Why N+ ions are instrumental in our understanding of near-Earth plasma dynamics

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ABSTRACT: The presence of heavy ions in the near-Earth environment has a profound impact on the global magnetosphere-ionosphere dynamics, especially during times of increased geomagnetic activity. Even though past observations have established that N+ is a significant ion species both in the ionosphere and the magnetosphere, the transport and energization of N+, in addition to that of O+, have not been considered by most studies, simply because the observational record has been overlooked. In spite of only 12% mass difference, nitrogen and oxygen have different ionization energies, scale heights and charge exchange cross sections with the exospheric hydrogen. The latter, together with the geocoronal density distribution, plays a key role in the formation of Energetic Neutral Atoms (ENAs), which in turn control the energy budget of the inner magnetosphere and the decay of the ring current. Based on these differences, tracking the behavior of oxygen and nitrogen ions serves as a tracer for the altitude dependent transport and energization processes of plasma throughout the ionosphere-magnetosphere system. However, the differences between O+ and N+ transport and energization are not quantified nor understood at this time and it could play a crucial role in the interpretations and analysis of data from many current magnetospheric missions. Numerical simulations using the Hot Electron and Ion Drift Integrator (HEIDI) model suggest that the contribution of N+ to the ring current dynamics is significant, as the presence of N+, in addition to that of O+, alters the development and the decay rate of the ring current. These findings suggest that differentiating the N+ transport from that of O+ in the near- Earth environment has a profound impact on global magnetosphere dynamics, as plasma composition affects both the local and the global properties of the plasma.