In-Situ F2-Region Plasma Density and Temperature Measurements from the International Space Station

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Introduction

The International Space Station (ISS) offers an ideal platform for in-situ studies of space weather effects on the mid and low-latitude F2 region ionosphere. The Floating Potential Measurement Unit (FPMU) operating on the ISS since Aug 2006 is a suite of plasma instruments: a Floating Potential Probe (FPP), a Langmuir Impedance Probe (LIP), a Wide-sweep Langmuir Probe (WLP), and a Narrow-sweep Langmuir Probe (NLP). This instrument package provides a new opportunity for collaborative multi-institutional studies of the F-region ionosphere during both quiet and disturbed periods. This presentation first describes the operational parameters for each of the FPMU probes and shows examples of an in-situ model validation. We then show comparisons with the plasma density and temperature measurements derived from the TIMED GUVI ultraviolet imager, the Millstone Hill ground scatter radar, and DIAS digisondes. Finally, we show one of the several observations of right-time equatorial density holes demonstrating the capabilities of the probes for monitoring mid and low-latitude plasma processes.

Probe Description

The FPMU operation is autonomous with either an on or off state. The only control is over the operation of a heater in the WLP. The FPMU is mounted on a camera port and its data is transmitted via the Ku-Band. The camera interface allows for high bandwidth (~2.72 MHz) data rates each second. For 2007 the OSU for the Ku-Band is ~60%-65%.

Independent Data Verification

The density and temperatures derived from the WLP and NLP Langmuir probes were compared to measurements from the incoherent scatter radar (ISR) at Millstone Hill, the European Digital Scatter radar (DIAS) digisondes, and the TIMED Global Ultraviolet Imager (GUVI). Differences between the WLP and NLP instruments are shown below where the difference is determined as the average of the two measurements. (Coffey et al., 2008).

Data Verification - Densities

In 2006, the FPMU has been operated during several data sessions and is meeting its primary requirement of providing floating potential measurements of the ISS and its secondary requirement of providing measurements of the local ionospheric plasma. It will continue to operate during intermittent data campaigns at least through 2008 and possibly through 2010. Potential science interests of the FPMU include: Storms, field perturbations, "motion of light ions through and plasmapause boundary during geomagnetic storms. Time variations of density and temperatures in equatorial anomaly regions. Electron temperature and density associated with sub-solar ion-drift (SKID) regions. Electron temperatures in stable auroral red (SAR) arcs. Collaborative studies with ground based remote sounding (ISR, ionosondos) and space based in-situ (CNOFS, CHAMP, COSMIC, GPS ionospheric tomography) sensors. Validation of real-time ionospheric forecast models (IAR, etc.) Interaction of large vehicles with ionospheric plasma.

Summary and Future Operations

The FPMU has been operated during several data sessions and is meeting its primary requirement of providing floating potential measurements of the ISS and its secondary requirement of providing measurements of the local ionospheric plasma. It will continue to operate during intermittent data campaigns at least through 2008 and possibly through 2010. Potential science interests of the FPMU include:

- Storms: field perturbations, "motion of light ions through and plasmapause boundary during geomagnetic storms.
- Time variations of density and temperatures in equatorial anomaly regions.
- Electron temperature and density associated with sub-solar ion-drift (SKID) regions.
- Electron temperatures in stable auroral red (SAR) arcs.
- Collaborative studies with ground based remote sounding (ISR, ionosondos) and space based in-situ (CNOFS, CHAMP, COSMIC, GPS ionospheric tomography) sensors.
- Validation of real-time ionospheric forecast models (IAR, etc.)
- Interaction of large vehicles with ionospheric plasma.

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Figure 1: FPMU mounted on the ISS
Figure 2: Typical OSU ground track.

Table 1: Measured parameters, stats, and density changes for the FPMU

Table 2: Operation dates of FPMU instrument suite

Figure 5: Difference in densities between ISR on March 6, 2008. Day 69 during active geomagnetic conditions.

Figure 6: Difference in temperatures between ISR on March 6, 2008. Day 69 during active geomagnetic conditions.

Figure 7: Difference in electron density between WLP and NLP on 2006/12/20.

Figure 8: Difference in electron temperature between WLP and NLP on 2006/12/20.

Figure 9: Difference in electron density between ISR and GUVI on 2006/12/20.

Figure 10: Difference in electron temperature between ISR and GUVI on 2006/12/20.

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