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Negative ion densities in the deep ionosphere of Titan

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The largest Kronian moon Titan has a unique nitrogen-rich atmosphere hosting complex organic chemistry that produces large pre-biotic molecules (tholins), and this could be similar to the upper atmosphere of early Earth. As tholin production has been shown to originate in Titan's extensive ionosphere, positive and heavy negative ions play crucial roles. The Cassini spacecraft Radio and Plasma Wave Science (RPWS) Langmuir Probe (LP) provides in-situ measurements of Titan's ionosphere, and we present here data from 46 deep flybys in the time period October 2004 to July 2012 of charge densities of positive and negative ions as well as electrons. These densities have been mapped with respect to altitude and solar zenith angle (SZA) in an altitude range of 880-1400 km. The inferred electron number densities are consistent with earlier presented observational results. Negative ion charge densities exhibit a trend that exponentially increases towards lower altitudes within the covered altitude range. This is especially evident on the night side of Titan (SZA > 110°). The negative ion charge densities at the lowest traversed altitudes (near 960 km) are inferred to be in the range 300-2000 cm-3. The results show that very few free electrons exist in the deepest regions (880-1050 km) of Titan's ionosphere. Instead this part of Titan's ionosphere is dominated by both negatively and positively charged heavy (>100 amu) organic ions. We therefore believe a dust/aerosol-ion plasma exist here, similar to what is found in noctilucent clouds in Earth's mesosphere.