Oxygen torus in the deep inner magnetosphere and its contribution to recurrent process of O^+-rich ring current formation

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Using the magnetic field and plasma wave data obtained by the Combined Release and Radiation Effects Satellite (CRRES), we search for enhancements of O^+ ion density in the deep inner magnetosphere known as "the oxygen torus". We examine 4 events on the dayside 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 approximately 3 amu in the plasma trough, while it shows an enhancement of $>$7 amu at L˜4.5-6.5 that is close to the plasmapause at L˜3.5-6.0. This indicates an existence of the oxygen torus in the vicinity of the plasmapause. The oxygen torus is found preferentially during the storm recovery phase. We interpret that these features of the oxygen torus (i.e., close relations with the plasmapause and the storm recovery phase) reflect its generation mechanism; that is, the ionospheric temperature is enhanced by heat conduction from high altitudes in the limited L range where the plasmasphere, because of its inflation during the recovery phase, encounters the ring current, and then the ionosphere has a larger scale height and supplies O^+ ions to the inner magnetosphere, resulting in the oxygen torus. We also discuss the contribution of the oxygen torus to the formation of the O^+-rich ring current. It is proposed that the O^+-rich ring current is formed in a recurrent process, in which the oxygen torus, the plasmasphere, and the ring current interact with each other.