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A transition parameter method for reordering ion data at magnetospheric boundaries at Venus

G. Guymer (1), M. Grande (1), S. Barabash (2) and T. Zhang (3)
(1) Institute of Maths and Physics, Aberystwyth University, UK, (2) Swedish Institute of Space Physics, Kiruna, Sweden, (3) Space Research Institute, Austrian Academy of Sciences, Graz, Austria
(gemma.guymer@gmail.com)

Introduction

The current work is an investigation of the characteristics of the bow shock, magnetic pile-up boundary, and ion composition boundary at Venus. The aim is to provide better resolution for the boundaries detected from ion data.

The data from the Venus Express Ion Mass Analyser (IMA), magnetometer (MAG), and Electrostatic Analyser (ELS) are used. These were gathered over a period of 14 months

Due to fluctuations in the solar wind at Venus, which cause boundary motions which are rapid compared to the spacecraft velocity, we need a procedure to identify the position of the spacecraft relative to the boundary. Using electron measurements of dayside boundary crossings a transition parameter is defined. This is then used to reorder the sparse ion data.

Methodology

Within the ionosheath the electron thermal pressure becomes turbulent but reduced in magnitude, whilst the magnetic pressure increases in both magnitude and turbulence.

The bow shock has been identified using electron data. The magnetic pile-up boundary has been defined as the location where magnetic pressure reaches its peak value. The bow shock exhibits a jump in both the electron thermal pressure and the magnetic pressure (see figure 1).

We have selected 10 examples which were examined by eye to find the upstream bow shock and magnetic pile-up boundaries.

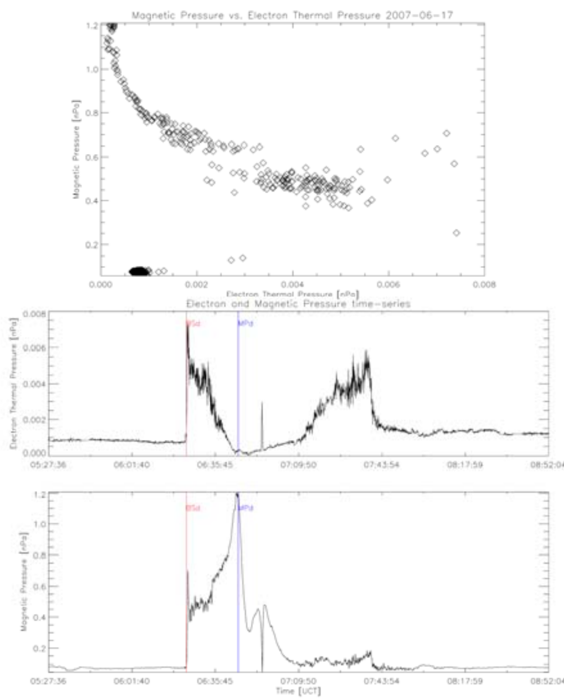

Figure 1 - *Dayside boundaries (bow shock & magnetic pile-up) using the electron and the magnetic data sets.*

An algorithm has been developed to automatically identify both upstream and downstream electron boundaries of the planet (similar to the method used by I. Whittaker (2010) [1] for the ions); however, this remains less reliable than visual identification by a skilled researcher.

The transition parameters were obtained with the electron data for the temperature and the density. The same method used by D.A. Bryant and S. Riggs (1989) [2].

$$r = \log_{10}(Ne) - 1.*\log_{10}(Te) \quad (1)$$

$$TP = 100*(r_{min} - r)/(r_{max} - r_{min}) \quad (2)$$

Where:

Ne: number density
Te: temperature
TP: transition parameter

This transition parameter can then be used to reorder any IMA data.

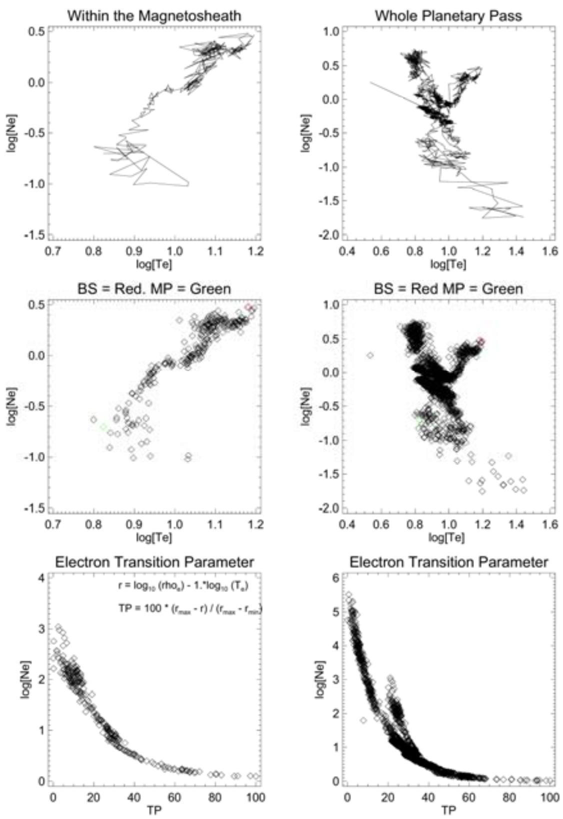

Figure 2 - *Transition parameter from the electron temperature & density*

Conclusions and further work

Transition parameter work can also be used to tackle the ‘bouncing boundary’ whereby the spacecraft encounter the boundary more than once, due to the boundary’s rapid movement in regards to the spacecraft.

The automatic algorithm will be improved by a more complex fitting system.

Re-ordering the IMA data sets with respect to the boundaries defined from MAG and ELS will allow a more highly resolved picture to be constructed. This picture can then be compared to the existing one.

Acknowledgements

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References

[1] I. Whittaker (2010), PhD Thesis

[2] D.A. Bryant and S. Riggs (1989) *Phil. Trans. R. Soc. Lond,* A 328