Solar cycle variations of magnetospheric molecular ions from the Arase Observations

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In the Earth’s magnetosphere, there are several kinds of ions originated from both the solar wind and the ionosphere. Molecular ions in the magnetosphere are originated in the Earth’s ionosphere. The Arase satellite has observed various kinds of ions since 2017 to the present, utilizing two ion analyzers, LEPi and MEPi, which cover the energy range from 10 eV/q to 180 keV/q. Using the data from the MEPi instrument, a previous study has investigated the variations of molecular ions in response to magnetic storms and solar wind conditions, and molecular ions have been observed in the inner magnetosphere even during small magnetic disturbances [Seki et al., 2019]. However, observations about molecular ions are still relatively limited in comparison to other ion observations, and the mechanism of the outflow from the ionosphere as well as the long-term variations are not well known. In this study, we analyzed the time-of-flight (TOF) data from LEPi [Asamura et al., 2018] onboard Arase to investigate variations of molecular ions in the inner magnetosphere and their correlation with magnetic activities aconditions well as the solar cycle. LEPi covers the energy range from 10 eV/q to 25 keV/q and obtains flux as a function of energy and TOF. The TOF measurements of LEPi have been operated in the outbound pass every four revolutions around the Earth. The estimated flux of molecular ions were obtained by fitting empirical functions to the TOF profile via a non-linear least squares method and were calibrated with the time-varying efficiency information of the LEPi instrument. Using this data set, we investigated relationships between molecular ion flux and geomagnetic index and solar wind parameters. The results indicate that molecular ion flux exhibits significant correlation with magnetic storms as well as solar wind speed. Furthermore, the long-term variations associated with the solar cycle were found. In recent two years (2021, 2022), the flux of the molecular ions increase significantly, suggesting that the solar EUV largely controls of the molecular ion flux in the inner magnetosphere.

