Statistical properties of molecular ions in the ring current observed by the Arase (ERG) satellite

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It is observationally known that the terrestrial heavy ion contribution to the magnetospheric plasma increases with increasing geomagnetic activities, while the mechanisms of the enhanced ionospheric supply are far from understood. O+ ions are the main species of the terrestrial heavy ions. The heavier molecular ions such as NO+ and O2+ have been also 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]. In order to get the molecular ion outflows from the deep ionosphere, they need to be transported upward within a short time scale (˜order of minutes) to overcome the dissociative recombination lifetime at the source altitudes typically less than 300 km altitude. Thus the existence of molecular ions in the magnetosphere can be a tracer of the rapid ion outflow from the deep ionosphere. However, previous observations based on event studies, and how frequently the molecular ions exist in the magnetosphere remains to be investigated.

In this paper, we report on statistical properties of molecular ions (O2+/NO+/N2+) in the ring current observed by the Arase (ERG) satellite and their relations to the solar wind and geomagnetic conditions. The ion composition data of the Arase satellite obtained by MEPi and LEPi instruments, which detects the ions less than 180 keV/q, were analyzed in details. The investigated period from late March to December 2017 includes 11 geomagnetic storms with the minimum Dst index less than -40 nT. The molecular ions are observed in the region of L=2.5-6.6 and clearly identified at energies above ˜12 keV during most of the magnetic storms. The lowest ion energy of detected molecular ions is consistent between two instruments (LEPi and MEPi). During quiet times, molecular ions are not observed. The average energy density and number density ratios of the molecular ions to O+ are 2.8 and 2.3 percent, respectively. The peak molecular ion ratio tends to increase with the size of the magnetic storms measured with the minimum Dst. The results show that the existence of molecular ions in the ring current is rather common even during small magnetic storms, and suggest that the rapid ion outflow from the deep ionosphere occurs frequently during geomagnetically active periods.

References:
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