Longitudinal Structure of Oxygen Torus and Its Coincidence with EMIC Wave in the Inner Magnetosphere

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A recent study employing the Arase and Van Allen Probes A satellites at different MLT revealed that the O+ density enhancement in the inner magnetosphere (i.e., oxygen torus) does not extend over all MLT but is skewed toward the dawn, being described more precisely as a crescent-shaped torus or a pinched torus [Nose et al., 2018]. In the reported event, Arase flying in the morning sector detected an enhancement of the average plasma mass up to ˜3.5 amu around L=4.9-5.2, while Probe A flying in the afternoon sector observed no clear enhancements in the average plasma mass.

In the present study, we focus on simultaneous observations of the magnetic field and plasma waves made by the Arase and Van Allen Probe B satellites on September 12, 2017. Orbital configuration of the satellites is opposite to that in the study by Nose et al. [2018]; that is, Arase started from afternoon, traversed dusk with an apogee around MLT = 19 hr, and arrived at pre-midnight, while Probe B was flying from morning to afternoon through noon. It is found that (1) only Probe B observed a clear enhancement of the average plasma mass up to ˜4 amu around L˜3.6 and MLT˜9.2 hr; and (2) a H+-band electromagnetic ion cyclotron (EMIC) wave appeared just outside the plasmapause where M is larger than approximately 2 amu. From the average plasma mass and the lower cutoff frequency of the EMIC wave, we can estimate that the oxygen torus for this event composes of 79.9% H+, 4.3% He+, and 15.8% O+. This result implies that the crescent-shaped torus or the pinched torus is a general feature of the O+ density enhancement in the inner magnetosphere. Using the linearized dispersion relation for EMIC waves, we calculated the growth rate of the H+-band EMIC wave, and found that cold O+ ions increase the growth rate of the H+-band EMIC waves. We suppose that the oxygen torus in the inner magnetosphere can lead to excitation of the H+-band EMIC waves, resulting in their simultaneous observations.