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Thermal electron balance in Titan's nightside ionosphere

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Abstract

We present an assessment of the thermal electron balance in Titan's nightside ionosphere in the altitude range between 1100 and 1300 km. The aim of the study is to identify the main sources and loss mechanisms of thermal electrons and ions. For that purpose we test our ability to reproduce the electron number densities, $n_{e,Observed}$, observed by the Cassini Radio Plasma Science Wave/Langmuir Probe (RPWS/LP) instrument using a model assuming photochemical equilibrium. Additional assumptions in the model are that electrons are formed exclusively by ionization of N_2 and CH_4 through precipitating auroral electrons (and their secondaries) and lost exclusively through dissociative recombination with molecular ions.

External parameters in the model are defined by Cassini data. We use in particular 1) measurements of N_2 and CH_4 number densities by the Ion Neutral Mass Spectrometer (INMS), 2) electron temperatures measured by the RPWS/LP and 3) suprathermal electron intensities measured by the Cassini Plasma Spectrometer/Electron Spectrometer (CAPS/ELS) instrument. These data are combined with laboratory measurements on electron-impact ionization processes and dissociative recombination reactions to assess modeled electron number densities, $n_{e,Model}$.

The agreement between modeled and observed electron number densities is found to be reasonably good, with the ratio $n_{e,Model}/n_{e,Observed}$ typically ranging from 0.7 to 1.5. Worse agreement with ratios in the vicinity of 2 is found towards the higher altitudes considered where the ambient N_2 densities are low, perhaps relating to the increased importance of transport for the ionospheric species. The results are compared with $n_{e,Model}/n_{e,Observed}$ values derived in Titan's sunlit ionosphere [1].

References

[1] Vigren, E., Galand, M., Yelle, R. V., et al: On the thermal electron balance in Titan's sunlit upper atmosphere, Icarus, Vol. 223, pp. 234-251, 2013.