

# Venus Express

The Soyuz-Fregat rocket carrying Venus Express lifts off on 9 November 2005

## GCSE key words

Forces  
Orbit  
Tectonic plates  
Greenhouse effect

*The European Space Agency (ESA) is off on its travels once more — this time to Venus. What is to be gained from a visit to our cloudy neighbour, a planet which some astronomers describe as ‘Earth’s evil twin’?*

The Venus Express spacecraft was launched at 3.30 in the morning on 9 November last year. The mission is modelled on ESA’s successful Mars Express mission (see CATALYST Vol. 14, No. 2). The term ‘Express’ refers to the speed with which the mission has been carried out, from first approval in 2002 to launch in 2005.

## Journey into space

The trip to Venus lasts 153 days. For most of this time, the strongest force on the craft is the pull of the Sun’s gravity. Once Venus Express is captured by Venus’s own gravitational pull, the engineers at the control centre in Darmstadt, Germany, need 5 days to manoeuvre it into its operational orbit.

There is no lander on this craft; it is planned to follow an extended elliptical path around the planet (Figure 1). This takes it first within 250 km of the planet’s surface, and then far out, 66 000 km into space, before it plunges back inwards once more. This is a polar orbit, giving the craft a view of the planet’s entire surface as it rotates slowly below.

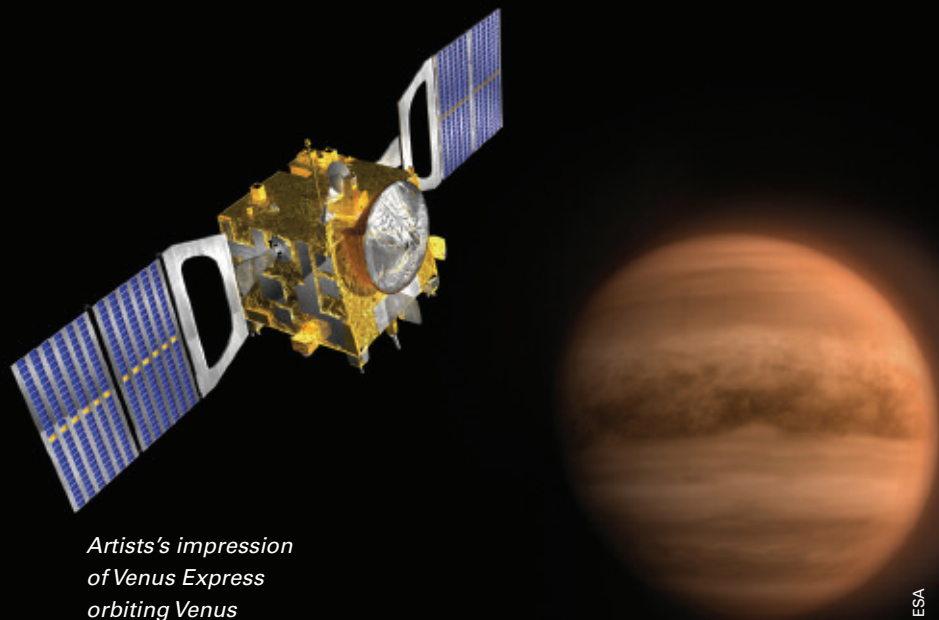
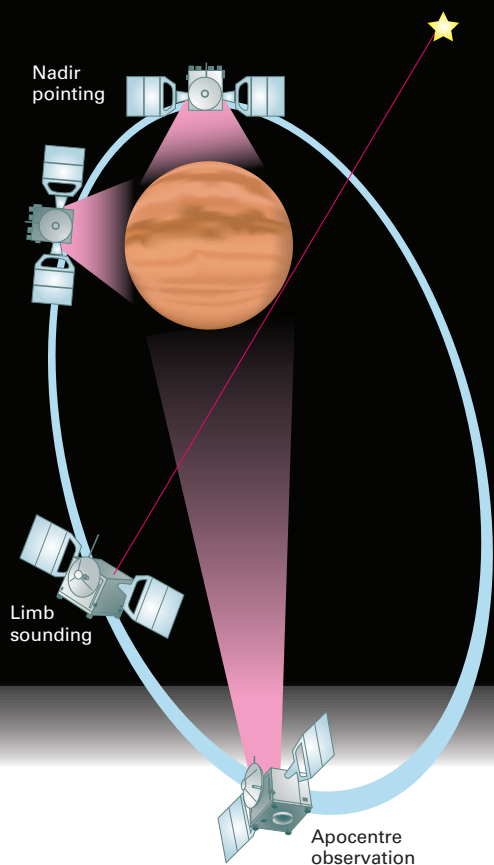
Venus is closer than Earth to the Sun, so the Sun’s rays are twice as intense. This has important consequences:

- There is an abundant supply of energy for the spacecraft’s solar panels, which generate its power.
- At the same time, there is a serious danger that the spacecraft could overheat, so it has built-in systems to remove excess heat and radiate it back out into space.

The spacecraft is something of a flying computer, with on-board systems which store data and process it, ready for transmission back to Earth.

**Table 1** Venus and Earth compared

	Venus	Earth
Mass (kg)	$4.87 \times 10^{24}$	$5.98 \times 10^{24}$
Equatorial radius (km)	6052	6378
Average distance from Sun (km)	108 000 000	150 000 000
Year length (Earth days)	225	365
Rotation period (Earth days)	243	1
Mean surface temperature (°C)	465	15
Tilt of axis	178°	23.5°
Surface gravity (N/kg)	8.9	9.8



Artists' impression of Venus Express orbiting Venus

ESA

**Figure 1** As Venus Express orbits, the planet will rotate slowly beneath it, allowing all parts of the surface to be scanned. During the limb-sounding experiment, instruments gather starlight which has passed through the planet's atmosphere and analyse it to learn more about its physical and chemical properties

## Why visit Venus?

In many ways, Venus is comparable to Earth (see Table 1). It is a rocky planet, with similar size, mass and gravity. However, there are two major differences: Venus is much hotter than Earth and its atmosphere is very different from ours. These two facts are connected, and they explain why Venus is of interest to us earthlings.

The atmosphere of Venus is dense (its pressure is about 90 atmospheres), and it is largely composed of carbon dioxide. This causes it to have a strong greenhouse effect; infrared radiation is trapped in the atmosphere, so that the surface temperature can rise as high as 500°C. This gives Venus some very odd weather, with winds up to 250 km/h, lurid yellow clouds of sulphur and heavy falls of lead sulphide 'snow'.

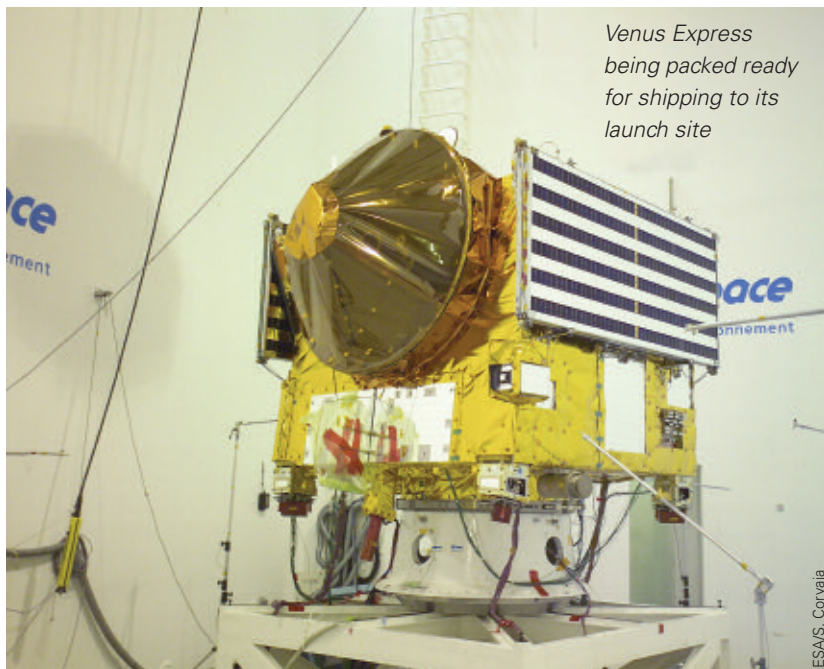
Venus Express will orbit high above this murky world, using radar to detect the planet's surface through the dense cloud layer.

Understanding how Venus's atmosphere works may help scientists to predict how Earth will change as we

pump increasing quantities of greenhouse gases into our own atmosphere. It may also give us ideas about the Earth's distant future. Dr Andrew Coates from UCL's Mullard Space Science Laboratory, who is one of the UK scientists involved in the mission, says:

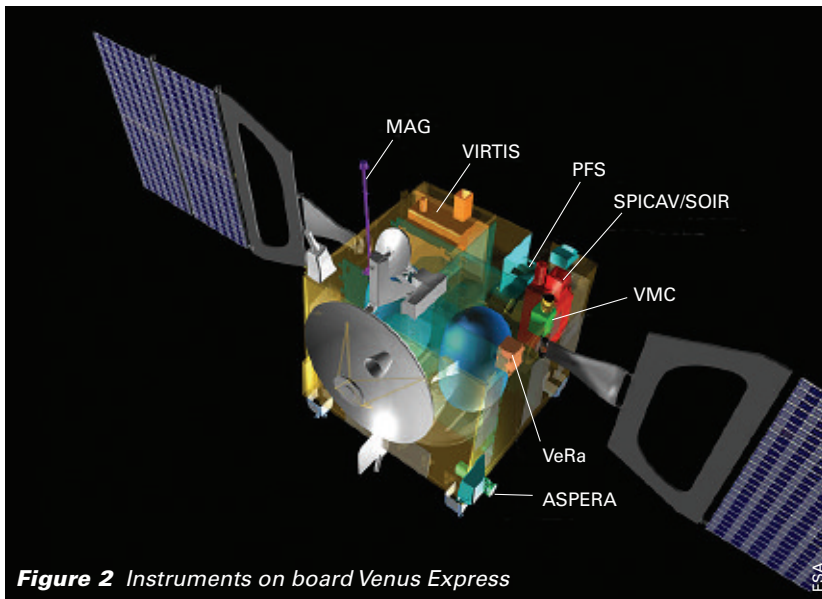
This is a wonderful mission of discovery — not only to find out why Earth's twin went wrong and to study its strange atmosphere now, but also to glimpse a possible future for the Earth. The extreme example of Venus will test models of our own atmosphere and humankind's contribution to greenhouse gases here. It

As well as Venus Express and Mars Express, ESA has the BepiColombo mission to Mercury, so it will have visited each of the rocky planets in the inner solar system. The final bill for the mission will be about 200 million euros — similar to the cost of making a blockbuster movie.



Venus Express being packed ready for shipping to its launch site

ESAS. Corvaja



**Figure 2** Instruments on board Venus Express

● Follow Venus Express on the ESA website ([www.esa.int/venus](http://www.esa.int/venus)).

will also give a preview of what it may be like in 2 billion years' time when the Sun has got brighter in its evolution along the main sequence of stars. At that time Earth will no longer be in the 'Goldilocks' zone and our planet may become more like what Venus is like now.

● Explain why Venus is always observed at dawn or dusk, close to the Sun in the sky.

### Planetary pressure cooker

Venus, like Earth, is rocky, and shows signs of volcanic activity. Its surface is cratered like the Moon, but there is a difference — the oldest craters on Venus are no

older than 500 million years, despite the fact that the planet is over 4000 million years old. It seems likely that the planet's entire surface was renewed 500 million years ago.

Earth has tectonic plates which move around and volcanoes which explode. These release any build-up of pressure beneath the crust. Venus seems to be different; its surface may be a single plate. As pressure builds up inside, a sudden outburst turns the whole thing over, creating a completely resurfaced planet.

### Instruments on board

The main structure of Venus Express was built by the Astrium company at Stevenage in Hertfordshire. It carries a number of instruments for studying the planet (Figure 2):

- MAG looks at the planet's magnetic field which does not come from inside the planet, but from its interaction with charged particles in the solar wind.
- VIRTIS uses ultraviolet, visible and infrared radiations to look at the planet's cloudy lower atmosphere.
- PFS measures temperatures and determines composition within the atmosphere.
- SPICAV/SOIR looks at the upper atmosphere.
- VMC is a camera that photographs clouds and the planet's surface.
- VeRa uses radio waves to study the ionosphere, an ionised layer high in the atmosphere.
- ASPERA looks at interactions between the solar wind and Venus's atmosphere, by collecting atoms and molecules leaving the planet.

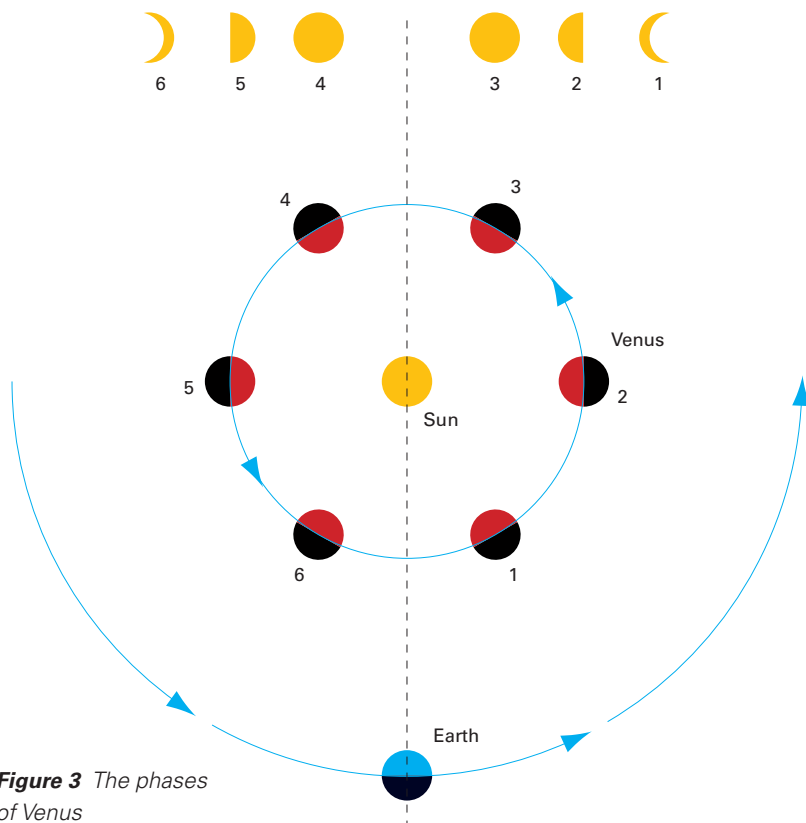
To ensure that the craft is always pointing in the right direction, it has four pairs of thruster rockets, each of which provides a force of 10 N. It uses star trackers to check its orientation in space, and then fires the thrusters for just the time necessary to put it into the correct orientation.

### Venus viewed from Earth

Venus may be familiar to you as the 'evening star'; it appears as a bright, untwinkling speck of light in the western sky at dusk. At other times, it appears around dawn in the eastern sky, and is known as the 'morning star'. Seen through a telescope, it shows phases, just like the Moon. Its apparent size also changes, from small when it is full to large when it is just a slim crescent.

This can be explained by picturing Venus in its orbit around the Sun (Figure 3). When it is on the opposite side of the Sun to Earth, it looks smaller, but we can see the whole of its illuminated side. When its orbit brings it close to Earth, we see the unilluminated side of the planet. Four hundred years ago, these observations helped to convince Galileo that Venus orbited the Sun, rather than Earth.

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**Figure 3** The phases of Venus