Ionosphere Plasma State Determination in Low Earth Orbit from International Space Station Plasma Monitor

Leonard Kramer
Boeing Space Environments
Houston

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A plasma diagnostic package is deployed on the International Space Station (ISS). The system – a Floating Potential Measurement Unit (FPMU) – is used by NASA to monitor the electrical floating potential of the vehicle to assure astronaut safety during extravehicular activity. However, data from the unit also reflects the ionosphere state and seems to represent an unutilized scientific resource in the form of an archive of scientific plasma state data. The unit comprises a Floating Potential probe and two Langmuir probes. There is also an unused but active plasma impedance probe. The data, at one second cadence, are collected, typically for a two week period surrounding extravehicular activity events. Data is also collected any time a visiting vehicle docks with ISS and also when any large solar events occur. The telemetry system is unusual because the package is mounted on a television camera stanchion and its data is impressed on a video signal that is transmitted to the ground and streamed by internet to two off center laboratory locations. The data quality has in the past been challenged by weaknesses in the integrated ground station and distribution systems. These issues, since mid-2010, have been largely resolved and the ground stations have been upgraded. Downstream data reduction has been developed using physics based modeling of the electron and ion collecting character in the plasma. Recursive algorithms determine plasma density and temperature from the raw Langmuir probe current voltage sweeps and this is made available in real time for situational awareness. The purpose of this paper is to describe and record the algorithm for data reduction and to show that the Floating probe and Langmuir probes are capable of providing long term plasma state measurement in the ionosphere. Geophysical features such as the Appleton anomaly and high latitude modulation at the edge of the Auroral zones are regularly observed in the nearly circular, 51° inclined, 400 km altitude ISS orbit. Evidence of waves in the ion collection current data is seen in geographic zones known to exhibit the spread-F phenomenon. An anomaly in the current collection characteristic of the cylindrical probe appears also too be organized by the geomagnetic field.