Introduction

The International Space Station orbit provides 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 Plasma Impedance Probe (PIP), a Wide-sweep Langmuir Probe (WLP), and a Narrow-sweep Langmuir Probe (NLP). This instrument package provides a new opportunity for collaborative multi-instrument 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 instrument validation. We then show comparisons with the plasma density and temperature measurements derived from the TIMED GUVI ultraviolet imager, the Millstone Hill ground based incoherent scatter radar, and DIAS digisondes. Finally, we show some of several observations of right-time equatorial density holes demonstrating the capabilities of the probes for monitoring mid and low latitude plasma processes.

Probe Description

**FPP** - a gold-plated sphere of radius 5.08 cm that performs a 512-point voltage sweep from -4.85 V to +4.85 V at a constant voltage step size of 12 mV.

**WLP** - a gold-plated cylinder with radius 1.43 cm and length 5.08 cm that performs a 2,048-point voltage sweep from -20 V to +80 V relative to chassis ground. Two different voltage step sizes (25 mV and 250 mV) are used. An internal heater allows surface cleaning.

**NLP** - a gold-plated cylinder with radius 1.43 cm and length 5.08 cm that performs a 2,048-point voltage sweep from -4.85 V to +4.85 V about a reference potential determined by the FPP. A constant voltage step size of 12 mV is used.

For each Langmuir probe, the voltage varies from low to high over one second and from high to low the next second with the collected current measured in gain channels.

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 Upper Atmosphere Sensor (DIAS) digisondes, and the TIMED Global Ultraviolet Imager (GUVI). Differences between the WLP and NLP and these instruments are given below where the difference = measurement - reference.

**Data Verification - Densities**

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Difference</th>
<th>NLP</th>
<th>WLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPP</td>
<td>-0.10</td>
<td>0.2</td>
<td>0.15</td>
</tr>
<tr>
<td>WLP</td>
<td>0.05</td>
<td>-0.1</td>
<td>-0.2</td>
</tr>
<tr>
<td>NLP</td>
<td>-0.05</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Data Verification - Temperatures**

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Difference</th>
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</tbody>
</table>

Sample Data

Figures 4 summarizes FPMU data for orbit day 2007062. The top panel contains floating potential measurements from the FPP, WLP and NLP. The ISS charges negative with respect to this plasma (graphed as a positive number here). The middle panel shows the density derived from the FPP, WLP and NLP. The bottom panel shows the electron temperature derived from the WLP and NLP. (Wright et al., 2008)

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

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Summary and Future Operations

Since August 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 goals of interest to the IT community that could be addressed by the FPMU include:

* Spread-F density perturbations, "Motion of light on shingles and plasmapause boundary during geomagnetic storms."
* Storm time variations of density and temperatures in equatorial anomaly regions. "Electron temperature and density associated with subauroral ion-drift (SID) regions. Electron temperatures in stable auroral no (SAR) arcs. Collaborative studies with ground based remote sensing (ISR, ionsondos) and space based in-situ (CNOFS, CHAMP, COSMIC, GPS, ionospheric tomography) sensors. Validation of real-time ionospheric forecast models (SARM, etc."
* Interaction of large vehicles with ionospheric plasma.

References, Acknowledgements

We would like to thank the Space Weather Center, TIMED GUVI team, and the WLP team for providing the data used in these comparisons.


2. We thank the TIMED and GUVI teams for providing us with their data.

3. We thank the WLP and NLP teams for providing us with their data.

4. We thank the FPP and PIP teams for providing us with their data.

5. We thank the DIAS digisonde team for providing us with their data.

6. We thank the FPMU team for providing us with their data.

7. We thank the FPMU team for providing us with their data.

8. We thank the FPMU team for providing us with their data.