Search for oxygen torus in the inner magnetosphere: Van Allen Probes observations

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The oxygen torus is found in the deep inner magnetosphere as enhancements of O^+ ion density in a limited L range. It was first reported by Chappell [1982] who used the DE-1/RIMS instrument. Horwitz et al. [1984, 1986] showed that the O^+ density sometimes becomes comparable to or exceeds the H^+ density at L=3-4. Following studies revealed that the oxygen torus is observed just inside the plasmasphere at all local time with higher occurrence frequency in the late evening and morning sectors. A recent study by Nose et al. [2010] cast a new light on the oxygen torus as a one of essential factors of O^+-rich ring current generation. They proposed that thermal O^+ ions preexisting in the oxygen torus are locally and nonadiabatically accelerated by fluctuations associated with dipolarization in the deep inner magnetosphere and contribute to ring current O^+ ions. Therefore investigation of the oxygen torus is important to understand the dynamics of ions of ionospheric origin in the inner magnetosphere.

In this study we search for the oxygen torus, using the magnetic field and plasma wave data obtained by the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) instrument onboard the Van Allen Probes. We examine a few events on the dawnside in which toroidal standing Alfven waves appear clearly. From the frequency of the toroidal waves, the magnetospheric local mass density (rho) is estimated by solving the MHD wave equation for realistic models of the magnetic field and the field line mass distribution. We also estimate the local electron number density (n_e) from the plasma wave spectrograms by identifying narrow-band emission at the upper-hybrid resonance frequency. Assuming the quasi-neutral condition of plasma, we infer the local average ion mass (M) by rho/n_e. It is found that M is generally less than 4 amu in the plasma trough, while it shows an enhancement of $>$6 amu near the plasmapause. This indicates an existence of the oxygen torus in the vicinity of the plasmapause. We will present the result and discuss possible formation mechanisms of the oxygen torus. Possible contribution of the oxygen torus to the formation of the O^+-rich ring current will be also discussed.