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Molecular and N⁺ Ions in the Auroral Ionosphere

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We present new direct ion composition observations of molecular and N⁺ ions in the auroral ionosphere from the Swarm-E (e-POP) Imaging and Rapid-Scanning Mass Spectrometer (IRM). Molecular N₂⁺, NO⁺ and O₂⁺ ions are regularly observed at all e-POP altitudes (350-1500 km) at auroral latitudes during quiet times, but more frequently and in greater abundances during active and storm times. Their presence is found to correlate with an enhancement in the local N⁺ density. We compare the detailed characteristics of the observed N⁺ and molecular ions at quiet, substorm, and storm times, respectively, as well as their occurrence distributions, based on both detailed case and statistical analyses from the first five years of the Swarm-E mission. Furthermore, we discuss the implications of the observed N⁺ and molecular ions on magnetosphere-ionosphere-thermosphere coupling, specifically the roles of the molecular ions in atomic oxygen production and those of both energetic N⁺ and molecular ions in the storm-time inner magnetosphere.