On contribution of minor ion species to the ring current of Earth's magnetosphere: Arase (ERG) satellite observations

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Two major ion species in the ring current is H^+ and O^+ ions. The H^+ ions are considered to mainly originate from the solar wind, while the O^+ ions come from the ionosphere. In addition to these ion species, some minor ion species such as O^{++} [e.g., Fennell et al., 1996] and molecular ions [e.g., Klecker et al., 1986; Seki et al., 2019] are known to exist in the ring current. Nitrogen related ion species are also potential contributor to the ring current, since they are observed in the ion outflow in the high-altitude ionosphere [e.g., Yau et al., 1993]. Previous observations indicate that geomagnetic activity dependences are different between the ion species. However, difficulty in clear identification of the minor ion species prevents understanding of transport mechanisms to cause the variations and their relative contribution to the ring current.

In this study, we investigated properties of O^+, O^{++}, and molecular ions ($O_2{}^+$/NO^+/$N_2{}^+$) in the ring current based on observations by the Arase (ERG) satellite and their relations to the solar wind and geomagnetic conditions. The ion composition TOF-mode data of the Arase satellite obtained by the MEPi and LEPi instruments, which detects the ions less than 180 keV/q, are analyzed in details. The statistical analysis of molecular ions shows that the molecular ions exist in near-Earth space during most magnetic storms, while they are not detected during geomagnetically quiet periods. The existence of molecular ions even during small magnetic storms suggests that the magnetic storm is an effective driver of the ion loss from the deep terrestrial ionosphere. On one hand, O^{++} ions contribution becomes relatively large during geomagnetically quiet periods. We also report on an attempt to identify N^+ ions in the ring current. Based on the results, we discuss possible cause of the different geomagntic activitiy dependences between the ion species.

References:
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