Titan’s Low Lower Atmospheric Electrical Conductivity

*Ralph Lorenz[1]

1. Johns Hopkins University Applied Physics Laboratory

A prominent result of the Huygens Atmospheric Structure Instrument (HASI) investigation was the detection of enhanced ionization at an altitude of ~60km, due to cosmic rays. The lower ionosphere profile is of interest in interpreting a possible Schumann resonance in terms of ice thickness above an internal ocean. The atmospheric conductivity profile above and below the ionization peak has received less attention, notably because the loss of one telemetry channel from the Huygens probe. This meant that the most sensitive Relaxation Probe (RP1) data were not received. Below 40km, the conductivity was below the measurement threshold of RP2 (i.e. during each 1-minute measurement sequence, the sensor voltage did not measureably decay, resulting in a (not widely reported) upper limit on conductivity in the lower atmosphere of ~0.2 pS/m. An independent measure of conductivity can be derived from the HASI mutual impedance probe, but is highly susceptible to calibration errors.

Some models have predicted rather high conductivity, driven apparently by assumed photoelectron release from aerosols. However, the ultraviolet flux assumed in these models is not consistent with occultation measurements by Cassini.

Cosmic ray fluxes and thus ionization are weak at the surface of Titan, while organo-nitrogen compounds and aerosols are electrophilic. Thus the balance of electron production and removal is biased strongly towards removal, explaining the low observed conductivity. It is possible that as on Earth, there may be a modest enhancement near the surface, due to radioactive potassium in surface ice, or beta decay from radiocarbon (itself produced by cosmic ray interactions with nitrogen). A radioisotope power supply on a future mission might also cause a local conductivity enhancement.

Keywords: Titan, Internal Ocean, Atmospheric Conductivity, Cosmic Ray, Ionization, Huygens

