Oxygen impulsive energization during the storm main phase and its contribution to the ring current buildup

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We investigate proton and oxygen ion energization during the main phase of magnetic storms. This study addresses one of the unresolved issues: supply, transport, and acceleration of ionospheric oxygen ions in the inner magnetosphere during magnetic storms. It is also yet to be determined whether oxygen ion contribution to the storm-time plasma pressure (and the ring current) is spatially global or localized. Plasma pressure in the inner magnetosphere is dominated by proton and oxygen ions with energies of a few to a few hundreds of keV. It is well known that such energetic oxygen ions increase drastically on a short time scale (< a few tens of minutes). We thus examine impulsive flux enhancements of protons and oxygen ions observed by the RBSPICE and HOPE instruments on board the Van Allen Probes spacecraft.

Van Allen Probes observed oxygen ion enhancements during the main phase of the 17 March 2015 storm. The oxygen energy density showed different temporal variations and radial profile from the proton energy density. It was enhanced during the early main phase (Dst ˜ -120 nT) up to the proton energy density level in an L range of 3 to 5. However, it decreased by about an order of magnitude around the beginning of the later main phase. It was increased again during the later phase (Dst ˜ -220 nT) particularly at L ˜ 3, while it did not reach the early phase level. The radial profile was affected by temporarily impulsive enhancements more significantly than the proton energy density. The difference between the outbound (pre-midnight) and inbound (around midnight) paths is much clearer for oxygen ions than protons.

In this poster, we show the results of multi-event studies on such mass-dependent features during magnetic storms that occurred in 2013 to 2016. Our analysis is particularly focused on changes of energy spectra and pitch angle distributions, and spatial distributions of the oxygen ion contribution to the ring current. We discuss when and where ionospheric oxygen ions are energized to make a significant contribution to the ring current.

Keywords: Magnetic storms, Ring current, Oxygen ion outflow, Plasma transport and acceleration

