EPSC Abstracts
Vol. 6, EPSC-DPS2011-929, 2011
EPSC-DPS Joint Meeting 2011

Constraining Solar System Parameterization from Lightning and Schumann Resonance Measurements in the Outer Planets

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Abstract

The formation and evolution of the Solar System is closely related to the abundance of volatiles, namely water, ammonia, and methane in the protoplanetary disk. Accurate measurement of volatiles in the Solar System is therefore important to understand not only the nebular hypothesis and life origin but also planetary cosmogony as a whole. In a broader context, volatile measurements also contribute to the investigation of exoplanets formation and dynamics, namely identification of the snow line location, i.e. the boundary between silicates and ices dominated thermodynamic processes. Recent detection of signatures of the Earth-ionosphere cavity from orbit made onboard the C/NOFS (Communications /Navigation Outage Forecasting System) satellite offers new means to study atmospheric electricity remotely, namely Extremely Low Frequency (ELF) electromagnetic wave propagation. In this work, we propose a new, remote sensing technique to infer the water content in planetary environments, mainly Uranus and Neptune. Assessment of lightning activity and Schumann resonance signatures in the giant planets contributes to constrain volatiles uncertainty in the gaseous envelope of giant planets. After presenting distinctive Schumann resonance remote sensing measurements of the Earth environment, we discuss to what extent ELF wave signatures can be used to estimate electric conductivity profiles and water content of the gaseous envelope of Uranus and Neptune.