Observations of Nighttime Equatorial Holes

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: Floating Potential Probe (FPP), Plasma Impedance Probe (PIP), Wide-sweep Langmuir Probe (WLP), and 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 intra-instrument validation. We then show comparisons with the plasma density and temperature measurements derived from the TIMED GLM ultraviolet imager, the Millstone Hill ground based incoherent scatter radar, and DIAS digisondes. Finally we show one of several observations of nighttime equatorial density holes, demonstrating the capabilities of the probes for monitoring mid and low-latitude plasma processes.

Intra-Probe Data Comparison

FIGURES 4 summarizes FPMU data for orbit day 2007/062. The top panel contains floating potential measurements from the FPP, WLP, and NLP. The ISS charges negative with respect to the plasma (graphed as a positive number here). Numbered labels for this panel are annotated on the right. The middle panel shows the density derived from the PIP, WLP, and NLP. The bottom panel shows the electron temperature derived from the WLP and NLP (expanded from Wright et al., 2008).

Data Verification - Densities

FIGURES 5 and FIGURES 6 show histograms of the difference in densities between the TIMED GuVI ultraviolet imager and the Wide-Sweep Langmuir Probe (WLP) and Narrow-Sweep Langmuir Probe (NLP). The left side of each histogram shows the difference in density in the positive direction (i.e., when the densities are larger in the WLP/NLP than in the TIMED GuVI). The right side of each histogram shows the difference in density in the negative direction (i.e., when the densities are larger in the TIMED GuVI than in the WLP/NLP). The median difference in density is shown for each histogram. The median difference in density for the TIMED GuVI and WLP/NLP is less than 1% for all cases.

Data Verification - Temperatures

FIGURES 7 and FIGURES 8 show histograms of the difference in electron temperatures derived from the WLP and NLP and the Incoherent Scatter Radar (ISR) at Millstone Hill, Massachusetts, and the WLP and NLP. The left side of each histogram shows the difference in temperature in the positive direction (i.e., when the temperatures are larger in the WLP/NLP than in the ISR). The right side of each histogram shows the difference in temperature in the negative direction (i.e., when the temperatures are larger in the ISR than in the WLP/NLP). The median difference in temperature is shown for each histogram. The median difference in temperature for the WLP/NLP and ISR is less than 1% for all cases.

Summary and Future Operations

Since August 2006, the FPMU has been operated during several data campaigns and is providing measurements of the local ionospheric plasma and floating potential of the ISS. Potential science goals for this F2-T community that could be addressed by the FPMU include:

- Spread F density perturbations - fraction of light ion troughs and plasmapause boundary during geomagnetic storms.
- Storm time variations of density and temperatures in equatorial anomaly regions.
- Low and mid-latitude collaborative studies with ground based remote sensing (ISR, ionosonde) and space-based in-situ sensors (C/NOFS, CHAMP, COSMIC, GPS ionospheric tomography).
- Validation of real-time ionospheric forecast models (GAIM, etc.)
- Interaction of large vehicles with ionospheric plasma.

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