Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09860, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09860
EGU General Assembly 2008
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Ion escape from the ionosphere of Titan

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Ions have been observed to flow away from Titan along its induced magnetic tail by the Plasma Science Instrument (PLS) on Voyager 1 and the Casini Plasma Spectrometer (CAPS) on Cassini. In both cases, the ions have been inferred to be of ionospheric origin. Recent plasma measurements made at another unmagnetized body, Venus, have also observed similar flow in its magnetic tail. Much earlier, the possibility of such flow was inferred when ionospheric measurements made from the Pioneer Venus Orbiter (PVO) were used to derive upward flow and acceleration of H^+, D^+ and O^+ within the nightside ionosphere of Venus [1]. The measurements revealed that the polarization electric field in the ionosphere produced the principal upward force on these light ions. The resulting vertical flow of H^+ and D^+ was found to be the dominant escape mechanism of hydrogen and deuterium, corresponding to loss rates consistent with large oceans in early Venus [2]. Other electrodynamic forces were unimportant because the plasma beta in the nightside ionosphere of Venus is much greater than one. Although the plasma beta is also greater than one on Titan, ion acceleration is expected to be more complex, especially because the subsolar point and the subflow points can be 180 degrees apart. Following what we learned at Venus, upward acceleration of light ions by the polarization electric field opposing gravity in the ionosphere of Titan will be described. Additional electrodynamic forces resulting from the interaction of Saturn's magnetosphere with Titan's ionosphere will be examined using a recent hybrid model [3].

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