed that of protons of solar wind origin. On the other hand, mechanisms of the enhanced terrestrial plasma contribution such as the ion supply, transport, and energization processes from the ionosphere are far from understood.
While the O+ ions are the main species of terrestrial heavy ions, the heavier molecular ions such as NO+ and O2+ have been observed in the various regions of the magnetosphere during geomagnetically active periods [e.g., Klecker et al, 1986; Peterson et al., 1994; Christon et al, 1994; Poppe et al., 2016]. In order to get the molecular ion outflows from the deep ionosphere with altitudes of 250-500 km, they need to be energized at least up to the escape energy of ˜10 eV within a short time scale (˜order of minutes) to overcome the dissociative recombination lifetime at the source altitudes. Recent observations by the Arase (ERG) satellite show that molecular ions with energies above 12 keV are often seen in the region of L=2.5-6.6 during geomagnetically active periods and suggest that the rapid (˜order of minutes) transport/heating in the deep (200-300km) ionosphere to cause molecular ion outflows are rather common during moderate geomagnetic disturbances.
In order to understand the supply mechanisms of these molecular ions to the inner magnetosphere, we here investigate simultaneous observations of the ionosphere by the EISCAT radar and molecular ions in the ring current by Arase. During the September 7, 2017 magnetic storm, two ion instruments (MEPi and LEPi) onboard Arase observed the molecular ions in the ring current during the storm main phase. From 16-20 UT on September 8, Tromso UHF radar of EISCAT made observations of the ionosphere at altitudes from 100-600 km. The period corresponds to the second main phase of the geomagnetic storm and Dst stayed less than -110 nT. The EISCAT radar observed strong ionospheric heating down to the altitude of ˜100 km and ion upflows from the deep ionosphere above 200 km. In the presentation, relations of these observations and possible scenario of terrestrial ion supply from the deep ionosphere will be discussed.

References:
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