Oxygen-proton differences in ion energies dominating plasma pressure: Dependence on storm phases and solar wind drivers

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The ion pressure in the inner magnetosphere is generally dominated by protons with energies of a few to a few 100s keV. Oxygen ions of ionospheric origin, O+, can make a significant contribution to the ion pressure during geomagnetically active periods. Our previous study (Keika et al., 2018, GRL) examined the radial dependence of contributing energies, which we term an energy range that makes the dominant contribution to the plasma pressure, during the main phase of the six magnetic storms in Year 2017. We found clear oxygen-proton differences in the contributing energies in the outer part (L>5) of the ring current region. The contributing energies were higher for O+ than for H+. The results provided in situ evidence of the contribution from mass-dependent/selective acceleration processes to the energization of the outer part of the ring current.

The present study extends this analysis toward a larger database obtained from a longer period of magnetic storm times including the recovery phase. We also compare mass-dependent/selective energization between different solar wind drivers such as coronal mass ejections and corotational interaction regions. We primarily use data from the MEP-i (Medium-Energy Particle experiments - ion mass analyzer) on board the Arase spacecraft. MEP-i measures ions with energies of 10 to 180 keV/q and distinguishes between different ion species. Arase observed the nightside near-Earth magnetosphere (L<10) during 7 CME-driven and 7 CIR-driven storms with the Dst minimum of smaller than -50 nT in Years 2017 and 2018. The dependence on storm phases and solar wind drivers helps identify magnetospheric conditions favorable for mass-dependent/selective acceleration and in turn provides clues for understanding important physical mechanisms. Utilizing observations made by the MMS spacecraft in the near-Earth plasma sheet, we also compare oxygen-to-proton differences inside earthward bursty bulk flows with the Arase/MEP-i observations. The multi-spacecraft observations help better understand the temporal evolution of the mass-dependent/selective acceleration processes.

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