

Venus Express

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Abstract. Results of the *Venus Express* mission to Venus are summarized.

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1. Results

After having been the ‘forgotten planet’ for more than a decade, Venus has again become a target for intense studies to better understand the many problems not answered by the more than twenty US and Soviet probes launched in the previous decades.

After a launch from the Baikonur cosmodrome, Kazakhstan, 9 November 2005, and a five-month cruise, the *Venus Express* spacecraft reached Venus on 11 April 2006. The spacecraft has now reached its final operational, 24 hr polar orbit, with apocentre altitude of 66 000 km and pericentre altitude of 250 km. The pericentre is located at about 80° northern latitude and drifts only slowly towards the pole. During the first weeks of routine operation the spacecraft has already sent back a wealth of exiting information.

The objective of the *Venus Express* mission is to carry out a comprehensive study of the atmosphere of Venus, the plasma environment and its interaction with the solar wind, and to study certain aspects of the surface of the planet. A well optimised payload, composed of two multi channel spectrometers, an IR-Vis-UV imaging spectrometer, a wide angle camera, a multi-sensor energetic particle instrument, a magnetometer, and a radio science experiment, allows all aspects of the objectives to be addressed at a sufficient depth.

Venus Express has been developed in record time, less than four years, using an efficient concept of re-using elements of recently developed spacecraft, mainly *Mars Express* and *Rosetta*. Significant savings for both the space and ground segments have been possible by using existing teams in industry, in ESA and in several of the science institutes involved.

The first data has shown a highly dynamic atmosphere, including close-ups of the double vortex at the South Pole and evidence of the superrotation, indeed topics of high interest and among the top priority objectives. The high-resolution spectrometers are finding several minor species at various depths of the atmosphere. *Venus Express* is the first mission fully exploiting the spectral ‘windows’ at infrared wavelengths, in order to map the atmosphere in three dimensions. The dynamic behaviour is studied by making measurements at a high-repetition rate. The surface will be studied through the 1 μm ‘window’ in order to search for active volcanism and hot lava fields. *Venus Express* will return more data to Earth than all previous Venus missions together, not counting the *Magellan* radar mapper. The first data returned from the mission promises an exiting time to come with analysis of very high-quality data from state-of-the-art instrumentation.

2. Mission details

Launch date: 9 November 2005

Arrival at Venus: 11 April 2006

Payload mass: 93 kg

Primary science instruments:

Venus Express-ASPERA (Analyser of Space Plasma and Energetic Atoms): investigates the interaction between the solar wind and the atmosphere of Venus by measuring outflowing particles from the planet's atmosphere and the particles making up the solar wind.

Venus Express-MAG (Magnetometer): studies the magnetic field that exists around the planet due to the interaction between the solar wind and the atmosphere, and the effect this has on Venus' atmosphere. This is an important measurement for improved understanding of the atmospheric escape processes.

Venus Express-PFS (Planetary Fourier Spectrometer): measures the temperature of the atmosphere between altitudes of 55–100 km at a high resolution, the surface temperature (to search for volcanic activity), and the abundance of the minor species of the atmosphere. (This instrument is presently out of operation due to a blocked mechanism)

Venus Express-SPICAV/SOIR (Ultraviolet and infrared Atmospheric Spectrometer): assists in the analysis of Venus' atmosphere, to search for the small quantities of water expected to exist in the atmosphere, sulphur compounds and molecular oxygen in the atmosphere, and determine the density and temperature of the atmosphere at 80–180 km altitude. The new additional SOIR channel has a spectral resolution $R > 20\,000$.

Venus Express-VeRA (Venus Radio Science Experiment): uses the powerful radio link between the spacecraft and Earth to investigate the conditions prevalent in the ionosphere and atmosphere of Venus; to study the electron density between 100 km and the ionopause, the density, temperature, and pressure of the atmosphere from 35–40 km up to 100 km from the surface. It will also determine roughness and electrical properties of the surface and investigate the conditions of the solar wind in the inner part of the Solar System.

Venus Express-VIRTIS (Ultraviolet/visible/Near-Infrared mapping spectrometer): studies the composition of the lower atmosphere between 40 km altitude and the surface, tracks the clouds in both ultraviolet and infrared wavelengths and studies atmospheric dynamics at different altitudes. Virtis will be able to recover parts of the objectives of the presently non-operating PFS instrument

Venus Express-VMC (Venus Monitoring Camera): a wide-angle multi-channel camera for imaging of the planet in the near-infrared, ultraviolet and visible wavelengths for global and local investigations, with emphasis on cloud dynamics and surface imaging.

3. In the literature

A series of overview papers of the *Venus Express* mission was published in the November 2005 issue of the *ESA Bulletin*. An insight into the project development is given by McCoy *et al.* (2005) and a description of the spacecraft and subsystems design is summarised by Winton *et al.* (2005). The scientific rationale for the mission and a description of the payload is given by Svedhem *et al.* (2005). A detailed description of specific scientific topics is given in the November 2006 issue of *Planetary and Space Science*. *Venus Express* science planning is outlined by Titov *et al.* (2006). Baines *et al.* (2006) describe how *Venus Express* will explore the deep atmosphere and surface of Venus. Formisano

et al. (2006) describe the Planetary Fourier Spectrometer (PFS) onboard *Venus Express*. Häusler *et al.* (2006) report on the radio science investigations by VeRa onboard the *Venus Express* spacecraft. Russell *et al.* (2006) describe lightning detection on the *Venus Express* mission. Zhang *et al.* (2006) report on the magnetic field investigation of the Venus plasma environment by *Venus Express*. Müller-Wodarg *et al.* (2006) discuss the thermosphere of Venus and its exploration by the *Venus Express* Accelerometer Experiment. Luhmann *et al.* (2006) discuss the expectations for *Venus Express* for analyzing Venus O⁺ pickup ions.

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