2015 年 3 月 17 日の磁気嵐発達に対する酸素イオンの寄与の時間変化

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Temporal variations of oxygen contribution to the ring current during the 17 March 2015 storm: Van Allen Probes observations

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We examine the contribution from oxygen ions to the development of the ring current during an intense storm that occurred on 17 March 2015, using Van Allen Probes observations. We primarily use data from the RBSPICE and HOPE instruments which cover a wide energy range of ions and determine composition. During the storm event, Van Allen Probes traveled in the pre-midnight sector on the outbound path and around midnight on the inbound path. The geocentric distance of spacecraft perigee and apogee is 1.1 RE and 5.8 RE, respectively; the orbital period is about 9 hours. The spacecraft completed four full orbits during the main phase of the storm, enabling us to examine temporal variations of the radial profile of ion energy density. The Dst index displayed a typical two-step decrease during the main phase.

The proton energy density was enhanced at an L range of 3 to 6 with a peak at L ˜4. The inner edge was displaced earthward to L ˜2.5 during the second Dst decrease. The energy density peaked at L = 3 - 4. The energy range that make the dominant contribution to the energy density differed between the two phases. The energy density was primarily dominated by 20-80 keV at L ˜3.5 (0.01-0.1 keV/nT) during the first phase, while it was contributed predominantly from 80-120 keV at L ˜4 (0.1-0.5 keV/nT) during the second phase. It is also noted that higher energetic protons with energies of 100-300 keV at L ˜3 (0.1 - 1.0 keV/nT) made a significant or even dominant contribution near the Dst minimum. The results indicate that the proton energy density increased in three steps.

The oxygen energy density showed different temporal variations and radial profile from the proton energy density. It was enhanced during the first phase 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 second phase. It was increased again during the second phase, and its inner edge was displaced earthward to L ˜3. It was further increased by a few factors particularly at L ˜3 during the third phase. The radial profile was affected by temporarily impulsive enhancements more significantly than the proton energy density. The oxygen flux suddenly increased by a factor of ˜3 during the main phase.

This presentation focuses most on such mass-dependent features of ring current ions to identify when and where ionospheric oxygen ions are energized to make a significant contribution to the ring current. We also examine temporal variations and pitch-angle evolution of lower-energy oxygen ions (lower than 10 keV) on a storm time scale to discuss about the significance of cold-to-warm oxygen supply from the ionosphere prior to the storm.