A new empirical model of Saturn's plasma environment

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Introduction

In relation to the ESA Testbed for Radiation and Plasma Planetary Environments Development (TRAPPED) project, we are developing an empirical model of the plasma environment at Saturn to support future mission planning.

We present

- an overview of literature on in-situ plasma observations and models developed from all spacecraft that have visited Saturn
- a review of the availability and quality of plasma moments data at the planet
- a description of the approach to modelling work
- Consideration of significant moons' locations into model

Literature Review

Pioneer 11

- First in-situ measurements of magnetospheric plasma populations between ~4-17 R_S during flyby (1 R_S = 60,268 km). These measurements were incorporated into initial modelling work (e.g. Bridge et al. (1981)).

Voyager 1 & 2

- Low-energy plasma populations were observed during both Voyager 1 and 2 flybys. These observations were included in the models of Bridge et al. (1981), Richardson and Sittler (1990), Saur et al. (2004) and others.

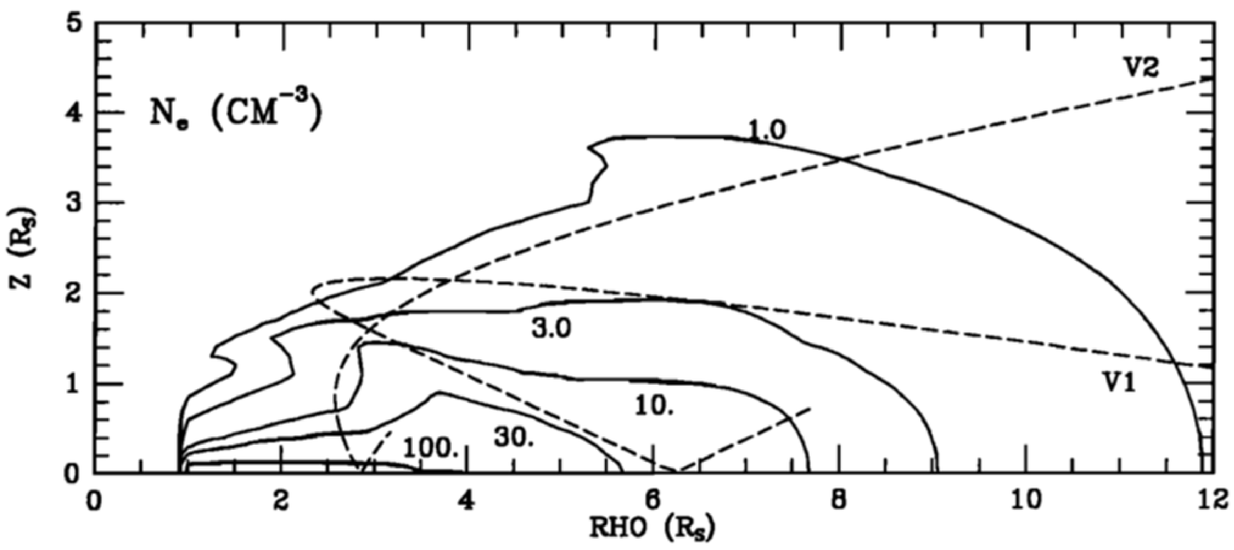

Figure 1: Model of electron density in rho-z space based on Voyager 1 and 2 plasma observations (Richardson and Sittler (1990)).

- The Voyager 2 flyby allowed modelling work to expand existing models (e.g. Richardson and Jurac (2004) and Jurac and Richardson (2005)).

Cassini

- The Cassini spacecraft payload provided multi-instrument in-situ plasma measurements with the Cassini Plasma Spectrometer (CAPS) and the Radio and Plasma Wave Science (RPWS) instrument over a 13-year period.

- Cassini-era models were able to identify a longitudinal asymmetry in electron density (e.g. Morooka et al., (2009)) and solar cycle modulation of Saturn's plasma torus (e.g. Holmberg et al., (2017)).

Data Review

We analyse the availability and quality of all plasma moments obtained using Cassini instruments on NASA-PDS and CDPP-AMDA.

CAPS

- CAPS-Fitted: ion moments determined by Wilson et al. (2017)
- CAPS-Derived: ion moments determined by Thomsen et al. (2010), and unpublished electron moments

RPWS

- RPWS-UHR: electron moments determined from upper hybrid resonance (UHR) frequency
- RPWS-LPST: electron and ion moments determined from voltage sweeps using Langmuir Probe (LP)
- RPWS-LPFP: electron moments determined from LP floating potential
- RPWS-QTN: electron moments determined using quasi-thermal noise (QTN) spectroscopy

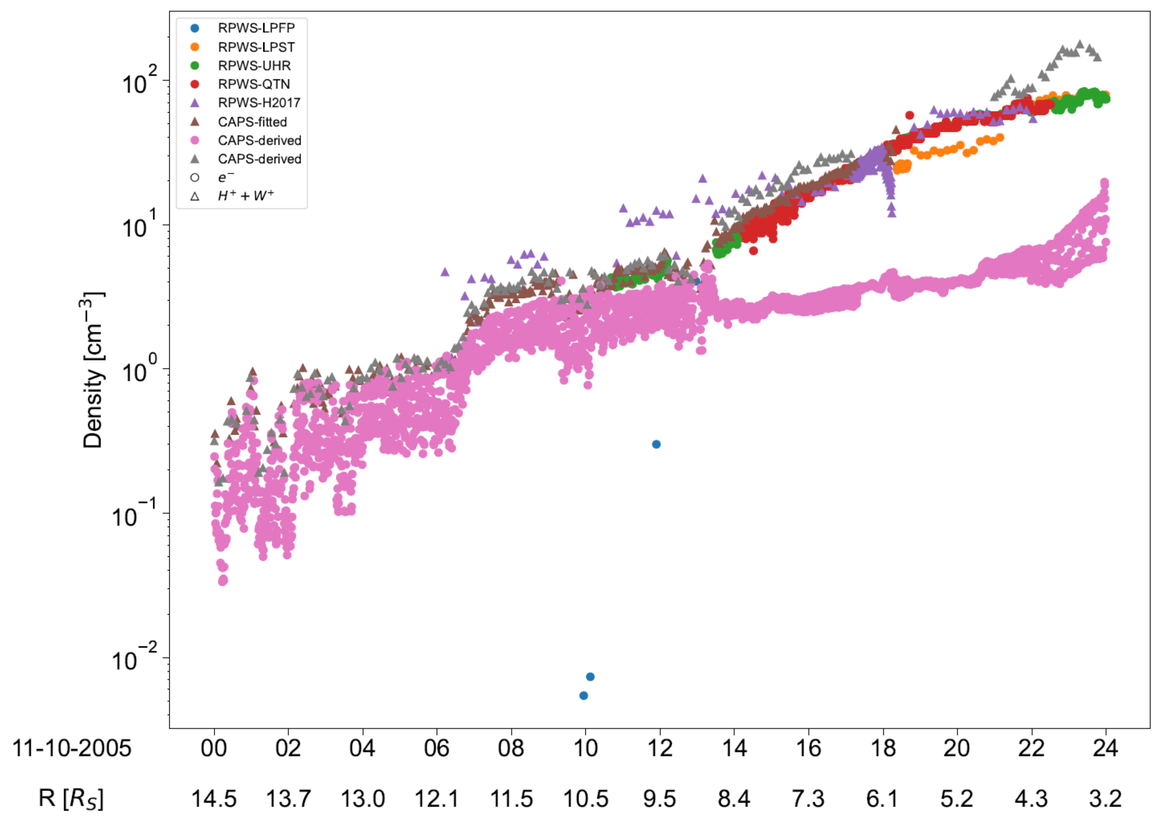

Figure 2: An example figure of daily figures generated to compare all publicly available plasma densities

Future Work

- We will develop the first empirical model of Saturn's plasma population that combines all Cassini datasets for average conditions.

- We aim to incorporate the moons Enceladus and Titan and their respective local environments into modelling work.

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CAPS-Derived ion data: https://doi.org/10.17189/0tg3-2z14

CAPS-Derived electron data: https://doi.org/10.17189/nzk5-rq31