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Need for a mission to understand the Earth-Venus-Mars difference in Nitrogen

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This presentation is based on a satellite mission proposal that was submitted to ESA's call for a Small Mission in June 2012. Although the mission was not selected, its science was recommended by the Solar System Exploration Working Group.

Nitrogen is a key element for life as an inevitable part of the amino acid and protein. While nitrogen is abundant on the Earth (the amount in the soil, crust, and ocean are small compared to the atmospheric amount) and on Venus (only 3% but pressure is 90 times of the Earth, resulting in three times as the Earth), Martian atmosphere has very little nitrogen, about only 0.01% of the Earth or Venus (with 10% of planetary mass). This contrasts the oxygen abundance, which is found in all three planets (Martian case, it is now believed to exist in the crust as oxidized rocks because the observed escape rate is equivalent only 10 m deep water). Considering the fact that nitrogen is much more difficult to be ionized than oxygen due to triple 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, absence of the nitrogen only on the Mars is a mystery, while this absence might explain the absence of life on Mars at the present knowledge.

From these viewpoints, it is important to understand the dynamic of N^+ and N_2^+ at different solar conditions, e.g., its difference from oxygen dynamics for whatever the planet. One reason for lack of such measurement except cold ions is the difficulty in separating hot N^+ from O^+ in the modern time-of-flight instruments, but it is now most likely possible to separate O^+ and N^+ using magnetic mass analyzer if we mask H^+ and if we limit the angular coverage to minimize contamination. The nitrogen study in space requires a dedicated space mission that covers both the polar region and inner magnetosphere. Instrumentation for such a mission also benefits study of inner magnetospheric study, substorm studies, and basic plasma physics such as ion energization. We present the science and instrumentation of the proposed NITRO mission.