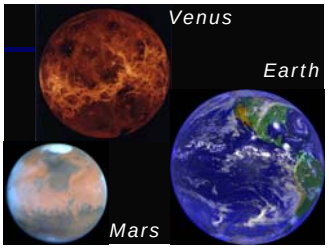
Earth, Venus and Mars

Water is abundant on the Earth, but not on Venus and Mars. This is because of their significantly different atmospheres and because of the presence or absence of plate tectonic activities.

- Considering the vast distances in Solar System, Venus, Earth and Mars are in about the same vicinity relative to the Sun, compared to the Jovian and the outer planets. Venus is closer to Sun than Earth, of course, and Mars is farther. But the surfaces of these planets receive about the same amounts of Solar heat. But then, while the computed and observed temperatures on the surfaces of Earth and Mars are comparable, the Venutian surface is far hotter than what is expected. Clearly, the Venutian surface too hot, and the Martian surface is too cold, to have water although, judging from their comparable overall densities, these three planets have similar chemical compositions.

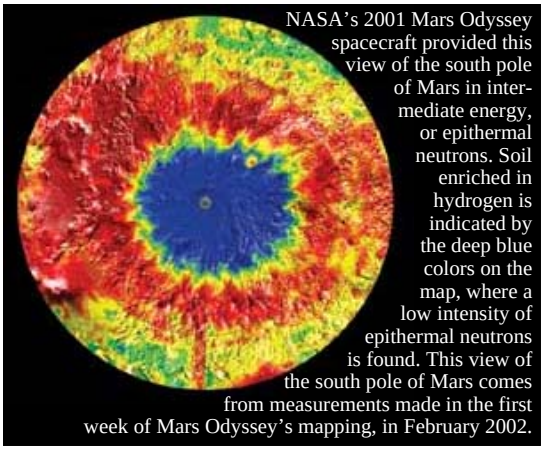
	Relative distance from Sun	Solar heat received …		Computed Temperatures at the planet's surface	Observed Temperatures at the planet's surface
		at the planetary location	on the planetary surface		
Venus	0.72	~2500 W/m²	~650 W/m²	323° K	730° K
Earth	1.00	~1360 W/m²	~680 W/m²	276° K	281° K
Mars	1.52	~600 W/m²	~600 W/m²	215° K	215° K



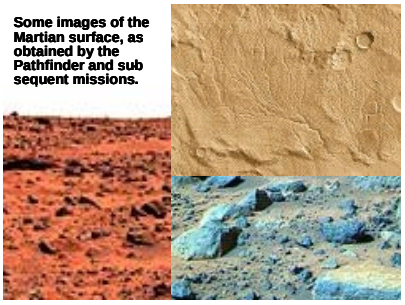
	Planetary Composition	Atmospheric	
		Compo-sition	Density (Earth = 1)
Venus	Rocky with metallic core	C, O	90.00
Earth		N, O	1.00
Mars		N, O ?	0.01

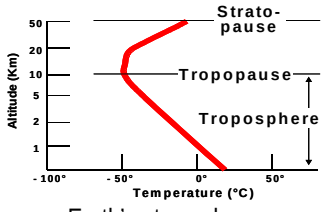
- Dissimilar atmospheric compositions partly explains why the Earth so unique in having the abundance of water that Venus and Mars lack. Earth's atmosphere, a ~110 Km thick gaseous halo that encases the Earth, now comprises ~78% Nitrogen and ~21% Oxygen, but was nearly 90% CO_2 until about 1.25 Ga ago. The Venutian atmosphere has 90 times the density of Earth's atmosphere, and is ~95% CO_2. Since this traps the Solar heat that is received on that planet's surface, Venus is also called the "Greenhouse Planet", therefore. Mars, on the other hand, has a very thin atmosphere.

- Another major peculiarity of Venus is that its average day-time temperature is about the same (~450ºC) as its mean night-time temperature. This is because the lengths of day and year are about the same on Venus, i.e., the planet takes about the same time to complete one spin on its axis as it does to complete one orbit about the Sun and therefore has the same face turned towards Sun all the time. The planet's thick atmosphere retains and distributes evenly this Solar heat that one side of the planet thus receives constantly, so producing the intense temperatures that preclude any possibility for even the water molecule to exist. This renders moot any question of hydrological cycle on Venus.


NASA's 2001 Mars Odyssey spacecraft provided this view of the south pole of Mars in intermediate energy, or epithermal neutrons. Soil enriched in hydrogen is indicated by the deep blue colors on the map, where a low intensity of epithermal neutrons is found. This view of the south pole of Mars comes from measurements made in the first week of Mars Odyssey's mapping, in February 2002.

- As for Mars, there is good evidence that water was once abundant enough on the planet's surface to have produced the land-forms we now see but now remains confined to the subsoil and the polar ice cap. This raises the question as to how and why might Mars have lost the hydrosphere that it obviously had once.





Earth's atmosphere

- This is perhaps because plate tectonics once occurred on Mars, but no longer does. Mars thus lacks hydrological cycle because it no longer has the plate tectonics to create new ocean basins to replace the ones flattened by the "run-off" component of hydrological cycle*.

- The presence of hydrological cycle on the Earth, and its absence on Mars, is therefore due as much to the planetary atmospheres as to plate tectonics, while its absence on Venus is entirely ascribable to the structure and composition of Venutian atmosphere.

* Seeking to answer this question by appealing to low density of Martian atmosphere, and argue that its temperature gradient is too gentle to have prevented the escape of atmospheric moisture (unlike Earth's tropospheric thermal gradient that is steep enough to have retained the hydrological cycle), ignores the fact that a vigorous hydrological cycle may have once existed on Mars.