



"We humans long to be connected with our origins,
so we create rituals.

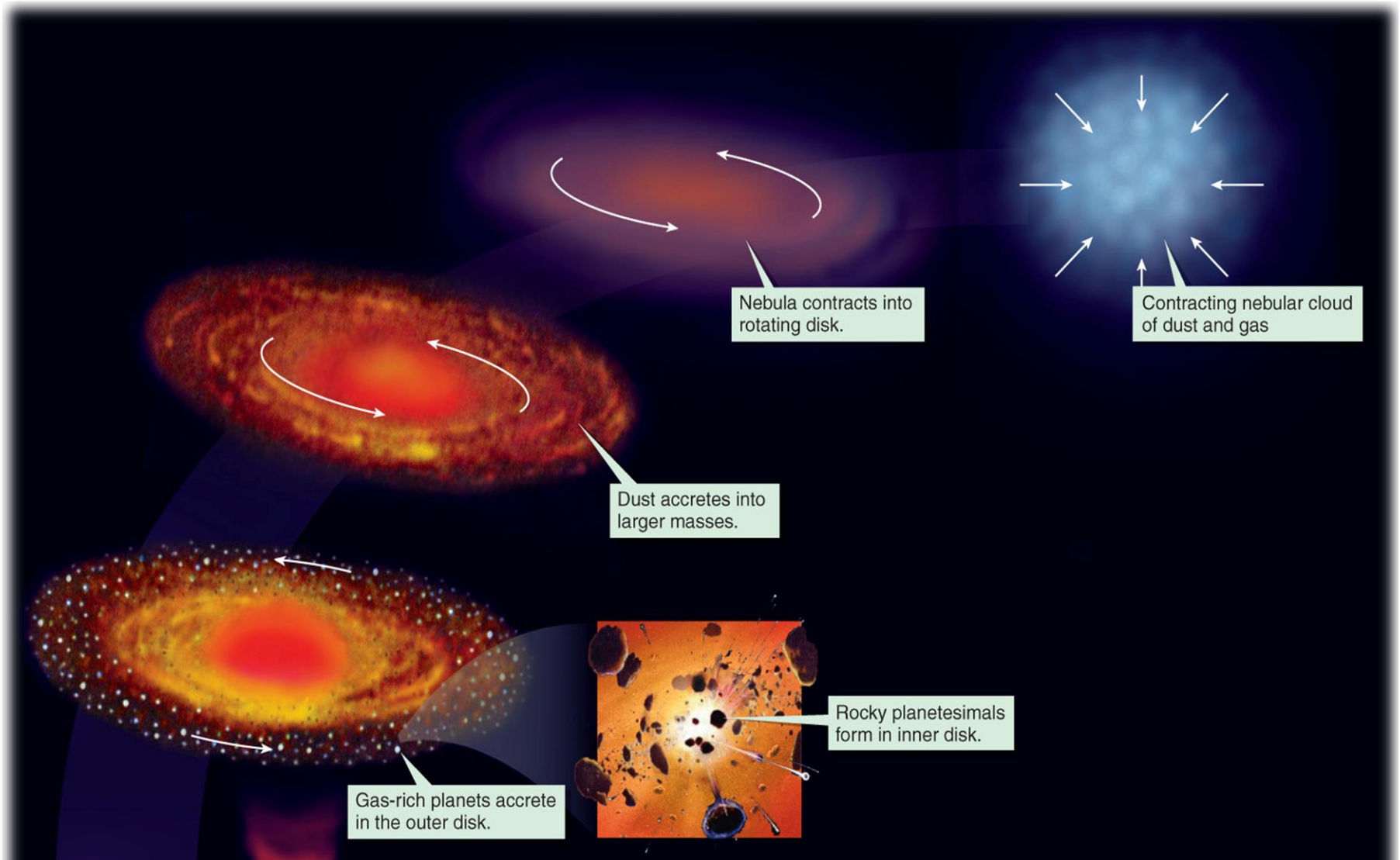
Science is another way to express this longing,
it also connects us with our origins, and it too, has its rituals,
and its commandments.

Its only sacred truth, is that there are no sacred truths."

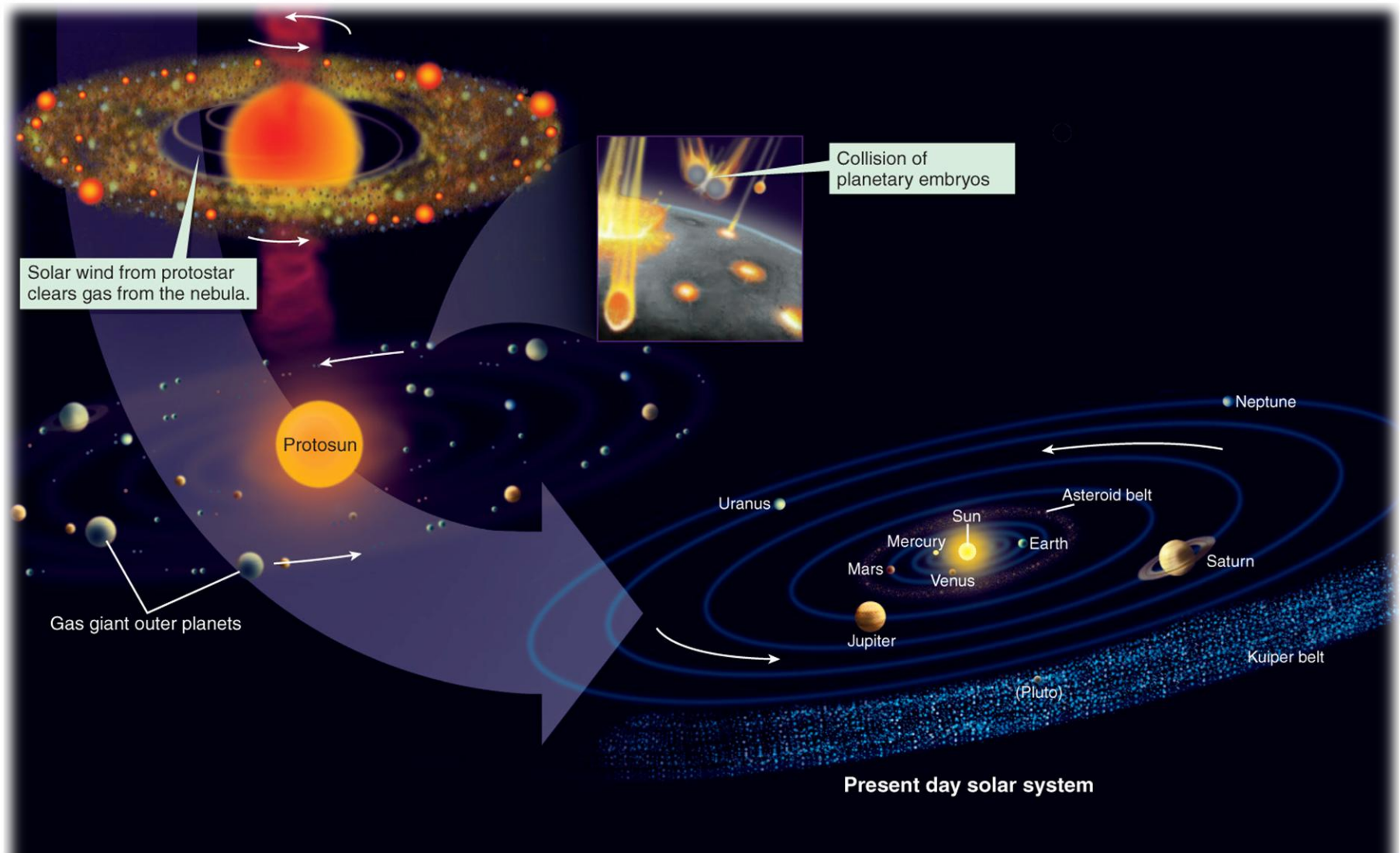
-CARL SAGAN

INTRODUCTION TO THE ATMOSPHERE: THE ORIGINS, STRUCTURE, AND COMPOSITION OF THE ATMOSPHERE

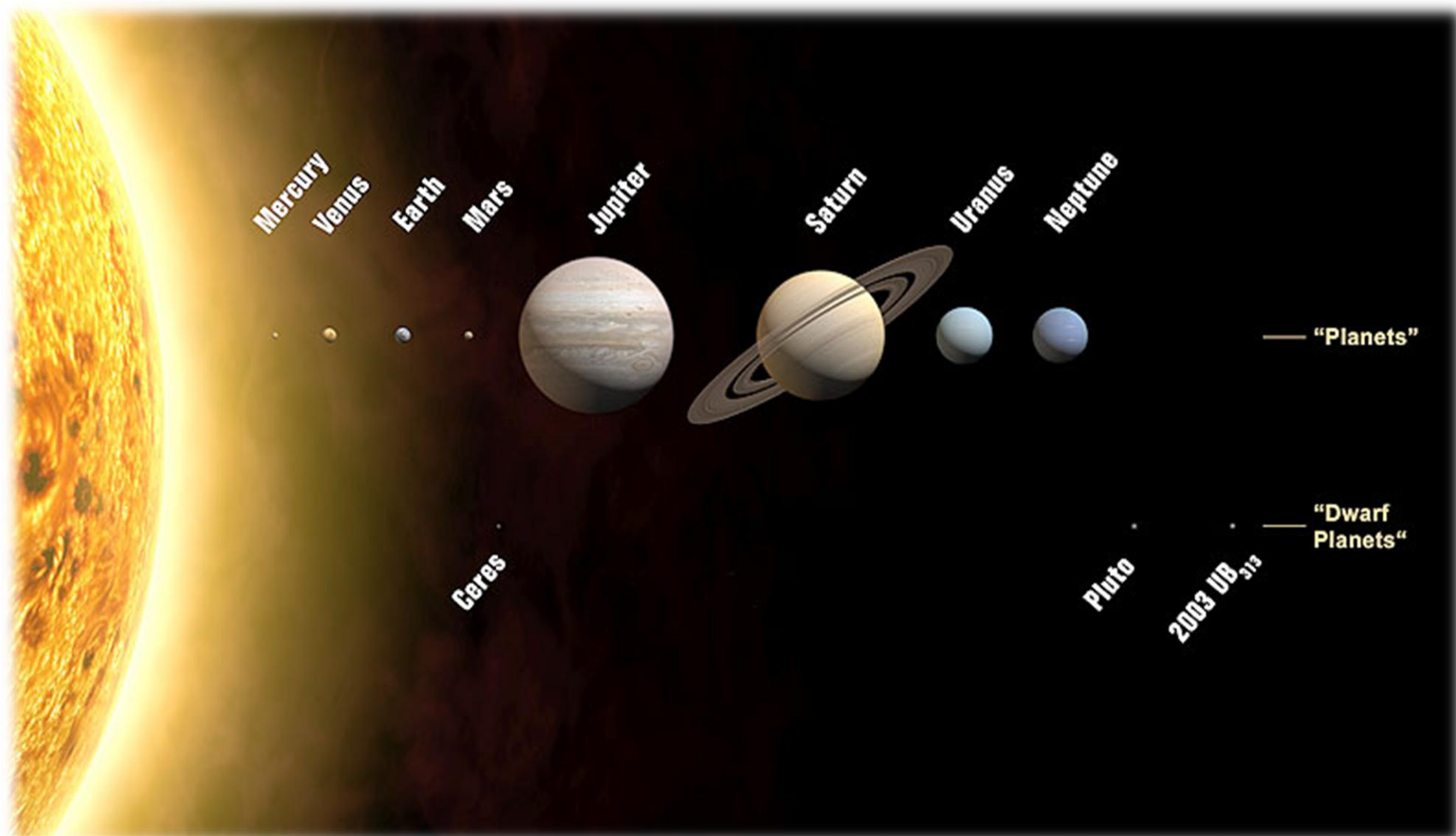
THE ORIGINS OF THE EARTH



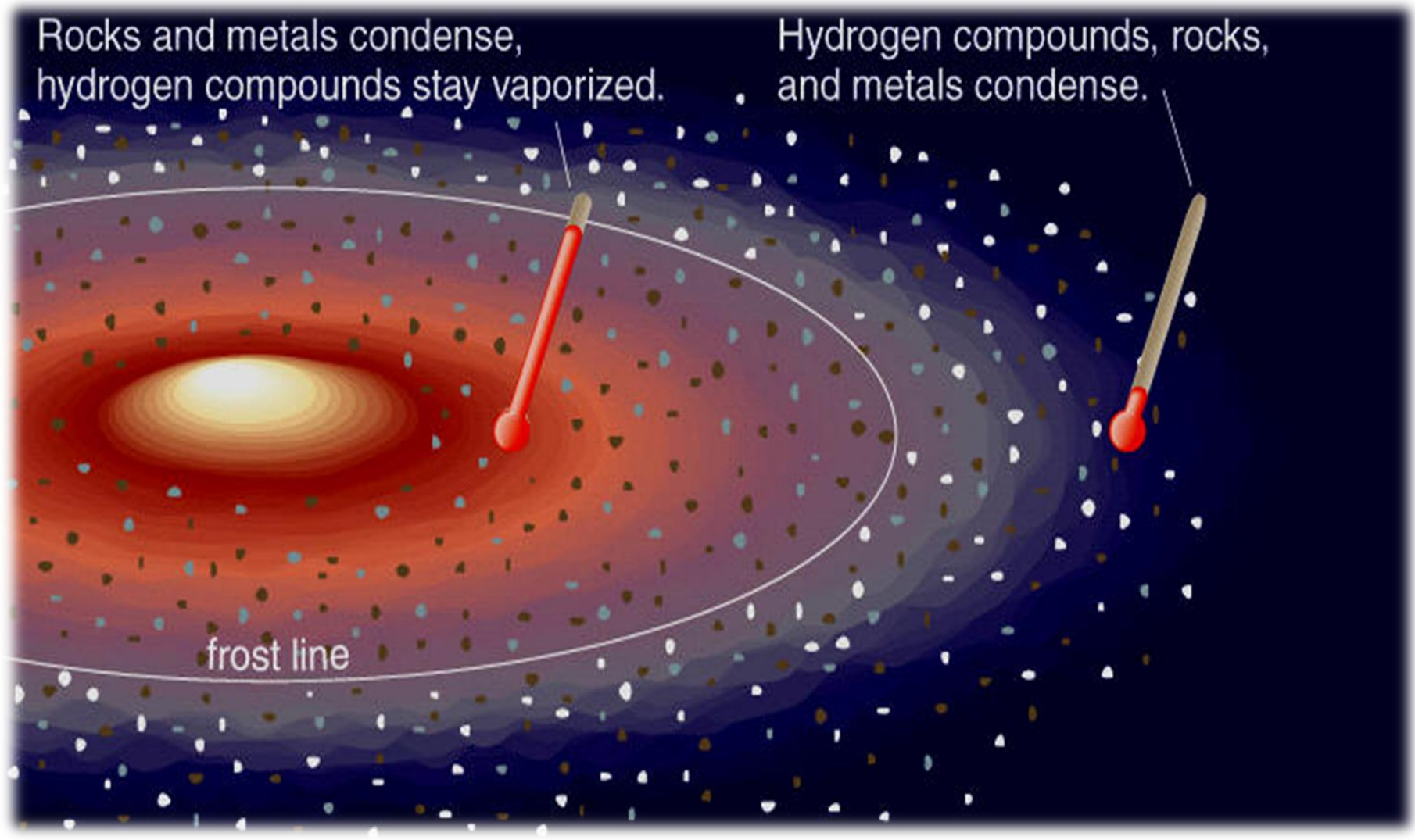
THE ORIGINS OF THE EARTH



THE SOLAR SYSTEM

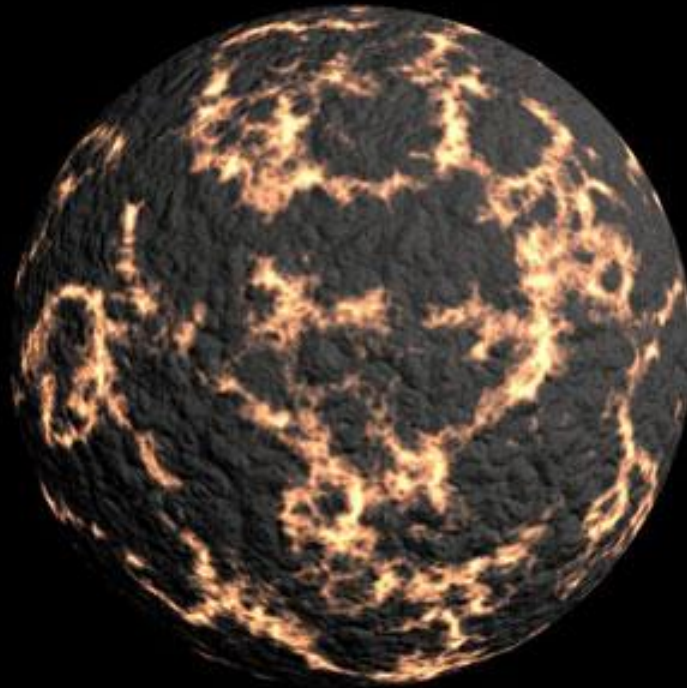


EXPLAINING PLANETARY DIFFERENCES



The reason that the inner planets are rocky and the outer planets are gaseous is NOT because of density but rather because of **TEMPERATURES** within the nebular cloud

EARTH'S EARLY ATMOSPHERE



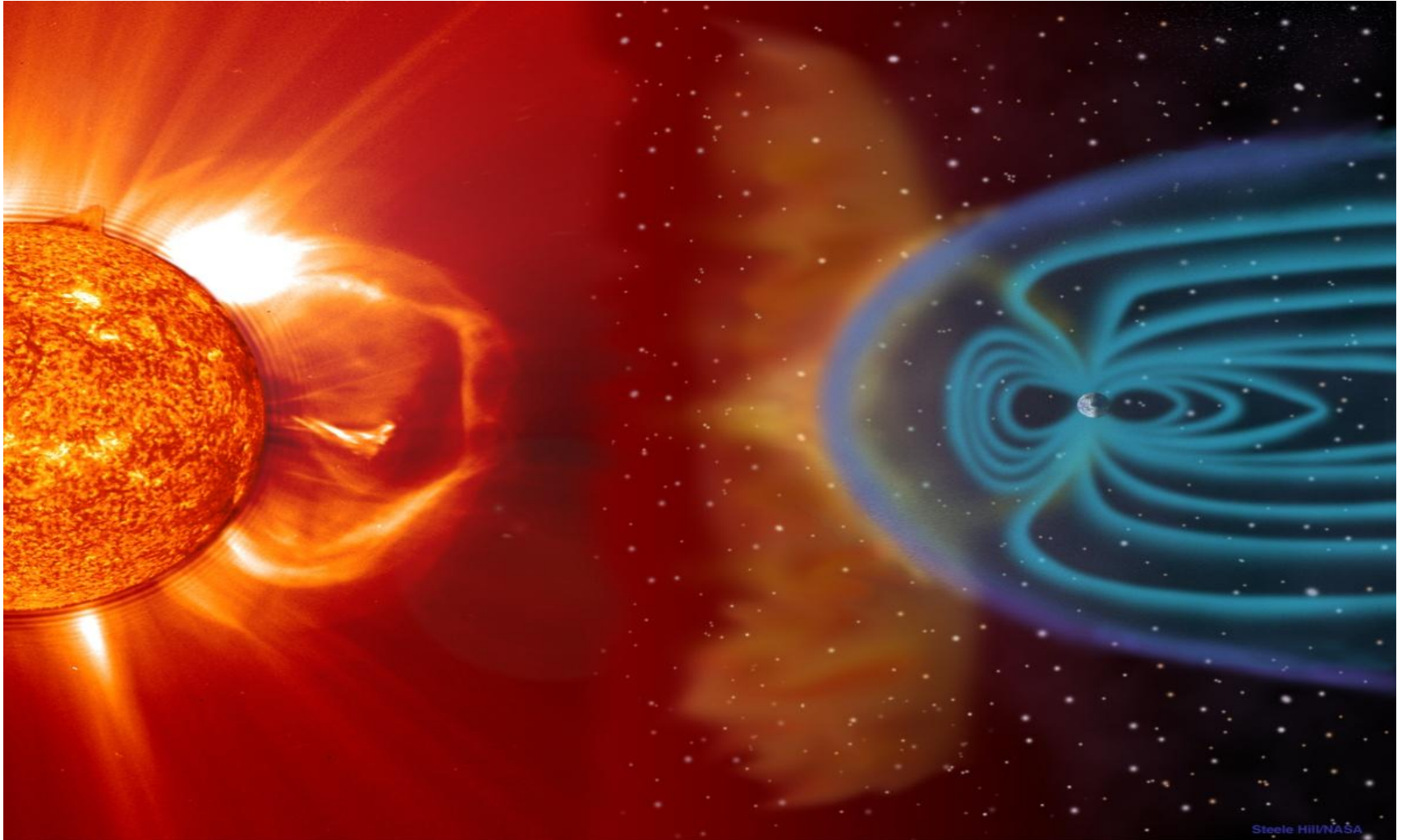
- **First Atmosphere**
- Composition - Probably H₂, He
- These gases are relatively rare on Earth compared to other places in the universe and were probably lost to space early in Earth's history because
 - Earth's gravity is not strong enough to hold lighter gases
 - Earth still did not have a differentiated core (solid inner/liquid outer core) which creates Earth's magnetic field (magnetosphere = Van Allen Belt) which deflects solar winds.
- Once the core differentiated the heavier gases could be retained

THE ORIGINS OF THE ATMOSPHERE



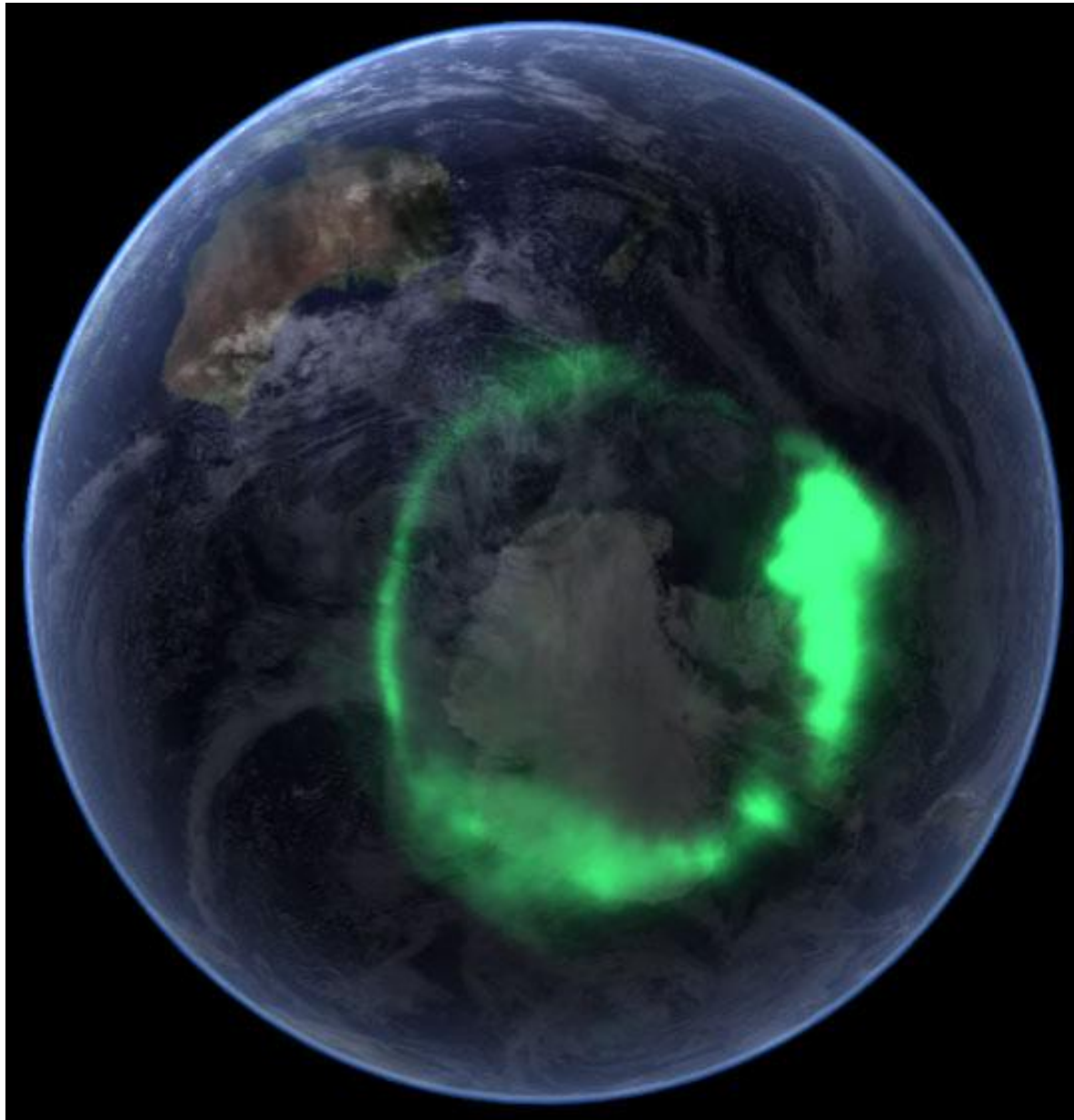
Volcanic eruptions spewed gases from Earth's interior to the atmosphere, a process called **outgassing** that continues today. Most of the gas was carbon dioxide and water vapor. ***The water vapor condensed to form part of Earth's oceans as the surface cooled. Comets may also have contributed water and complex organic molecules to Earth's environments.***

THE MAGNETOSPHERE

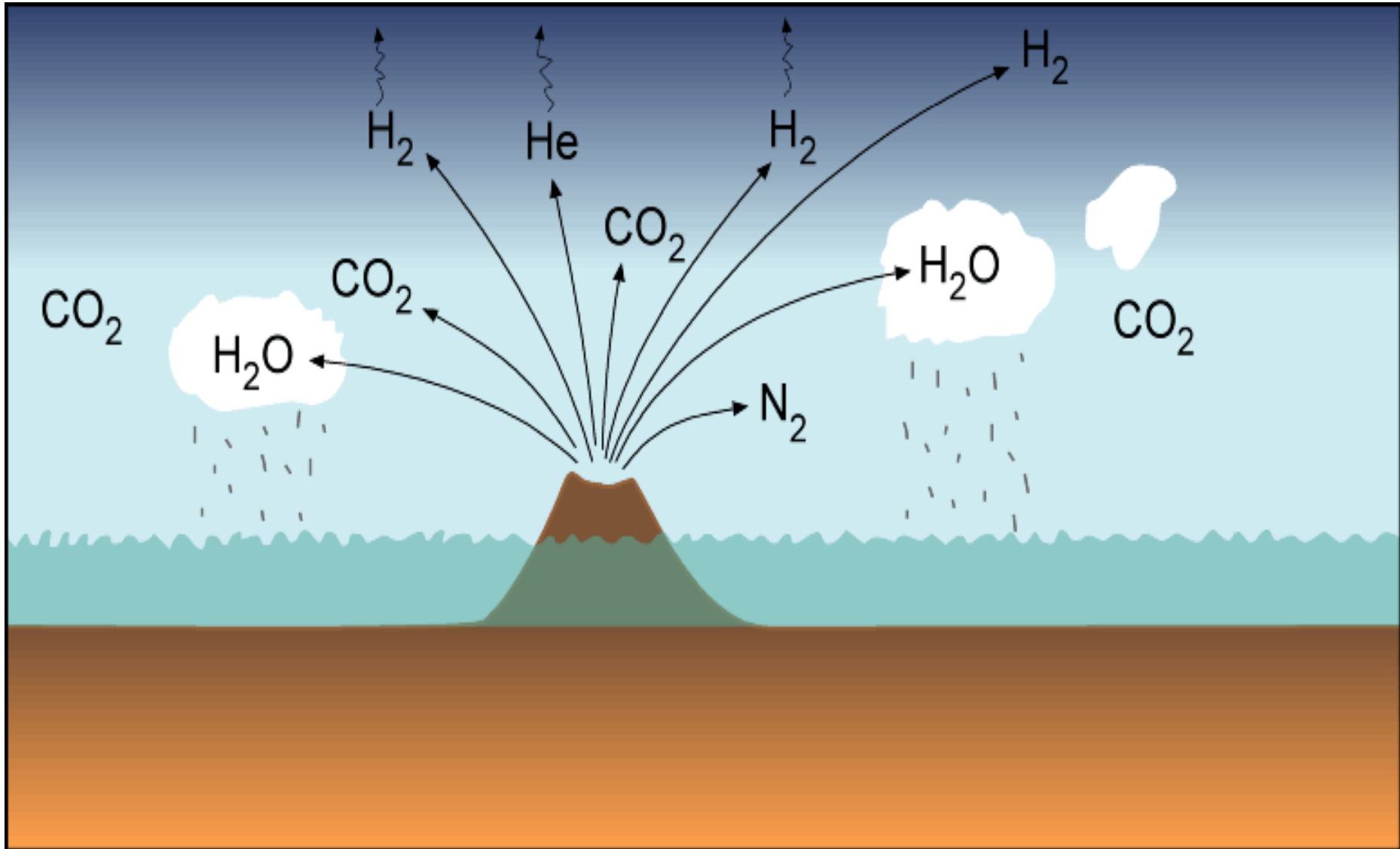


The magnetosphere soon formed as a result of this differentiation and the Earth's rotation. This is important as the magnetosphere acts as a barrier that deflects the solar winds which protects our atmosphere from being swept away. The interactions between the magnetosphere and the solar wind creates the Aurorae.

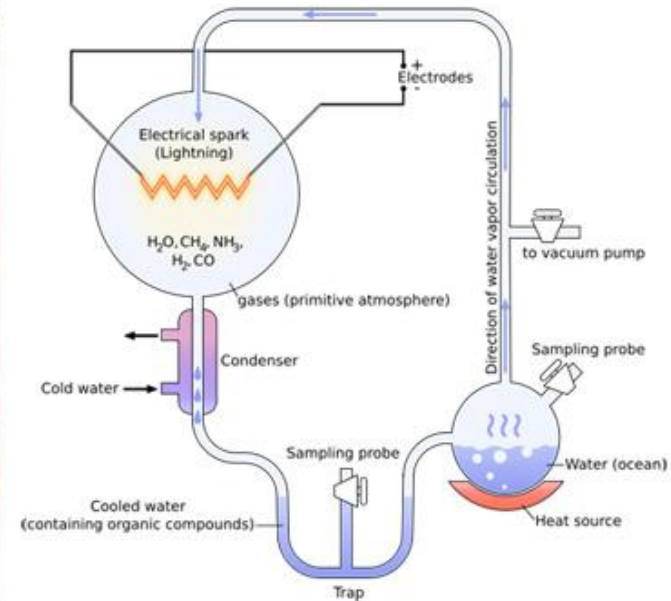
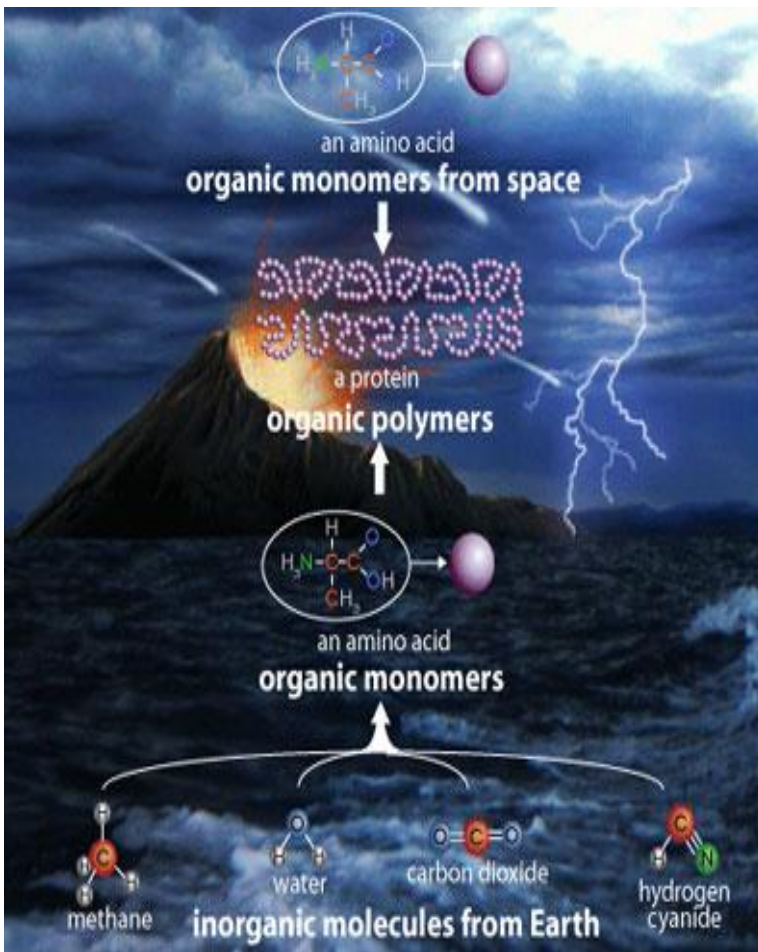
AURORA BOREALIS



REVISITING VOLCANIC OUTGASSING



THE ORIGINS OF LIFE



The Miller-Urey experiment was an experiment that simulated the conditions thought at the time to be present on the early Earth, and tested for the occurrence of chemical origins of life.

THE ORIGINS OF OXYGEN



Oldest Fossils

The **oldest undisputed fossils known** are **stromatolites**. Modern stromatolites are made of alternating thin layers of sediment and microbes, primarily bacteria, photosynthetic bacteria, and archaea that live in warm shallow seas. **Photosynthesizing organisms** ultimately changed Earth's atmosphere by consuming its carbon dioxide and releasing **oxygen**.

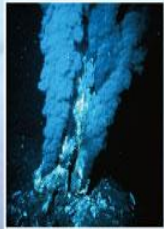
BANDED IRON FORMATIONS

Building a banded iron formation

Banded iron formations began as sediments accumulating on the ocean floor of early Earth. The formations record how different both ocean and atmospheric chemistry were from today's, and in what ways they may have dramatically changed. Pictured is one scenario for how the formations may document Earth's transition to an oxygen-rich atmosphere.

1 Iron from the deep

Iron from Earth's interior enters the ocean through hydrothermal vents, which are essentially hot springs on the ocean floor. Modern vents dot spreading ridges, where blocks of ocean crust are moving apart and making room for magma from below to travel upward and create new ocean crust.



2 Iron from the land

Continental crust on land also contains iron. Water and weather break the crust down, and rivers carry dissolved iron particles into the ocean.



3 Oxygen makers

Oxygen could have entered the scene as it was produced in large enough quantities by cyanobacteria, microbes that perform photosynthesis.

4 Iron back down

The ocean of early Earth contained much more dissolved iron than today's ocean. One way iron leaves water is if it reacts with dissolved oxygen. The reaction forms a type of iron that precipitates out of water, falling as iron oxide particles onto the ocean floor.



5 Oxygen up

Being a gas, oxygen can travel between atmosphere and ocean. One question is whether oxygen first built up in the atmosphere, then flooded the water and caused iron to precipitate out; or whether oxygen accumulated in the water and then spent time using up the iron supply until enough oxygen was available to fill the atmosphere.



6 Banding beginnings

Particles of silica also drop out of water onto the ocean floor. The layering of banded iron formations shows that sometimes ocean precipitates were mostly silica and other times they were mostly iron. Why remains unclear.



7 Sediment to rock

Over time, sediments accumulate atop sediments. As the particles are buried deeper and deeper, they undergo changes that form them into rock. Over millions of years, as continents and oceans change, the rocks are uplifted and exposed on the continents. Pictured is Dales Gorge, part of the Brockman Iron Formation in Western Australia.



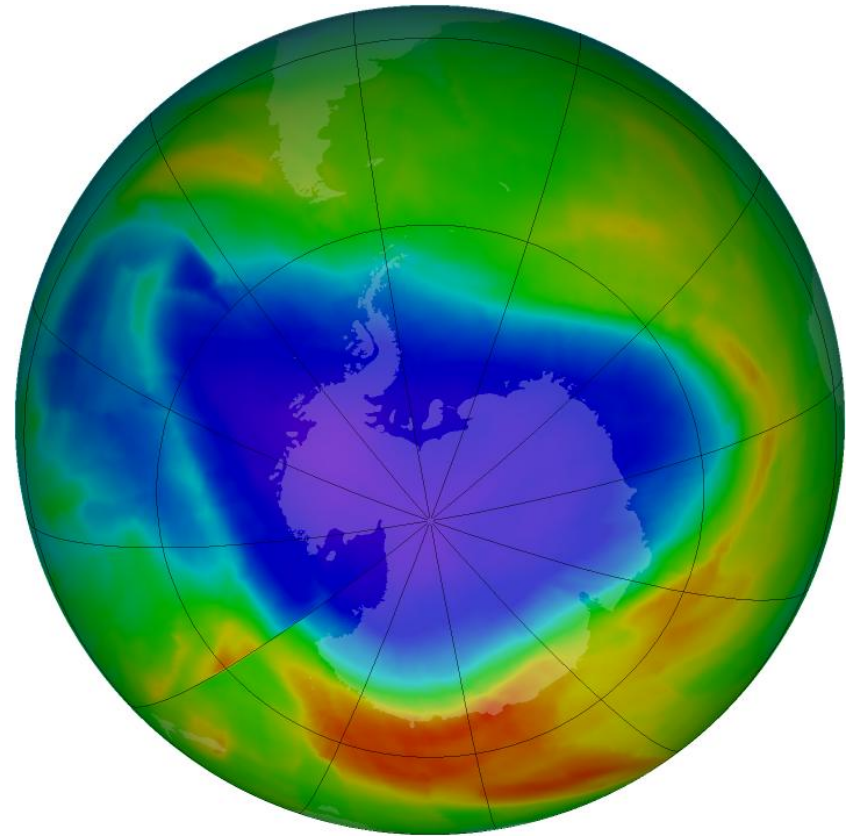
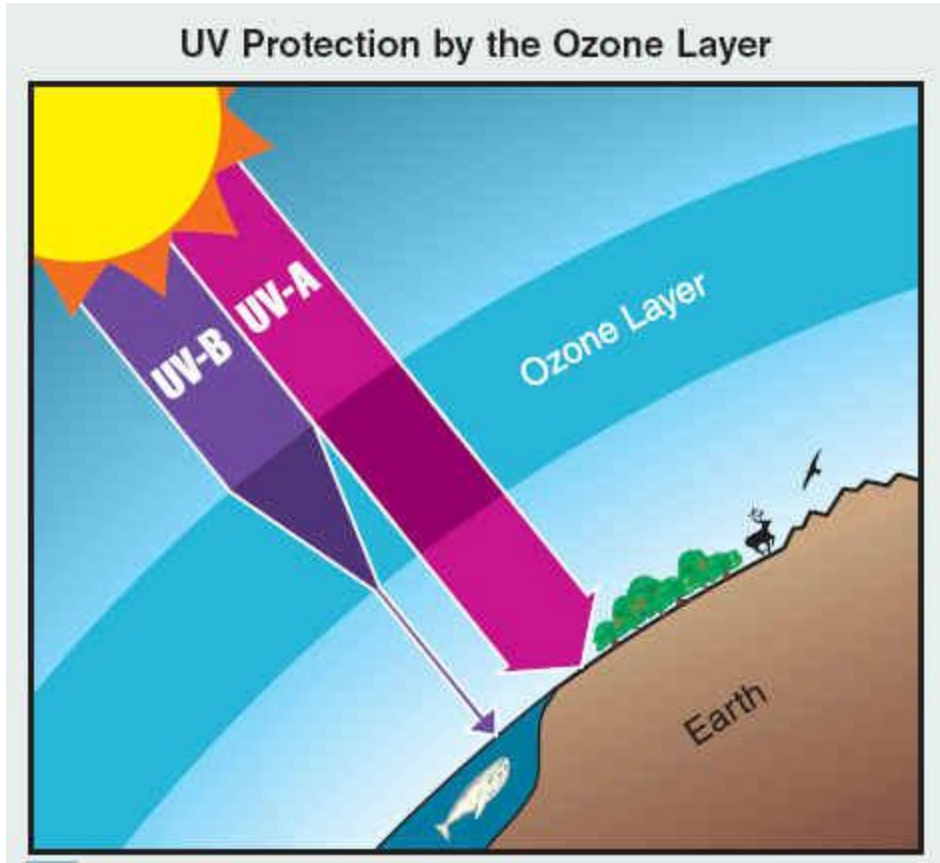
Making Oxygen

As **photosynthesizing organisms pumped oxygen into Earth's atmosphere and ocean**, the oxygen reacted with dissolved iron in the oceans and formed massive rock deposits called "***banded iron formations.***" Once the dissolved iron was used in chemical reactions, oxygen began to increase in the atmosphere. Much of the iron used in industry today originated at this time. Photograph of a banded iron formation outcrop located on the Upper Peninsula, Michigan.

RED BEDS AND OXIDATION



FORMATION OF THE OZONE LAYER



If it wasn't for stratospheric ozone, life as we know it now wouldn't be possible on Earth. **Ozone prevents harmful ultra-violet radiation from the Sun (light with wavelengths less than 320 nm) reaching the ground.** If allowed to reach Earth, this radiation would severely damage the cells that plants and animals are made up of. Ozone was first formed in the Earth's atmosphere after the release of oxygen, between 2000 and 600 million years before the first humans appeared.

COMPOSITION OF THE ATMOSPHERE

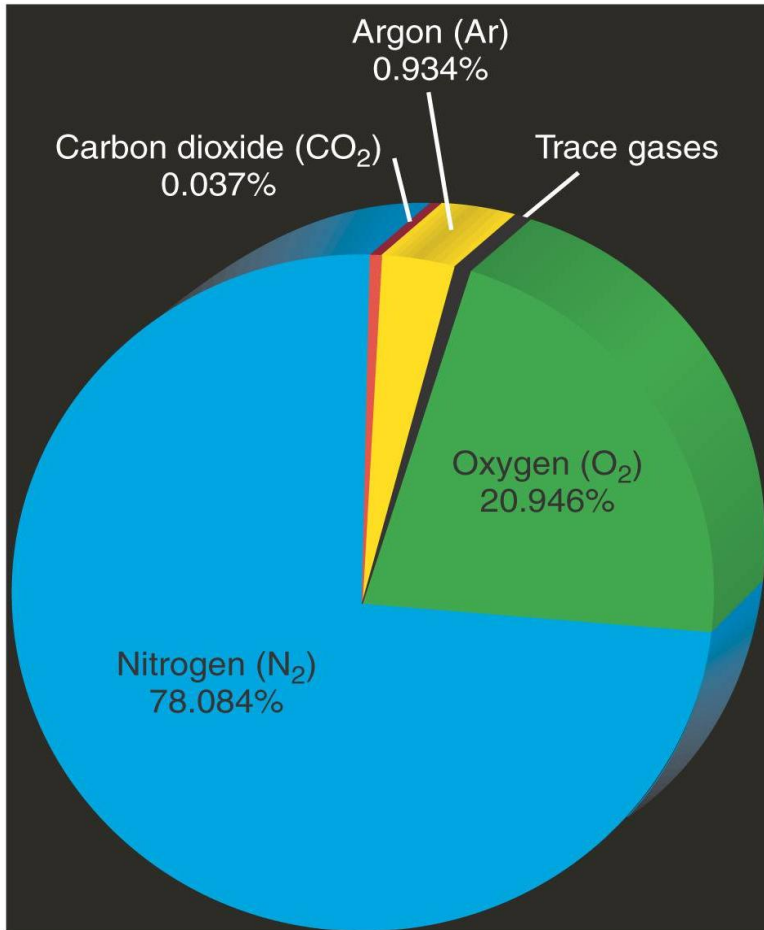
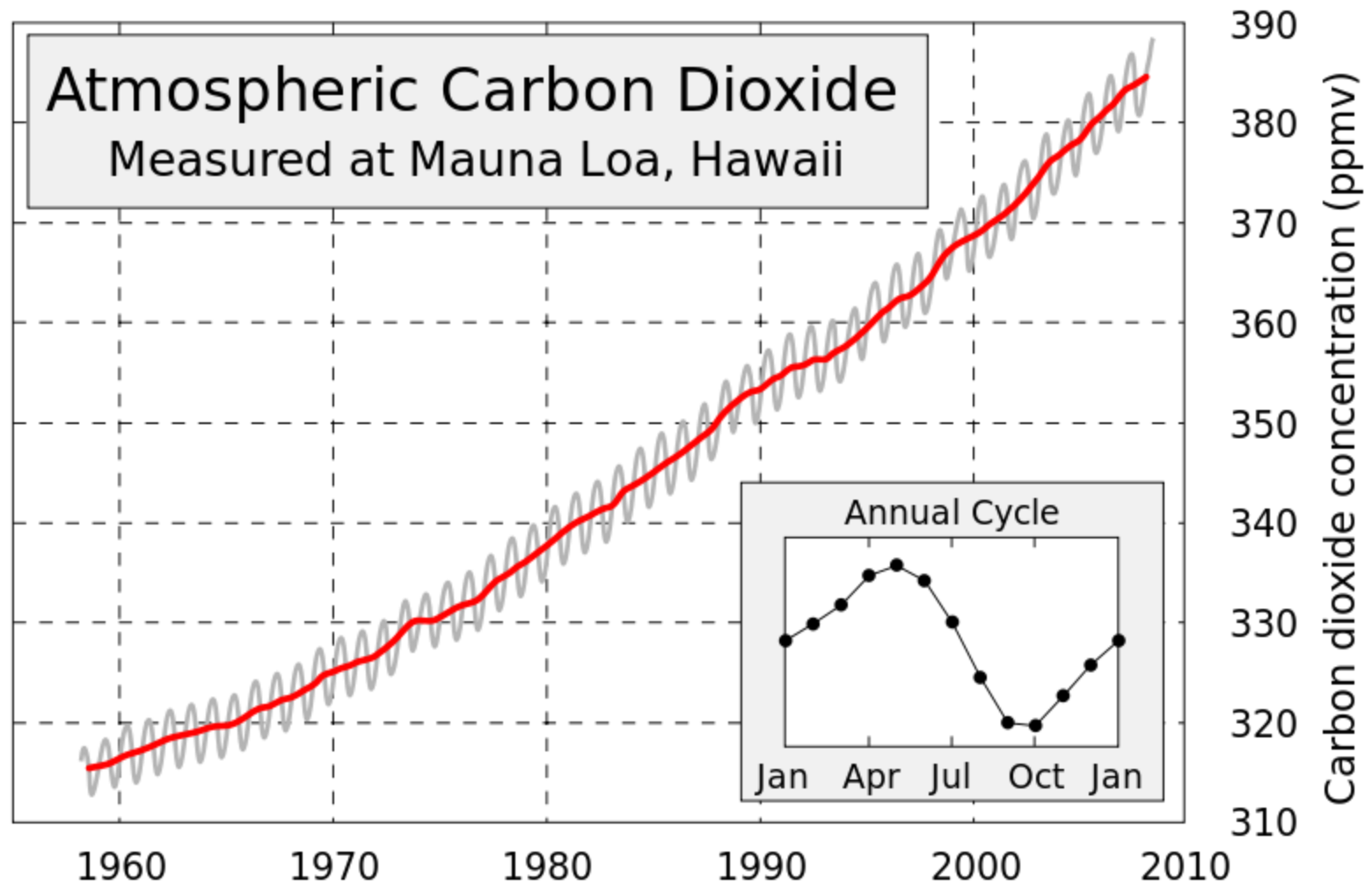


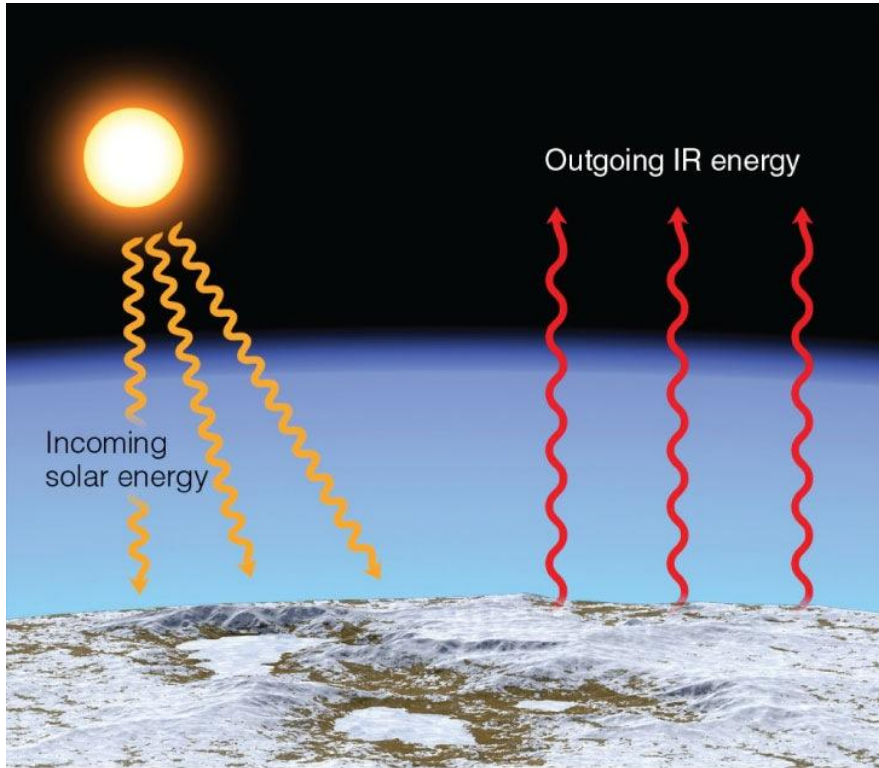
Table 1-2 Principal gases of dry air

Constituent	Percent by Volume	Concentration in Parts Per Million (PPM)
Nitrogen (N ₂)	78.084	780,840.0
Oxygen (O ₂)	20.946	209,460.0
Argon (Ar)	0.934	9,340.0
Carbon dioxide (CO ₂)	0.036	360.0
Neon (Ne)	0.00182	18.2
Helium (He)	0.000524	5.24
Methane (CH ₄)	0.00015	1.5
Krypton (Kr)	0.000114	1.14
Hydrogen (H ₂)	0.00005	0.5

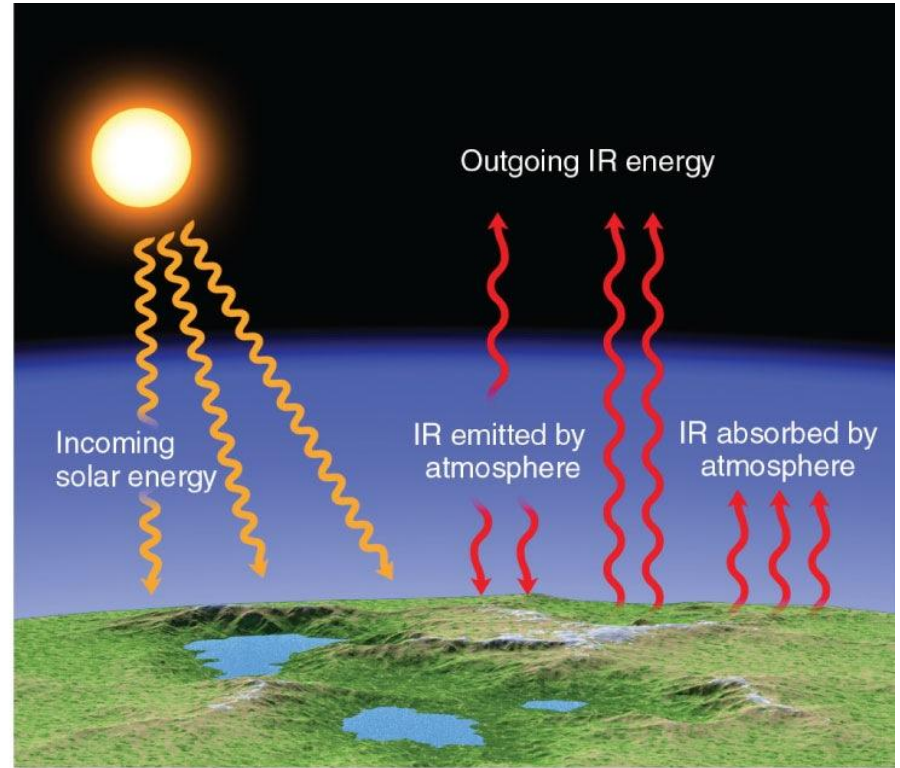
COMPOSITION OF THE ATMOSPHERE



THE GREENHOUSE EFFECT



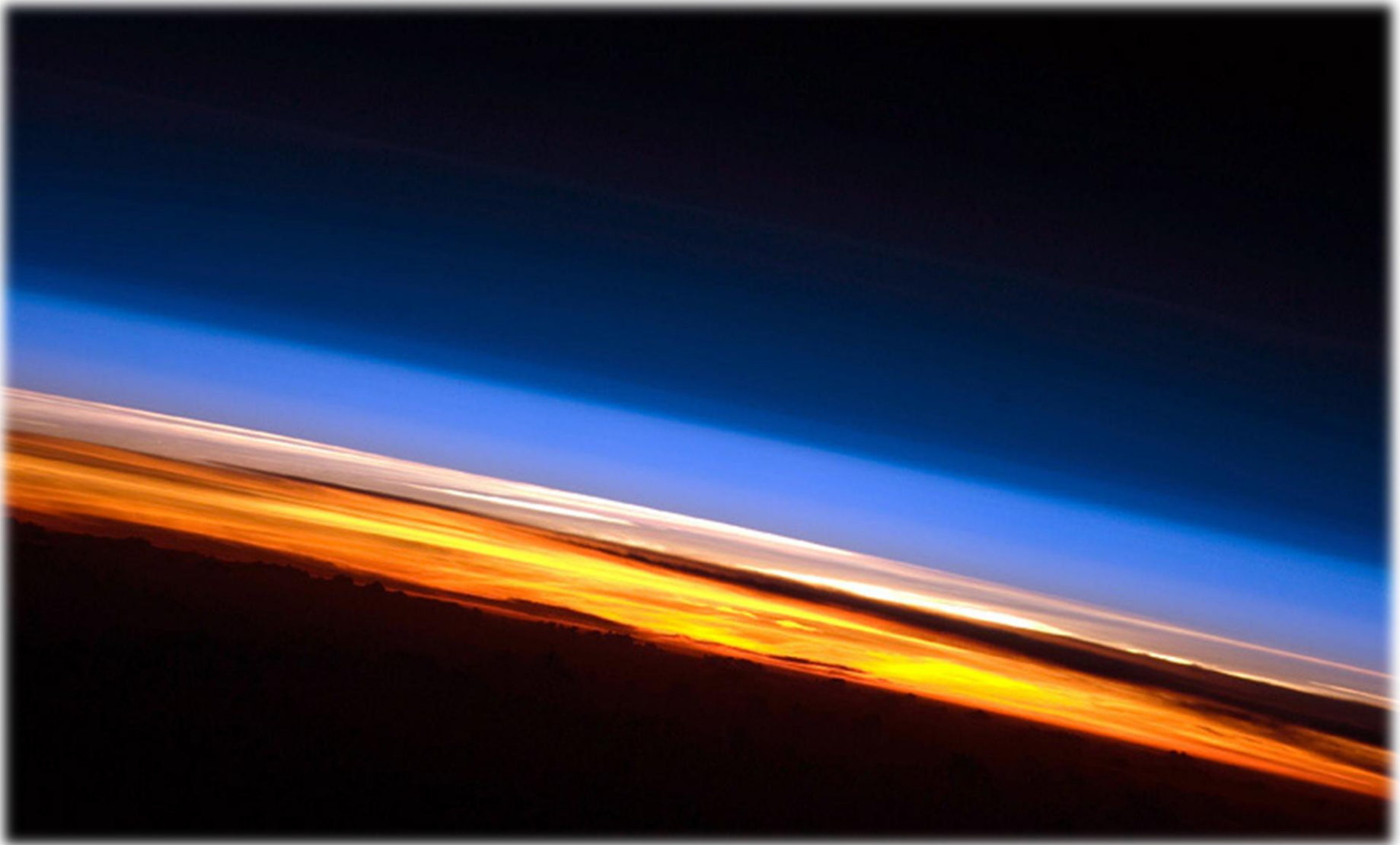
(a) Without greenhouse gases



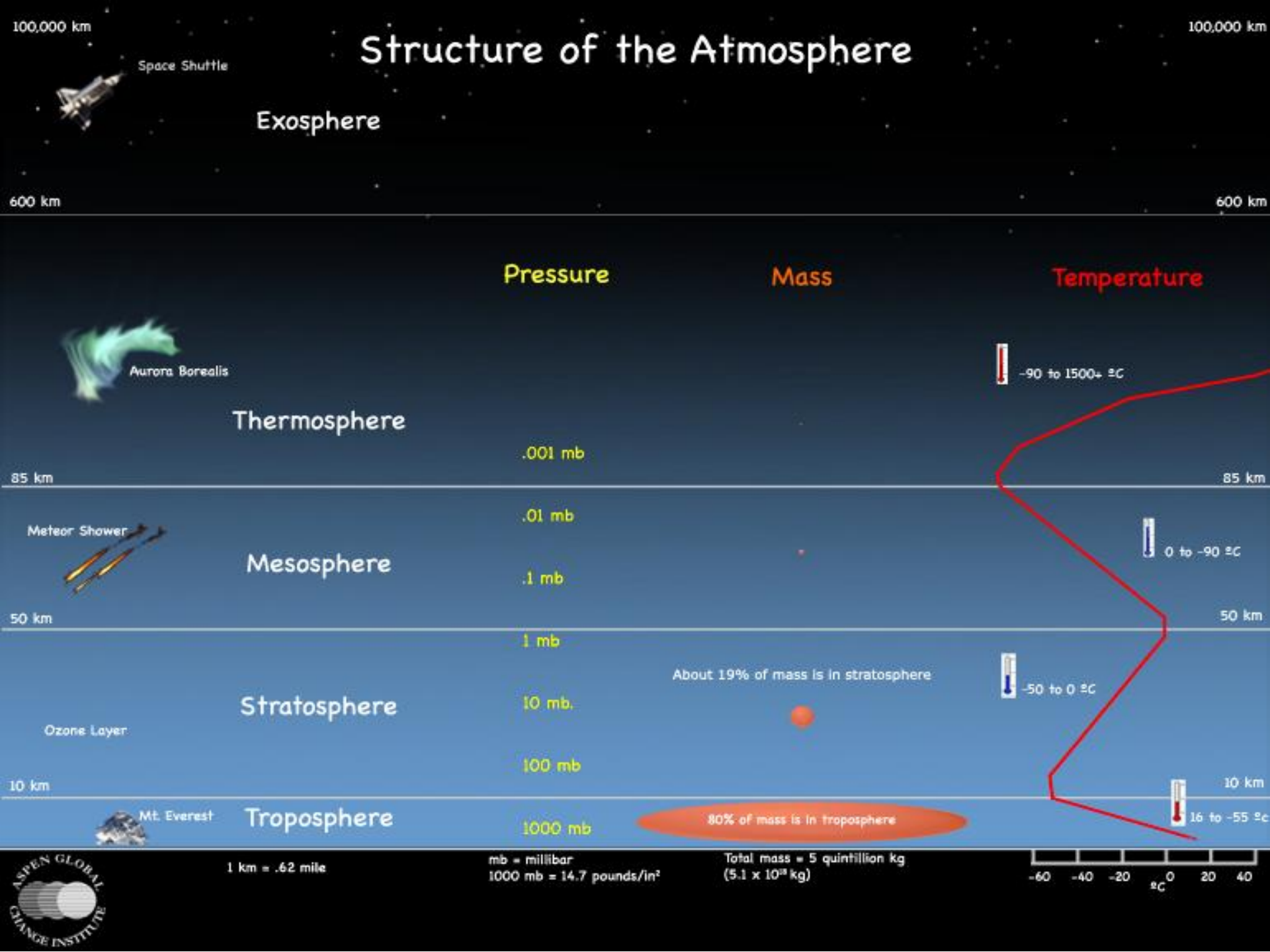
(b) With greenhouse gases

(a) Near the surface in an atmosphere with little or no greenhouse gases, the earth's surface would constantly emit infrared (IR) radiation upward, both during the day and at night. Incoming energy from the sun would equal outgoing energy from the surface, but the surface would receive virtually no IR radiation from its lower atmosphere. (No atmospheric greenhouse effect.) The earth's surface air temperature would be quite low, and small amounts of water found on the planet would be in the form of ice. (b) In an atmosphere with greenhouse gases, the earth's surface not only receives energy from the sun but also infrared energy from the atmosphere. Incoming energy still equals outgoing energy, but the added IR energy from the greenhouse gases raises the earth's average surface temperature to a more habitable level.

THE ATMOSPHERE'S LAYERED STRUCTURE



Structure of the Atmosphere





FELIX BAUMGARTNER

MISSION TO THE EDGE OF SPACE

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