Deeper and earlier penetrations of oxygen ions than protons into the inner magnetosphere observed by Van Allen Probes

*Kenji Mitani[1], Kanako Seki[2], Kunihiro Keika[2], Matina Gkioulidou[4], Louis Lanzerotti[3], Donald Mitchell[4], Craig Kletzing[5]

1. Institute for Space-Earth Environmental Research ,Nagoya University, 2. Graduate School of Science, University of Tokyo, 3. New Jersey Institute of Technology, 4. Applied Physics Laboratory, Johns Hopkins University, 5. Department of Physics and Astronomy, University of Iowa

It is observationally known that protons and oxygen ions are the main components of the ring current during magnetic storms and are considered to have different source and supply mechanisms. In order to characterize the ion supply to the ring current during magnetic storms, we study the properties of energetic proton and oxygen ion phase space densities (PSDs) during the 23-25 April 2013 geomagnetic storm observed by the Van Allen Probes spacecraft. We calculated ion PSDs for specific first adiabatic invariants (for proton; for oxygen ion) and the local pitch angles near 90 degrees. The PSD profiles as a function of L show that both proton and oxygen ions penetrated to L < 5 during the main phase of the magnetic storm. The timing of oxygen ion penetration was approximately the same for all values. The observations also show that oxygen ions penetrated more deeply in L and earlier in time than protons for the same value. The early penetration of oxygen ions suggest that the source of the transported oxygen ions was located closer to the Earth than the inner edge of plasma sheet protons. We also discuss the possibility that the interaction between >200 keV oxygen ions and Pc3 ULF waves in the inner magnetosphere causes selective transport of oxygen ions. Our results imply the importance of the contribution from >200 keV oxygen ions to the storm-time ring current.

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