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Venus Express Contributions to the Study of Planetary Lightning

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Abstract

Planets with dynamic wet atmospheres such as Earth, Jupiter, and Saturn are expected to generate the electrical potential differences in their clouds sufficient to cause a breakdown in the atmosphere, creating a conducting path for the electric potential to discharge. This high-energy phenomenon creates a hot, high-pressure channel that enables chemical reactions not possible under usual local thermodynamic conditions. Thus it is of some interest to determine if lightning occurs in an atmosphere. While Venus is not usually considered one of the wet planets, lightning has been an object of interest since the Venera landers. It was observed with electromagnetic coils on Venera 11, 12, 13, 14 landers [2]. It was observed with a visible spectrometer on the Venera 9 orbits [1]. It was mapped during solar occultations by the electric antenna on the Pioneer Venus Orbiter [4]. These measurements revealed extensive lightning activity with an electromagnetic energy flux similar to that on Earth. However, the observations were limited in number in the atmosphere and to the nightside from orbit. In order to improve the understanding of Venus lightning, the Venus Express magnetometer was given a 128-Hz sampling rate that could cover much of the ELF frequencies at which lightning could be observed in the weak magnetic fields of the Venus ionosphere [5]. This investigation was immediately successful [3], but mastering the cleaning of the broadband data took several years to accomplish. Furthermore, the high polar latitudes of VEX periapsis were not the ideal locations to conduct the more global survey that was desired. Fortunately, after precessing poleward over the first few years the latitude of periapsis has returned to lower latitudes (Figures 1 and 2) and active electrical storms are now being studied.

The charged constituent of the Venus atmosphere need not be water. In fact, we believe it is H_2SO_4 which polarizes much as water does and which freezes and melts at similar temperatures. If it is H_2SO_4, we would expect the constituent to be sensitive to the rate of Venus volcanism releasing sulfur and sulfur dioxide into the atmosphere. This is one correlation we are anxious to pursue on future missions.

1. Figures

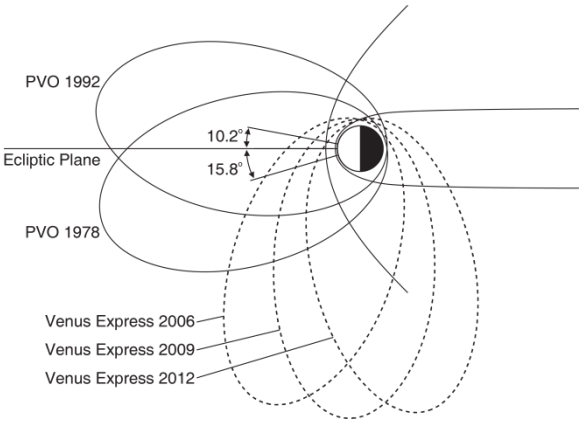

Figure 1: Venus Express and Pioneer Venus orbits.

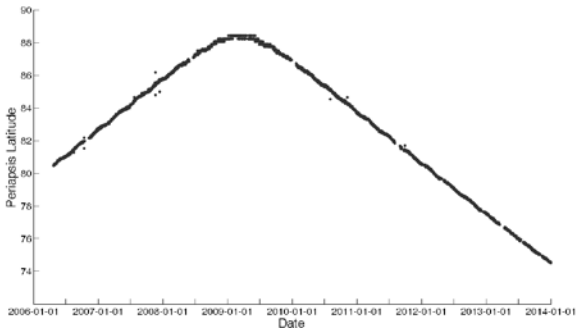

Figure 2: The periapsis of the Venus Express orbit precessed over the pole and has reached lower latitudes than at the beginning of the mission. The latitude is decreasing 3° per year.

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