Geophysical Research Abstracts
Vol. 16, EGU2014-3822, 2014
EGU General Assembly 2014

Nitrogen Ion TRacing Observatory (NITRO) concept: a possible mission for next ESA's M-class call

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Nitrogen is a key element for life as an inevitable part of the amino acid and protein, and its oxidation state (NH_3 or N_2 or NO_X) in the ancient atmosphere is one of the key factors that determine the difficulty in forming amino acid without biological processes. Considering the fact that nitrogen molecule with triple chemical binding is much more difficult to be desolved/ionized than oxygen molecule with double chemical binding, and that dependence of the ion outflow from the ionosphere on the geomagnetic activity is more drastic for cold nitrogen ion than cold oxygen ions, it is important to understand the dynamic of N^+ and N_2^+ at different solar conditions as compared to oxygen dynamics or proton dynamics. However, nearly no such observation exists at low energy less than keV, except very little observations for thermal nitrogen.

One reason for lack of such measurement is difficulty in separating hot N^+ from hot O^+ even with the modern instruments, causing past instruments on board magnetospheric missions not targeting such separation but rather targeting higher temporal and spatial resolutions. However, with recent improvement of mass-separating ion analyser, it is now most likely possible to separate O^+ and N^+ by masking H^+ and He^{++} and by limiting the angular coverage to minimize the contamination. In this sense, the nitrogen study in the magnetosphere requires a dedicated space mission.

At moment there are two options: (1) pioneering single spacecraft mission with minimum instrumentation to detect hot nitrogen ions of missing energy range from 50 eV to 10 keV in the past missions; and (2) multi-spacecraft mission to make a comprehensive understanding of the dynamics of nitrogen ions in the magnetosphere. Here we present necessary spacecraft and instrumentation for the second option because that will be fitted into the M-class mission (450 MEUR) that European Space Agency most likely announces soon this year.

The mission consists of three spacecraft, two mid-altitude satellites for in-situ measurement with gradient information (by the second spacecraft), and one low-altitude satellite for outward remote sensing to obtain line-of-sight integration information. Instrumentation for such a mission also benefits studies on the inner magnetosphere, substorms, and basic plasma physics such as ion energization. We welcome contributions for the model instrumentation fitting into the mission particularly the optical ones toward the coming European M-class announcement. The other ideas to detect the nitrogen ions and their dynamics are also very welcome.