

Planetary Atmospheres: Earth and the Other Terrestrial Worlds



What is an atmosphere?



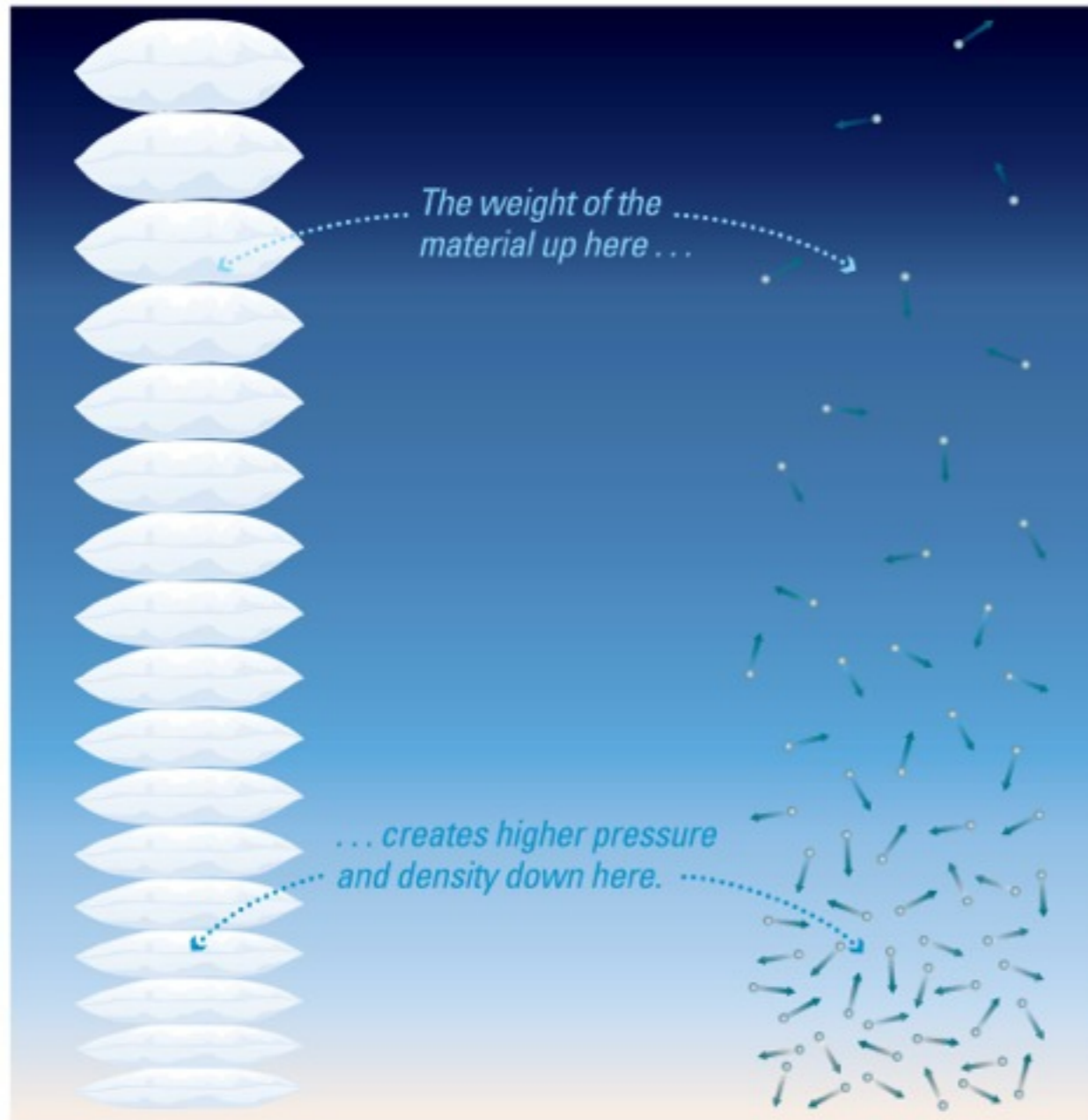
- An atmosphere is a layer of gas that surrounds a world.

Earth's Atmosphere



- About 10 kilometers thick
- Consists mostly of molecular nitrogen (N_2) and oxygen (O_2).

Where does an atmosphere end?

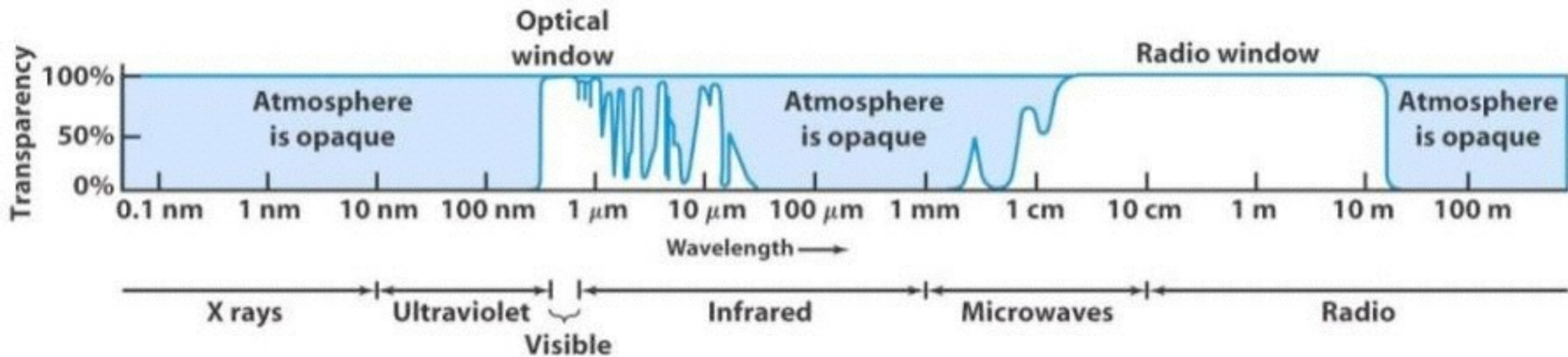


- There is no clear upper boundary.
- Most of Earth's gas is less than 10 kilometers from surface, but a small fraction extends to more than 100 kilometers.
- Altitudes more than 100 kilometers are considered "space."

Effects of Atmospheres

- They create pressure that determines whether liquid water can exist on surface.
- They absorb and scatter light.
- They create wind, weather, and climate.
- They can make planetary surfaces warmer through the greenhouse effect.

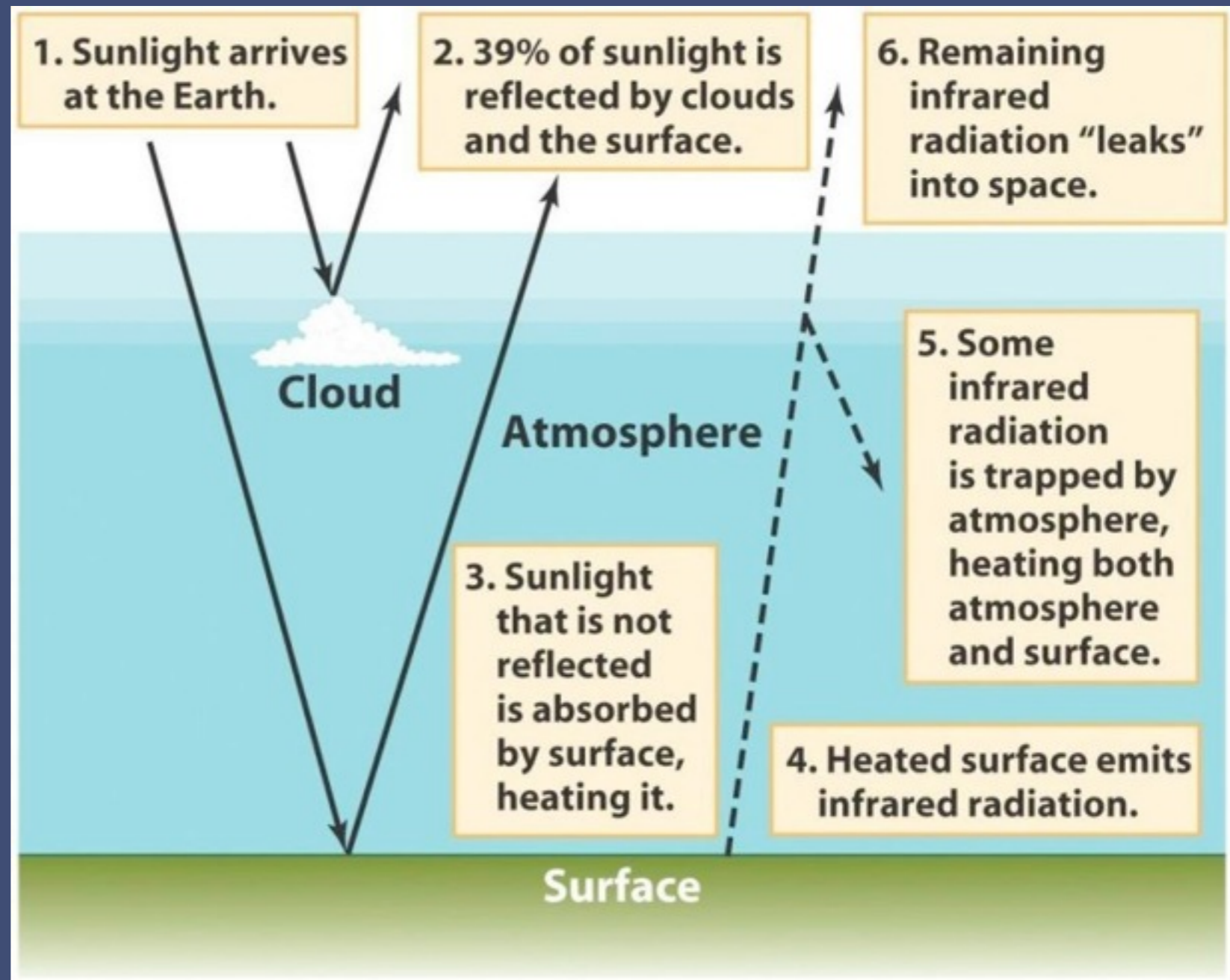
EM Protection of Atmosphere



- Earth's atmosphere is opaque to most harmful radiation from space
 - X-rays and most UV

Greenhouse Effect

- Certain gases in the Earth's atmosphere act as a thermal blanket, insulating the Earth from the cold of space
- These gases are called greenhouse gases
 - primarily include H₂O (water vapor), CO₂ (carbon dioxide), and CH₄ (methane)



Venus' Atmosphere

- Much denser than Earth's
 - surface pressure on Venus is 90 times higher than on Earth
 - equivalent to diving 1 km below the surface of the ocean on Earth

Venus' Atmosphere

- Surface of Venus is covered by a perpetual layer of clouds
 - cover the entire surface
 - opaque
 - can't "see" the surface of Venus
 - by same token, couldn't see the Sun or stars from the surface of Venus
 - have learned about the surface through
 - radar images
 - spacecraft landings

Atmosphere Comparison

- Venus

- clouds are made of droplets of concentrated sulfuric acid

- may rain acid

- CO₂ : 96%

- N₂ : 3%

- Earth

- clouds are made of water vapor

- rains water

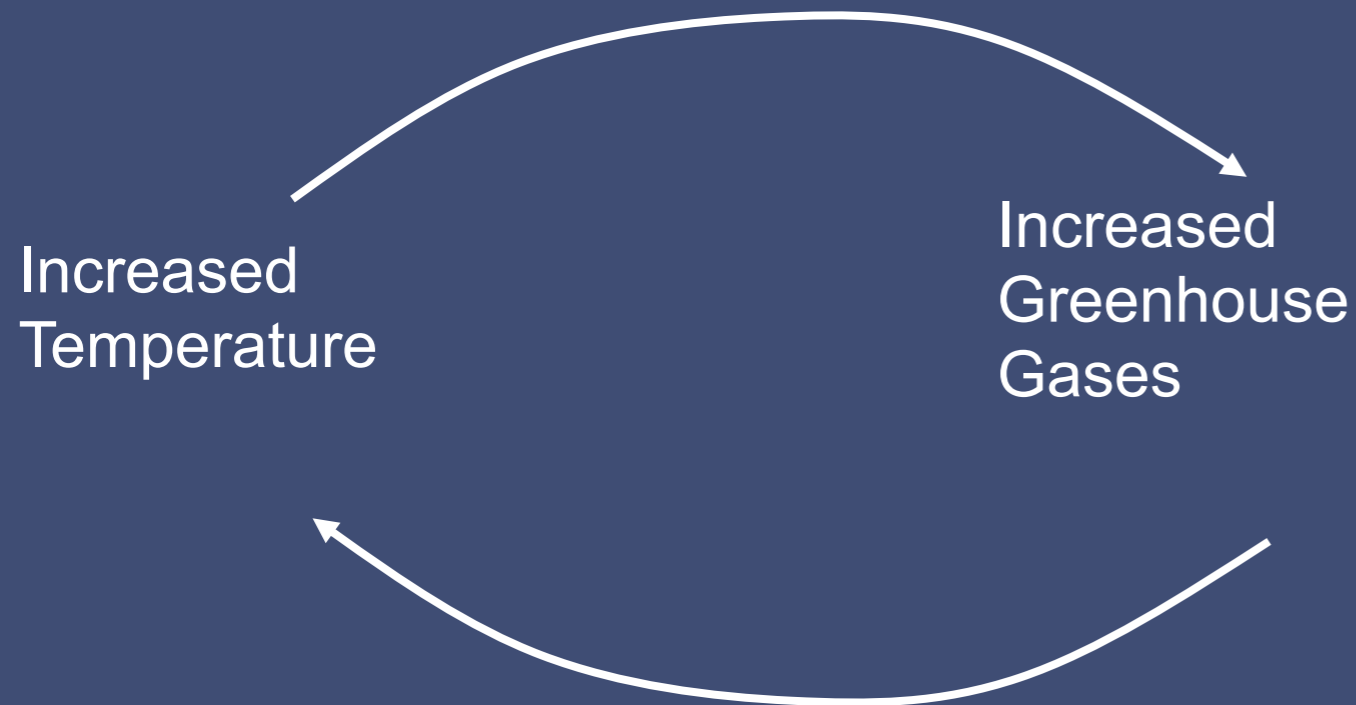
- N₂ : 78%

- O₂ : 21%

Greenhouse Effect

- High CO₂ content in Venus' atmosphere has led to extreme greenhouse effect
 - raises temperature of Venus 400° C (720 ° F) over what it would be without a greenhouse gases
 - this in spite of the fact that the clouds in Venus' atmosphere reflect 59% of sunlight back into space (albedo=0.59)
- Leading theory is that Venus started out much more like Earth, but underwent runaway greenhouse effect

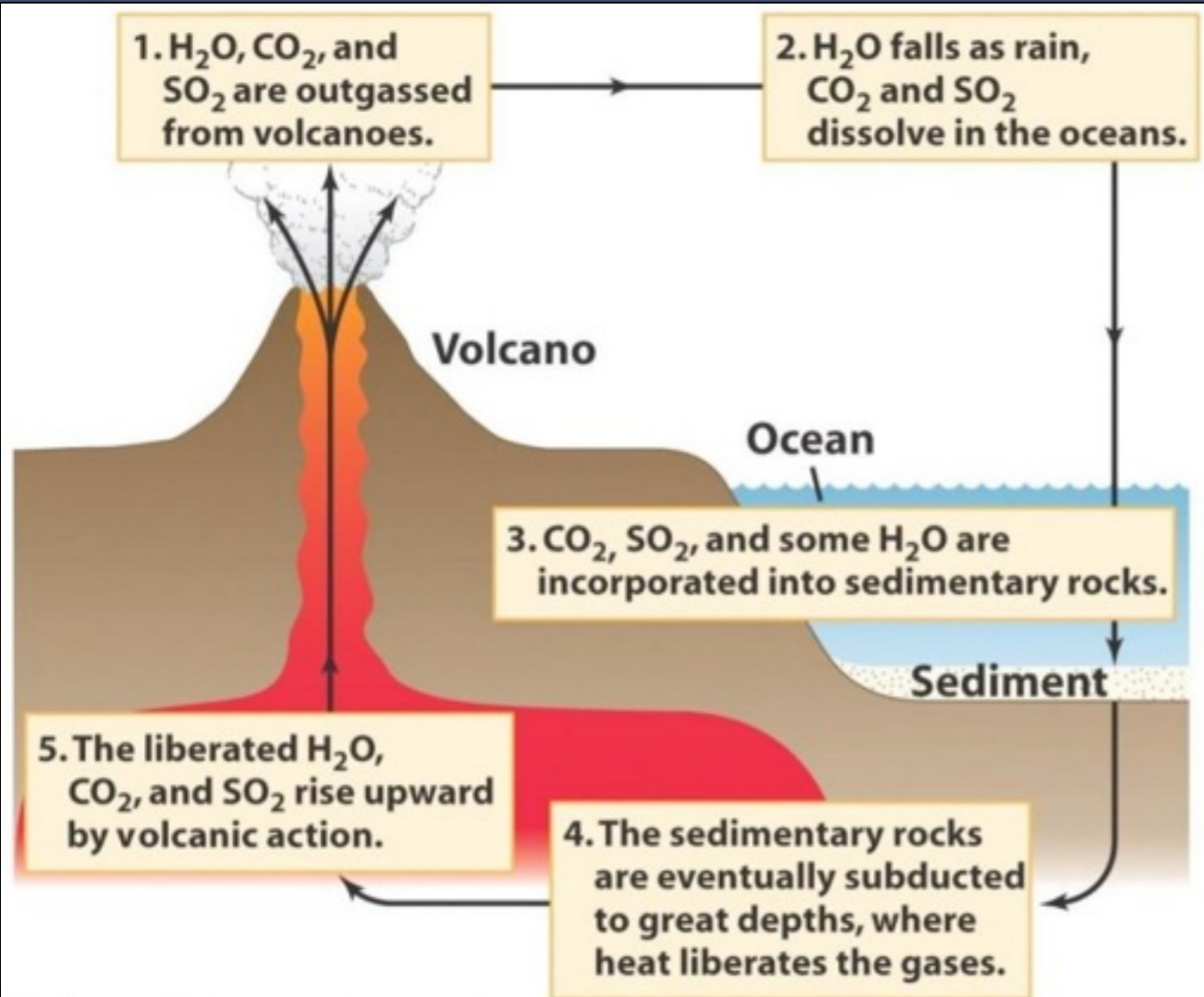
Runaway Greenhouse Effect



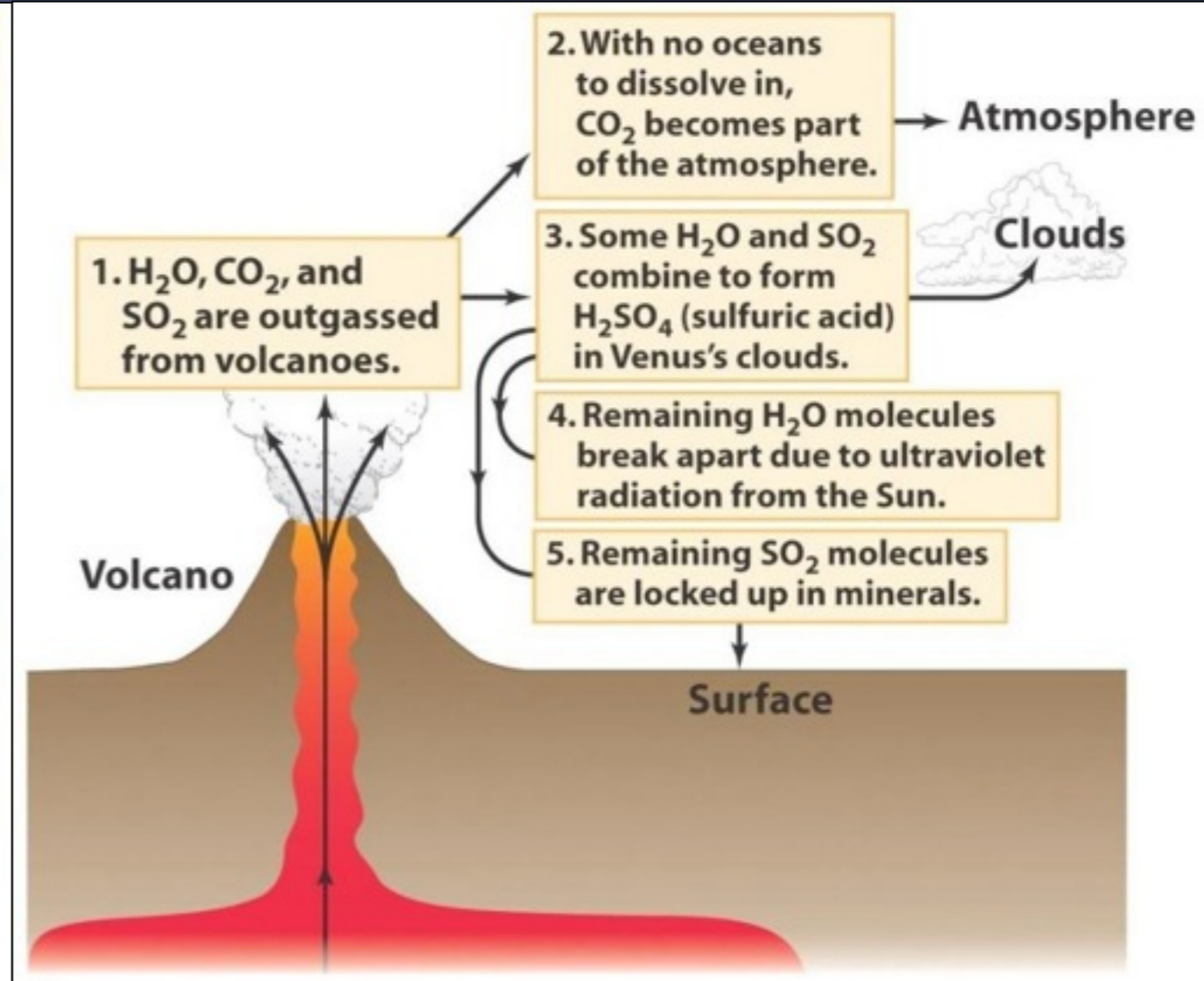
- Greenhouse gases increase because:
 - water evaporates out of oceans
 - CO₂ bakes out of rocks

Some scientists fear something similar could happen on Earth

Runaway Greenhouse Effect



(a) Earth: H_2O , CO_2 , and SO_2 are recycled



(b) Venus: H_2O , CO_2 , and SO_2 are NOT recycled

Atmosphere Comparison

- Earth

- Moderate temperature
- Moderate pressure (1 atm)
- N₂ : 78%
- O₂ : 21%
- H₂O: 1%

- Venus

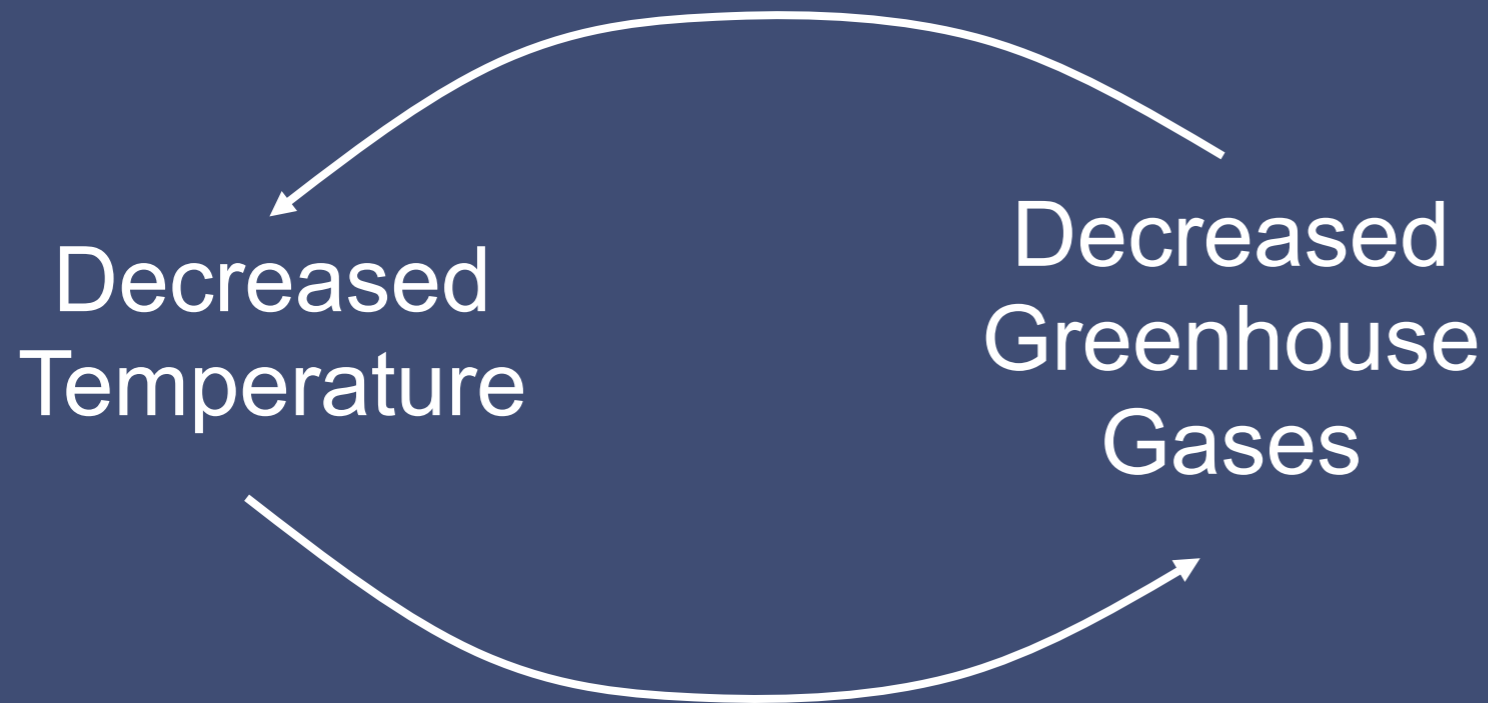
- Runaway greenhouse
- Very high pressure (90 atm)
- CO₂ : 96%
- N₂ : 3.5%

- Mars

- Runaway icehouse
- Low pressure (0.01 atm)
- CO₂ : 95%
- N₂ : 3%

Even though Mars' atmosphere is still mostly CO₂, there isn't enough of it to raise the temperature significantly

Runaway Icehouse Effect



- Greenhouse gases decrease because:
 - rain washed CO_2 out of atmosphere
 - CO_2 locked into carbonate rocks
 - little geologic activity on Mars meant CO_2 remained trapped

Runaway Icehouse Effect

