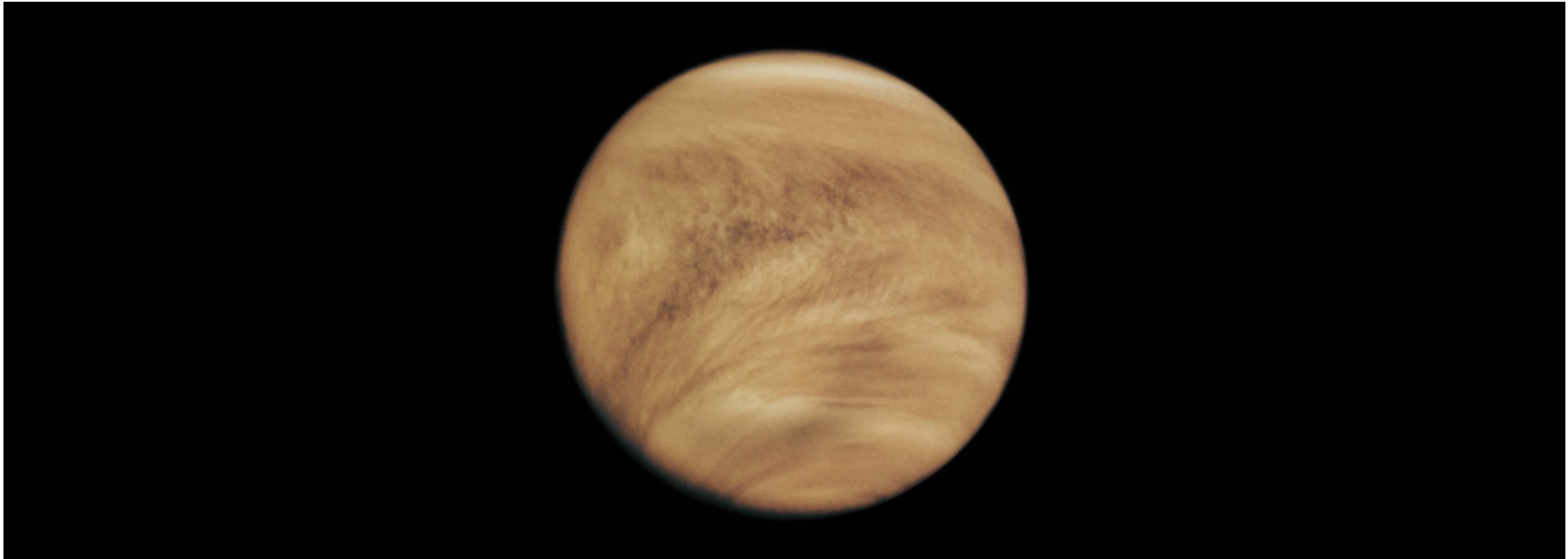


ASTRONOMY

Chapter 10 EARTHLIKE PLANETS: VENUS



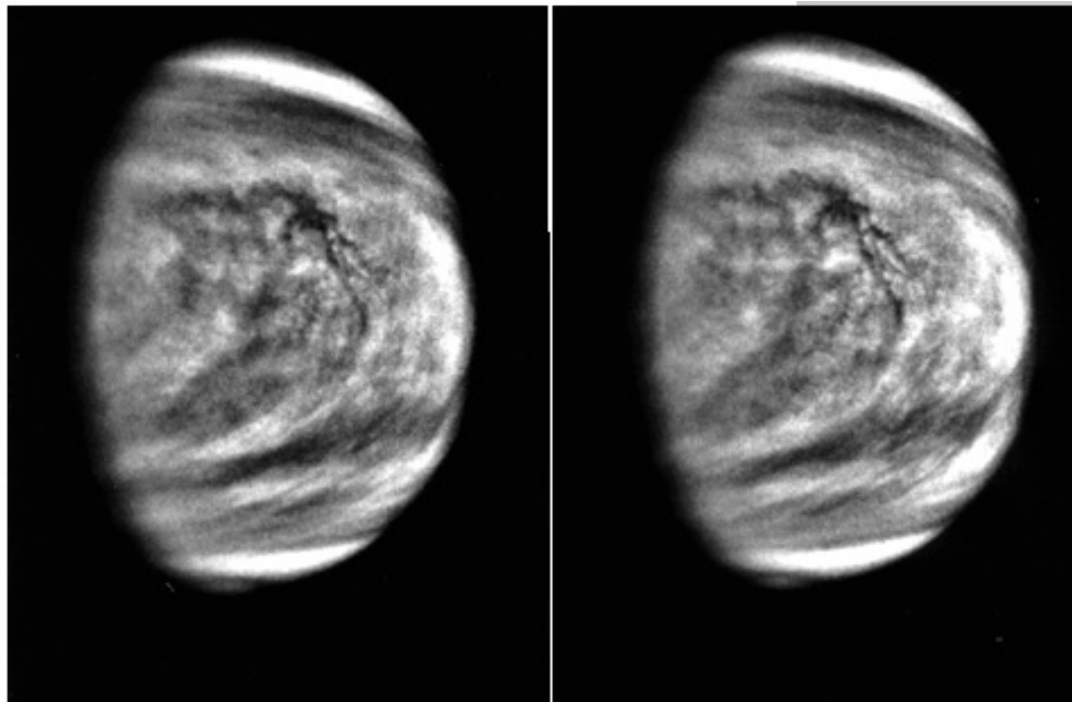
FIGURE 10.2



Venus as Photographed by the Pioneer Venus Orbiter. This ultraviolet image shows an upper-atmosphere cloud structure that would be invisible at visible wavelengths. Note that there is not even a glimpse of the planet's surface. (credit: modification of work by NASA)

CLOUDS ON VENUS

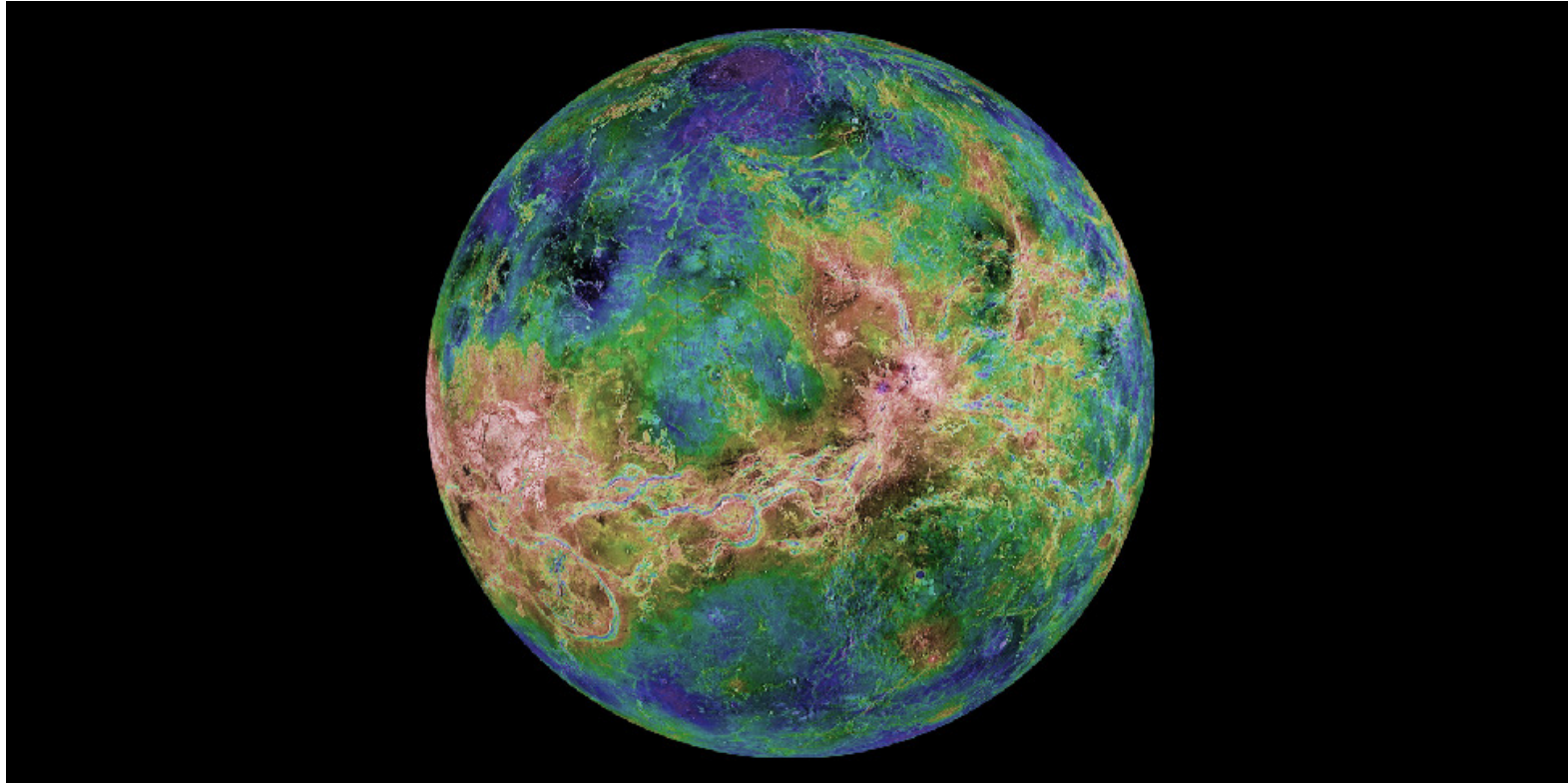
These images were taken 2 hours apart. Note that the patterns move right to left in the figure. The temperate zones have the equivalent of Jet streams.



VENUS' SPIN

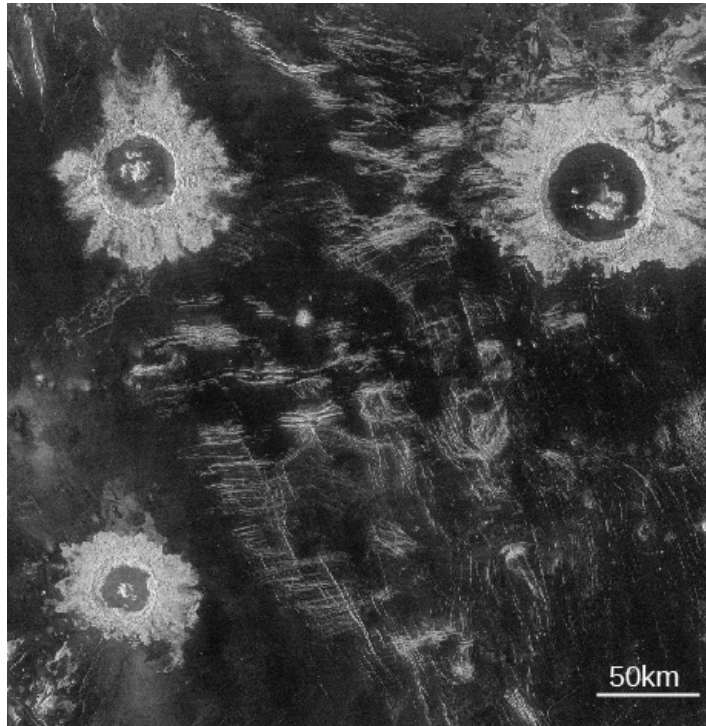
Venus spins backwards (retrograde rotation) when compared to the other planets. This means that the sun rises in the west and sets in the east on Venus.

FIGURE 10.6

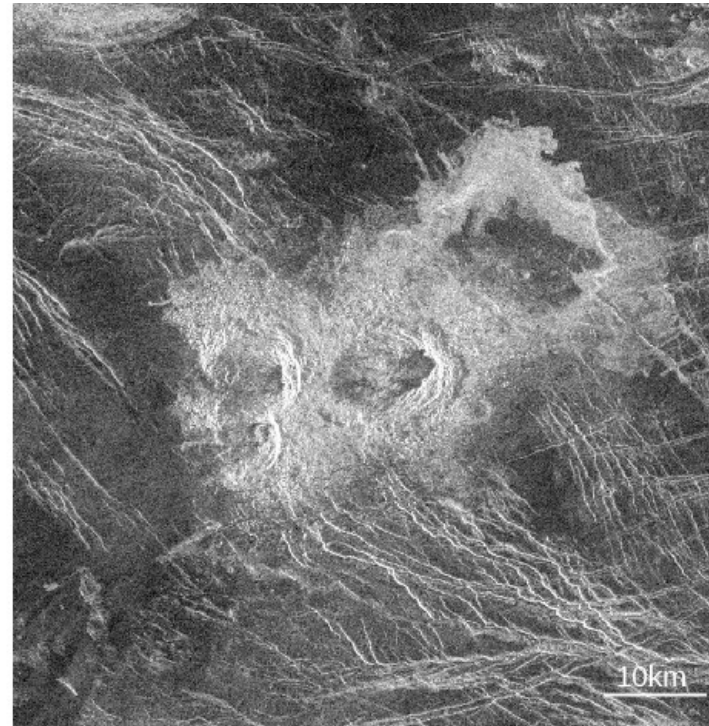


Radar Map of Venus. This composite image has a resolution of about 3 kilometers. Colors have been added to indicate elevation, with blue meaning low and brown and white high. The large continent Aphrodite stretches around the equator, where the bright (therefore rough) surface has been deformed by tectonic forces in the crust of Venus. (credit: modification of work by NASA/JPL/USGS)

FIGURE 10.7



(a)

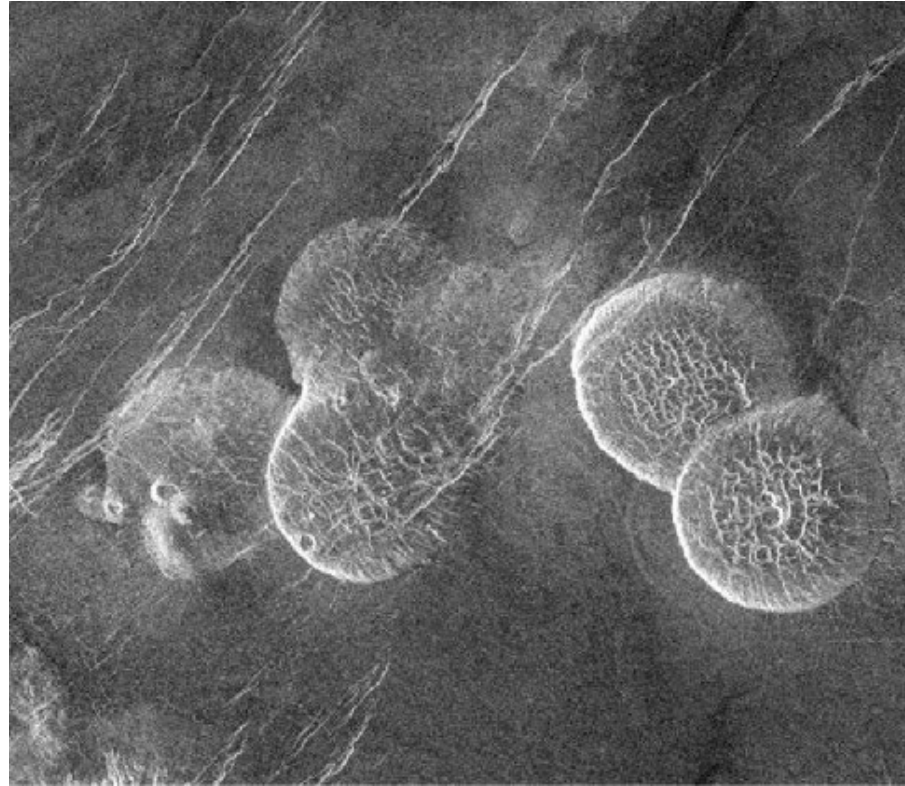


(b)

Impact Craters on Venus.

- (a) These large impact craters are in the Lavinia region of Venus. Because they are rough, the crater rims and ejecta appear brighter in these radar images than do the smoother surrounding lava plains. The largest of these craters has a diameter of 50 kilometers.
- (b) This small, complex crater is named after writer Gertrude Stein. The triple impact was caused by the breaking apart of the incoming asteroid during its passage through the thick atmosphere of Venus. The projectile had an initial diameter of between 1 and 2 kilometers. (credit a: modification of work by NASA/JPL; credit b: modification of work by NASA/JPL)

FIGURE 10.8



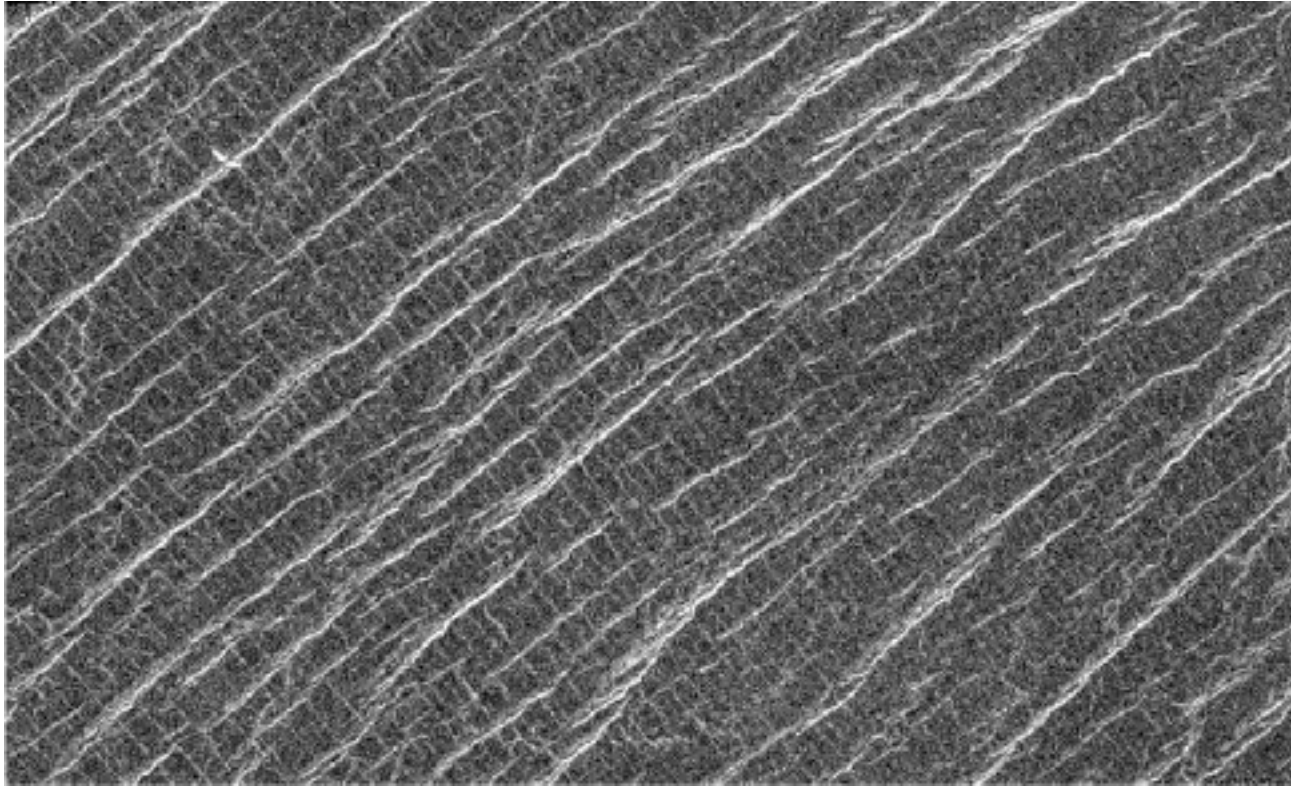
Pancake-Shaped Volcanoes on Venus. These remarkable circular domes, each about 25 kilometers across and about 2 kilometers tall, are the result of eruptions of highly viscous (sludgy) lava that spreads out evenly in all directions. (credit: modification of work by NASA/JPL)

FIGURE 10.9



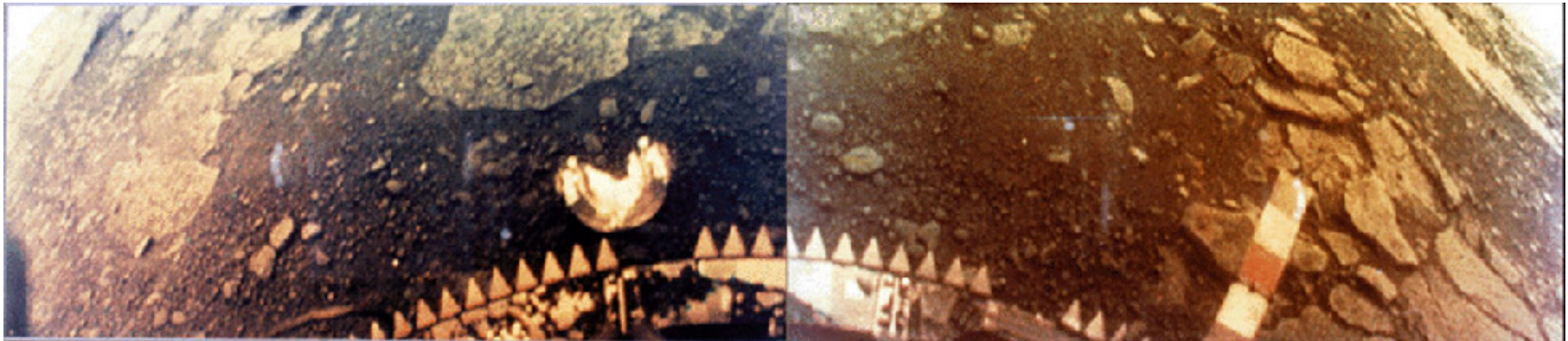
The “Miss Piggy” Corona. Fotla Corona is located in the plains to the south of Aphrodite Terra. Curved fracture patterns show where the material beneath has put stress on the surface. A number of pancake and dome volcanoes are also visible. Fotla was a Celtic fertility goddess. Some students see a resemblance between this corona and Miss Piggy of the Muppets (her left ear, at the top of the picture, is the pancake volcano in the upper center of the image). (credit: NASA/JPL)

FIGURE 10.10



Ridges and Cracks. This region of the Lakshmi Plains on Venus has been fractured by tectonic forces to produce a cross-hatched grid of cracks and ridges. Be sure to notice the fainter linear features that run perpendicular to the brighter ones. As this is a radar image, the brightness of the ridges indicates their relative height. This image shows a region about 80 kilometers wide and 37 kilometers high. Lakshmi is a Hindu goddess of prosperity. (credit: modification of work by Magellan Team, JPL, NASA)

FIGURE 10.11



Surface of Venus. These views of the surface of Venus are from the Venera 13 spacecraft. Everything is orange because the thick atmosphere of Venus absorbs the bluer colors of light. The horizon is visible in the upper corner of each image. (credit: NASA)

VENUS' SURFACE

Craters are rare and shallow

Ejecta stay close to crater due to dense atmosphere.

Surface is "new" -- only 1 billion years old.

Volcanoes are common

“Pancake Domes”: slow eruption of viscous lava

DOES VENUS HAVE ACTIVE VOLCANOES?

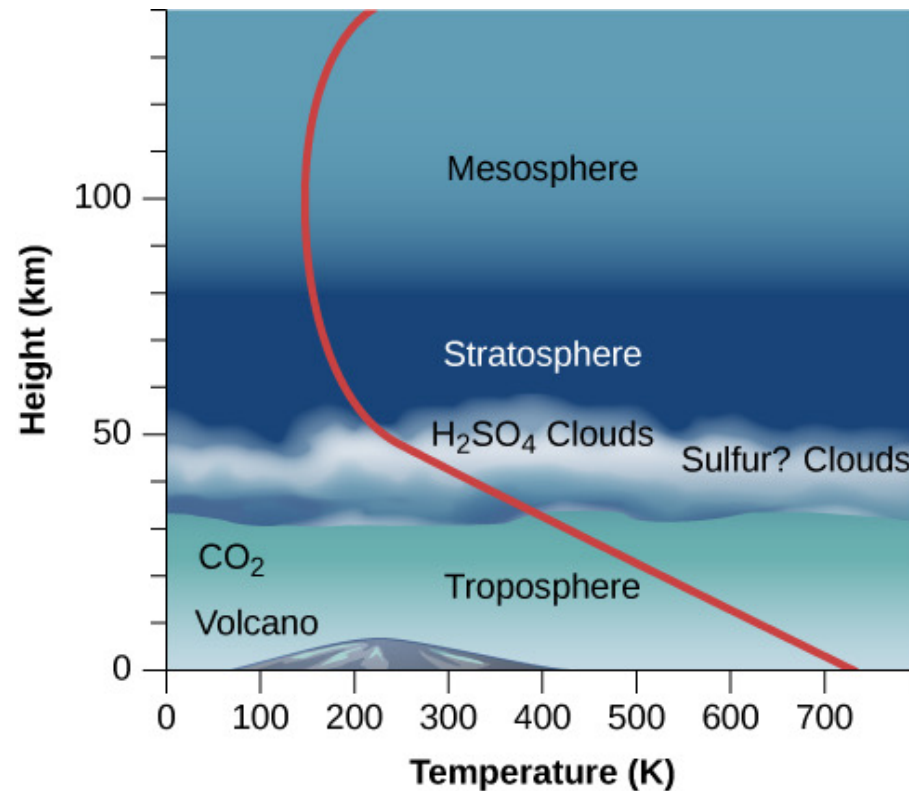
Six years of observations by Venus Express have shown a marked rise and fall of the levels of sulfur dioxide (SO₂) in Venus' atmosphere, similar to what was seen by NASA's Pioneer Venus mission from 1978 to 1992.

These spikes in SO₂ concentrations could be the result of volcanoes on the planet's surface, but they could also be due to variations in Venus' complex circulation patterns which are governed by its rapid "super-rotating" atmosphere.

VENUS' ATMOSPHERE

Venus' thick and toxic atmosphere is made up mostly of carbon dioxide (CO_2) and nitrogen (N_2), with clouds of sulfuric acid (H_2SO_4) droplets.

FIGURE 10.12

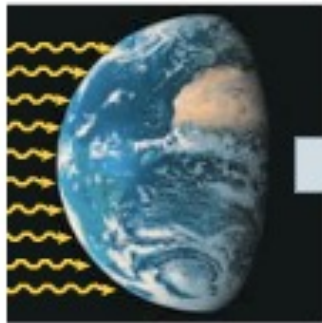


Venus' Atmosphere. The layers of the massive atmosphere of Venus shown here are based on data from the Pioneer and Venera entry probes. Height is measured along the left axis, the bottom scale shows temperature, and the red line allows you to read off the temperature at each height. Notice how steeply the temperature rises below the clouds, thanks to the planet's huge greenhouse effect.

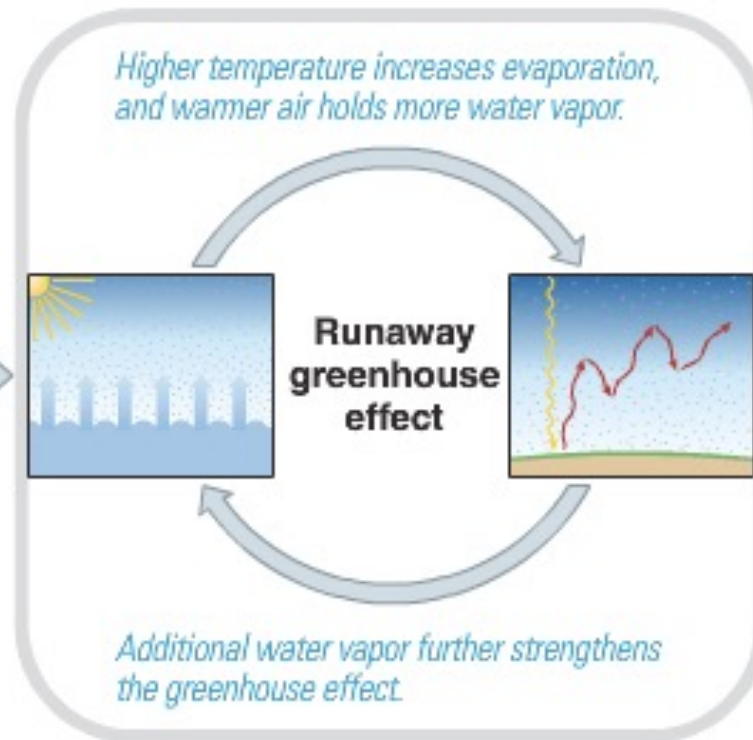
RUNAWAY GREENHOUSE EFFECT

**If Earth moved to
Venus's orbit**

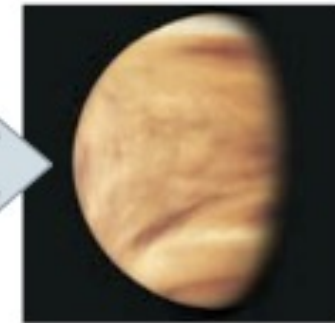
More intense sunlight...



*...would raise surface
temperature by about
30°C.*



*Result: Oceans evaporate
and carbonate rocks
decompose, releasing
CO₂...*

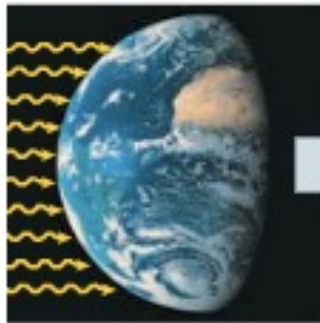


*...making Earth hotter
than Venus.*

RUNAWAY GREENHOUSE EFFECT

**If Earth moved to
Venus's orbit**

More intense sunlight...

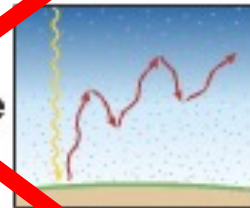


*...would raise surface
temperature by about
30°C.*

*Higher temperature increases evaporation,
and warmer air holds more water vapor.*

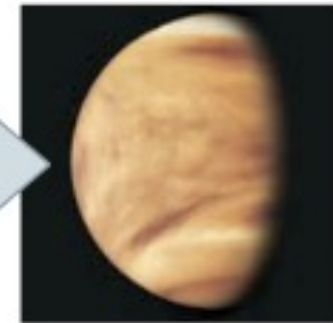


**Runaway
greenhouse
effect**



*Additional water vapor further strengthens
the greenhouse effect.*

*Result: Oceans evaporate
and carbonate rocks
decompose, releasing
CO₂...*



*...making Earth hotter
than Venus.*