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Energetics of Titan's Ionosphere: Model and Cassini Data Comparisons

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Electron and ion temperatures in the terrestrial and planetary ionospheres are observed to be higher than neutral temperatures and measurements made by instruments onboard the Cassini spacecraft have shown that this is also true for Titan. Electron temperatures in excess of 1000 K were measured by the Radio and Plasma Wave (RPWS) Langmuir probe (LP). Ion temperatures were determined with a combined analysis of Cassini Plasma Spectrometer (CAPS)) and Ion and Neutral Mass Spectrometer (INMS) data and the published temperatures are close to neutral temperatures below an altitude of about 1500 km but become higher above this altitude. Elevated electron temperatures were predicted by pre-Cassini models and were due to heating by suprathermal electrons (both photoelectrons due to solar radiation and electrons from Saturn's magnetosphere). Suprathermal electron populations were observed in Titan's atmosphere by the Cassini electron spectrometer (CAPS-ELS). Models of the energetics that include Cassini inputs including neutral densities measured by the INMS were run and the results were compared with data including suprathermal electron fluxes and plasma temperatures. The effects on the energetics because of relative flow between the ions and neutrals (i.e., Joule heating), mass-loading, heat conduction, and flow parallel to the magnetic field line are examined. Estimates of the relative ion-neutral flow velocity are made using simple MHD theory plus Cassini data.