Geophysical Research Abstracts
Vol. 16, EGU2014-2720, 2014
EGU General Assembly 2014

Ion heating near the ion composition boundary at Venus

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In this study we focus on the boundary layer above the ionopause of Venus. The first measurements which demonstrated the existence of such a boundary layer were those of the electron energy spectra obtained by the Pioneer Venus Orbiter Retarding Potential Analyser (ORPA) [Spenner et al., 1980, JGR]. The measurements of the ASPERA-4 electron spectrometer on board Venus Express (VEX) confirmed the existence of such a layer [Coates et al. 2008, Planetary and Space Sci.]. The upper end of the interaction layer, where planetary ions disappear, is called ion composition boundary (ICB).

Due to the interaction of the two plasma populations near the ICB – the shocked solar wind and planetary ions – instabilities are excited. Significant collisionless momentum and energy exchange takes place because of wave-particle interaction, creating a highly turbulent layer. In earlier works we proposed that modified two stream instabilities (MTSI) excited there (see e.g. Dobe et al., 1999, Phys. Rev. Lett., 83, pp. 260–263) might explain the 100-Hz waves observed by the electric field detector (OEFD) on board PVO in the dayside of Venus. The instability also heats the ions. PVO data covered only partially the energy range of the particles in question. Using the much better 3-D energy and spatial coverage of the Analyser of Space Plasmas and Energetic Atoms (ASPERA-4) instrument suite on board VEX, we compare here with data the charged particle heating due to the MTSI. The first data set is for average solar wind conditions, the second one is for a case when a strong solar storm hit Venus. This analysis will be expanded in the future to have a broader picture on planetary space weather effects. After having summarised the properties of the modified two stream instability, and the ion heating and ion acceleration mechanism in the framework of a numerical hybrid model which retains electron inertia, we show that MTSI works effectively. We also discuss the limits of this approach.