

Statistical study of selective transport of higher-energy oxygen ions into the inner magnetosphere during geomagnetic storms observed by Van Allen Probes

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It is recently reported that the transport mechanism of the ring current ions differs among ion energies. Lower-energy ($< \sim 150$ keV) ions are well known to be transported convectively. Higher-energy ($> \sim 150$ keV) protons are reported to be transported diffusively, while there are few reports about transport of higher-energy oxygen ions. Selective transport of higher-energy ring current oxygen ions was detected during the storm main phase on 24 April 2013 by the Van Allen Probes spacecraft. An enhancement of 1-100 mHz magnetic fluctuations is simultaneously observed. Observations of 3 and 30 mHz geomagnetic pulsations indicate the azimuthal mode number is $< \sim 10$. The fluctuations can resonate with the drift and bounce motions of the oxygen ions. The results suggest that the combination of the drift and drift-bounce resonances is responsible for the radial transport of higher-energy oxygen ions. To understand occurrence conditions of the selective transport of the higher-energy oxygen ions, we investigate all magnetic storms observed by Van Allen Probes from February 2013 to September 2017. We calculated ion PSDs for various first adiabatic invariants ($\mu=0.1-2.0$ keV/nT) and for the local pitch angles near 90 degrees. Comparing μ -L diagrams of PSDs between neighboring orbits of Van Allen Probes during a storm, we detect >3 times enhancement of oxygen ion PSDs without no enhancement of proton PSDs throughout >0.5 RE L-shell band. We regard the selective enhancement of higher-energy oxygen ions as selective transport of higher-energy oxygen ions. We found similar events during the 28 magnetic storms out of 89 magnetic storms. The higher-energy oxygen ions are transported deeper when the maximum of the AE index in 9 hours (\sim orbital cadence of Van Allen Probes) before the detection of selective transport is larger. We also investigate global distributions of magnetic fluctuations during magnetic storms observed by Van Allen Probes, THEMIS, GOES, and ground magnetometers. We discuss about correlation between selective transport of higher-energy oxygen ions and enhancement of magnetic fluctuations.

Keywords: Ring current, Oxygen ion, Van Allen Probes