EPSC Abstracts,
Vol. 4, EPSC2009-733, 2009
European Planetary Science Congress,

An examination of pressure balance in high altitude flux ropes at Venus

G. Guymer (1), M. Grande (1), I. Whittaker (1), T.Zhang (2), S. Barabash (3), H. Wei (4) and the ASPERA-4 Team

(1) Institute of Maths and Physics, Aberystwyth, UK, (2) Space Research Institute, Austrian Academy of Sciences, Graz, Austria, (3) Swedish Institute of Space Physics, Kiruna, Sweden, (4) IGPP, University of California, Los Angeles, USA (geg07@aber.ac.uk)

Abstract

Venus has an insignificant intrinsic magnetic field, with an upper limit in the order of 10^{-5} of Earth's [1]. Thus the Venusian ionosphere presents the main obstacle to the solar wind. However, IMF frozen-in to the solar wind interacts with the ionosphere to induce a magnetic field. This interaction results in two cases, dependant on the dynamic pressure of the solar wind (p_{dyn}) and the thermal pressure of the ionosphere, p_{iono}. When p_{dyn} exceeds (p_{iono}) the ionosphere is compressed and the ionopause becomes a thick layer. In this case large-scale magnetic fields may occur within the ionosphere; this is known as the magnetised ionosphere. In the reverse case the ionopause is a more distinct barrier at a higher altitude leading to an ionosphere free of large-scale fields, known as the un-magnetised ionosphere.

In the un-magnetised case small-scale magnetic structures known as flux ropes are detected in the ionosphere of Venus. They are apparent in magnetic field data as discrete increases in field magnitude (which can be many 10's of nT) from the background field and lasting for a matter of seconds with diameters in the region of 10^1 km. Flux ropes possess strong axial magnetic fields at their centre which are then wrapped in field with increasing azimuthal components as the distance from the central axis increases [2].

Venus Express (VEX), which arrived at its destination in 2005 carries onboard the plasma analyser, ASPERA-4 which includes the Ion Mass Analyser (IMA). The payload of VEX also includes dual magnetometers (MAG). The data collected by these instruments are being used to analyse the ion response to magnetic flux ropes in the upper ionosphere.

An examination of time series energy spectra for H^+, He^{++}, He^+ and O^+ reveals simultaneous high and low energy populations of these species. In several instances these occurrences are also temporally coincident to the detection of flux ropes in the upper ionosphere. However, whether these flux ropes and ion species phenomena are directionally aligned is, as of yet, undetermined.

Figure 1 shows a time series trace of magnetic field magnitude and ion energy-count rate spectra. At ~ 01:55:30 an instance of high and low energy populations of O^+ and H^+ occurring simultaneously to a flux rope can be seen. Note, these plots do not give any information regarding the direction of detection of these ions. Figure 2 demonstrates that both energy populations occur within the same spacecraft sampling sectors.

Ledvina *et al.* [3] studied flux ropes detected by Pioneer Venus Orbiter during solar maximum. They found high altitude flux ropes to be statistically force-free, exhibiting no dip in thermal pressure with the incumbent rise in magnetic pressure during rope traversal. Decreased thermal pressure across flux ropes would indicate whether they exclude ionospheric material as they are dragged through the ionosphere. VEX has been detecting flux ropes at solar minimum and a similar study has been undertaken and preliminary results will be presented.

References

[1] Philips, J.L. and Russell C.T. (1987) *JGR,* 92, 2253–2263.

[2] Russell, C.T. et al. (1979) *Science,* 203,745–748.

[3] Ledvina, S.A. *et al*. (2002) *JGR*, 107, SMP7-1–SMP7-8.

EPSC Abstracts,
Vol. 4, EPSC2009-733, 2009
European Planetary Science Congress,

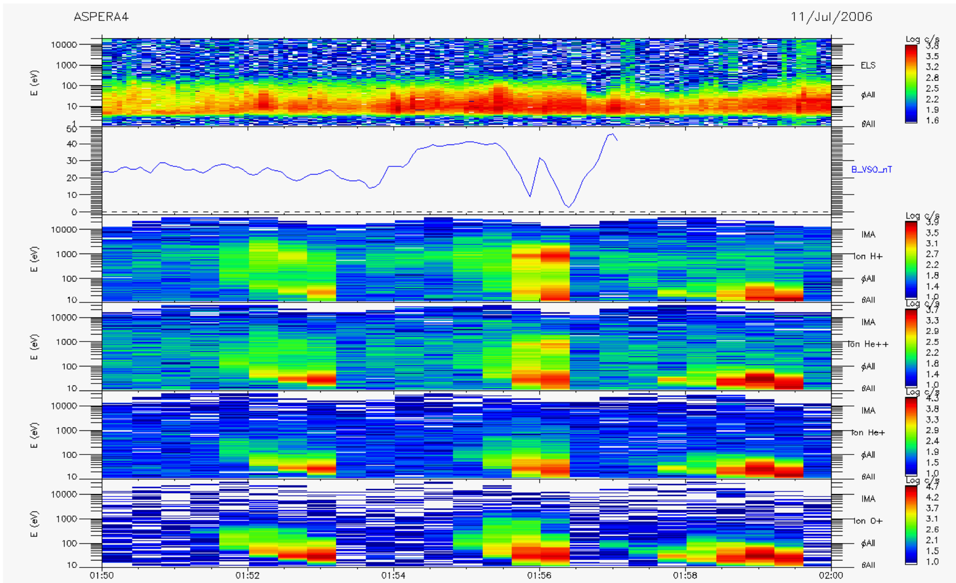

Figure 1: Time series trace of magnetic magnitude and energy-count rate spectra for ion species H^+, He^{++}, He^+ and O^+.

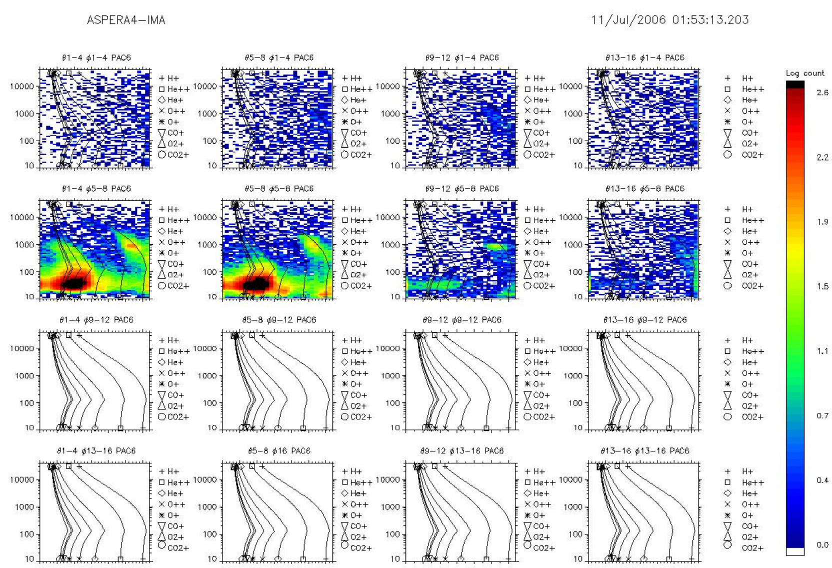

Figure 2: Energy-Mass spectra from ASPERA-4 IMA showing two energy populations of singly ionised hydrogen and oxygen.