

## 02 Atmosphere

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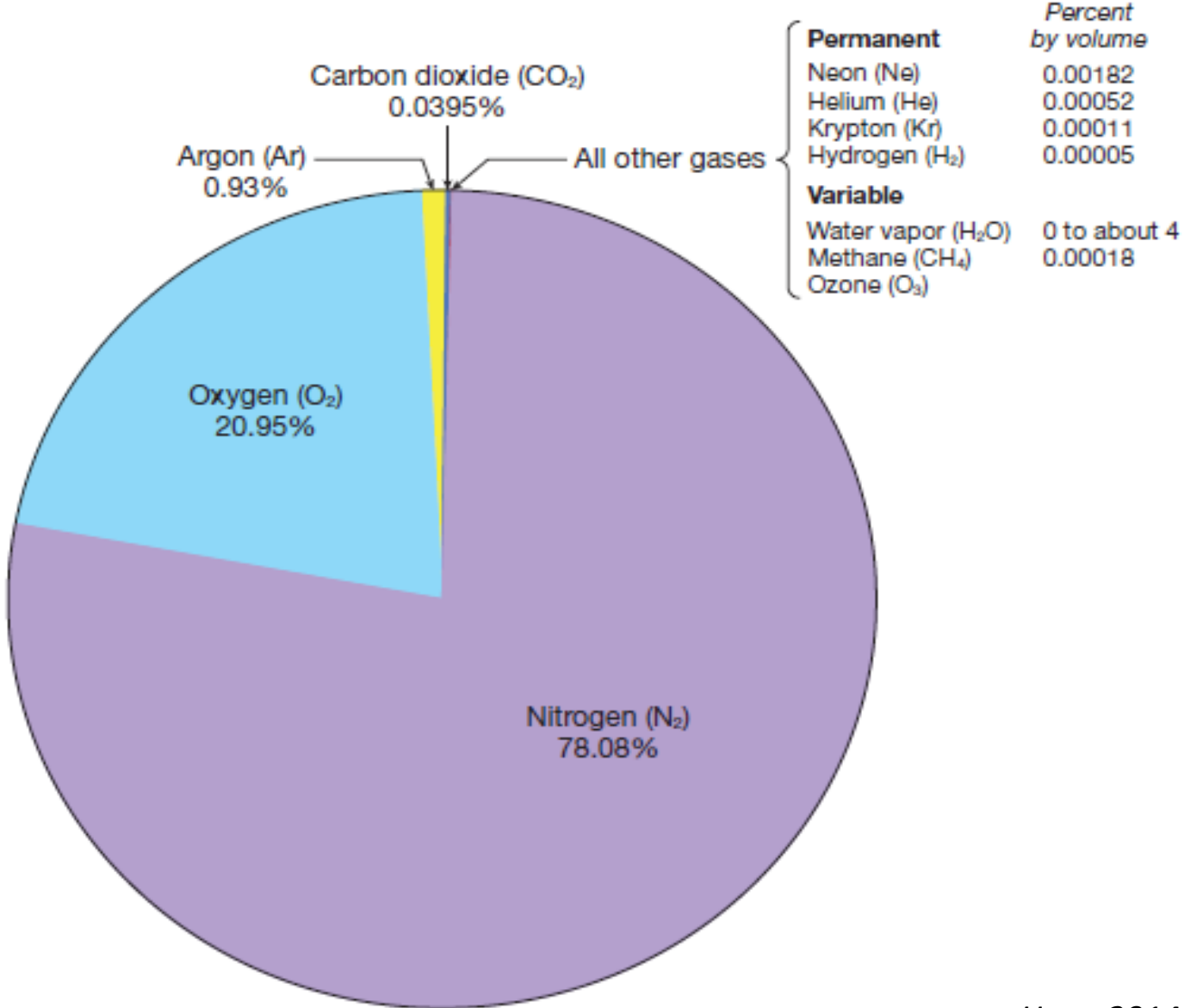
# Atmosphere

- **Complex and dynamic system** consisting of layers of gases that envelop a planet
- **Environmental sphere** allowing the existence of life on the Earth (essential gasses, water supplies, protection from UV radiation...)
- The place where the **weather** takes place



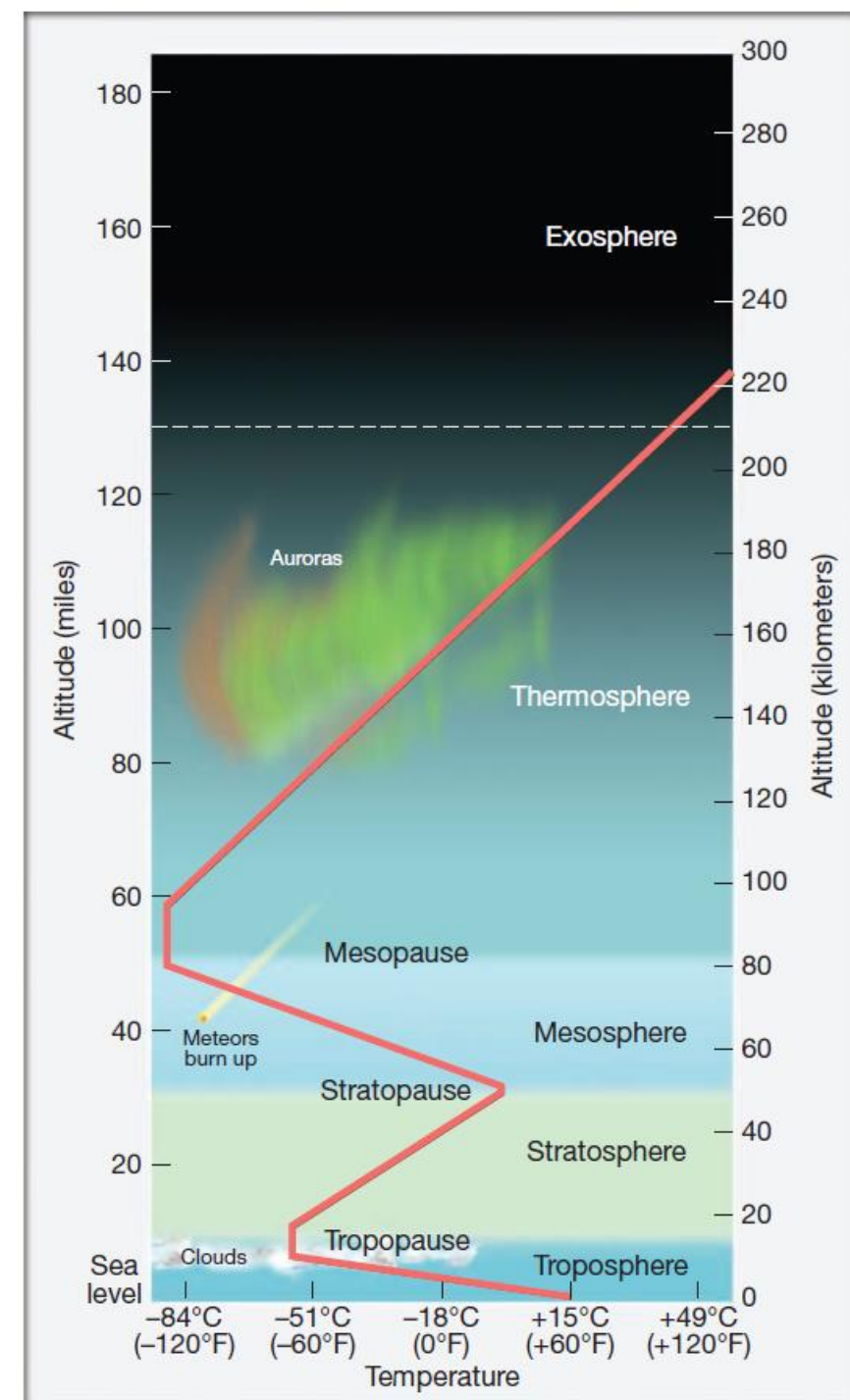
# Composition of the atmosphere

- A mix of gases, solid and liquid particles/aerosols (dust, water vapour, ice crystals, pollen, microbes, air pollutants...)



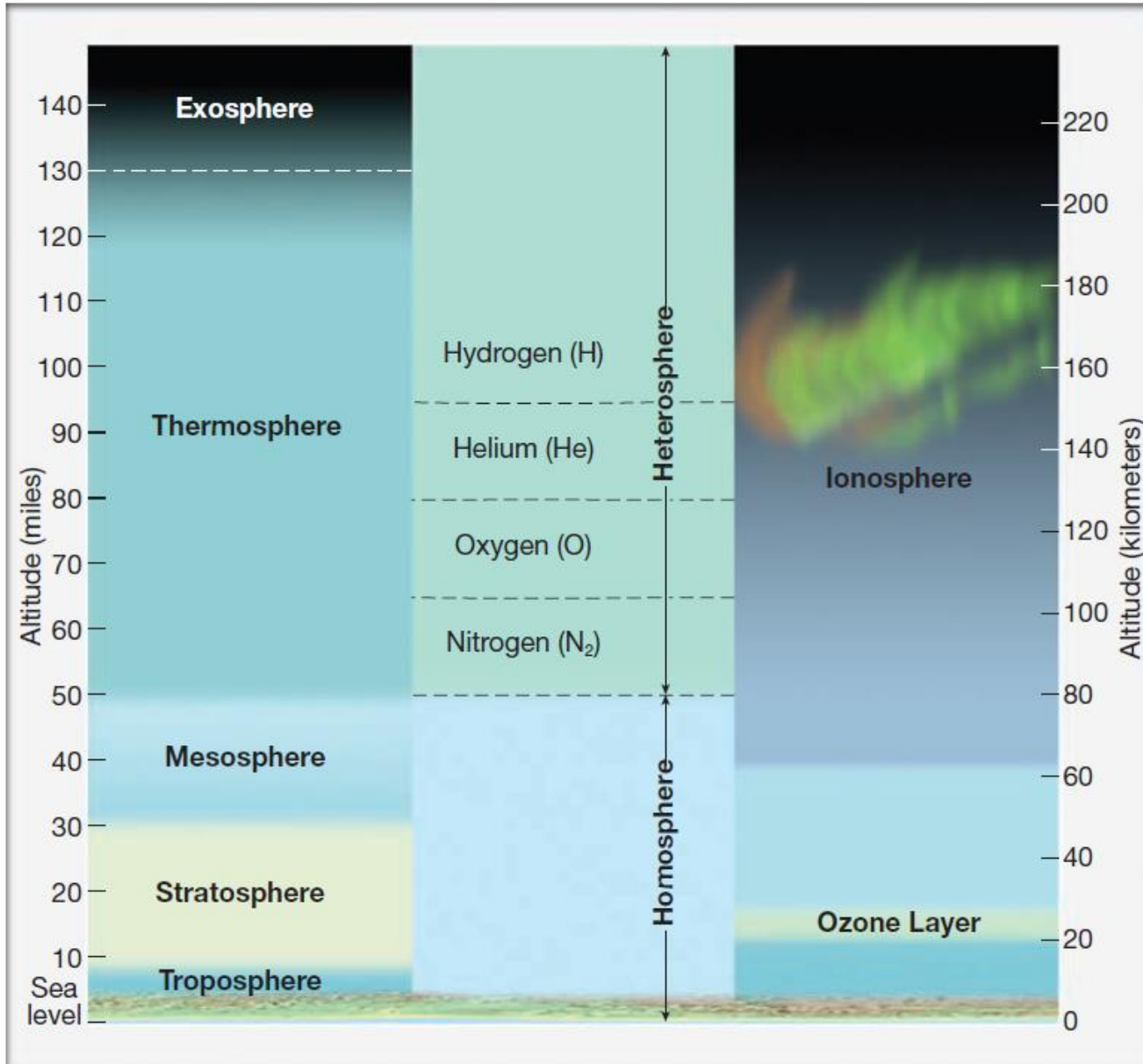
# Vertical structure of the atmosphere

- Various possibilities to divide atmosphere into the individual layers (temperature, gas composition, pressure)
- Thermal structure of the atmosphere: **thermal layers** →



Hess, 2014

# Vertical structure of the atmosphere

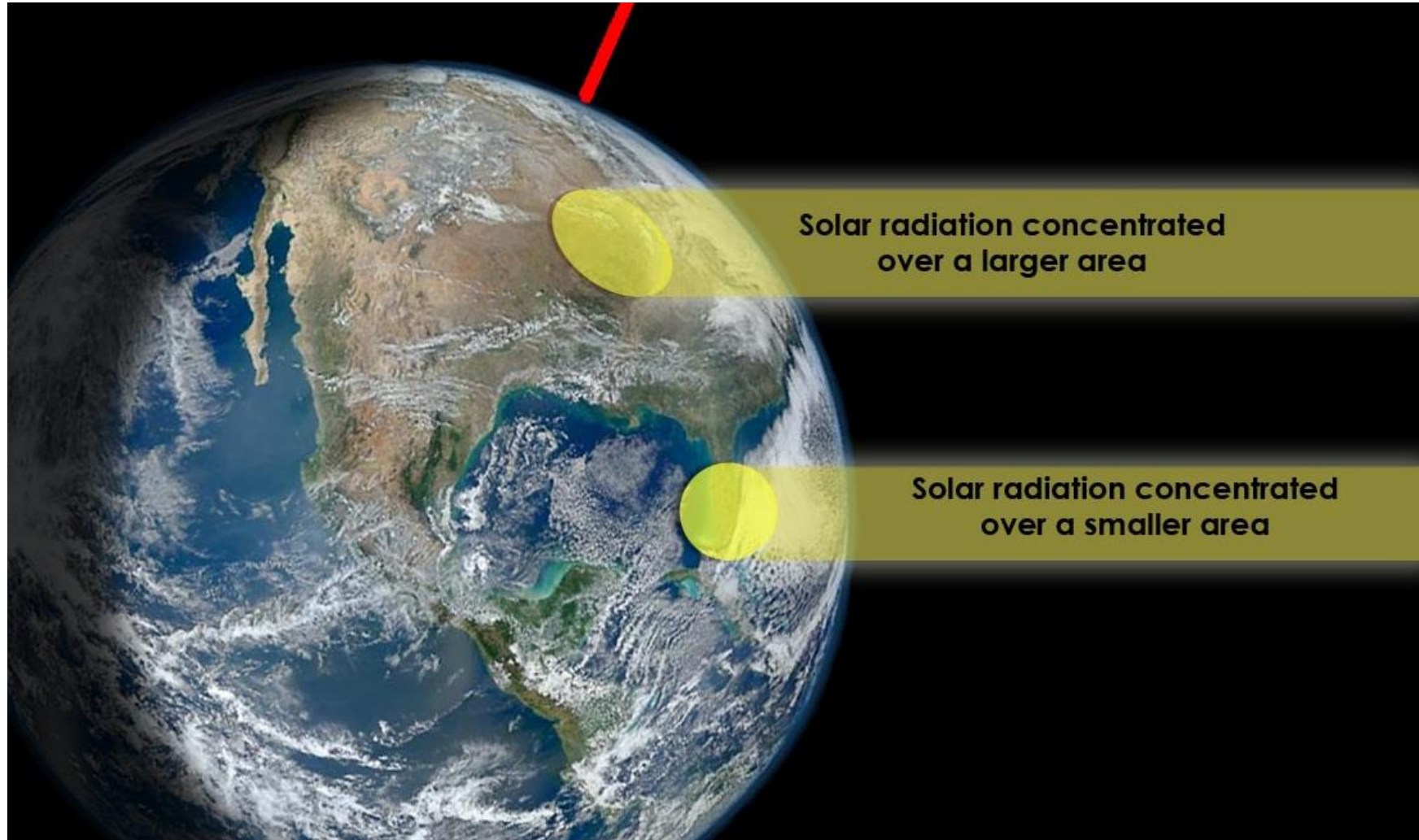


Total atmospheric mass:  
 **$5.157 \times 10^{18}$  kg**

- 50% of the total mass occurs in the 5-6 km layer,
- 75% in the 0-11 km layer,
- 99% in the 0-36 km layer

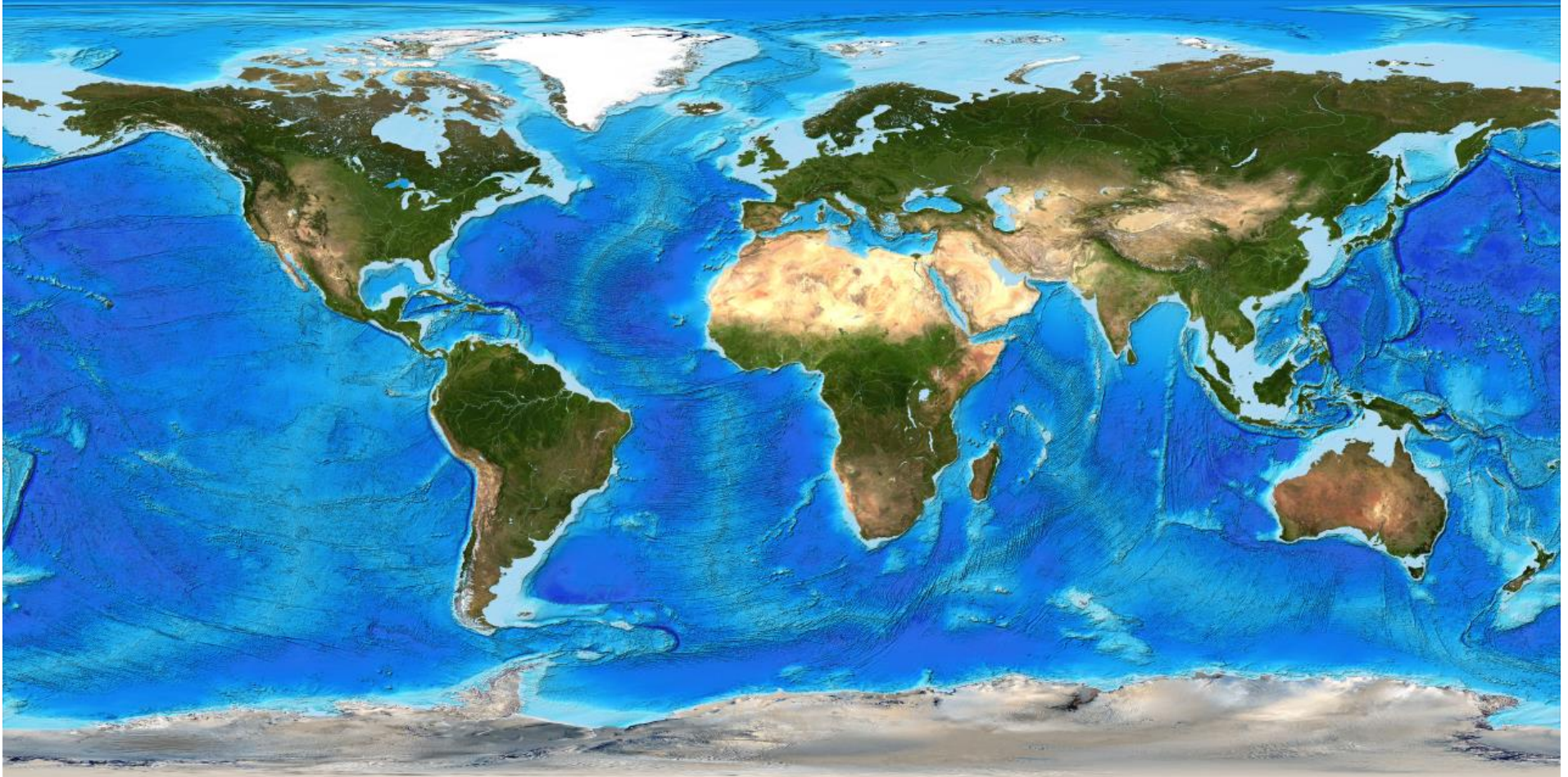
# Controls of weather and climate

## 1. Latitude



# Controls of weather and climate

## 2. Land-water distribution

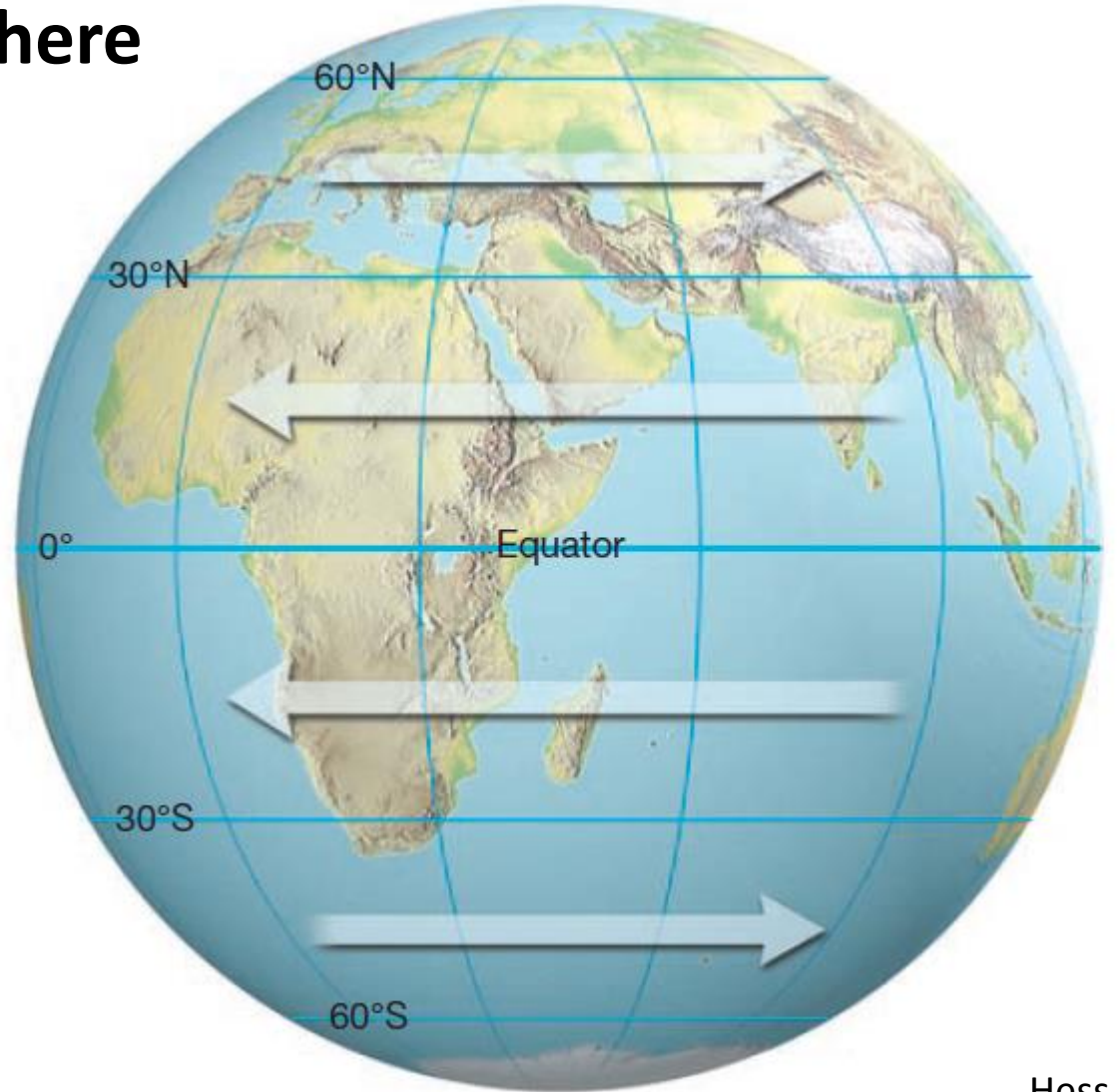




# Controls of weather and climate

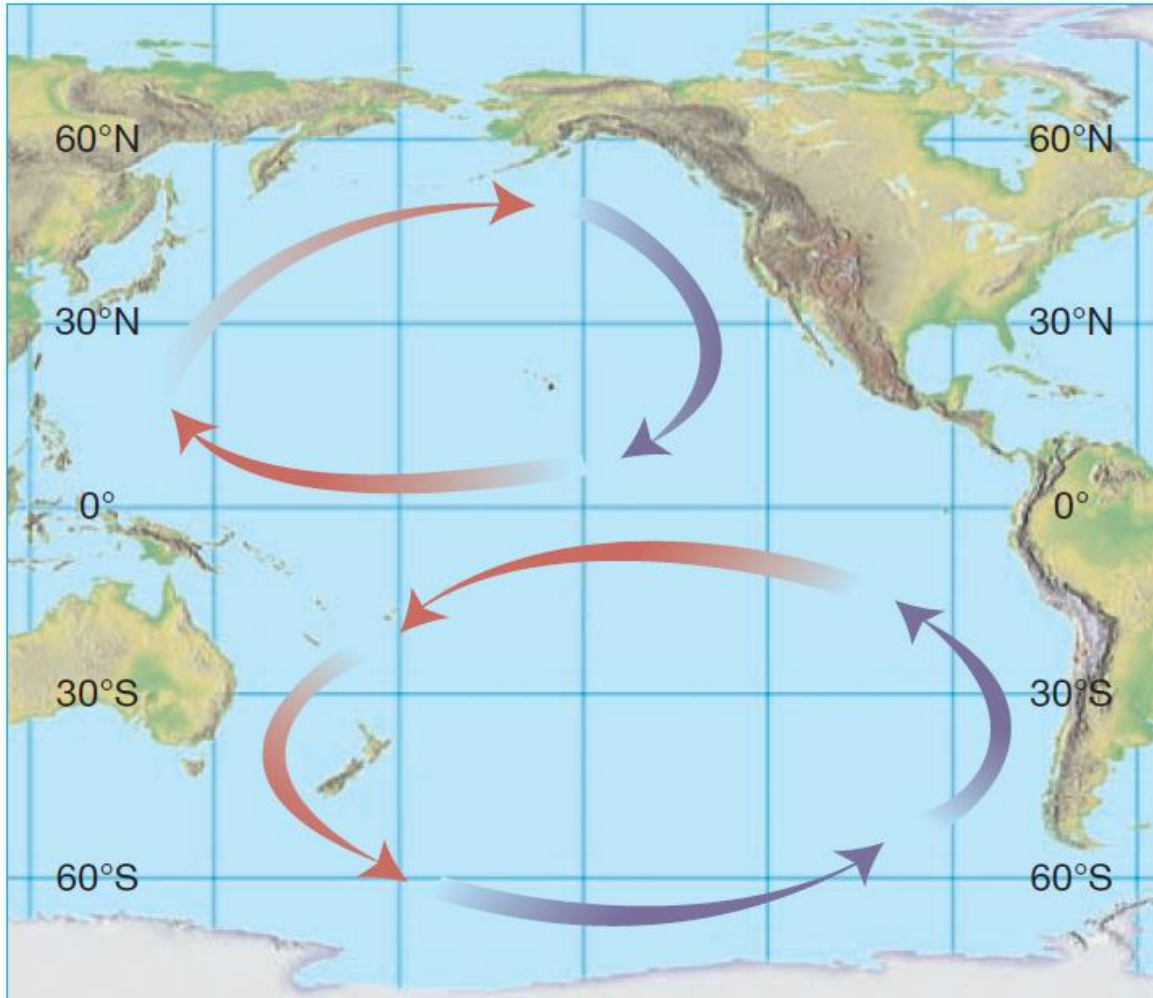
## 3. General circulation of the atmosphere

- Trade winds
- Westerlies



# Controls of weather and climate

## 4. General circulation of the oceans



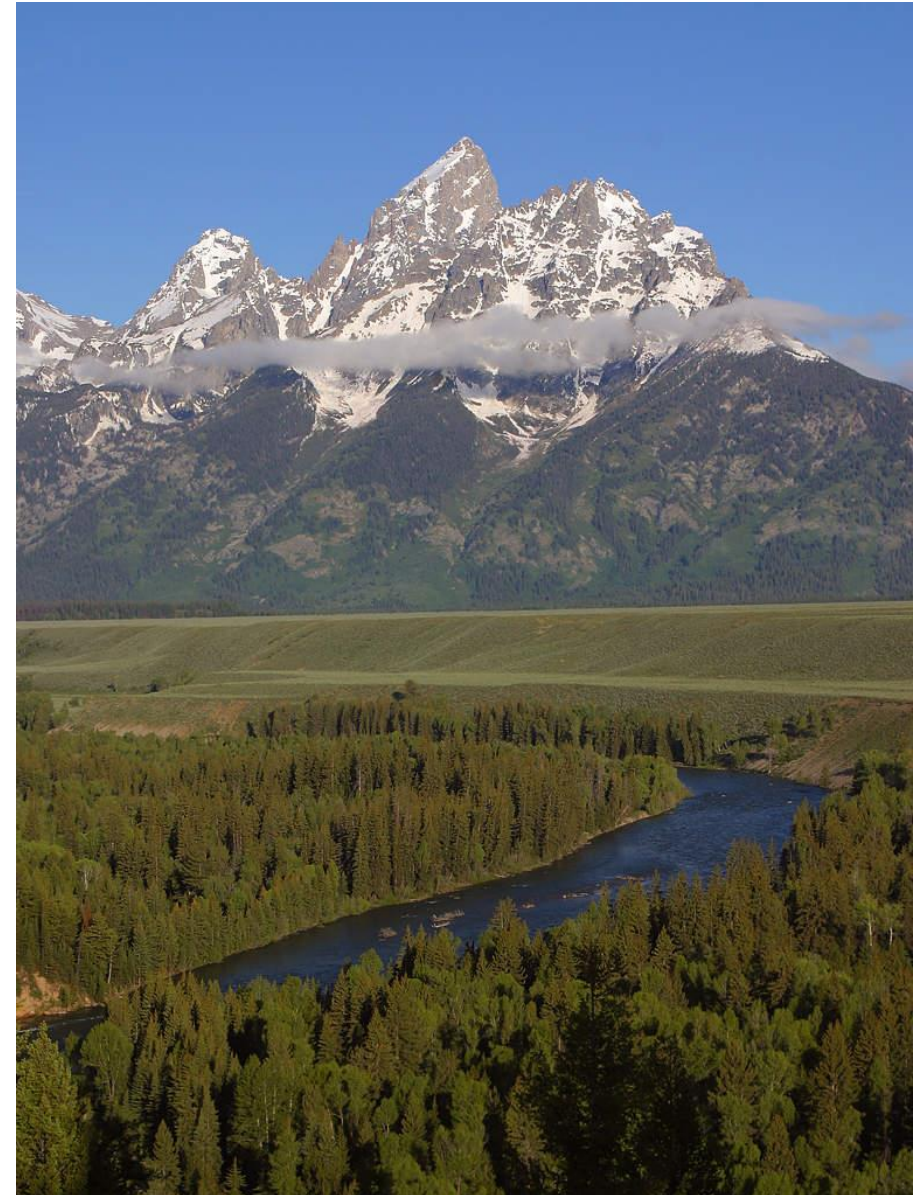
- warm water (red arrows)
- cool water (blue arrows)

# Controls of weather and climate

## 5. Altitude

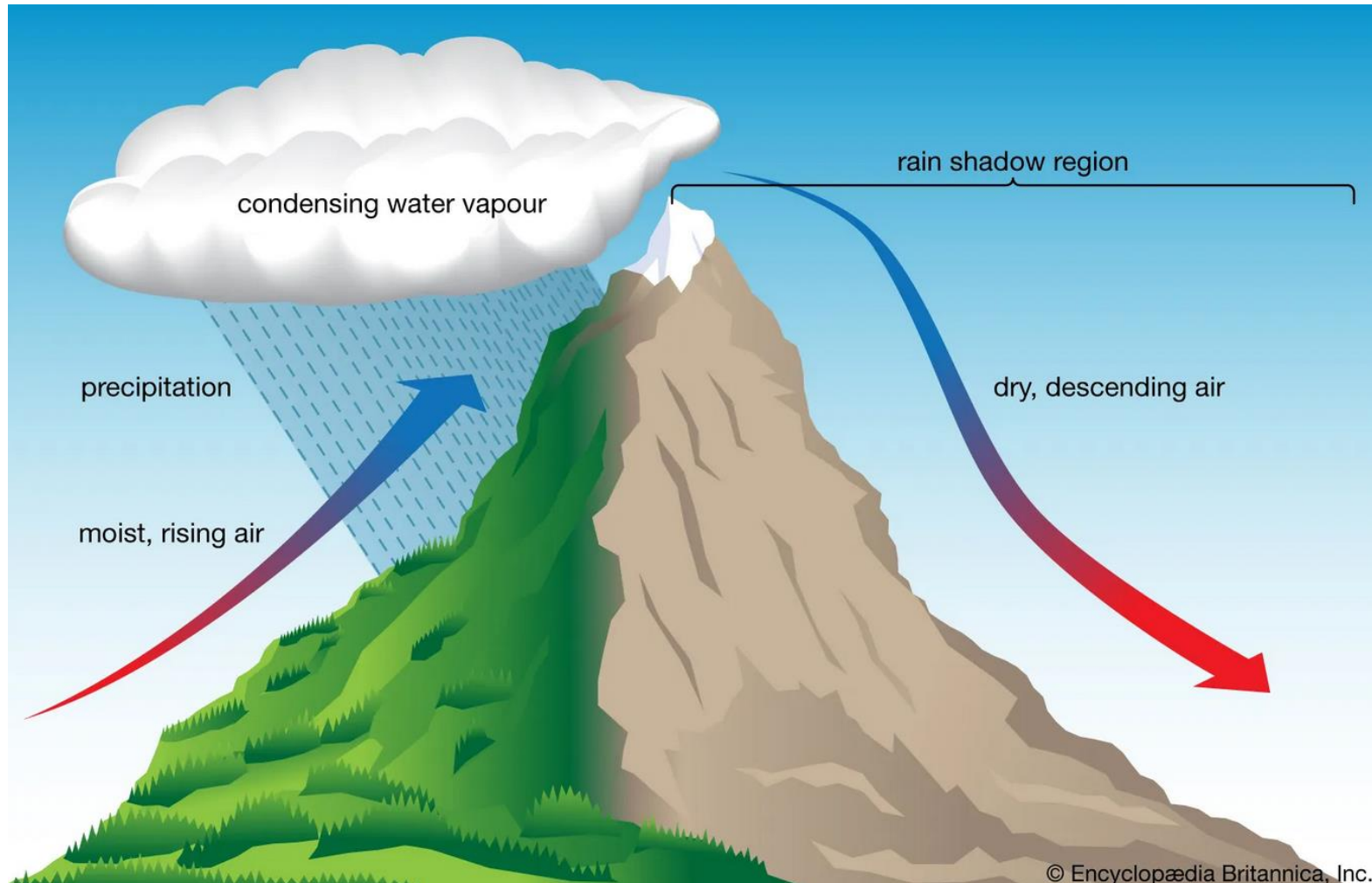
Atmospheric temperature drops with increasing altitude by about **0.5 to 0.6 °C per 100 metres** (0.9 to 1.1 °F per 328 feet)  
– **normal (temperature) lapse rate**

**Altitudinal zonation**



# Controls of weather and climate

## 6. Topographic barriers

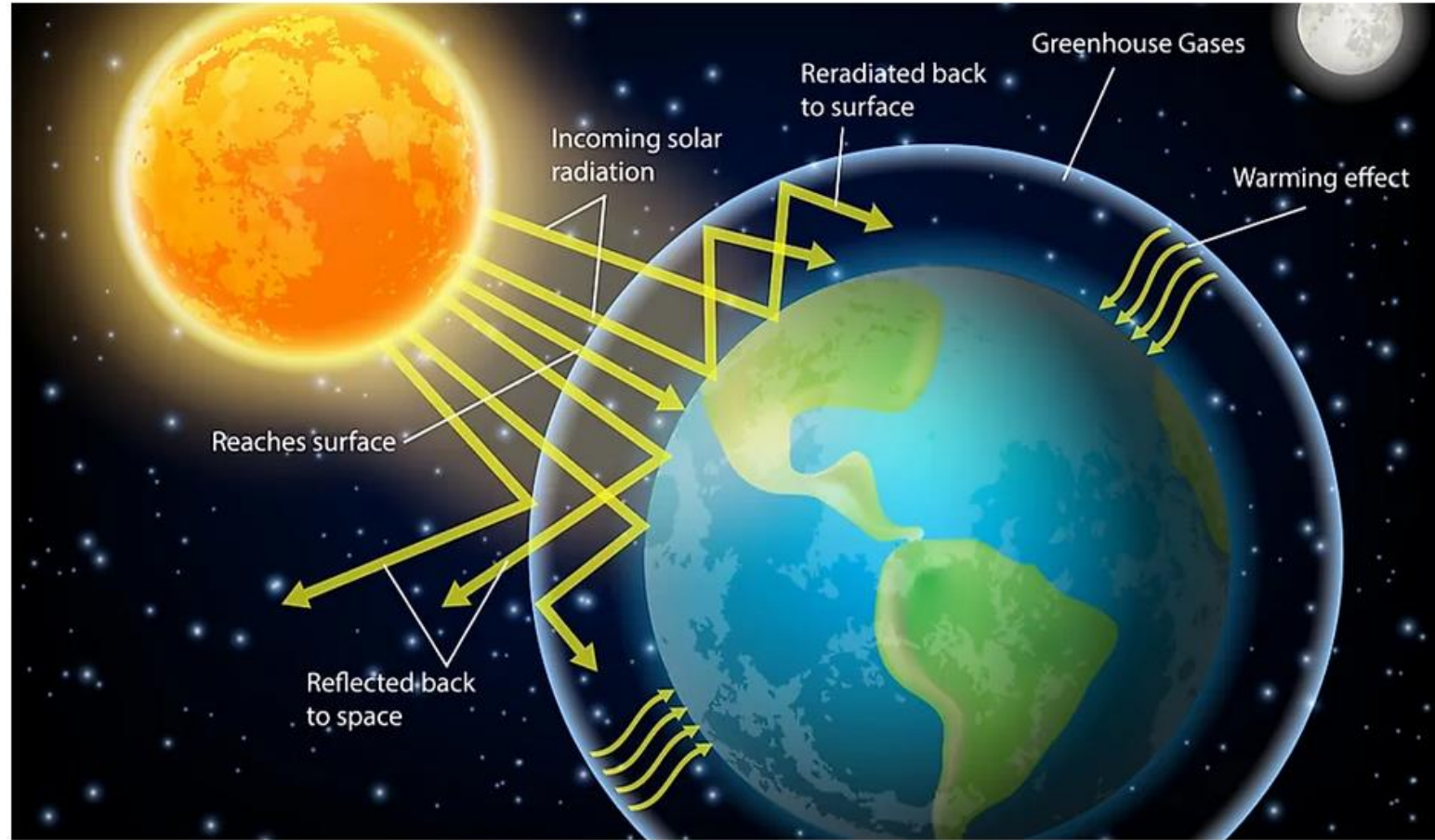


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<https://www.britannica.com/science/orographic-precipitation>

# Energy transfers

- **solar energy** – primary energy source for most processes in the atmosphere, hydrosphere, and biosphere
- processes leading to the **warming and cooling of the atmosphere**

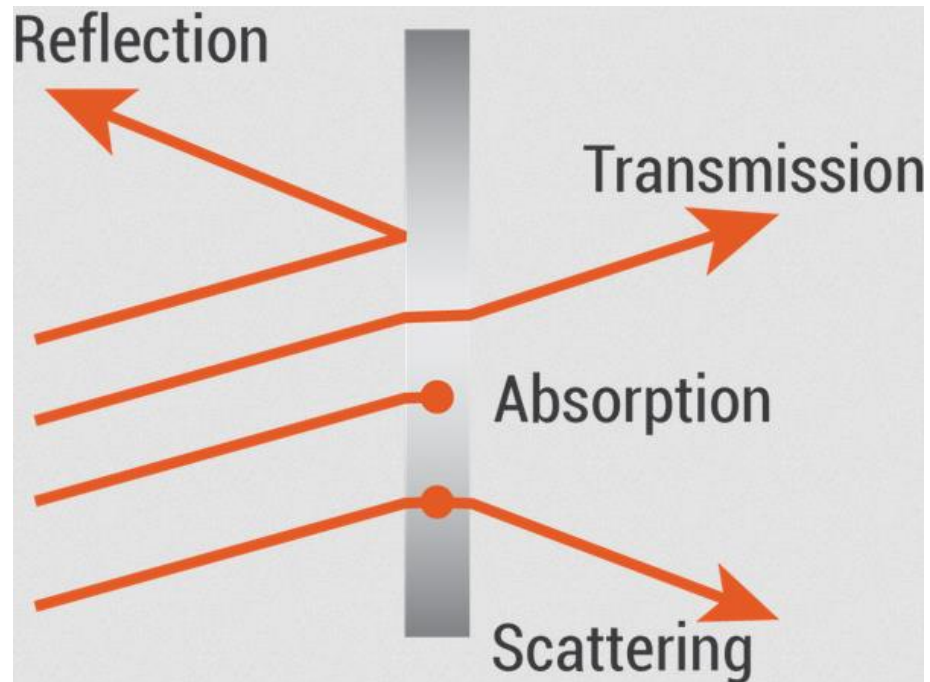


*Earth's energy balance depends on the incoming and outgoing energy from the sun.*

# Energy transfers

## Radiation (emission, $\text{W}/\text{m}^2$ )

- emission of electromagnetic radiation from an object (e.g. Sun)
- hotter object = more intense radiation

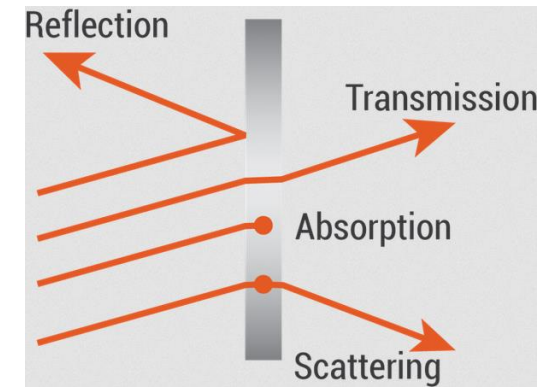
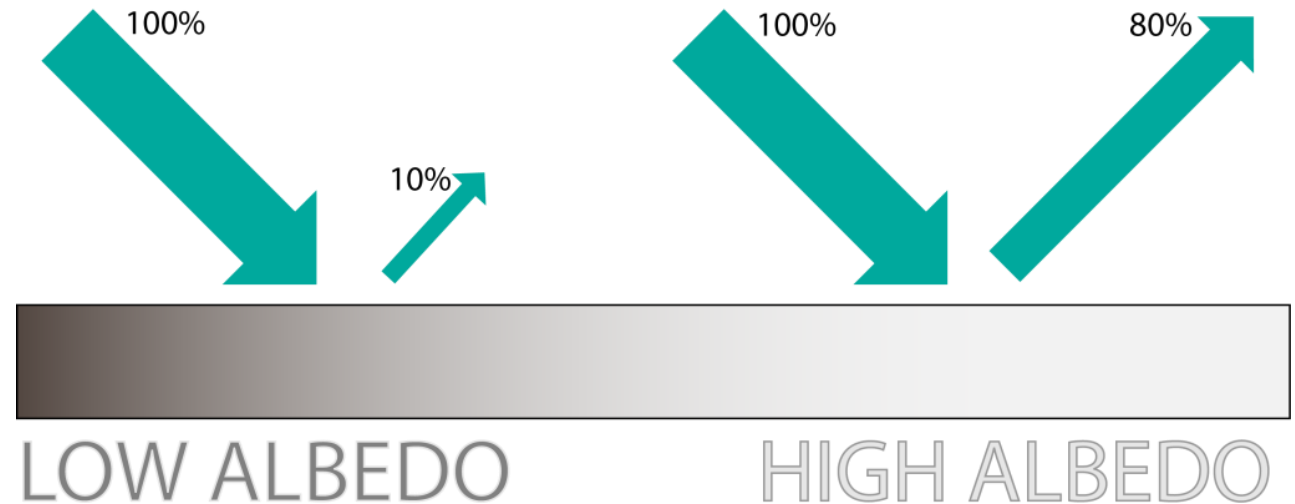


# Energy transfers

## Reflection

- ability of an object to repel/return electromagnetic waves that strike it
- different reflection based on wavelength angle

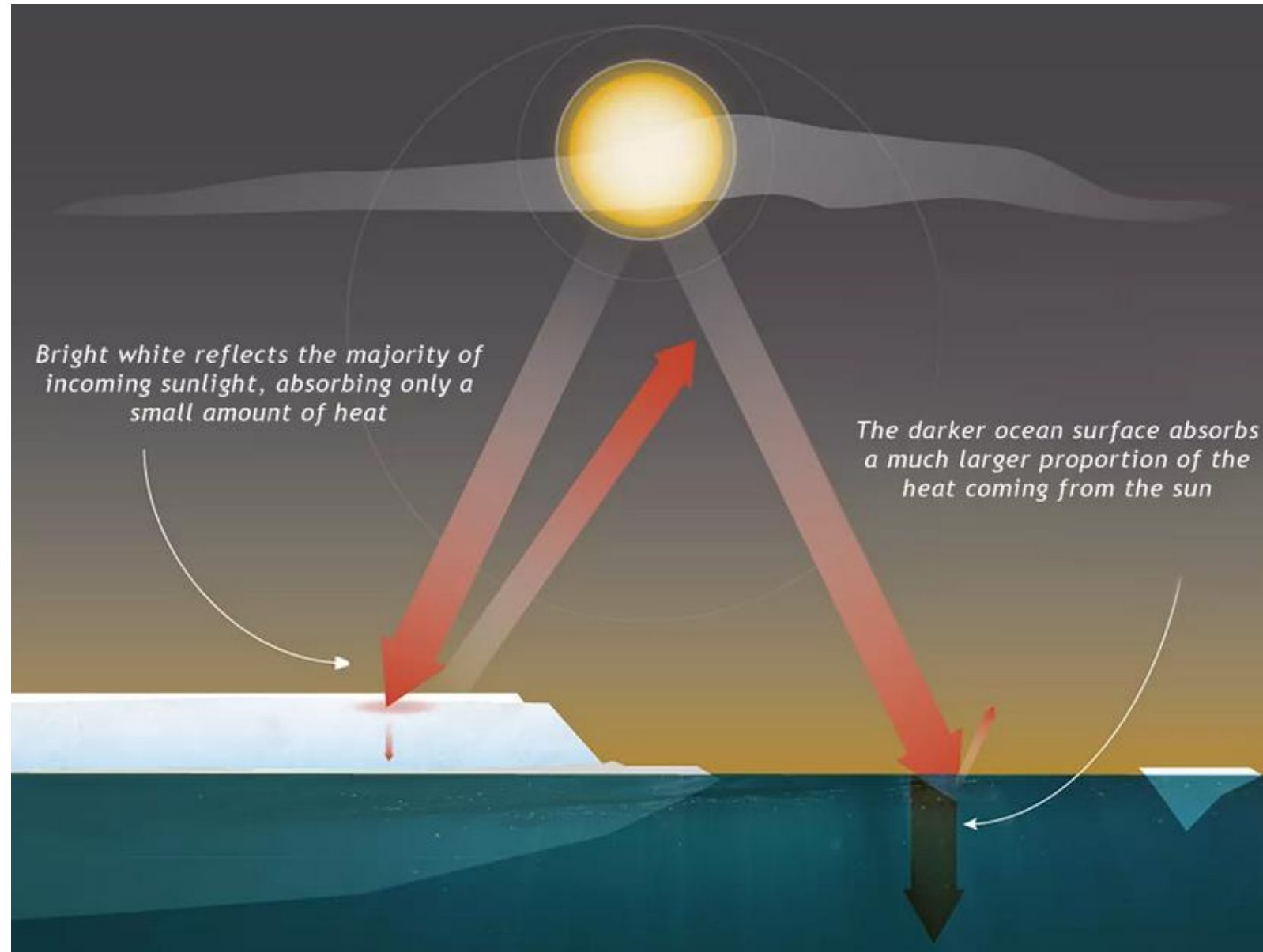
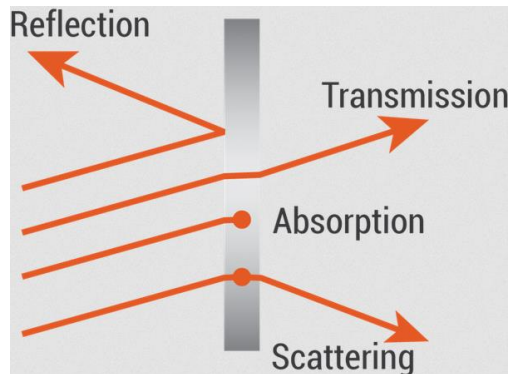
**Albedo (%)**  
overall reflectivity of an object or surface



# Energy transfers

## Absorption

- assimilation of electromagnetic waves by an object
- different absorptive capabilities of various materials and colours



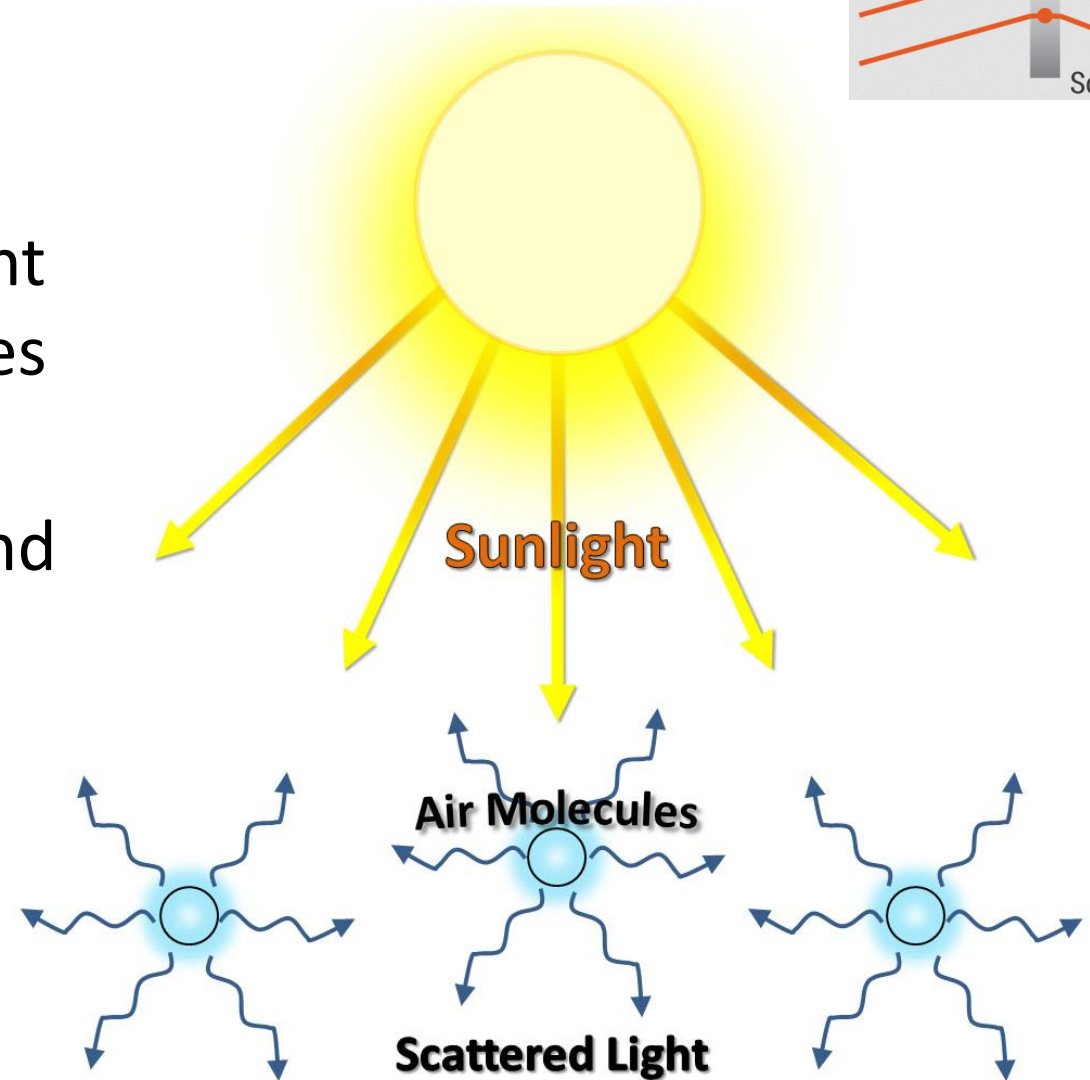
<https://nsidc.org/learn/parts-cryosphere/sea-ice/quick-facts-about-sea-ice>



# Energy transfers

- **Scattering**

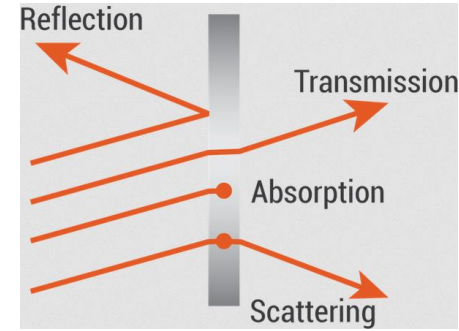
- deflecting and redirecting of light waves by molecules and particles in the atmosphere
- recently increased scattering and diminished intensity of solar radiation striking the surface as a result of recent climate change



# Energy transfers

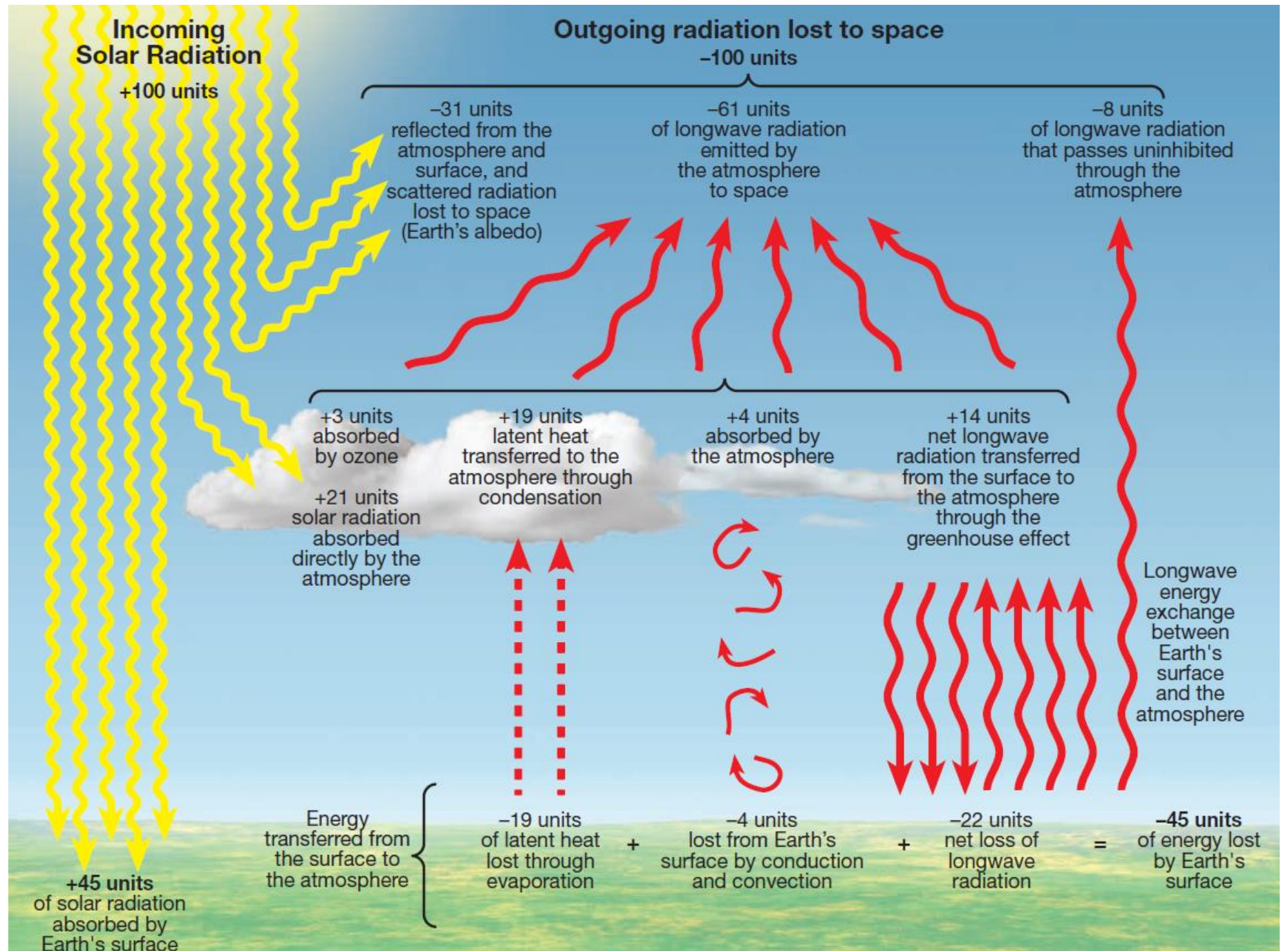
- **Transmission**

- complete pass of electromagnetic waves through a medium (Earth materials vs. water)
- dependence of medium transmission ability on the wavelength radiation (e.g. glass)



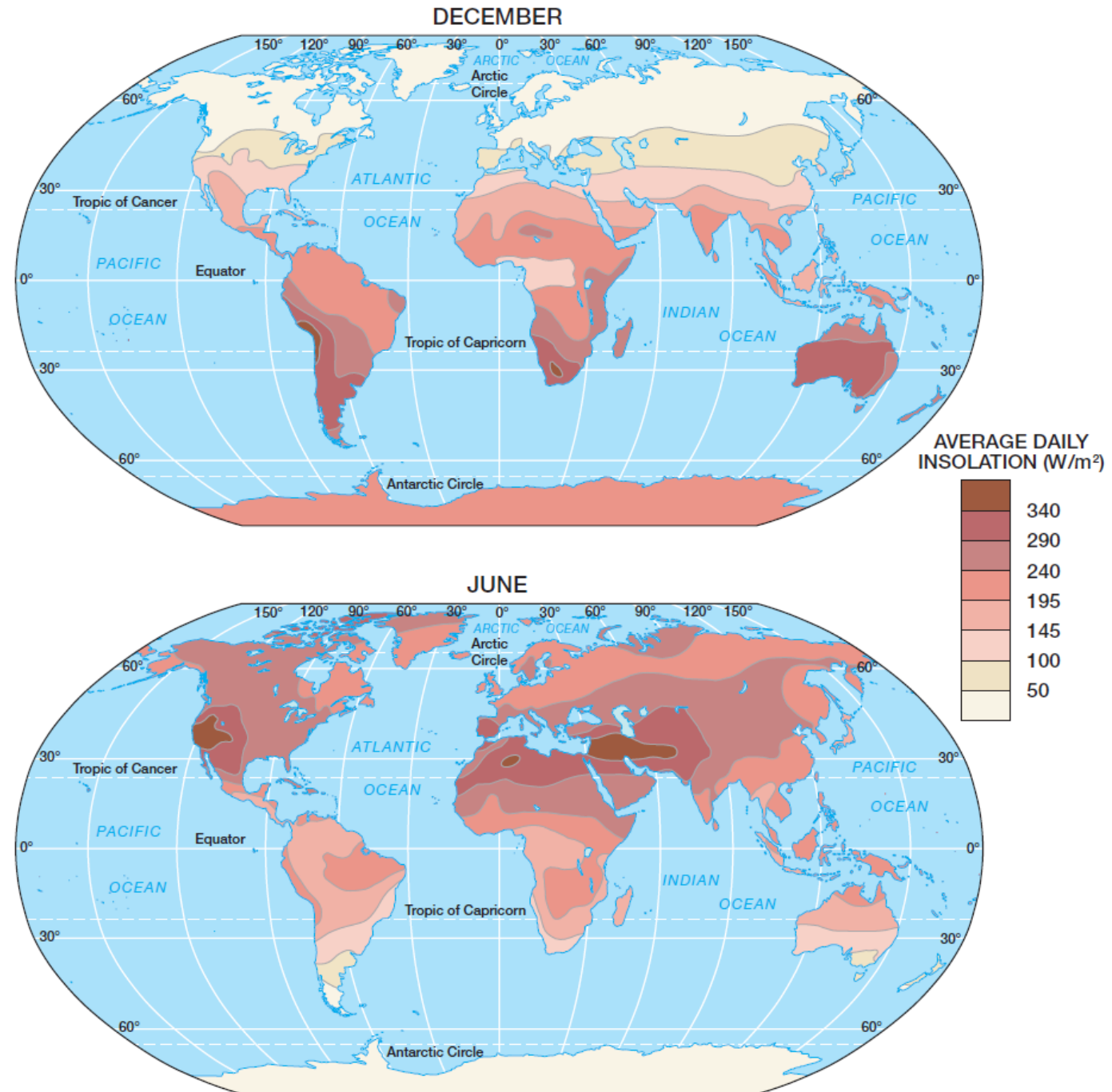
# Earth's energy budget

- Annual balance between incoming and outgoing radiation





# Earth's energy budget

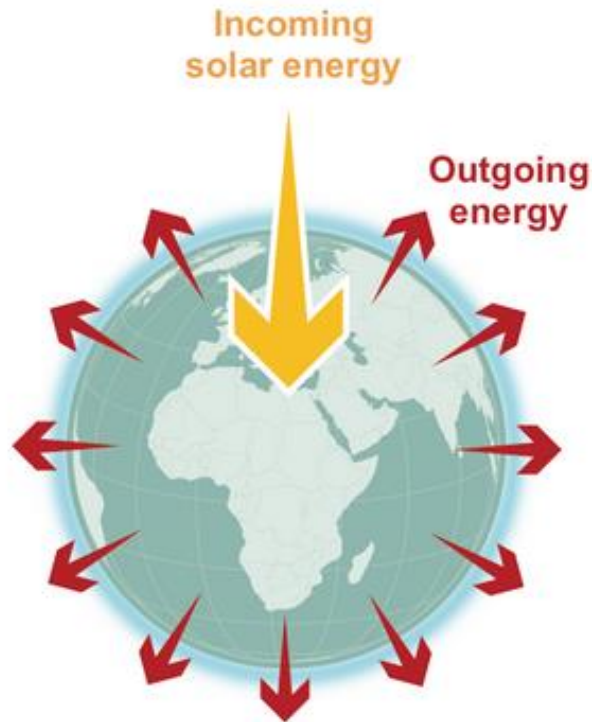


# Anthropogenic influences on Earth's energy budget

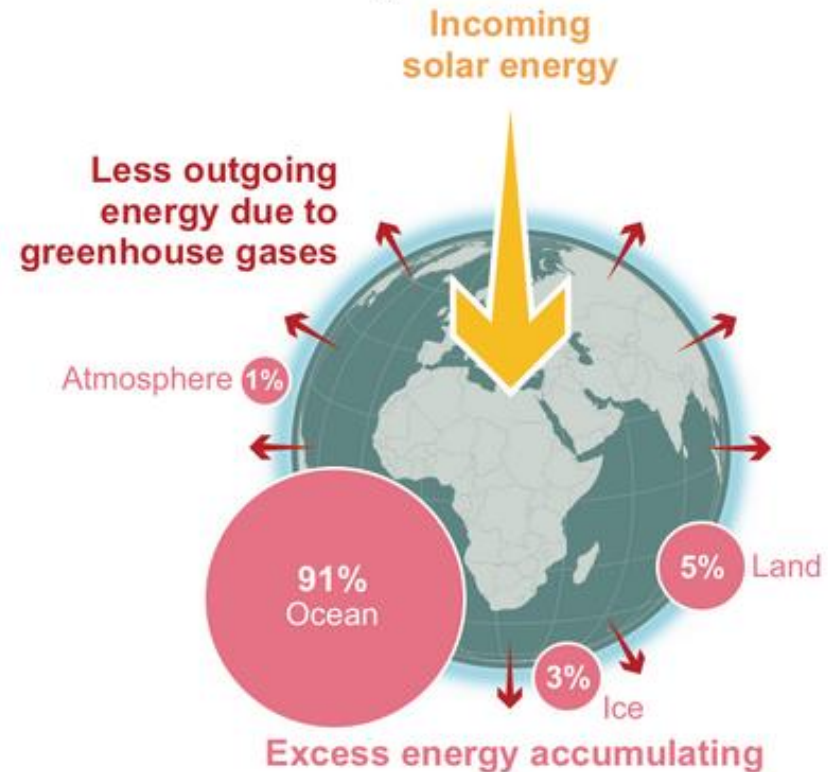
## FAQ 7.1: The Earth's energy budget and climate change

Since at least 1970, there has been a persistent imbalance in the energy flows that has led to **excess energy being absorbed by different components of the climate system.**

### Stable climate: in balance



### Today: imbalanced

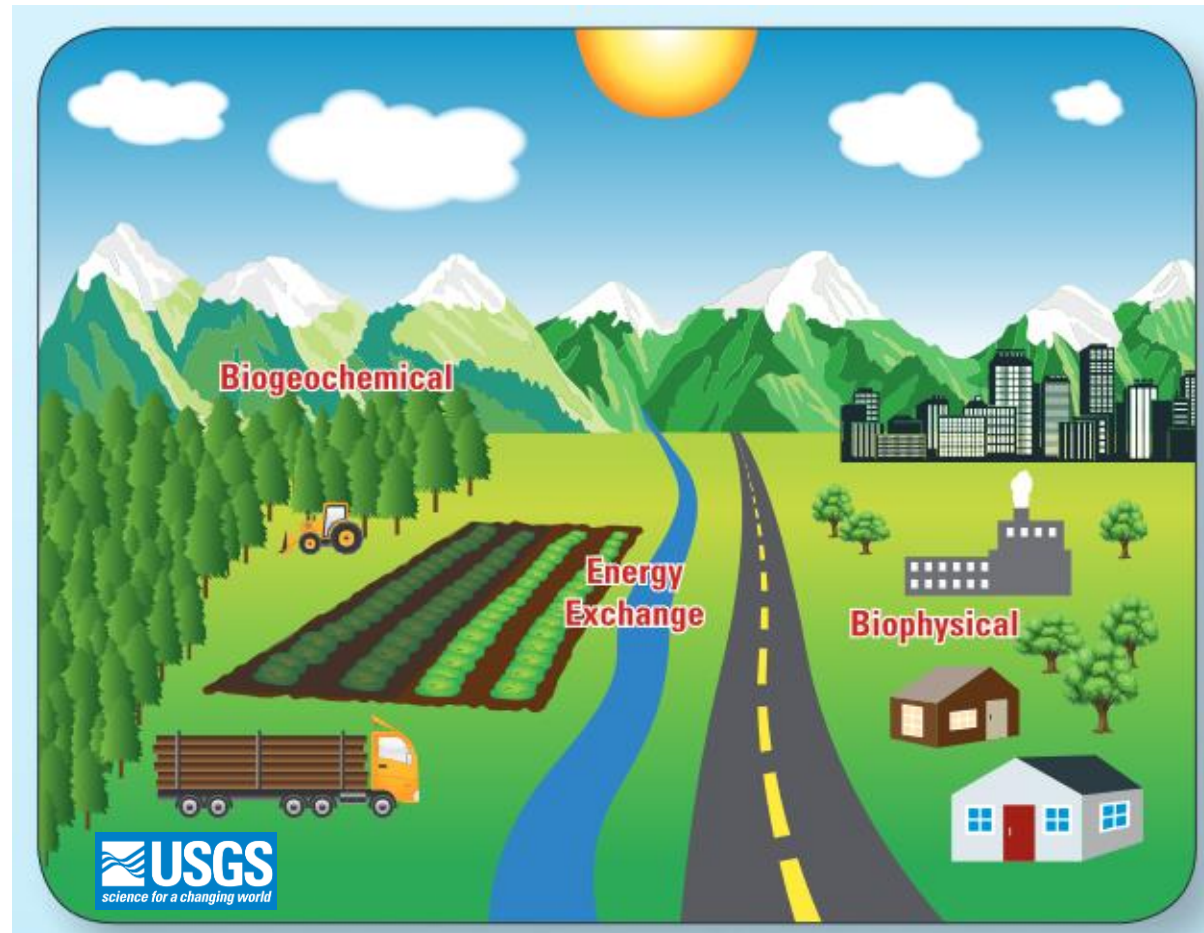


# Anthropogenic influences on Earth's energy budget

- **Enhanced greenhouse effect**
  - increased concentration of greenhouse gases (GHGs) as the result of human activities and the main cause of recent global warming
- **Pollution of the atmosphere by aerosols**
  - **upper layers:** increased radiation scattering – decreased shortwave radiation (wasted energy)
  - **lower layers:** increased absorption of longwave radiation (additional energy)
  - global dimming

# Anthropogenic influences on Earth's energy budget

- Changes in land-use and land cover





**Thank you for your attention**