

# Atmosphere

Formation  
Composition  
Role  
Layers

# Atmosphere Formation

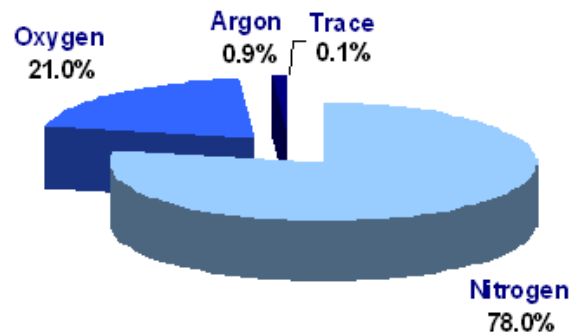
- ✈ More than 4 billion years ago
- ✈ Via volcanic eruptions ( $\text{H}_2\text{O}$ ,  $\text{CO}$ ,  $\text{CO}_2$ ,  $\text{HCl}$ ,  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{N}_2$ ,  $\text{SO}_x$ )
  - ✈  $\text{H}_2\text{O}$  condensed & precipitated
  - ✈ Carbon sequestered in rocks

# Current Atmosphere

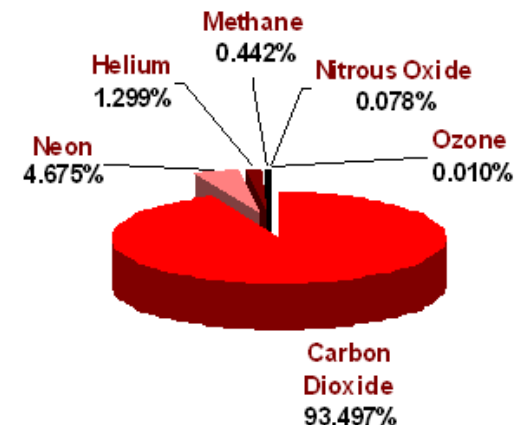
## ✈ Composition:

- ✈ Nitrogen (~78%)
- ✈ Oxygen (~21%)
- ✈  $\text{H}_2\text{O}$ , Ar,  $\text{CO}_2$  (~1% combined)
- ✈ Ozone,  $\text{CH}_4$ , & others (trace)

Atmospheric Composition



Trace Gases



# Roles of the Atmosphere

- ✈ **Reservoir of gases for photosynthesis & respiration**
- ✈ **Global transfer of heat & moisture**
- ✈ **Moderation of Earth's temperature via natural greenhouse effect**
- ✈ **Absorption of solar radiation**

# The Greenhouse Effect

Some solar radiation is reflected by the Earth and the atmosphere.

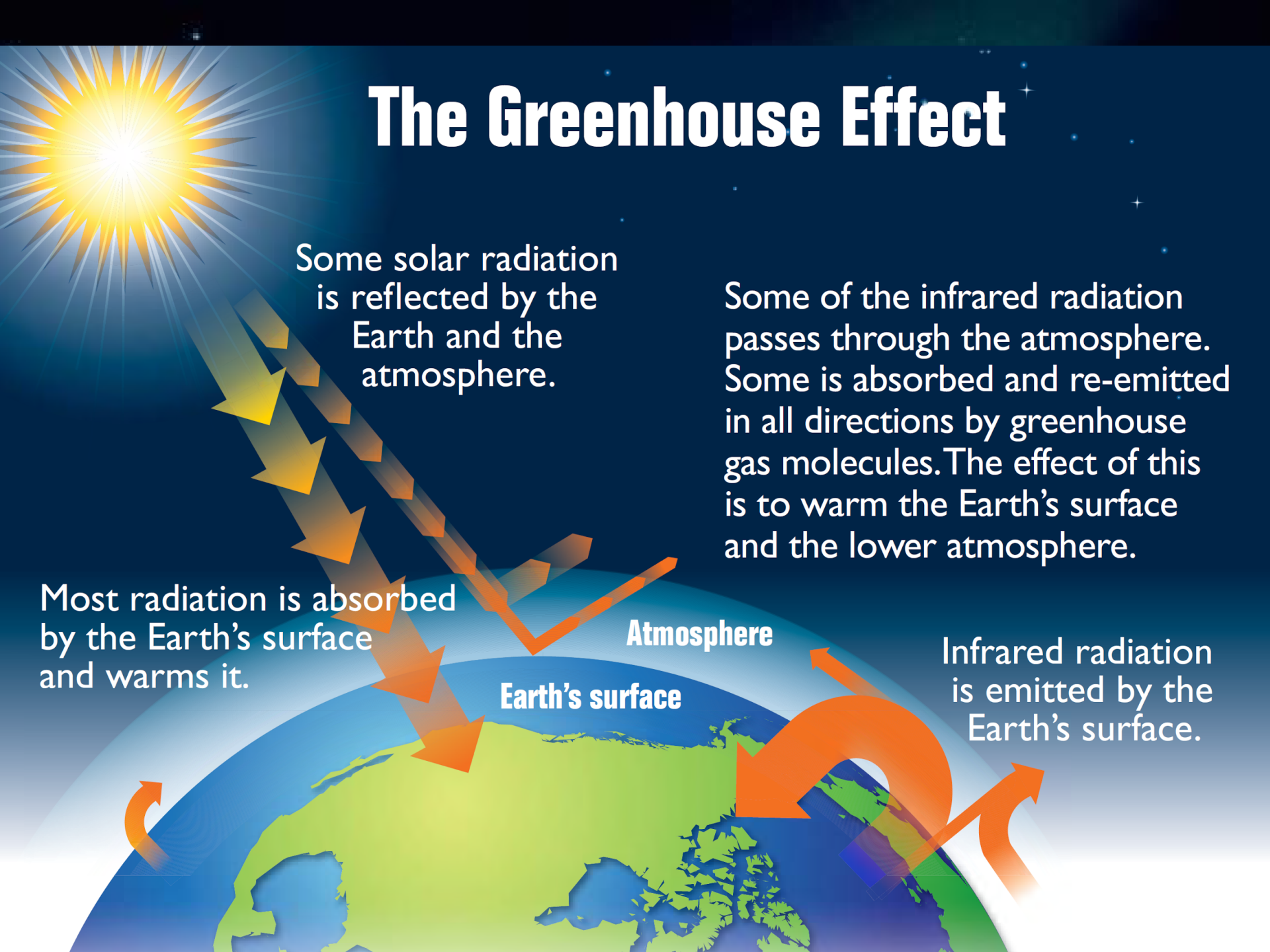
Some of the infrared radiation passes through the atmosphere. Some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.

Most radiation is absorbed by the Earth's surface and warms it.

Atmosphere

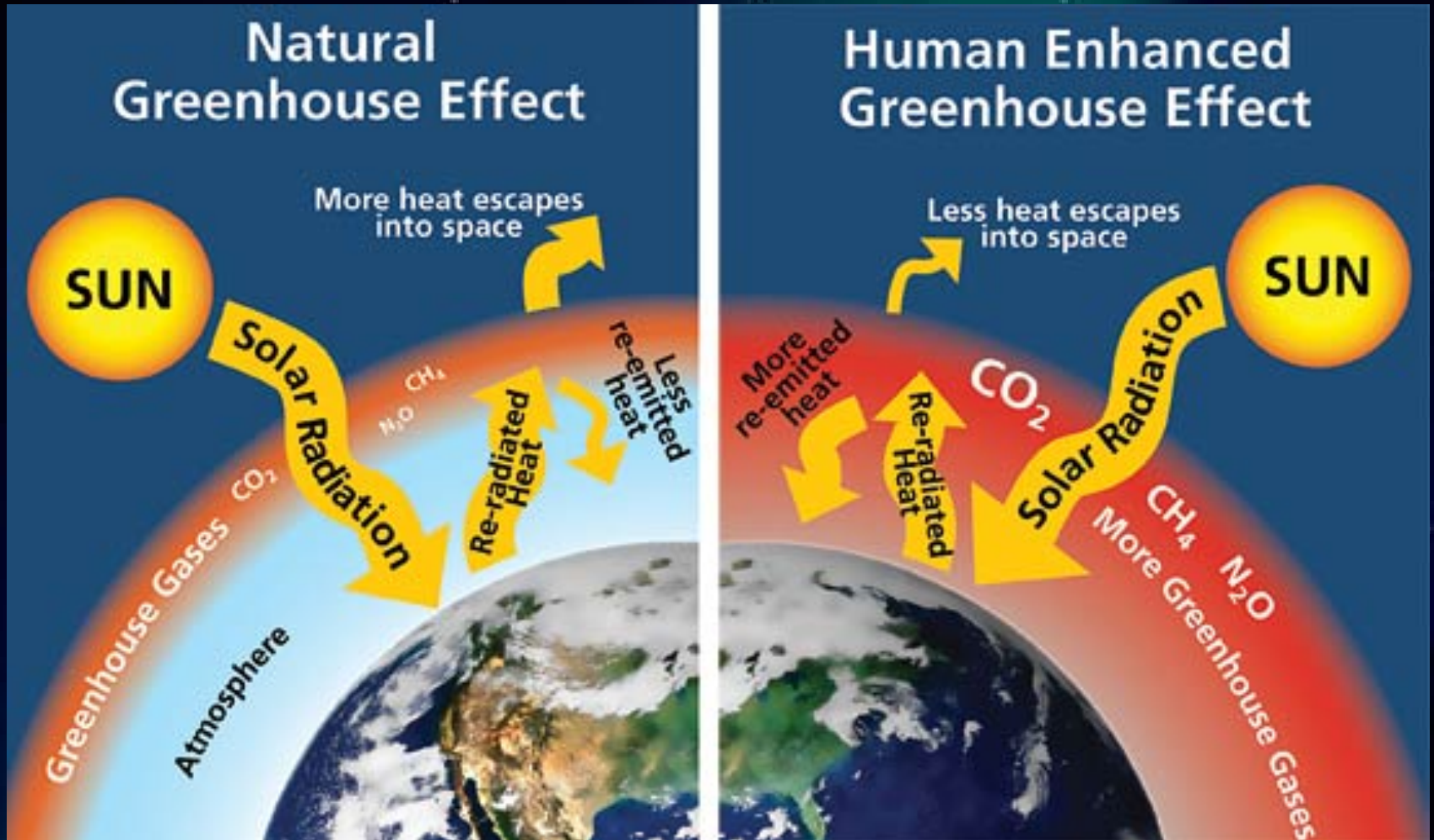
Earth's surface

Infrared radiation is emitted by the Earth's surface.

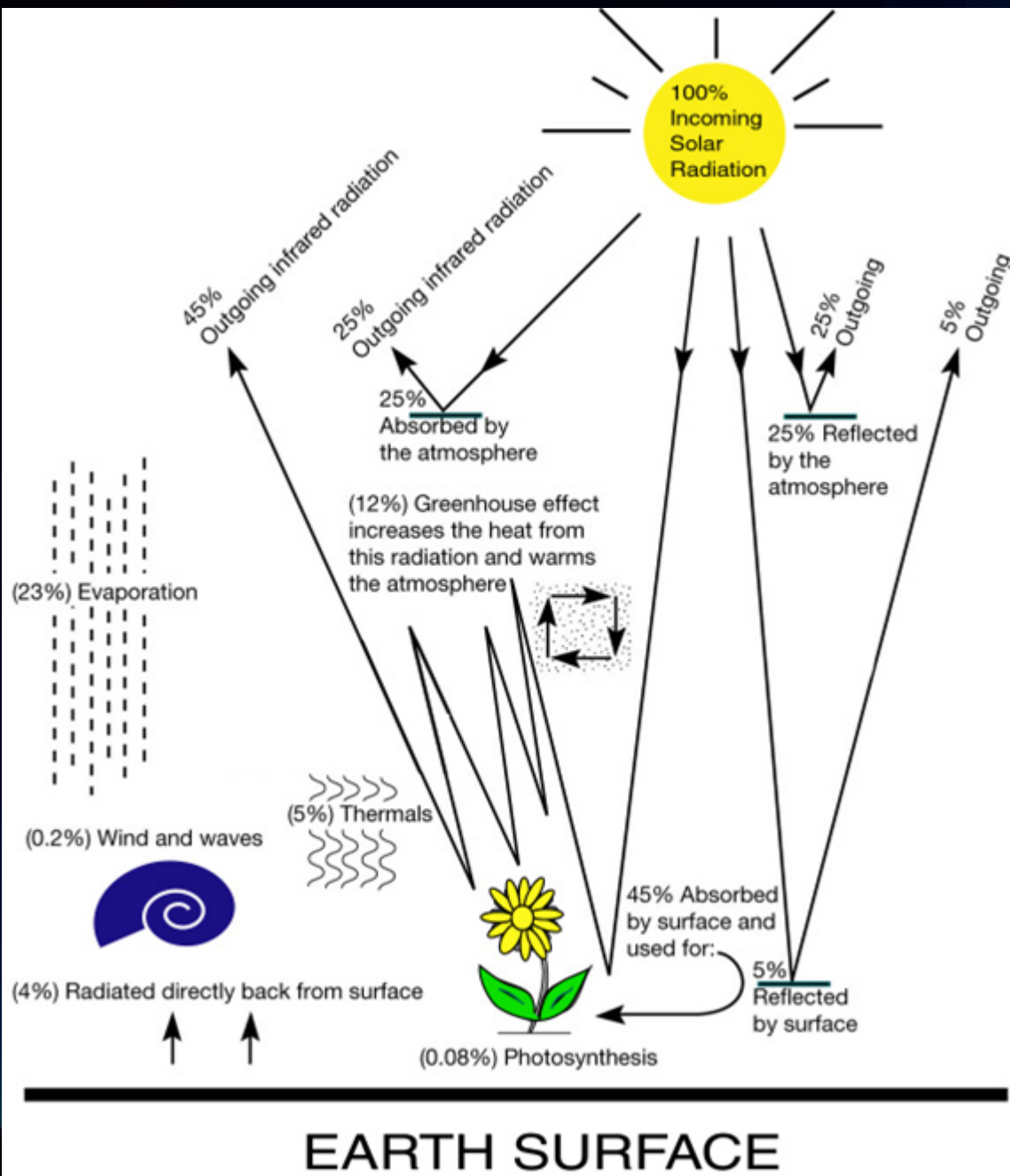




# Greenhouse Effect



How does nature's cooling process at Earth's surface balance the heating effect of greenhouse gases?



Most absorption of ultraviolet radiation from the sun occurs in the stratosphere.

# Absorption of Solar Radiation

## Exosphere

over ~500 km (300 mi)

## Ionosphere

~50-500 km (30-300 mi)

F region 100

D Region 60

E Region 50

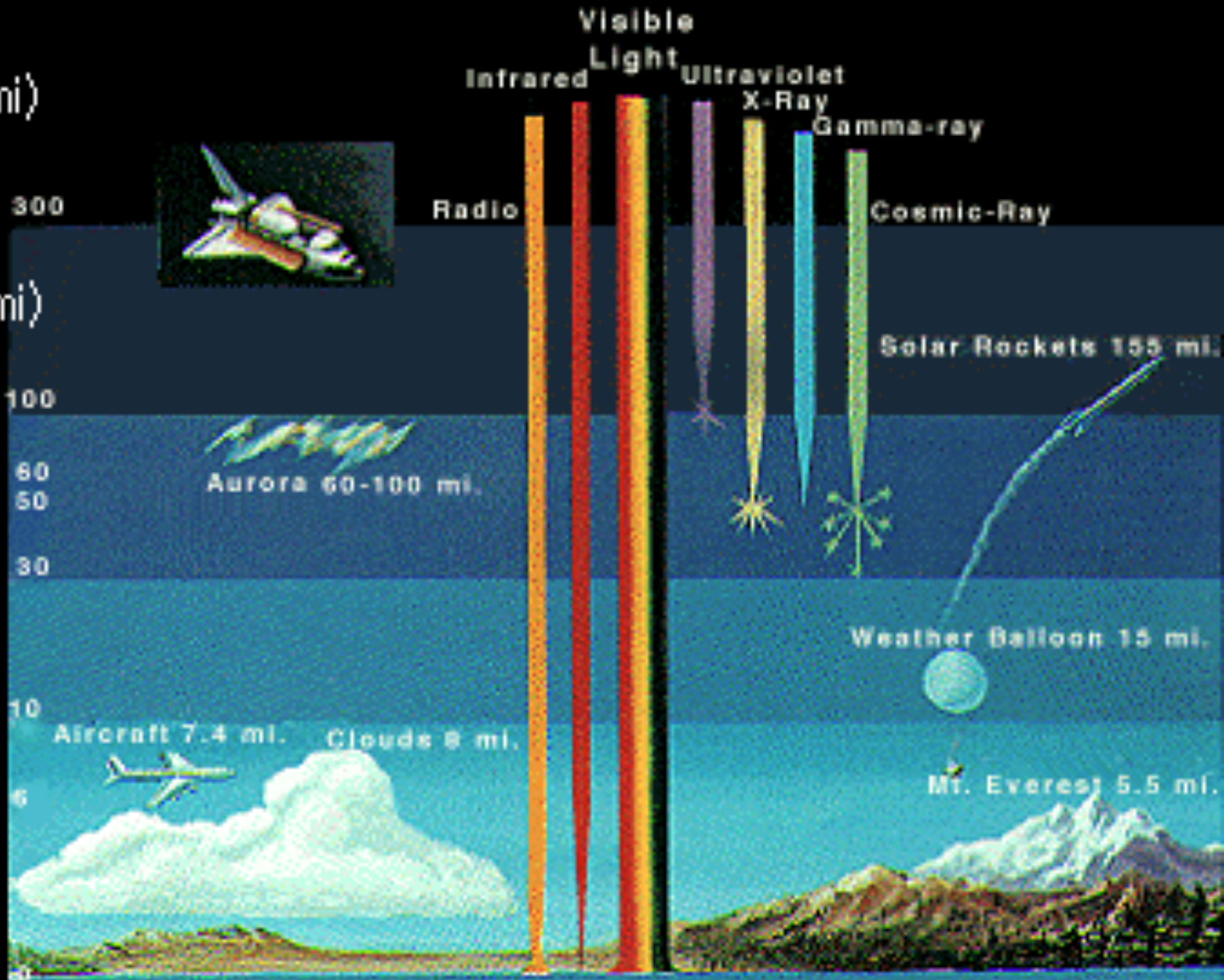
## Stratosphere

16-50 km (10-30 mi)

## Troposphere

0-16 km (0-10 mi)

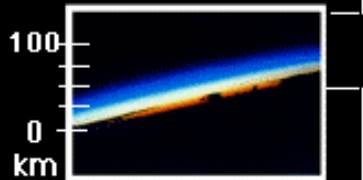
Sea Level



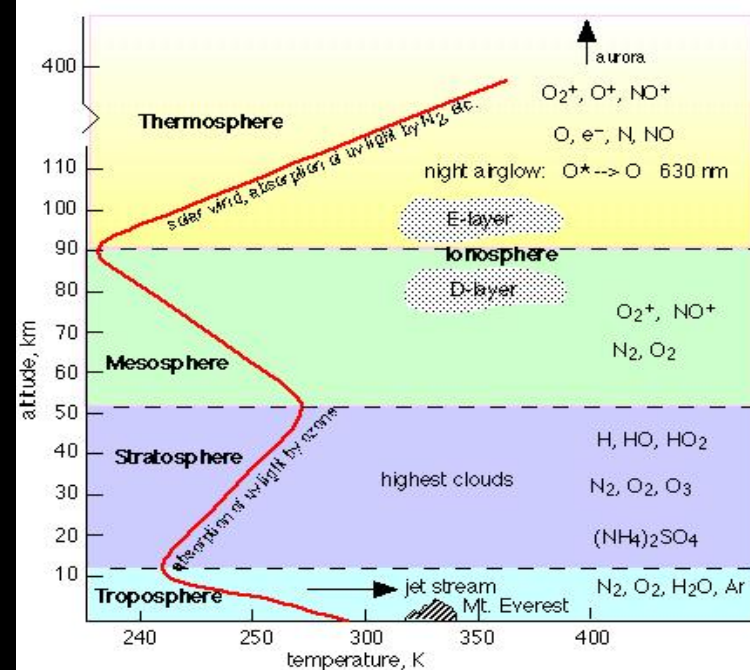
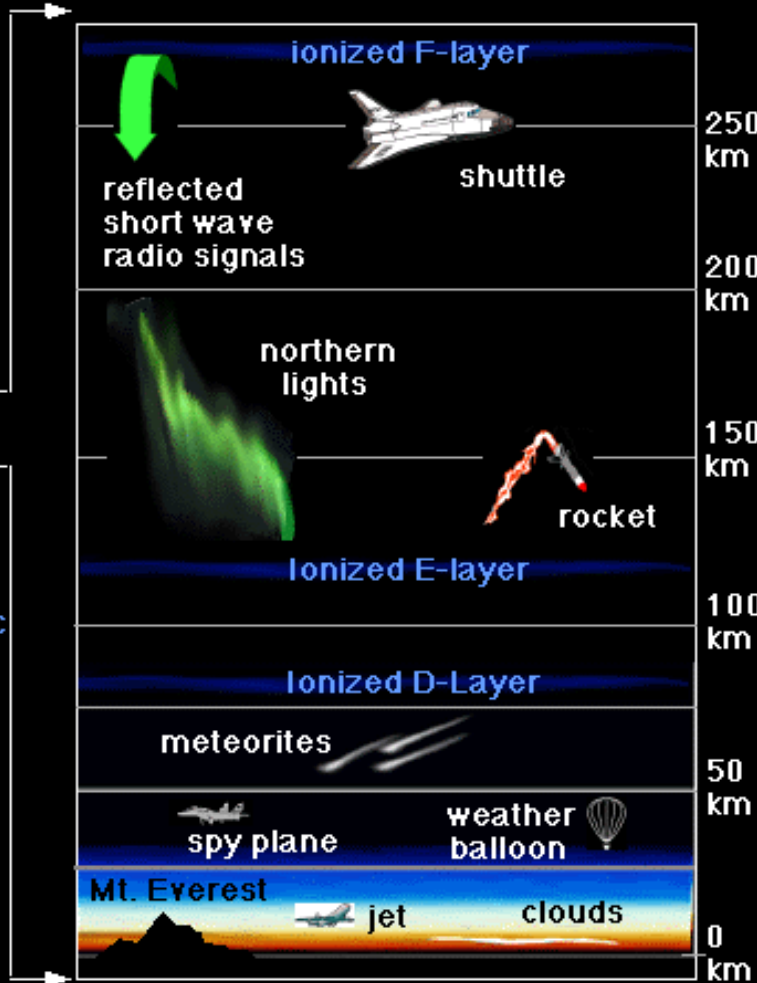


# Layers of the Atmosphere

## The Atmosphere and the Earth-Space Interface



View of the entire atmospheric layer from the space shuttle (courtesy of NASA)



Ionosphere/exosphere; is composed mostly of very low density helium and hydrogen