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Ion densities in Titan's ionosphere, multi-instrument case study

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Abstract

The Cassini s/c *in-situ* plasma measurements of Titan's ionosphere by Radio and Plasma Wave Science (RPWS) Langmuir Probe (LP), Cassini Plasma Spectrometer (CAPS) Electron (ELS) and Ion Beam (IBS) are combined for selected flybys (**T16**, **T29**, **T40** & **T56**) to further constrain plasma parameters of ionosphere at altitudes 880-1400 km.

1. Introduction

Saturn's largest moon Titan hosts an atmosphere with complex organic chemistry initiated in the ionosphere and responsible for the production of aerosols in Titan's signature orange haze [*1-10*]. Lower region of Titan's ionosphere has been shown to be populated by negative ions [*8, 11-15*] and dusty plasma/aerosols [*9, 15*], which are important for the complex organic chemistry of the moon [*7, 16*]. Altitude and solar zenith dependencies of the ion charge densities were analysed previously [*14, 15*]. However, the charge of the neg. ions and dust grains has so far only been predicted theoretically [*17*]. Also, the average mass of ions in the LP data analysis has previously been derived from INMS data which gives a good flyby-coverage but is limited to lighter pos. ions (<100 amu) [*15*]. CAPS/ELS and CAPS/IBS can both detect heavy ions, but lack the coverage, especially since the CAPS instrument has been turned off in June 2012. Since the all heavier ions are formed from lighter ones, the average masses of the heavier ions are expected to exhibit a dependency on the average masses of the lighter ions. This trend is indeed present (**Figure 1**) and effectively extends the legacy of now offline CAPS to all Titan flybys.

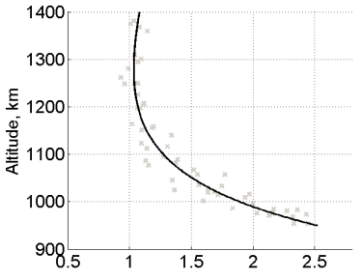

Figure 1. CAPS/IBS to INMS mean positive ion mass ratio

An immediate application is a correction of RPWS/LP-derived pos. and neg. ion charge densities, which reveals that previously reported densities [*15*] were severely underestimated (**Figure 2**). Combining the measurements of the negative ions/dust *density per charge* by CAPS/ELS with the negative ions/dust *charge density* by RPWS/LP gives a first empirical estimate of the negative ion/dust average charge to be ~2. Overall, the negative ion/dust *profiles* seem to match well between CAPS/ELS and RPWS/LP instruments (**Figure 2**).

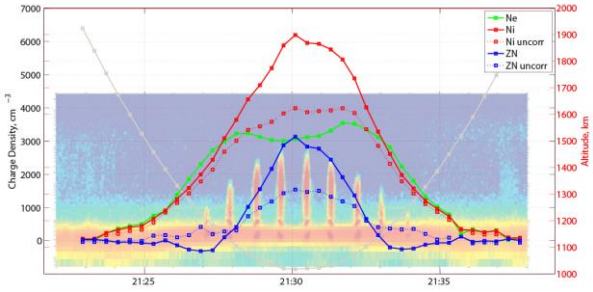

Figure 2. Example (T40) of RPWS/LP pos. (red, Ni) and neg. (blue, ZN) ion charge density correction with CAPS/ELS+IBS derived mass profiles. Dotted lines show the uncorrected densities; electron density (green, Ne) is shown for reference. Background: CAPS/ELS energy spectrum [*12*] with temporal scale adjusted to fit RPWS/LP.

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