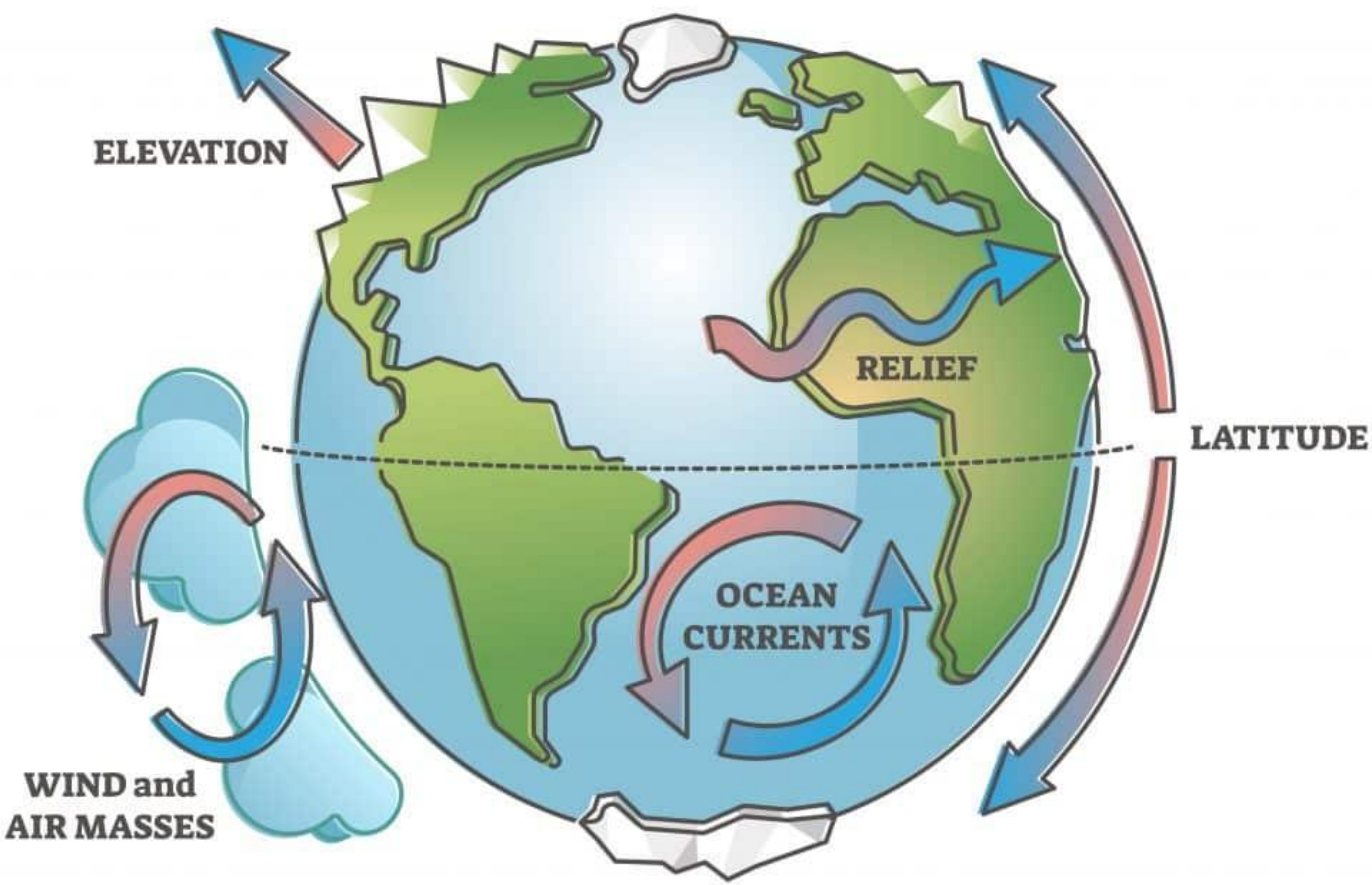
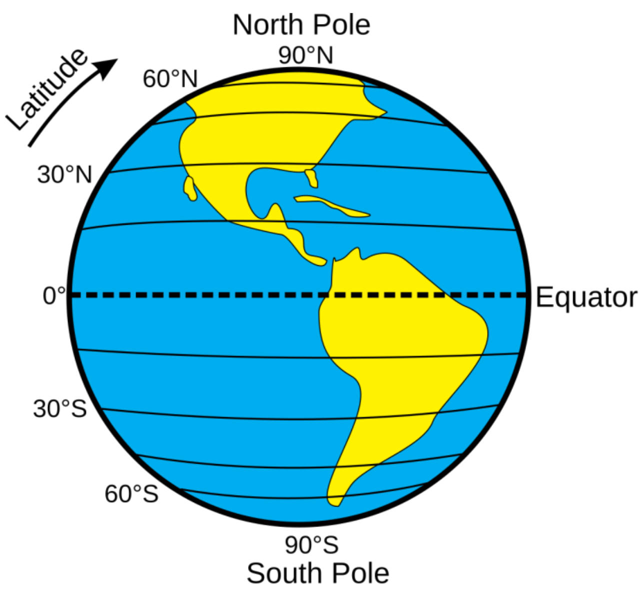
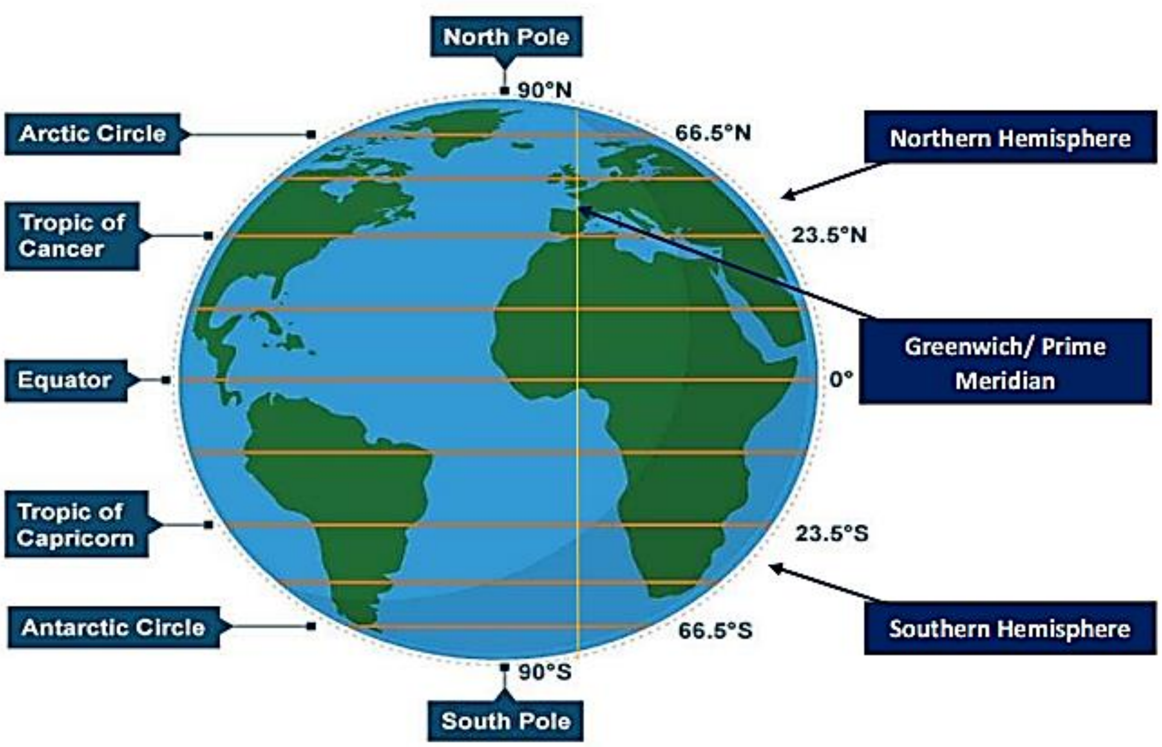
CLIMATE FACTORS



The latitude and solar radiation

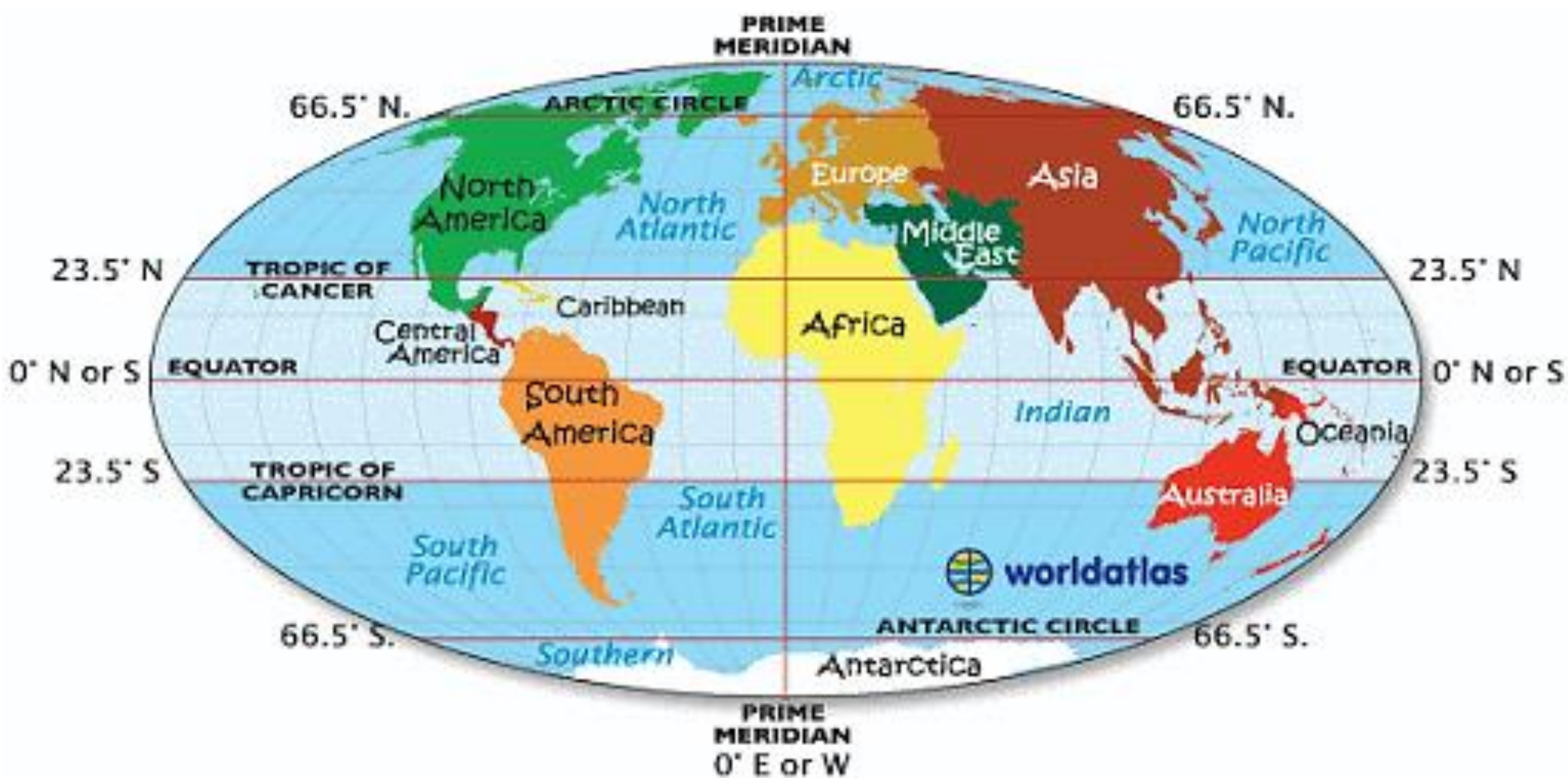
Latitude is the distance north or south of the equator. It's measured in degrees, from 0° to 90°. Several climate factors vary with latitude.





The latitude and solar radiation

- Lines of latitude circle the Earth parallel to the Equator.
- Lines of latitude run in an east-west direction all of the way around the Earth.
- Latitude is measured in degrees.
- The Equator is located at 0°.
-Anything north of the Equator is in the northern hemisphere and is labelled °N.
-Anything south of the Equator is in the southern hemisphere and is labelled °S.



Arctic Circle: Is the boundary of the North Frigid Zone to the north.

Antarctic Circle: Is the boundary of the South Frigid Zone to the south.

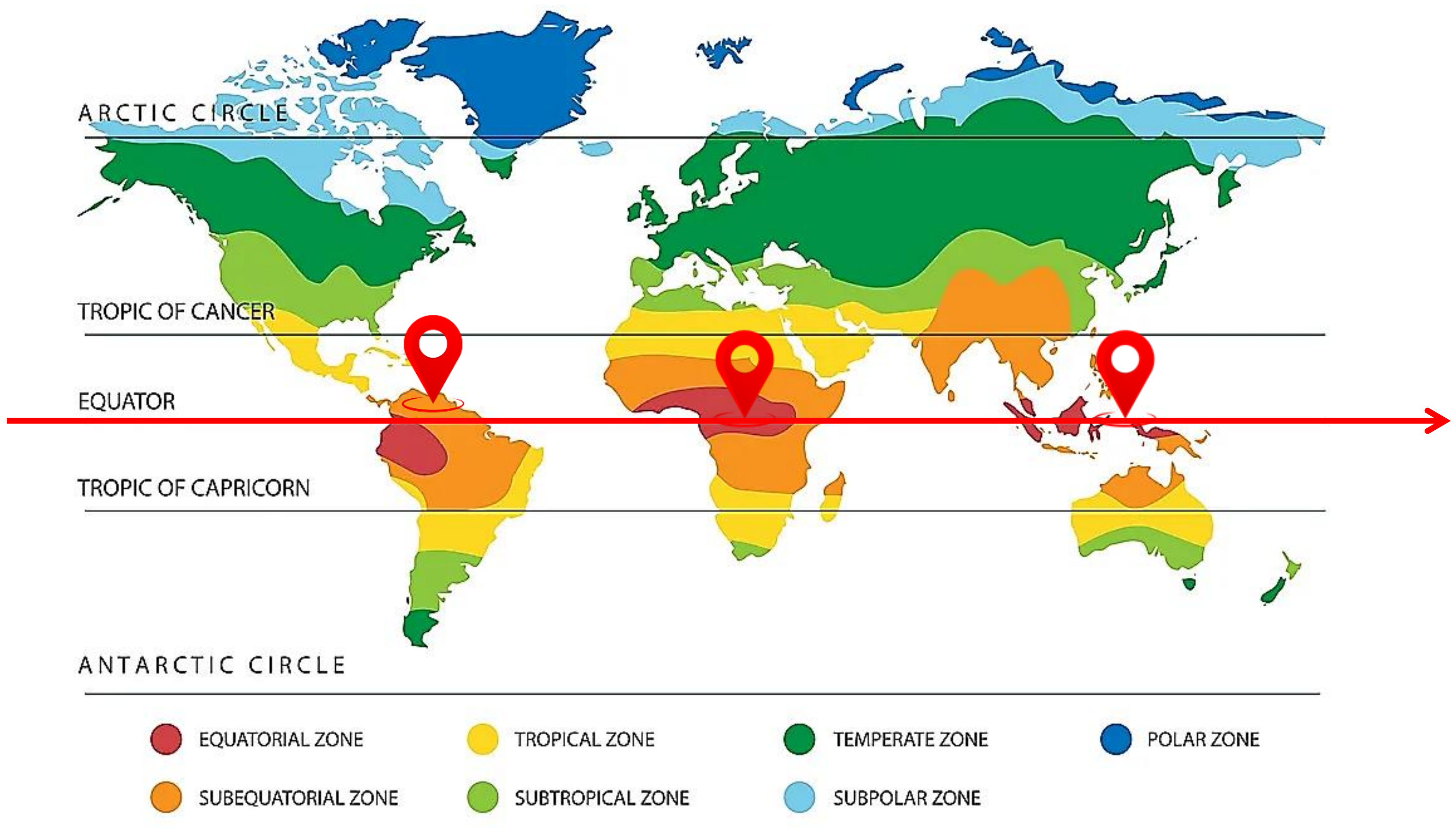
The Equator: is an imaginary line of latitude which circles the Earth. It lies halfway between the North/ South Poles. -It splits Earth into the Northern/ Southern Hemispheres.

Tropic of Cancer: is an imaginary line of latitude which circles the Earth. It lies at 23 degrees north (23°N). It is the latitude where the Sun is overhead on June solstice (middle of summer in the northern hemisphere)

Tropic of Capricorn: is an imaginary line of latitude which circles the Earth. It lies at 23 degrees south (23°S). -It is the latitude where the Sun is overhead on December solstice (middle of summer in the southern hemisphere).

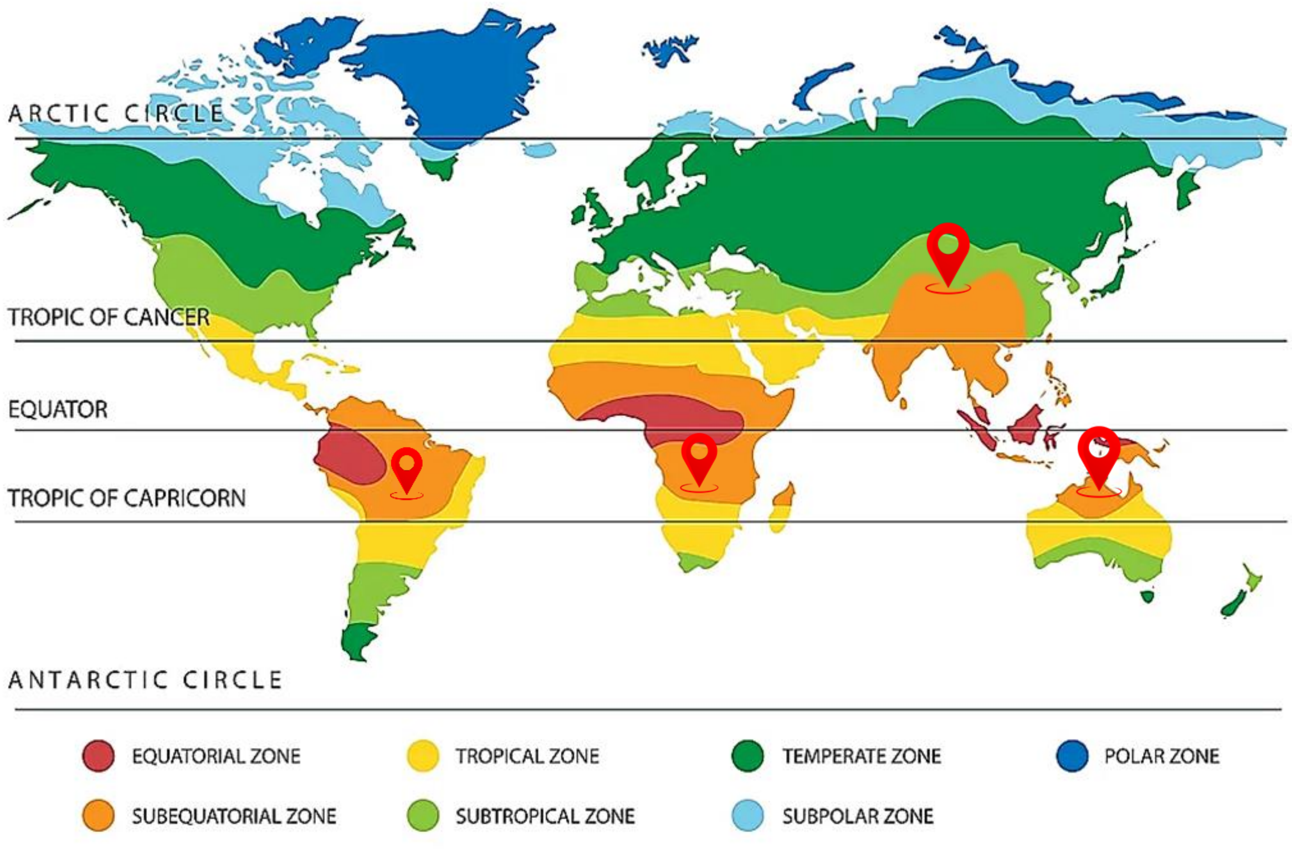
Equatorial climate

An equatorial climate is marked by hot and moist equatorial air masses. Air temperature is constant (+24–28°C) and there is much rain throughout the year (from 1500 to 5000 mm). Rain falls faster than water can evaporate from the ground, so the soil in an equatorial climate is waterlogged and covered by a dense and high rainforest.



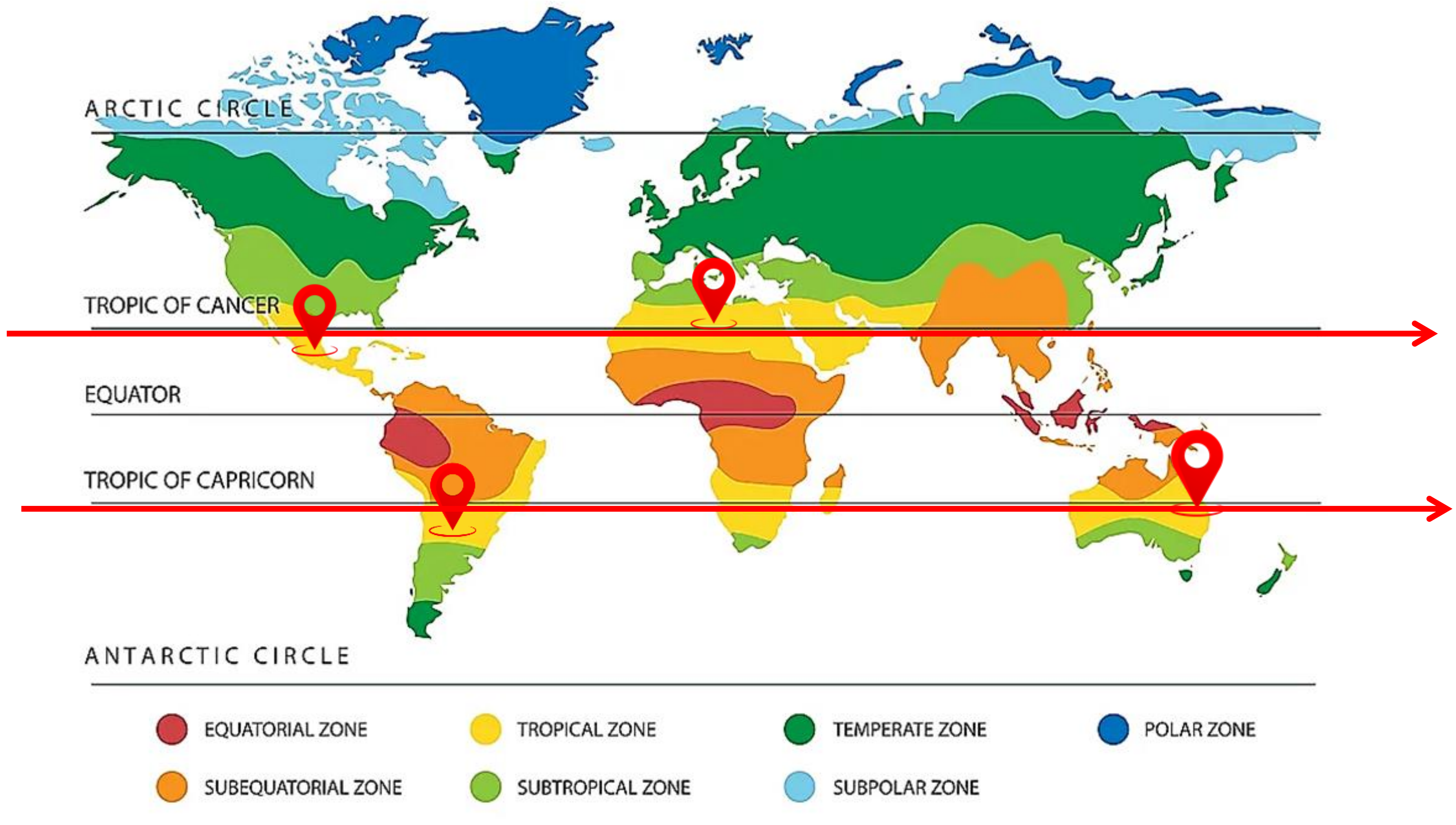
Sub-equatorial climate

A sub-equatorial climate is marked by a rainy season in the summer, followed by a cool and dry season in the winter. Rainfall in a sub-equatorial climate is very uneven throughout the year. For example, Conakry (the capital of Guinea) receives just 15 mm of rain from December-March, but 3920 mm from June-September.



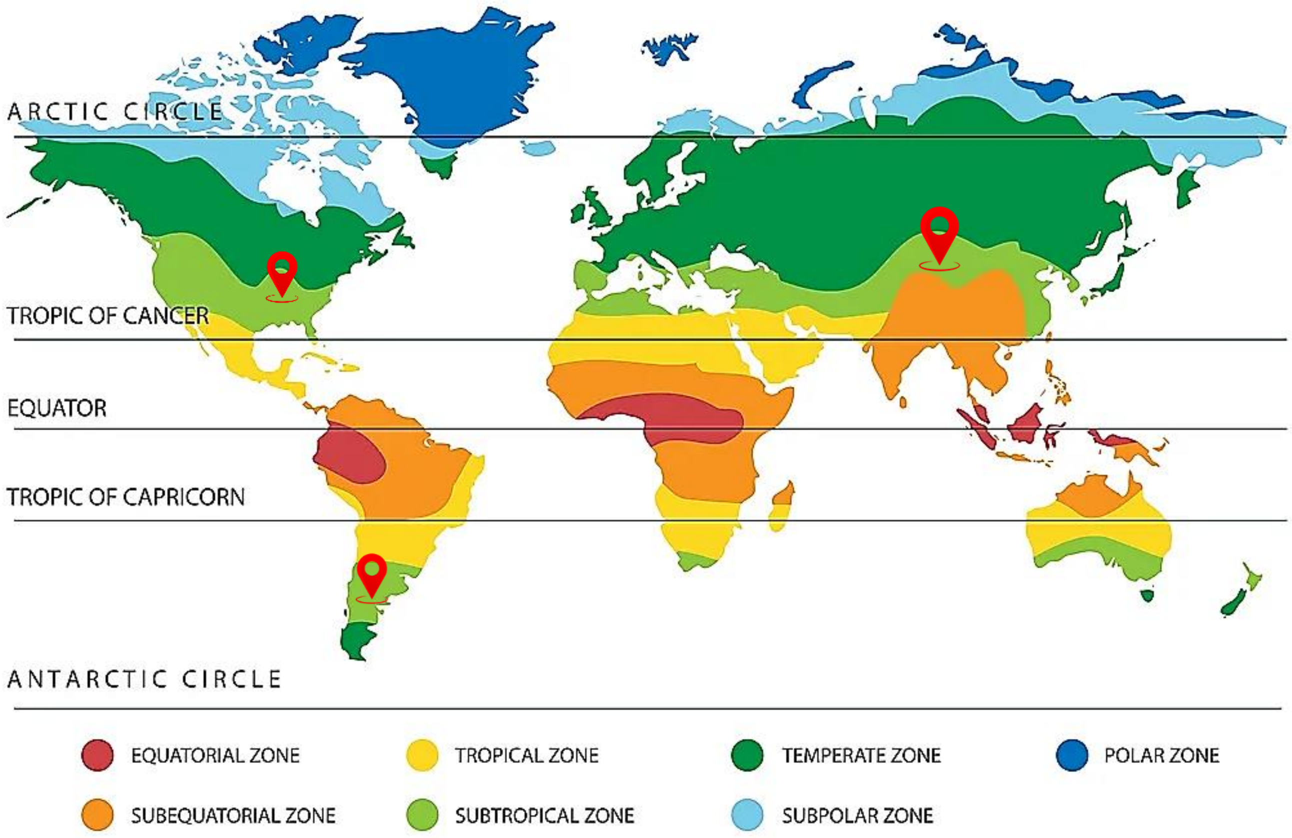
Tropical climate

A tropical climate is dominated by anticyclones with high pressure, giving clear weather nearly all the year round. There are two seasons: warm and cold. Temperatures can vary from +20°C on the coast to +50°C in the interior. The temperature can also vary greatly within a single day: on a summer afternoon the air heats up to +40–45°C but cools down at night to +10–15°C. Deserts are often found in tropical climates, and the largest is the Sahara Desert in Africa.



Sub-tropical climate

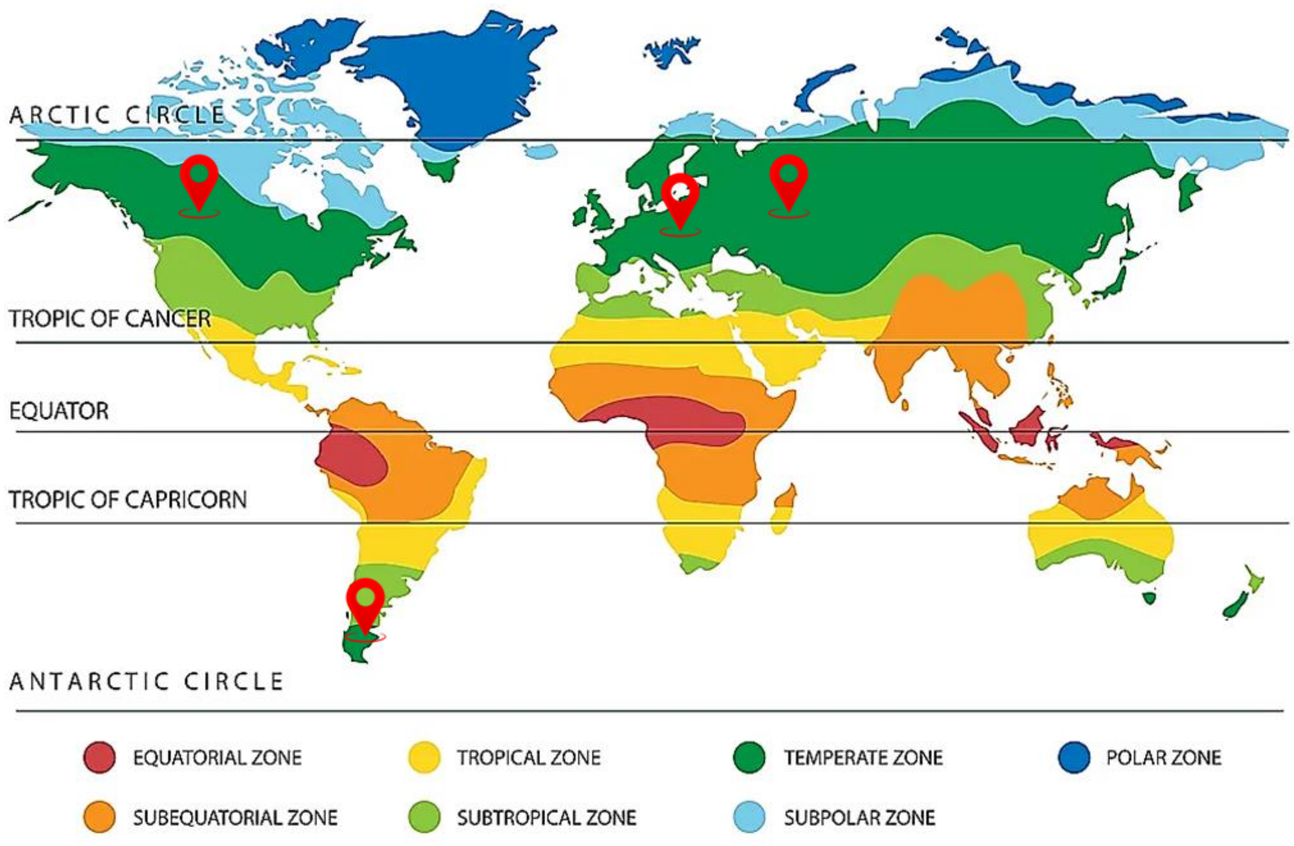
A sub-tropical climate is found in regions between tropical and temperate latitudes, from about 30° to 45° north and south of the equator. They are marked by hot, tropical summers and cool winters. The average temperature in summer is above +22°C and in winter above -3°C, but the arrival of air from polar regions in wintertime may cause temperatures to drop to -10 to -15°C, and occasionally even as low as -25°C



Temperate climate

A temperate climate is found in so-called temperate latitudes (from 40°–45° north and south of the equator as far as the polar circles).

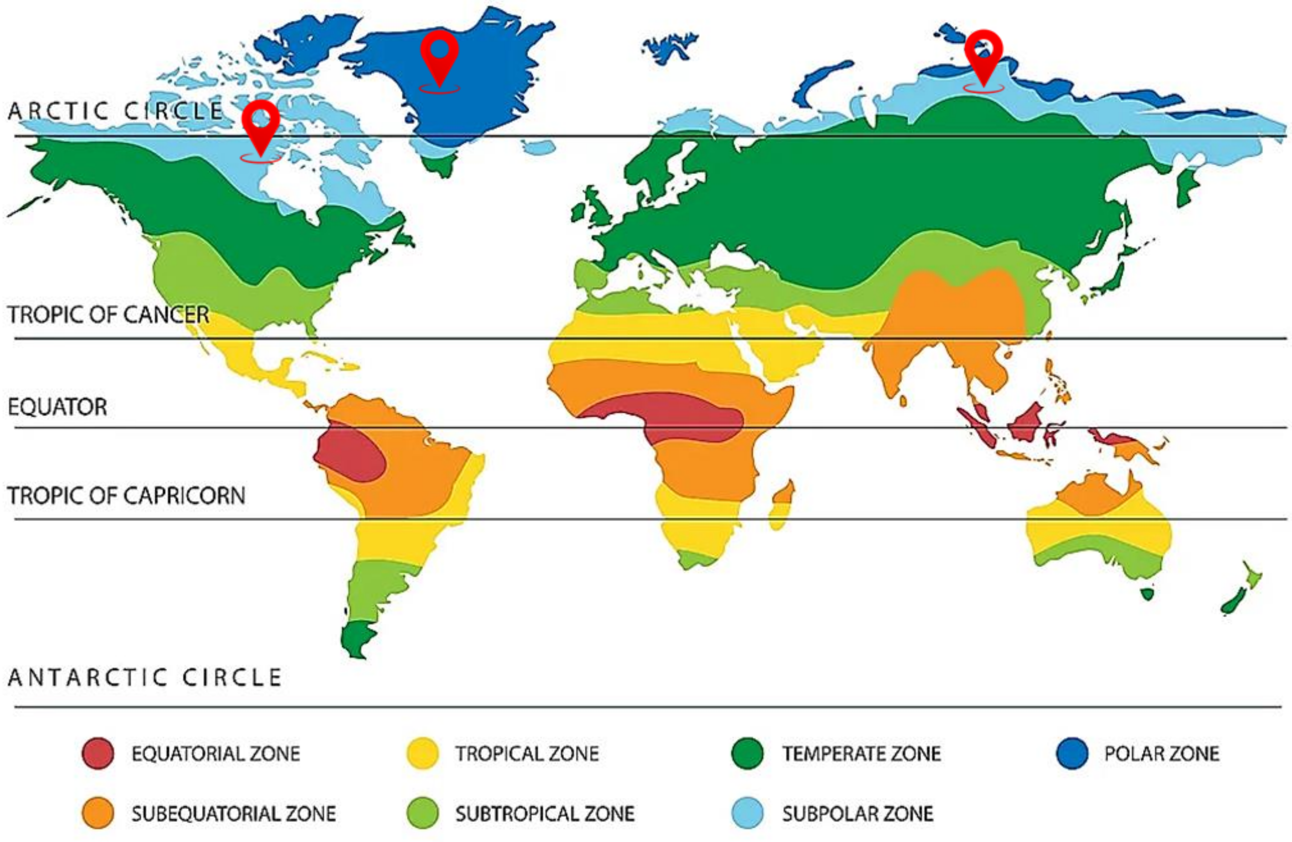
A temperate climate is marked by frequent and severe weather changes due to cyclones. A temperate climate is characterized by four seasons, of which one is cold (winter), one is warm (summer) and the other two (spring and autumn) are transitional.



Polar and Sub-polar climate

A sub-Arctic climate is found between Arctic and temperate climate zones in the northern hemisphere. This climate is marked by air masses at moderate temperature in the summer and cold air masses from the Arctic in the winter.

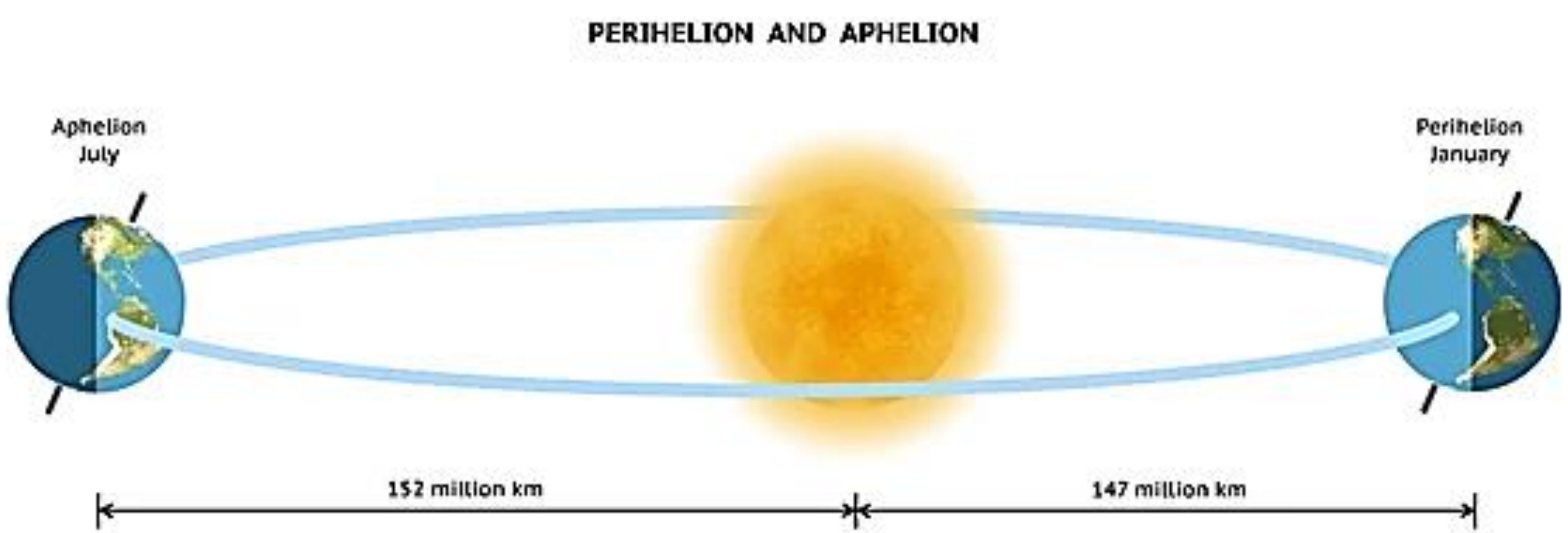
A polar climate is found to the north of 70° latitude in the northern hemisphere (Arctic climate) and to the south of 65° latitude in the southern hemisphere (Antarctic climate). Polar air masses are dominant all year round.



Solar Radiation and Insolation

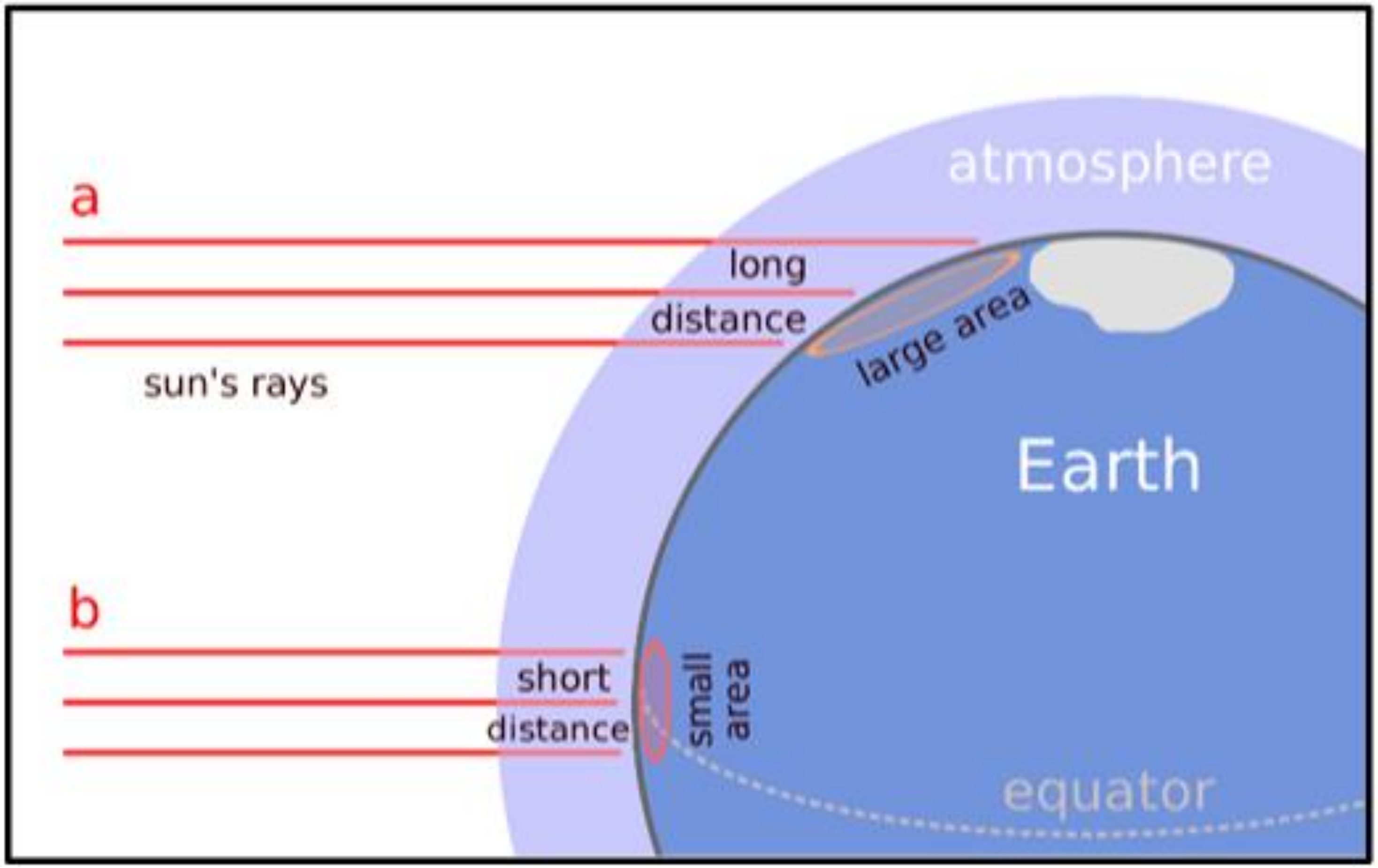
- The Earth receives a tiny fraction (about one two-billionth) of the Sun's total energy output.
- It takes approximately 8 minutes and 20 seconds for solar energy to reach the Earth.

- The solar energy reaching the Earth's surface varies throughout the year due to the Earth's elliptical orbit around the Sun, with the closest approach, or **perihelion**, on January 3rd, and the farthest point, or **aphelion**, on July 4th.



Spatial Distribution of Insolation at the Earth's Surface

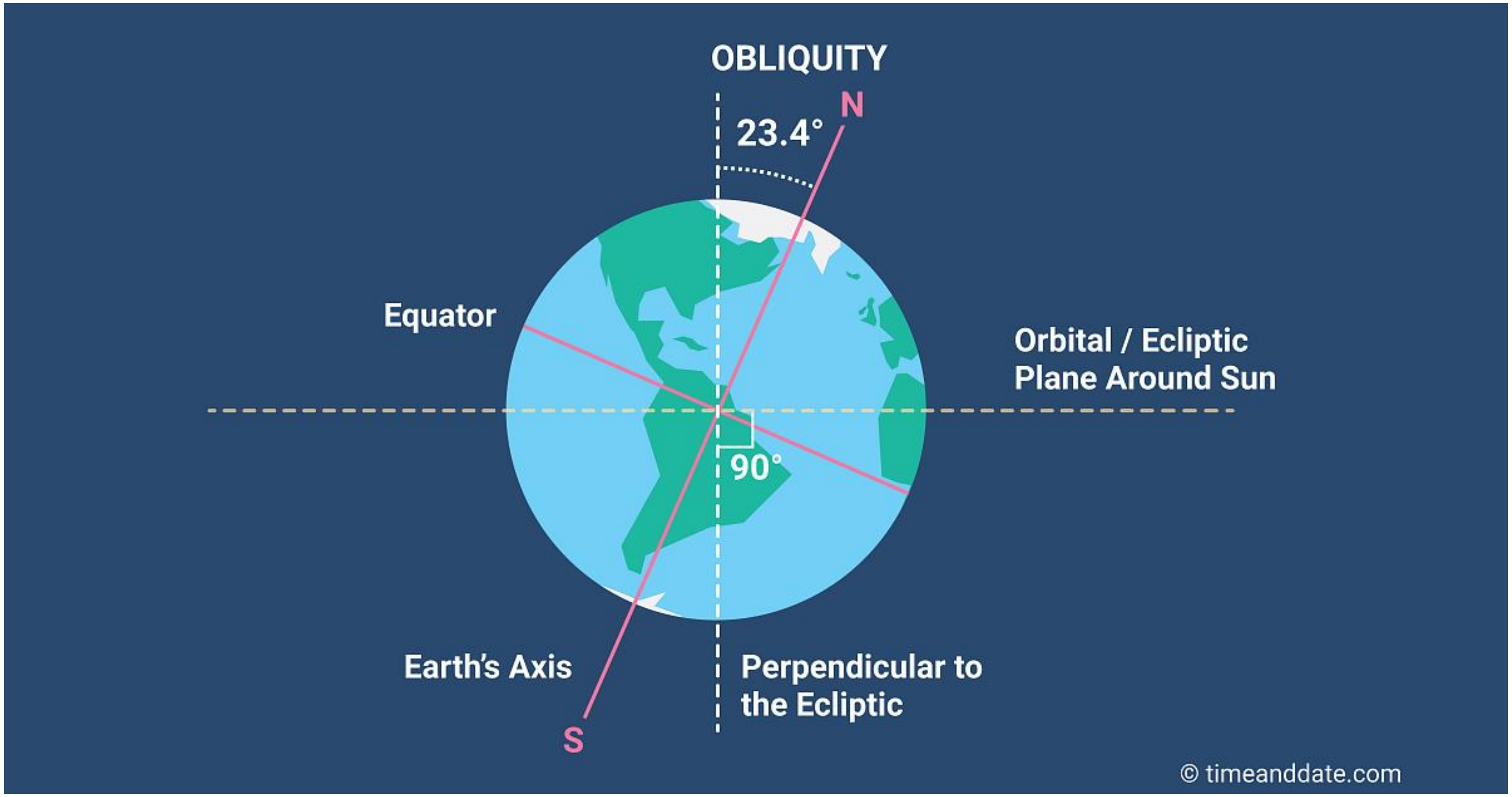
•Insolation varies across different parts of the Earth, with the tropics receiving about 320 Watt/m^2 and the poles around 70 Watt/m^2. Subtropical deserts, which are the least cloudy, receive the maximum insolation.



Factors affecting Insolation

- **The rotation of the Earth on its own axis**, passing through the poles, takes 23 hours and 56 minutes.
- This rotation does not occur in a plane parallel to the plane of the ecliptic (the plane of the Earth's revolution around the Sun), but rather in a plane inclined by 23°27′.

This angle defines **the obliquity** of the Earth's axis.



Factors affecting Insolation

The movements of the Earth:

The Earth rotates:

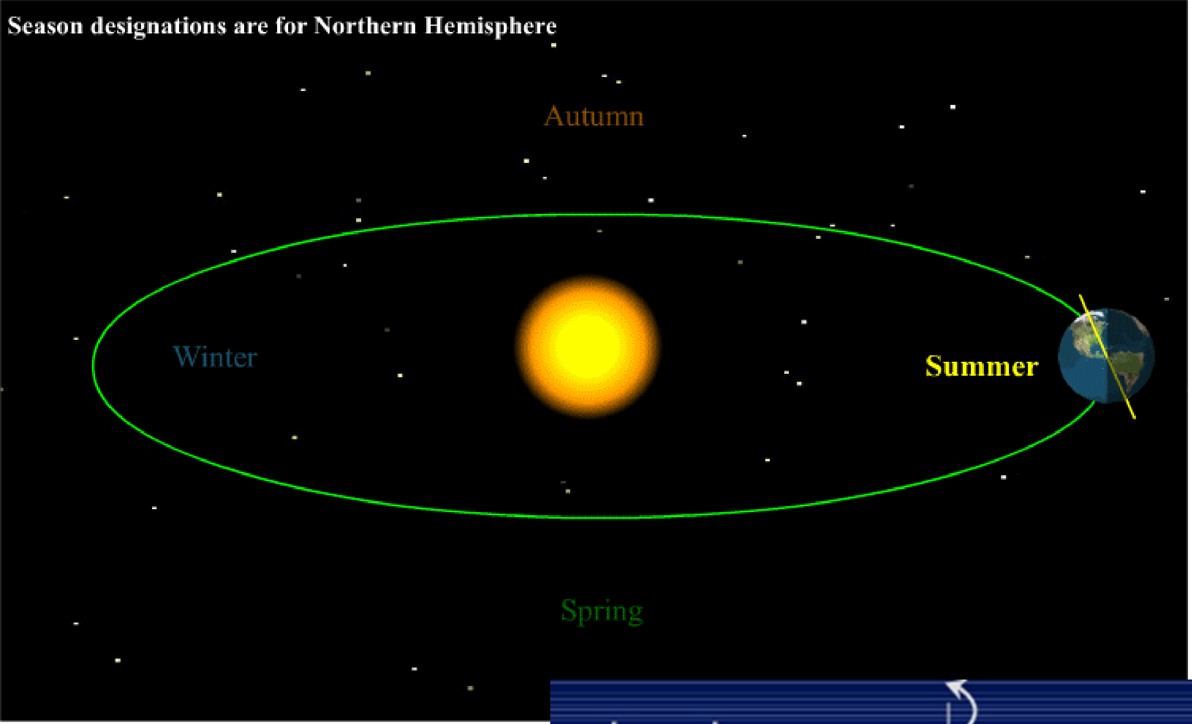
•The Earth spins on its own axis once every day — this is the **rotation** movement.

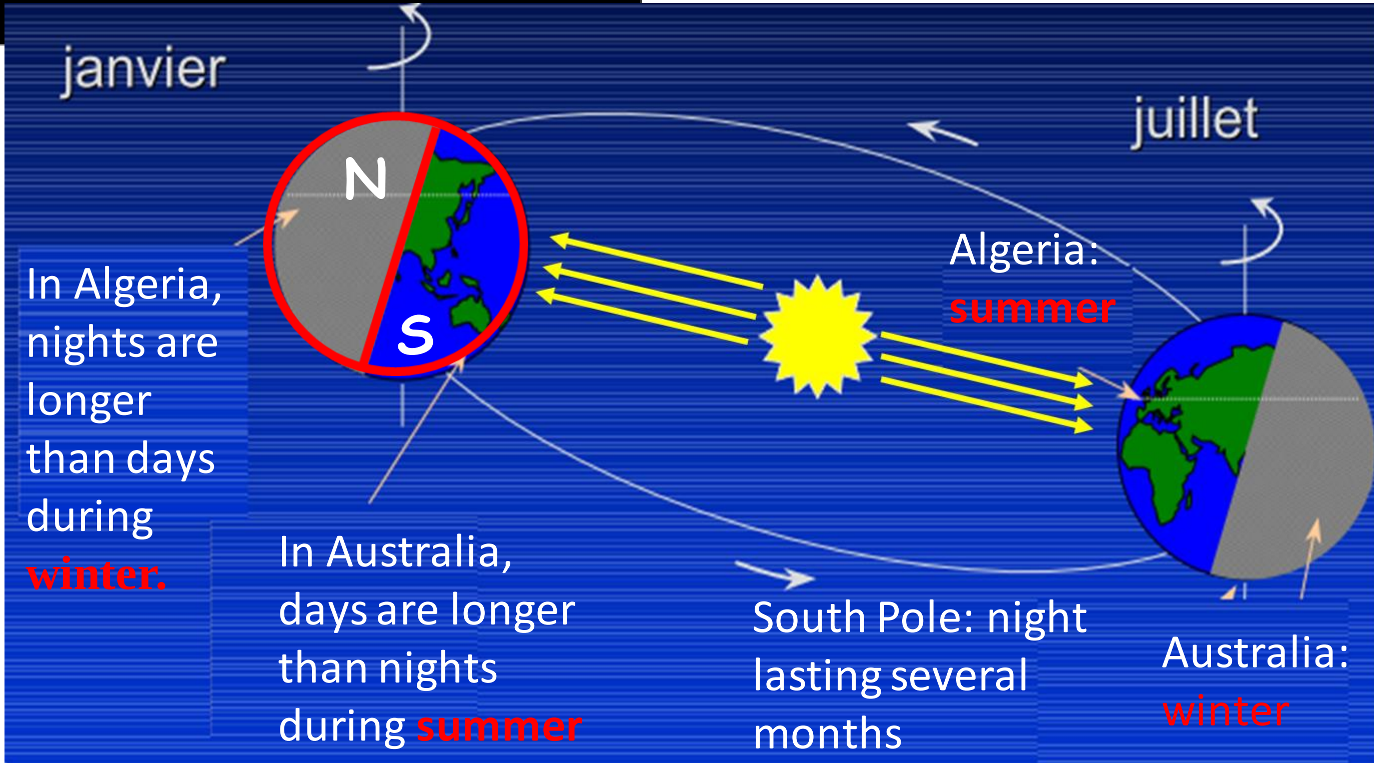
•The Earth travels around the Sun once every year — this is the **revolution** movement.

Rotation of the Earth around the Sun

This revolution takes **365.25** days.

It results in: The alternation of the seasons, The difference between the hemispheres (Northern and Southern).

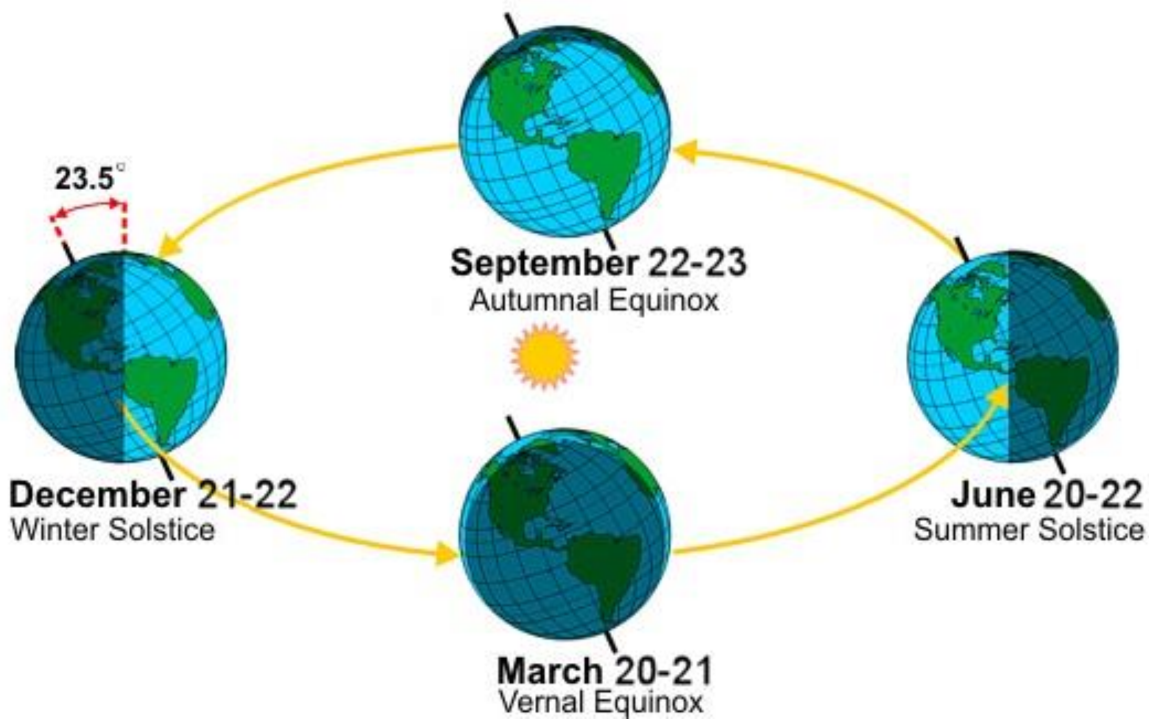

Season designations are for Northern Hemisphere
Autumn
Winter
Summer
Spring

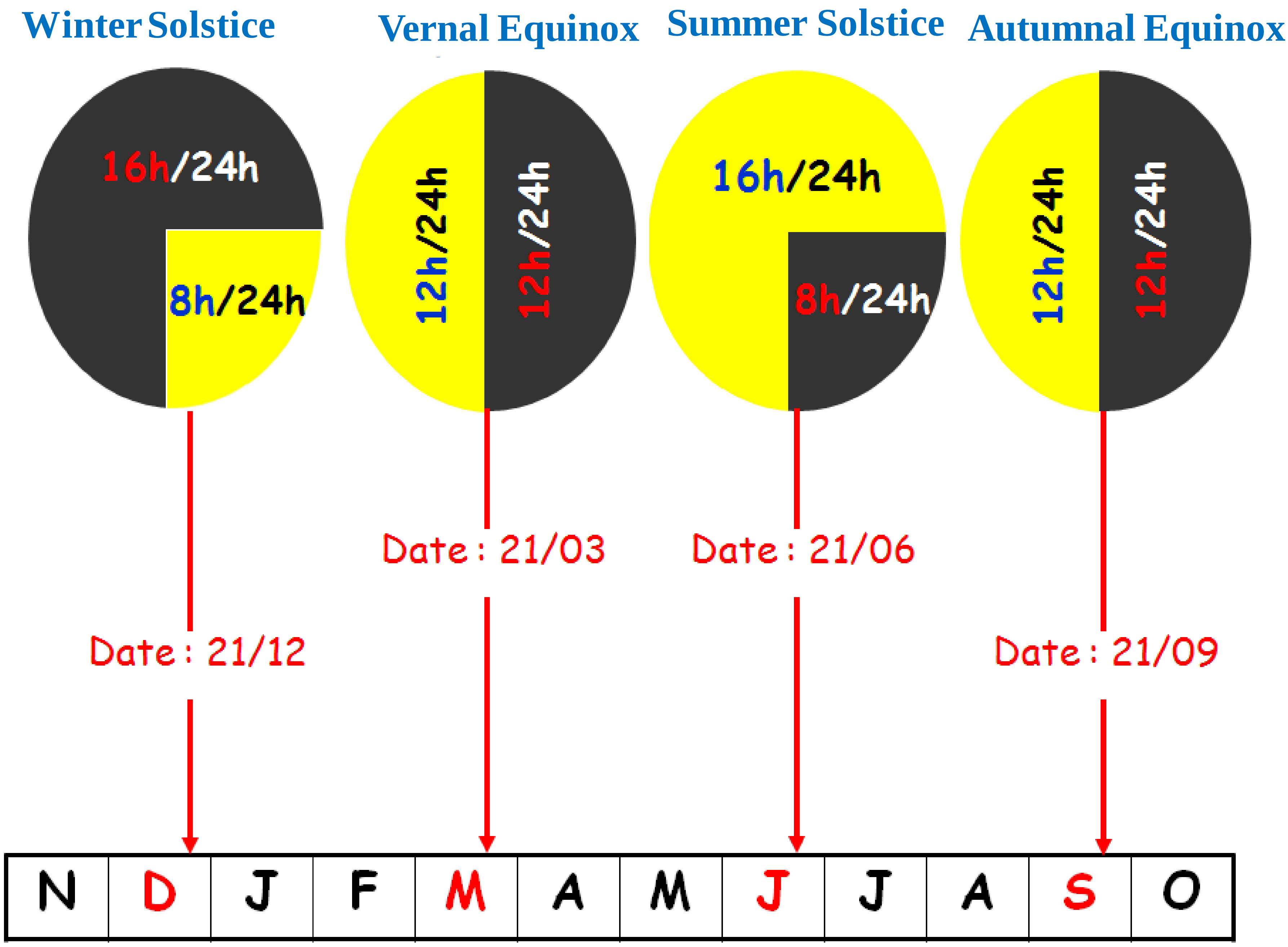

janvier
juillet
N
S
In Algeria, nights are longer than days during winter.
In Australia, days are longer than nights during summer
South Pole: night lasting several months
Algeria: summer
Australia: winter

•At the equator: the duration of the day is equal to the duration of the night throughout the entire year.
•In other regions: the length of the day differs from that of the night, except during the **equinoxes**.

Note:

•Equinoxes: moments of the year (**March 21** and **September 21**) when the **circle of illumination** coincides with the **axis of the poles**. This corresponds to the time of year when the day lasts **12 hours**, and the Sun is positioned **90° above the horizon** at the equator.
•Solstices: moments of the year (**June 21** and **December 21**) when the angle between the **circle of illumination** and the **axis of the poles** reaches its maximum (**23°27′**). This corresponds to the time when the Sun is **90° above the horizon** at the Tropics



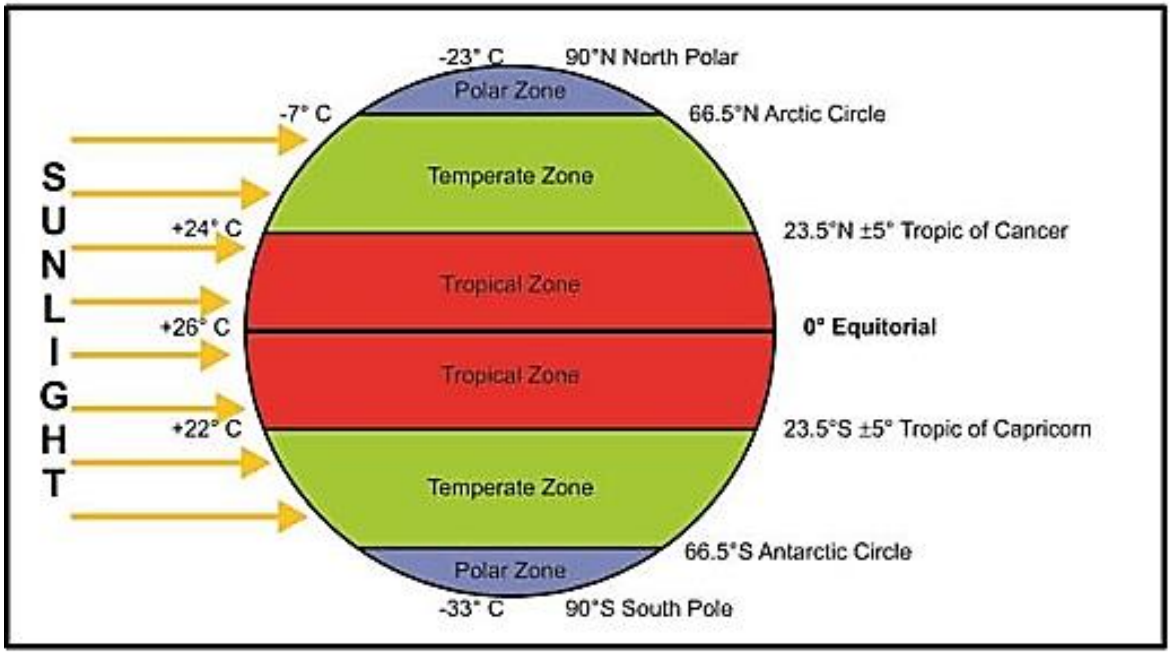

Winter Solstice
Vernal Equinox
Summer Solstice
Autumnal Equinox
16h/24h
8h/24h
12h/24h
12h/24h
16h/24h
8h/24h
12h/24h
12h/24h
Date : 21/03
Date : 21/06
Date : 21/12
Date : 21/09
N D J F M A M J J A S O

Factors affecting Insolation

•**Transparency of the Atmosphere:** Insolation is affected by the transparency of the atmosphere, which can be influenced by cloud cover, dust, and water vapor content. These factors affect the reflection, absorption, and transmission of solar radiation, thereby influencing the amount of insolation that reaches the Earth's surface.

Altitude: Higher altitudes receive more insolation because the atmosphere is thinner, resulting in less absorption and scattering of solar radiation.

•**Latitude:** Temperature largely depends on the amount of insolation, which varies with latitude. Higher latitudes receive less insolation, leading to lower temperatures.



Local Factors Influencing Temperature

Amount of Cloud Cover: Clouds can reflect solar radiation back into space, reducing the amount of energy that reaches the Earth's surface, or they can trap longwave radiation from the Earth, warming the atmosphere.

- **Urbanization:** Urban areas can experience higher temperatures due to the heat island effect, where human activities and structures absorb and re-radiate heat.

Surface Absorption

Reduced Vegetation

Waste Heat

Limited Air Flow

- The concept of an **"urban heat island"** refers to the phenomenon where urban areas experience significantly higher temperatures compared to their surrounding rural areas.

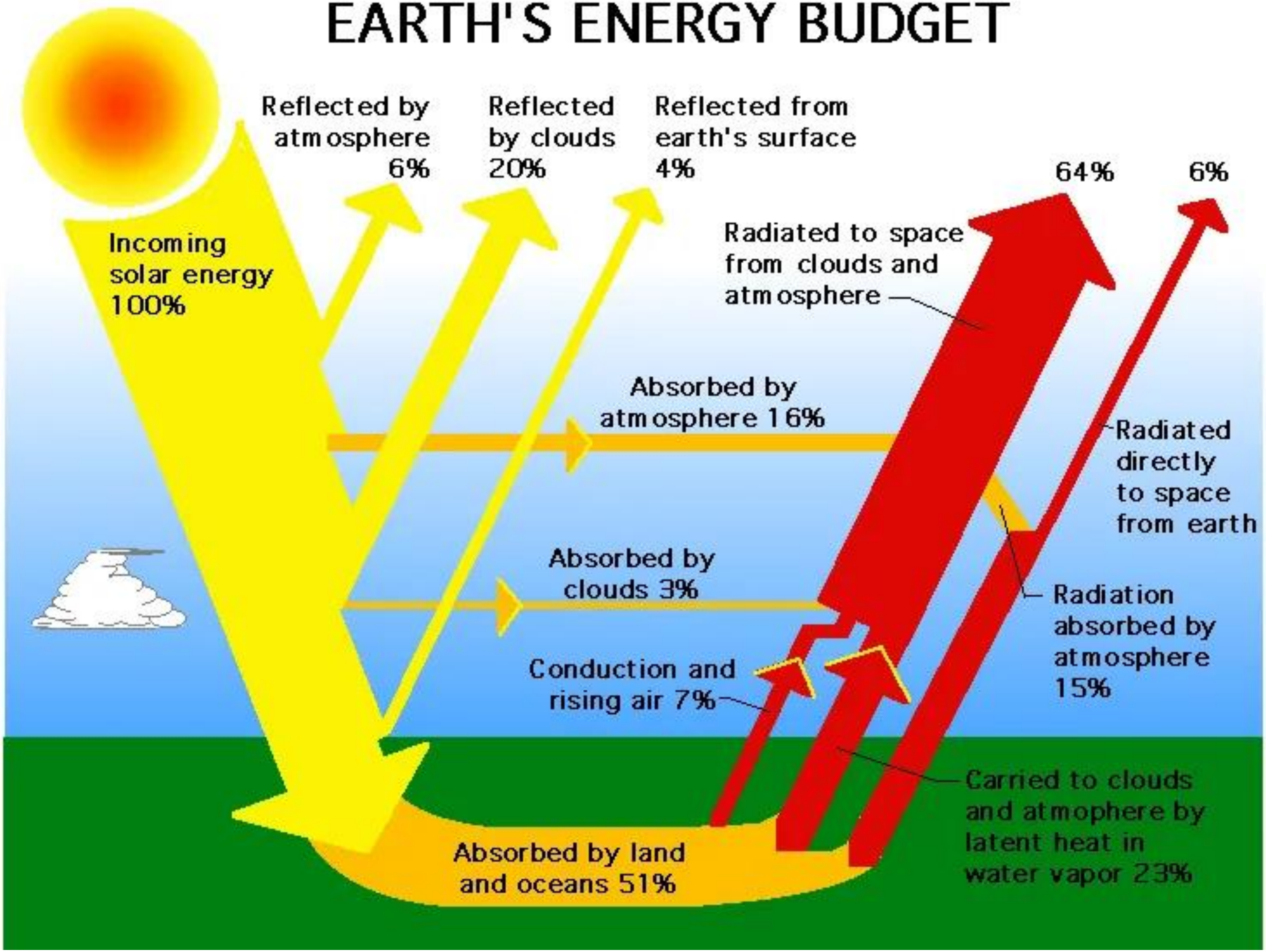
The Solar Energy Budget

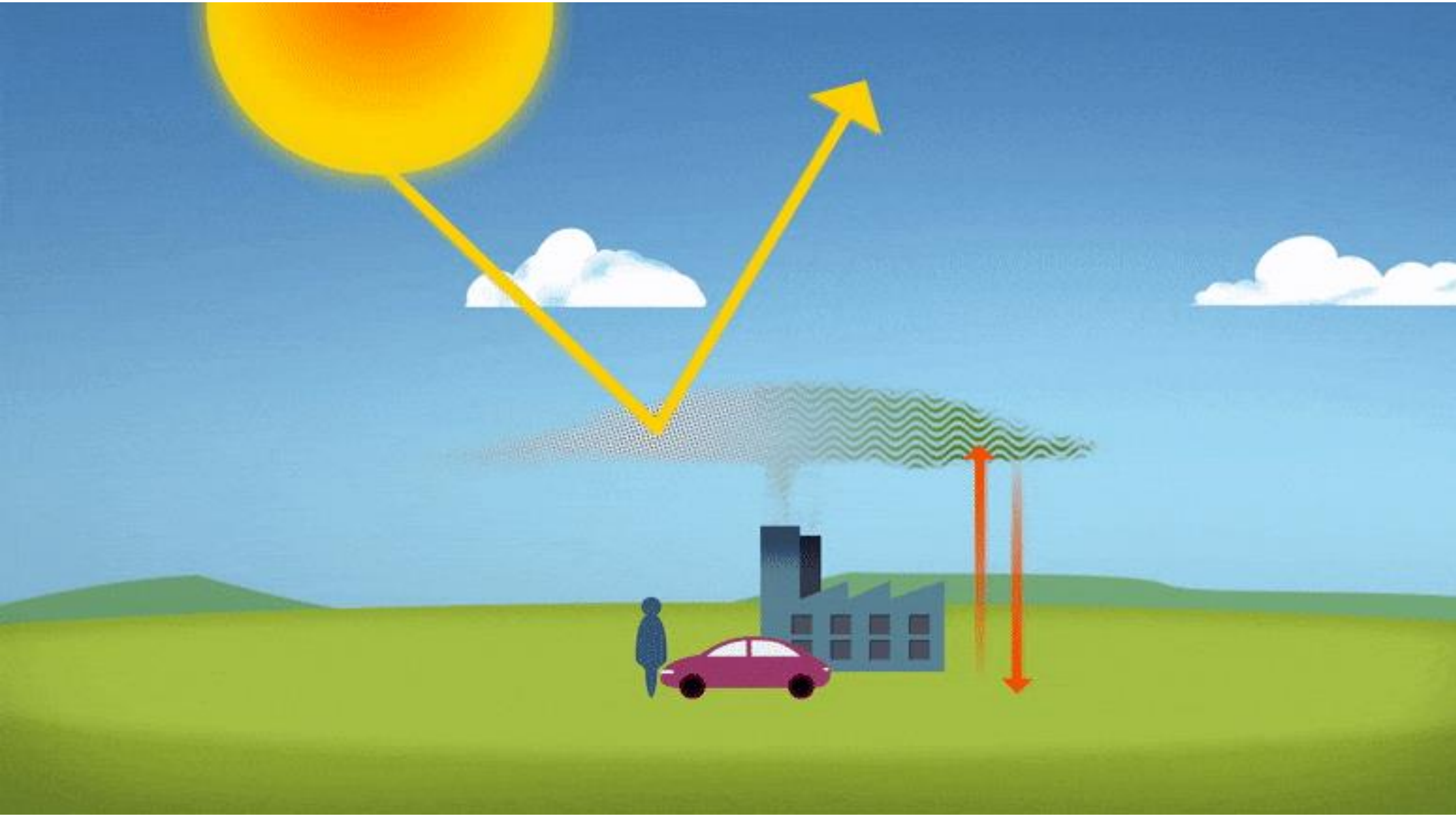
Earth's energy budget represents the balance between the amount of energy incoming to Earth from the Sun and the amount of energy outgoing from Earth back to space. The energy budget provides a way to account for all the energy entering and leaving the Earth system.

The incoming solar energy is measured in watts per square meter (W/m^2).

The next diagram shows how the energy reaching Earth from the Sun is **absorbed, reflected, and released** by Earth's atmosphere and surface

EARTH'S ENERGY BUDGET



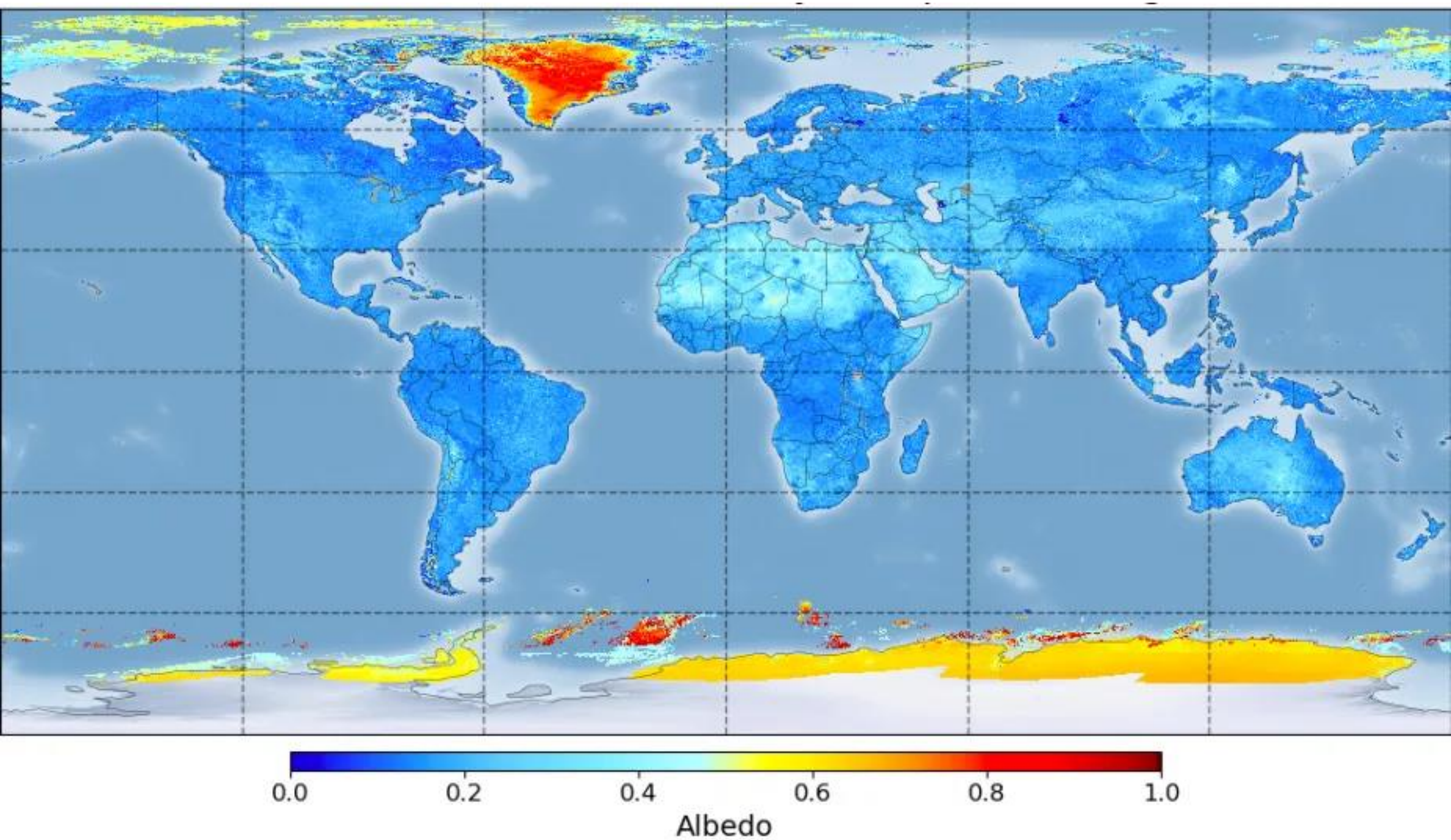


Earth's surface is covered by things like water, soil, rocks, forests, snow, and sand. Different surface characteristics have different ways of affecting the solar energy reaching our planet. Some surfaces are more reflective than others, characterized by the surface's **Albedo.**

Albedo refers to the amount of energy reflected by a surface and is measured on a scale from **0 to 1.**

Dark colored surfaces, like ocean and forests, reflect very little of the solar energy that gets to them, while **light** colored parts of the planet's surface, like snow and ice, reflect almost all of the solar energy that reaches them.

0 ……… > corresponds to a black body, which reflects no radiation.



1 …> corresponds to a body that diffuses radiation in all directions without absorption.

The more reflective a surface is, the higher its albedo.

Example: the albedo of fresh snow is 0.87, meaning that 87% of the incoming solar energy is reflected by this type of snow

The main elements contributing to the Earth’s albedo are: clouds, snow and ice surfaces, and aerosols.

The characteristics of the Earth's surface include:

•**Albedo**,

•**Heat capacity**,

•**Degree of moisture and permeability**,

•**Color**,

•**Vegetation cover**,

•**Exposure**,

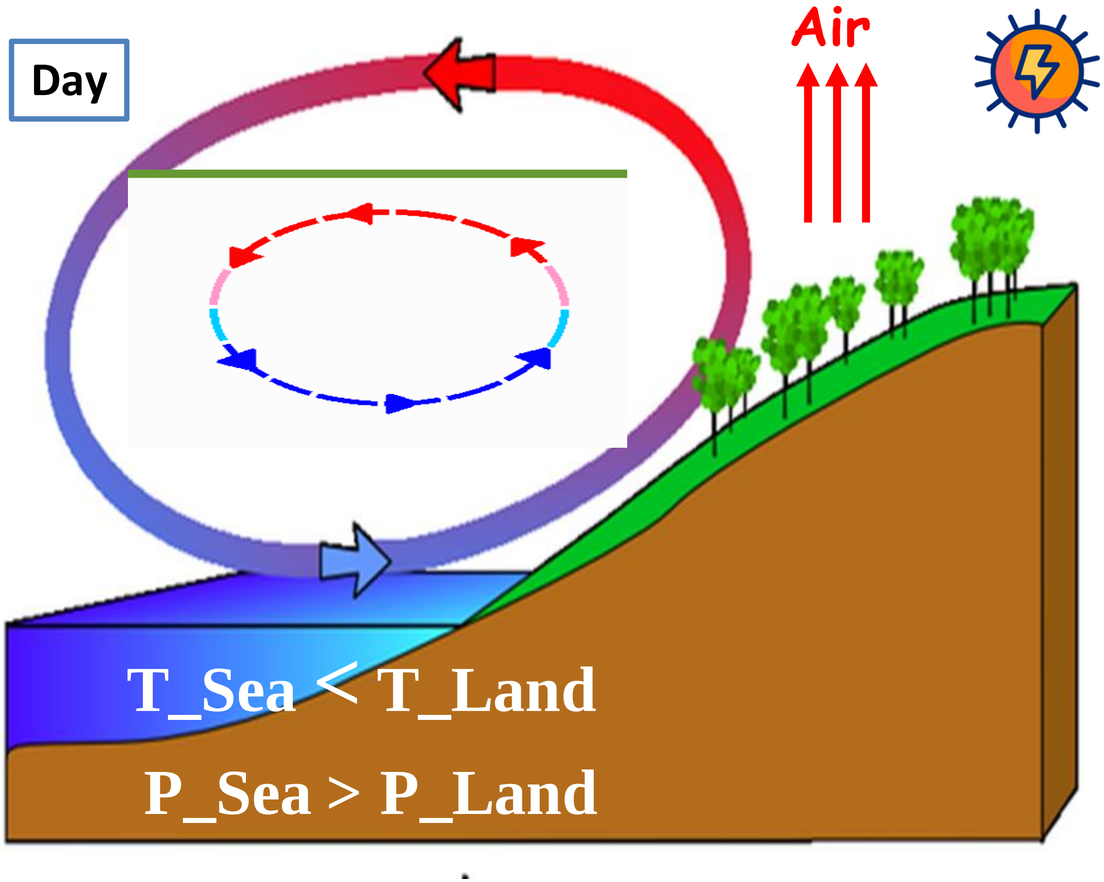
•**Orientation and shape**.

These factors influence the **exchange of heat energy and moisture** between the atmosphere and the Earth.

It should be noted that:

- The soil has **low thermal conductivity**: only the **surface layer** heats up, then transfers its heat to the atmosphere.
- The **temperature near the ground** is primarily governed by **energy exchanges** between the soil and the atmosphere.
- **Vegetation cover** reduces both **daytime heating** and **nighttime cooling** of the soil, resulting in a **smaller diurnal temperature range** for covered soil compared to bare soil.

•The **temperature of the seas** rises and falls more slowly than that of the land. This gives rise to **sea and land breezes** and allows the seas to act as **climate regulators** for nearby regions (by facilitating air mixing between land and sea), as well as at a **global scale** , since **71% of the Earth's surface** is covered by water compared to **29% land**.



Sea breeze:

Sun

The **land surface heats up very quickly**, while the **water surface warms much more slowly**.

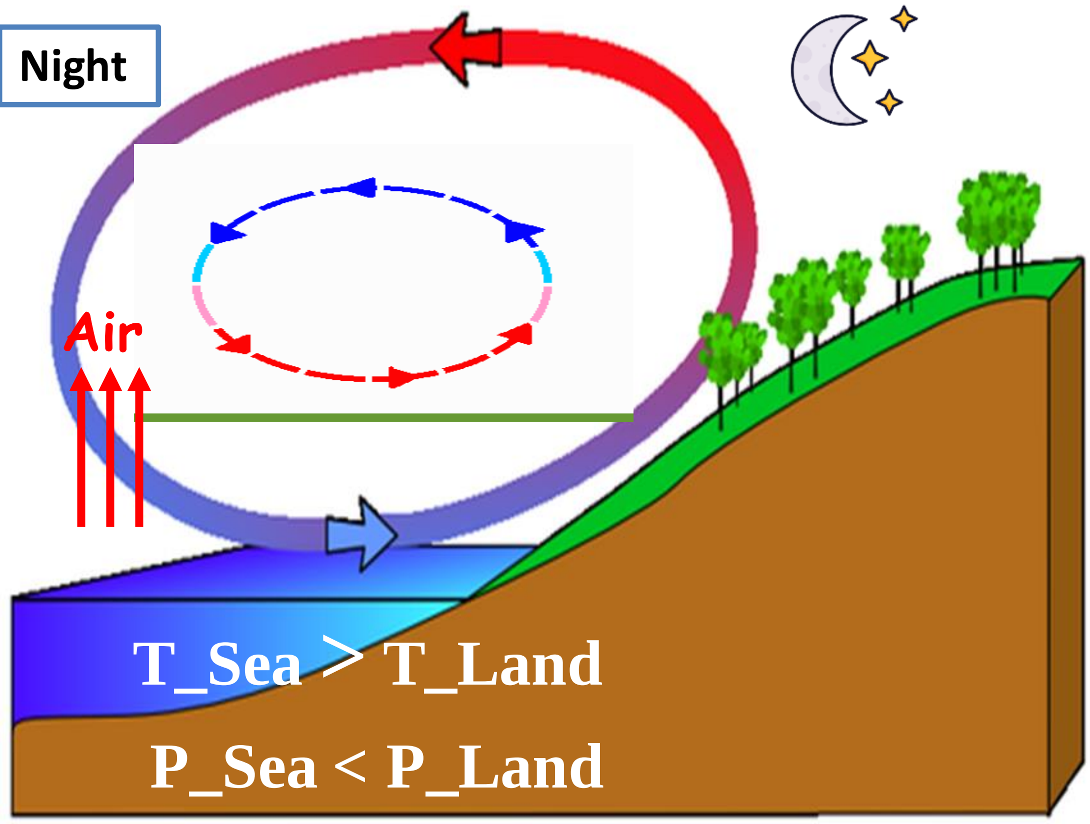
A **temperature and pressure gradient** develops between the two areas.

The **warm air over the land rises**, creating a **low-pressure zone**.

This causes a **deficit of air (a partial vacuum)** over the land.

cooler air from the sea moves inland to compensate for this lack of air

The sea breeze.



Land breeze:

At night, the opposite phenomenon occurs:

↓

The land loses heat more rapidly than the sea.

↓

A temperature and pressure gradient is established between the two.

↓

The land becomes cooler than the sea, resulting in the formation of a low-pressure zone over the sea

↓

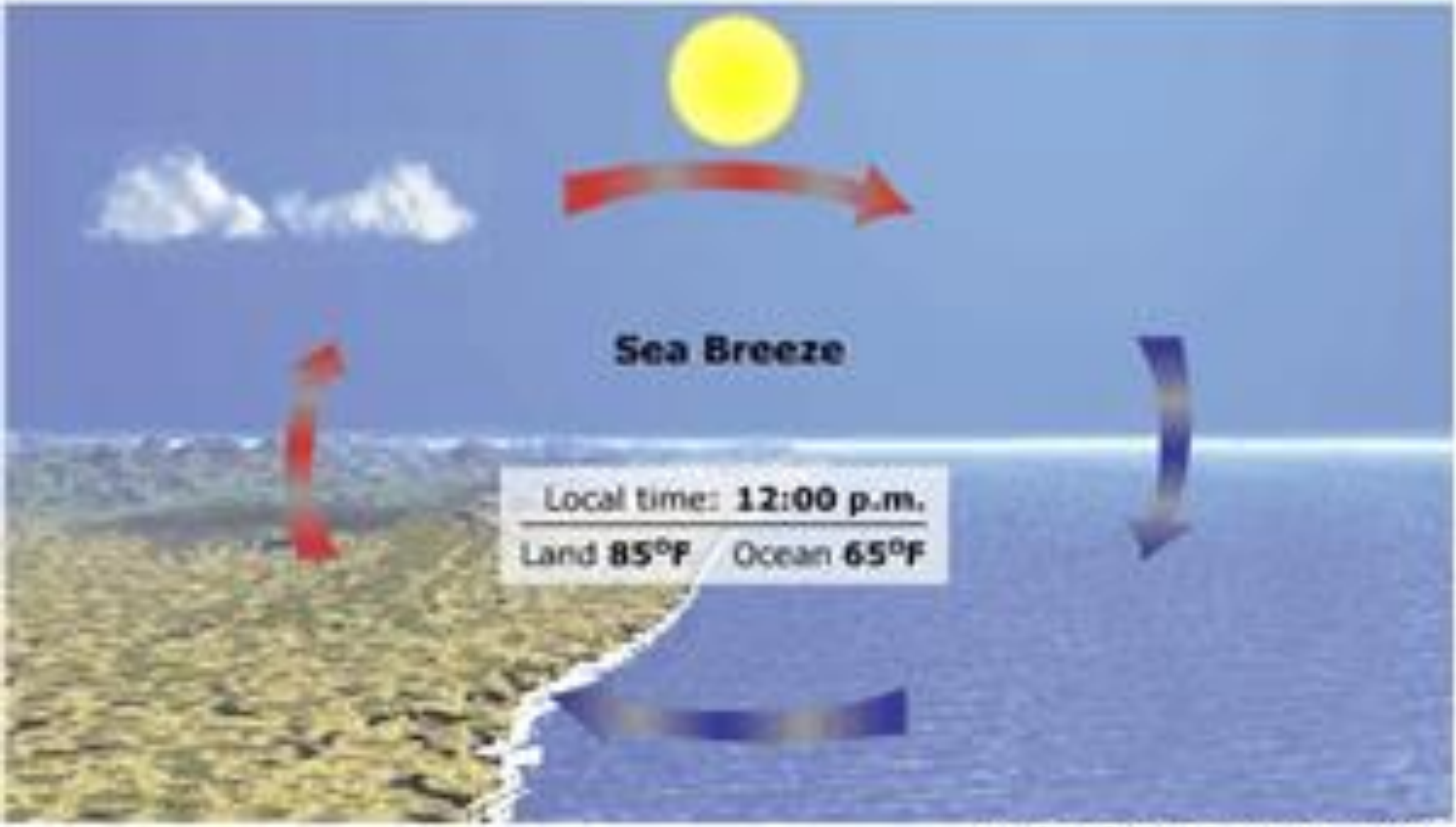
This causes a **deficit of air (a partial vacuum)** above the sea

←

To compensate for this low-pressure area, air flows from the land toward the sea.

↑

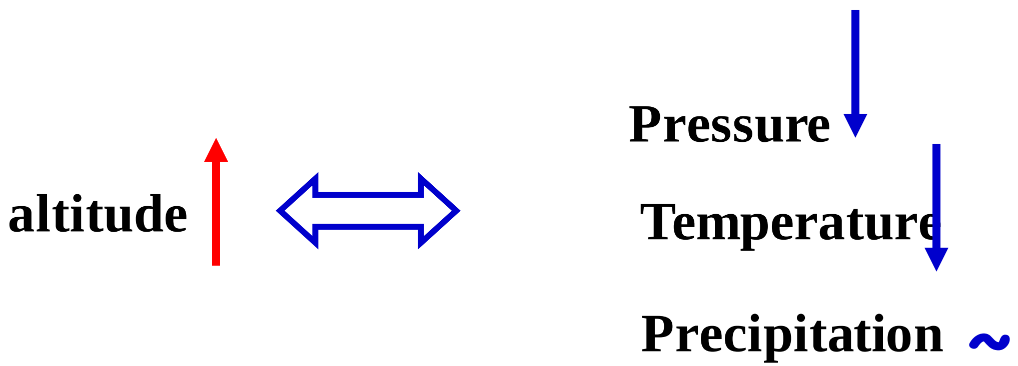
Nocturnal land breeze



Modified from Precision Graphics

Relief:

An **increase in altitude** corresponds to a **decrease in atmospheric pressure and temperature**, as well as a **modification in precipitation patterns**.



Moreover, **air currents are disturbed by topography** due to **friction**, producing both **thermal effects** (such as the influence of turbulence on temperature) and **dynamic effects**, which depend on factors such as the **shape of the relief**, the **speed and direction of the air current**, and the **stability of the air mass**.

Foehn Effect

↓

The **Foehn effect** is a **meteorological phenomenon** that occurs mainly in **high mountain regions**, but it can also take place at **altitudes between 500 and 600 meters**.

↓

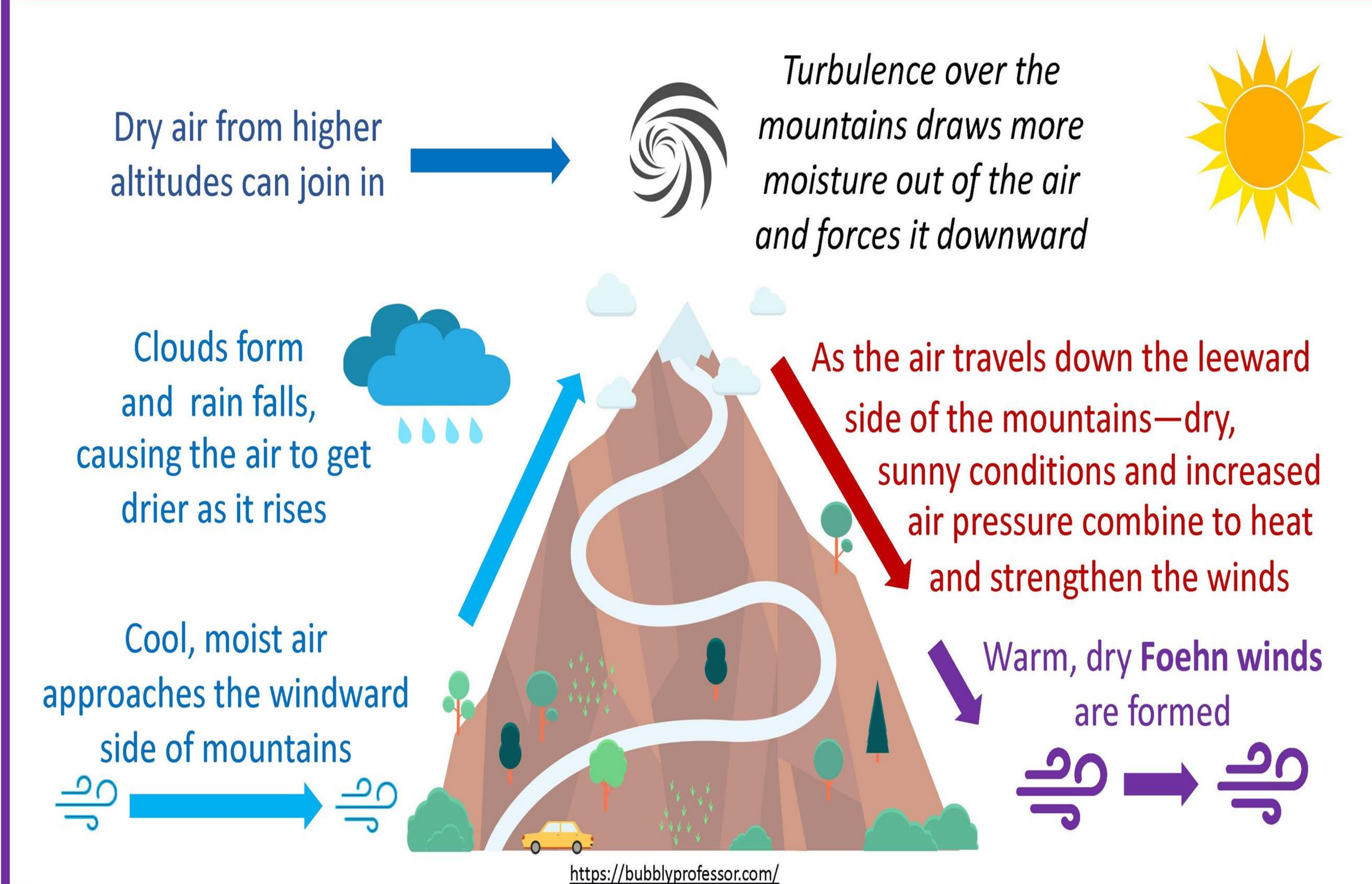
It involves a **cold, moist air mass** that becomes **warm and dry** as it passes over a mountain range.

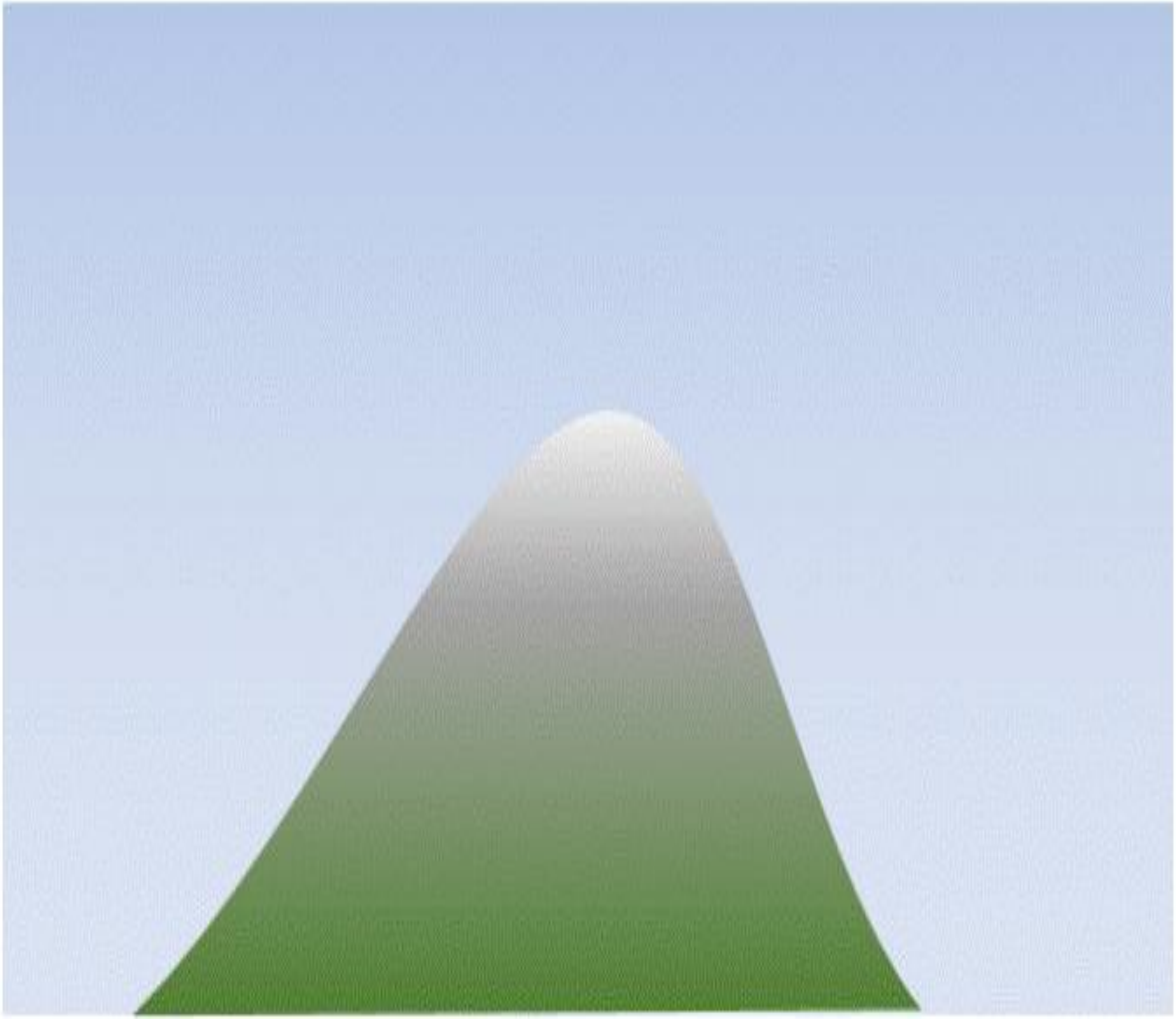
↓

This phenomenon is characterized by:

- **Heavy precipitation** on the **windward slope** of the mountain (the side exposed to the incoming air), and
- A **warm, dry wind** on the **leeward slope** (the side sheltered from the wind)

The Foehn Effect



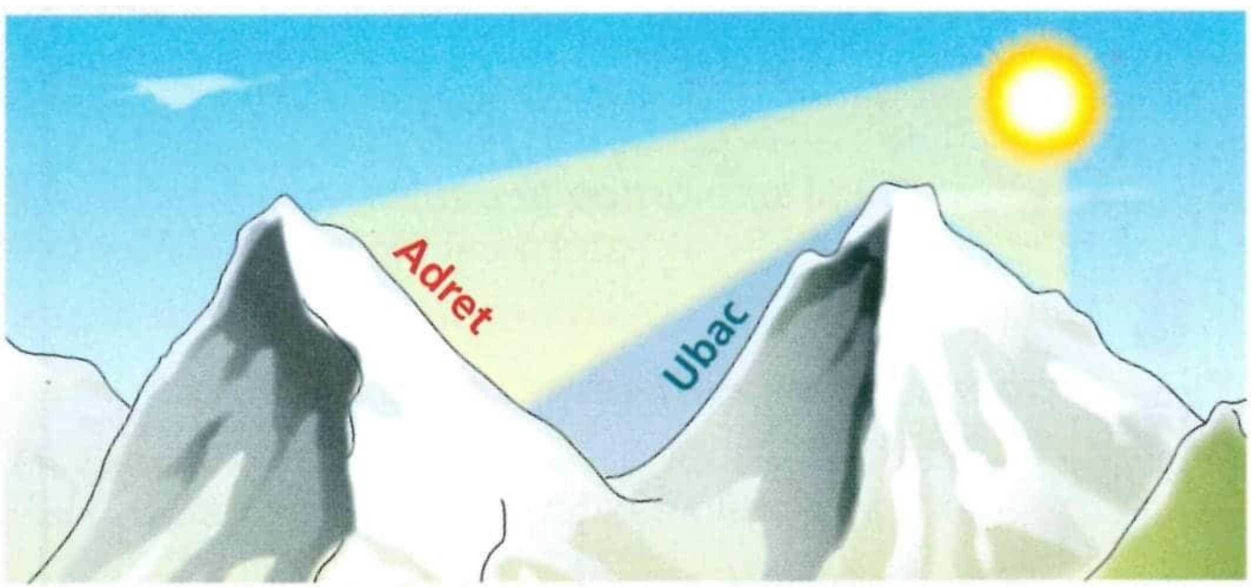


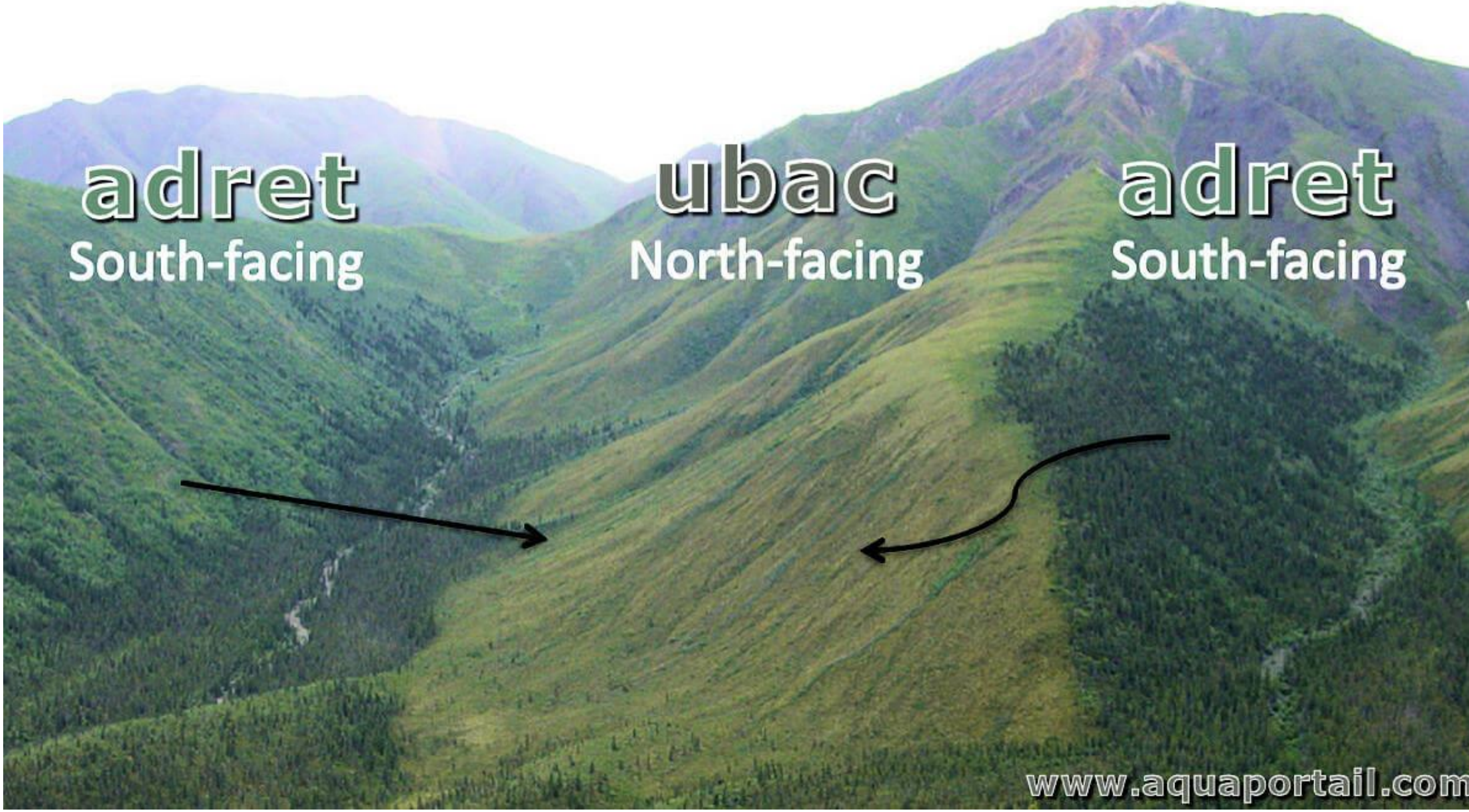
Adret and Ubac Slopes

The **adret slopes**, that is, the **south-facing slopes**, are generally **warmer** than the **ubac slopes**, which face **north**.

•**Adret:** the **slope of a mountain that receives the greatest exposure to sunlight**. It is therefore the **warmest slope**.

•**Ubac:** the **slope of a mountain valley that receives the least sunlight**, remaining **shaded and cooler**




adret
South-facing
ubac
North-facing
adret
South-facing
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