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Energization of planetary oxygen ions in the Venusian induced magnetosphere

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Abstract

Venus is a terrestrial planet with a dense CO_2 atmosphere. Whereas the Earth has a strong intrinsic dipolar magnetic field (compared to the interplanetary space), Venus is a non-magnetic body with an induced magnetosphere. As a result, the Venusian upper atmosphere is directly exposed to the interplanetary conditions such as the solar wind. The electric and magnetic fields of the induced magnetosphere enable the planetary ions to gain energy, to be picked up by the solar wind, and escape from the upper atmosphere.

The European spacecraft Venus Express has orbited Venus since April 2006 and has gathered, among other things, detailed observations of the particle and magnetic environment of the planet. Here we especially concentrate on the events observed by the ASPERA-4 instrument showing gradual acceleration of O^+ ions to energies exceeding 10 keV inside the induced magnetosphere. An oxygen ion moving with a typical solar wind velocity has about 15 keV of bulk flow energy.

In order to study the ASPERA-4 observations of the oxygen energization we use a 3-dimensional hybrid code (HYB-Venus) to model the Venus-solar wind interaction. In the simulation the ions are treated self-consistently as particles and, therefore, different ion species can have different velocities and temperatures. The simulation has planetary ion sources for hot and thermal populations of both oxygen and hydrogen. The planetary ions are injected into the simulation from the inner boundary of the model at $r = R_v + 300$ km (ionospheric ions) and via photoionization from density profiles of the neutral exosphere (exospheric photoions).

We use the HYB-Venus hybrid simulation to study how the oxygen is energized in the observed events and discuss global characteristics of the O^+ escape.

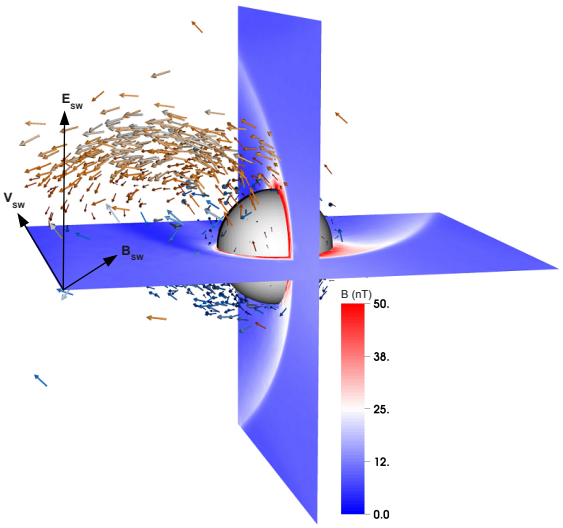

Figure 1: Visualization of a nominal Venus hybrid simulation run. The vectors show the flow of planetary ions in the regions where their bulk flow flux is high. The colored planes display the magnitude of the magnetic field.

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