The consequences of heavy ion outflow on the near-Earth plasma dynamics

Changes in the ion composition throughout the Earth's magnetosphere-ionosphere system can have profound implications on plasma structures and dynamics, since it can modify the temperature and the magnetic field configuration, altering the convection patterns inside the magnetosphere. The ratio of light to heavy ions has been shown to be highly dependent of geomagnetic activity, with the heavy ion content increasing with increasing activity. This suggest that ions of ionospheric origin can become the dominant species in the inner magnetosphere during disturbed times. Numerous studies focused on the transport and energization of O^+ through the ionosphere-magnetosphere system; however, relatively few have considered the contribution of N^+ to the ionospheric outflow and the near-Earth plasma, even though past observations have established that N^+ is a significant ion species in the ionosphere and its presence in the magnetosphere is significant.

In spite of only 12% mass difference, N^+ and O^+ have different ionization potentials, scale heights and charge exchange cross sections. The latter, together with the geocoronal density distribution, plays a key role in the formation of ENAs, which in turn controls the energy budget of the inner magnetosphere and the overall loss of the ring current. In addition, the presence of N^+ adds another frequency band for EMIC waves between the He^+ and O^+ cyclotron frequencies, which is relevant to study some unexplored part of the observed wave spectrum. Observations show significant variation in density ratio and temperature anisotropy of heavy ions, and these variations can alter the threshold and the growth of the EMIC instability significantly.

Numerical simulations 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. Electron transfer collisions are far more efficient at removing N^+ the system, compared with O^+ ions. These findings suggest that differentiating the N^+ loss and transport from those of O^+ in the near-Earth environment has a profound impact on global magnetosphere dynamics.

This presentation highlights the consequences of heavy ions outflow on the near-Earth plasma, which suggest that tracking the behavior of oxygen and nitrogen ions could serves as a tracer for the altitude dependent transport and energization processes of ionospheric plasma.