Observations of magnetospheric particles during large storms and assessing their effects on the Earth's atmosphere

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Strong solar wind drivers such as coronal mass ejections (CMEs) and high-speed solar wind streams can produce large increases in magnetospheric particle populations. The energetic particles produced at interplanetary shock waves and deep within the Earth's magnetosphere have been observed over the polar regions using the Polar/PIXIE X-ray experiment. The sensors onboard the Student Nitric Oxide Explorer (SNOE) spacecraft show these events to produce substantial increases of nitric oxide in the Earth's upper atmosphere. We have examined the impacts of major storm events on atmospheric particle precipitation rates and on atmospheric chemistry in the thermosphere. Using the constellation of available spacecraft, we are able to follow the particle chain from the Sun's surface all the way to the upper layers of Earth's atmosphere. We present specific information on intensities, energy spectra, and anisotropies of precipitating particle populations and assess their impacts on the Earth's atmosphere. A particularly striking set of chemical changes in the middle atmosphere (including 60% O_3 reductions at 40 km altitude) were seen following the Halloween storms of 2003 [Randall, et al., 2005]. However, a key remaining challenge is to measure directly the effects of precipitating energetic particles on atmospheric chemistry in the polar night. We argue that stellar occultation measurements of odd-nitrogen species are required to properly characterize the last leg of the Sun-Earth Connection chain. Such a program of measurements has been advocated in the recent NASA Science Roadmap and we discuss a mission concept in this presentation.