Geophysical Research Abstracts
Vol. 20, EGU2018-5742, 2018
EGU General Assembly 2018

Development and Initial Results of a Double Hemispherical Probe (DHP) for The Advancement of Space Plasma Measurements

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Langmuir probes are an important instrument used for characterizing space plasmas. However, the local plasma conditions around a probe, due to the interaction of the ambient environment with the spacecraft (SC) and probe itself, could be very different from the true ambient plasmas. These local plasma conditions are often anisotropic and/or inhomogeneous. Most of the current in-situ Langmuir probes, that are made of a single electrode sensor, have difficulty to minimize these local plasma effects on the probe measurements, causing errors in the derived plasma parameters. A directional probe is an appropriate instrument for characterizing anisotropic and inhomogeneous plasmas. The split Langmuir probe and the Segmented Langmuir Probe (SLP) have been developed to measure the plasma flow in Earth's ionosphere. Here we introduce a new type of a directional Langmuir probe, the Double Hemispherical Probe (DHP), aimed for improving the capability and accuracy for space plasma measurements in a broad range of scenarios: low-density plasmas; high surface-emission (photo and/or secondary electron emission) environments; flowing plasmas; and dust-rich plasma environments. The DHP is composed of two identical hemispheres that are electrically insulated and swept with the same potential biases simultaneously. The differences between the current-voltage (I-V) curves of two hemispheres are used to identify and characterize the anisotropic/inhomogeneous plasma conditions created around the probe, which will be then aid in removing or minimizing these effects to improve the analysis and interpretation of the I-V curves. This paper describes the basic concept of the DHP, as well as its initial results tested in the laboratory plasma environments.