Heat budget of the Earth

Earth receives **heat energy** from ;

1. Solar radiation.
2. Gravity
3. Endogenetic force from within the earth.

Most significant source - Terrestrial heat energy.

Sun - engine driving many phenomenons in earth

Air movement
Ocean current
Denudational processes
Hydrological cycle
Geo-biochemical cycle
Photosynthesis etc.

} Sustaining life in biosphere

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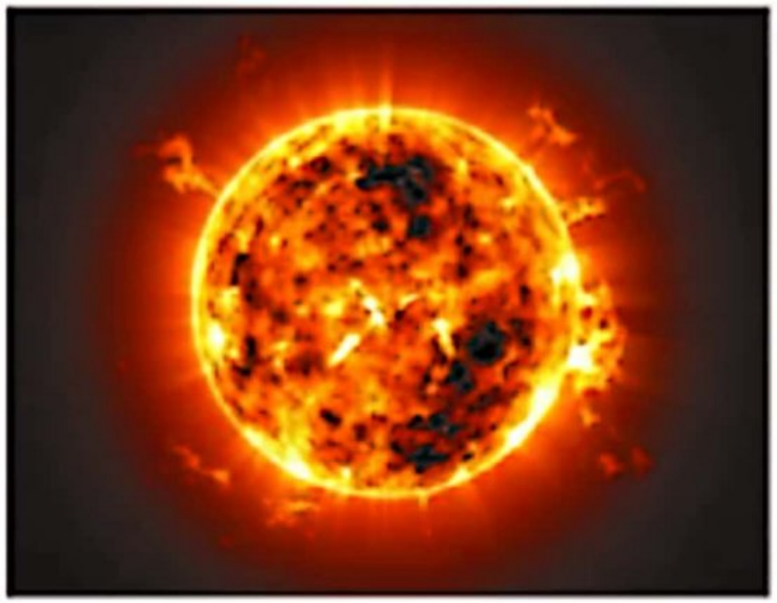
Mechanism of solar radiation

Source of **Sun energy** - interior - **hydrogen** converted into **helium.**



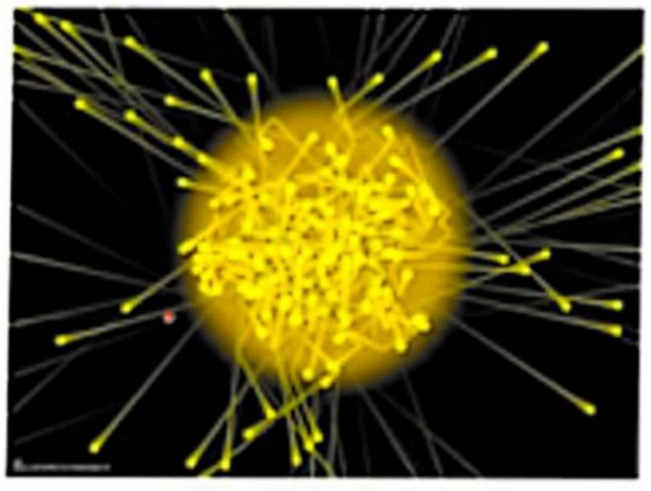
Enormous pressure
Very high temperature
Nuclear fusion

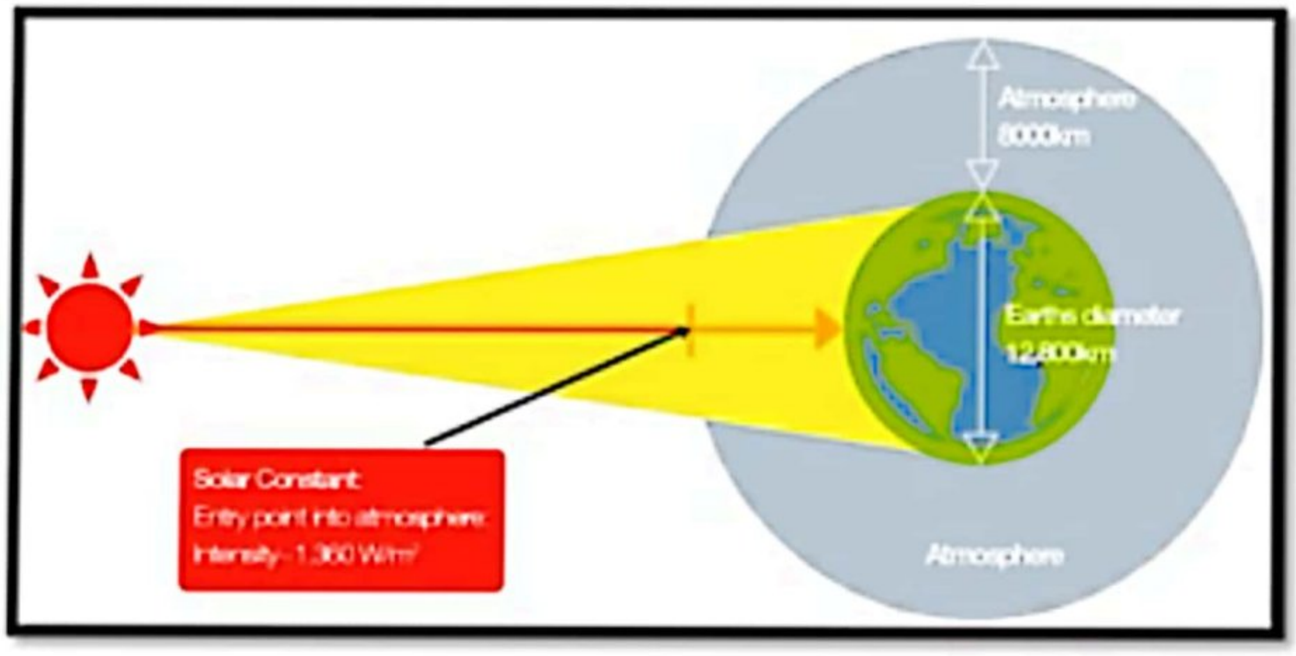
Generating huge quantity of heat

This **heat transported** - outer surface of sun (conduction and convection).

Radiation of energy (**Sun outer surface**) - constant (**solar constant**)

In the form of bundle of energy (**Photon**)





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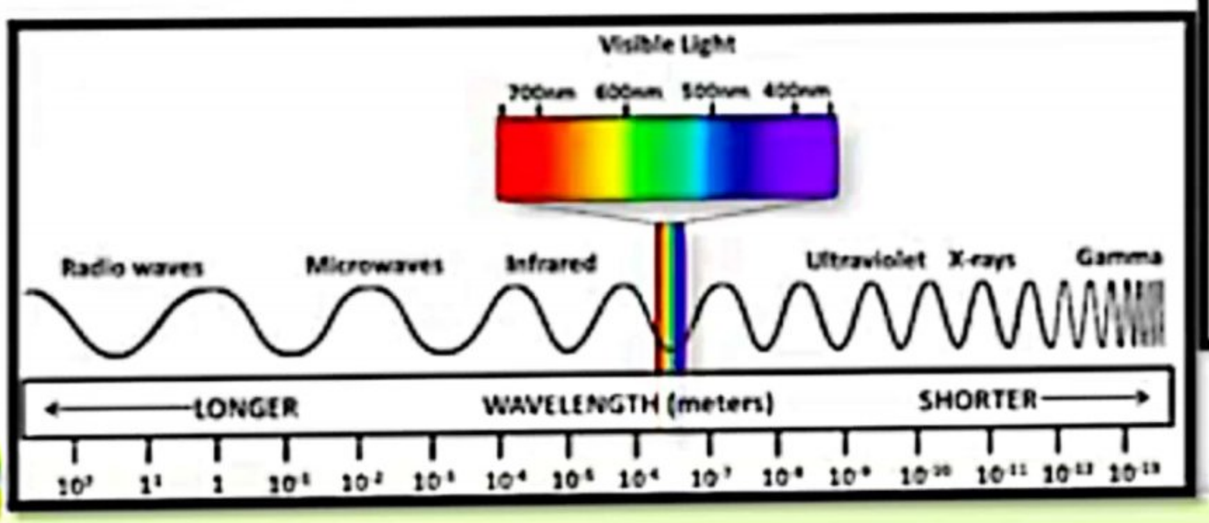
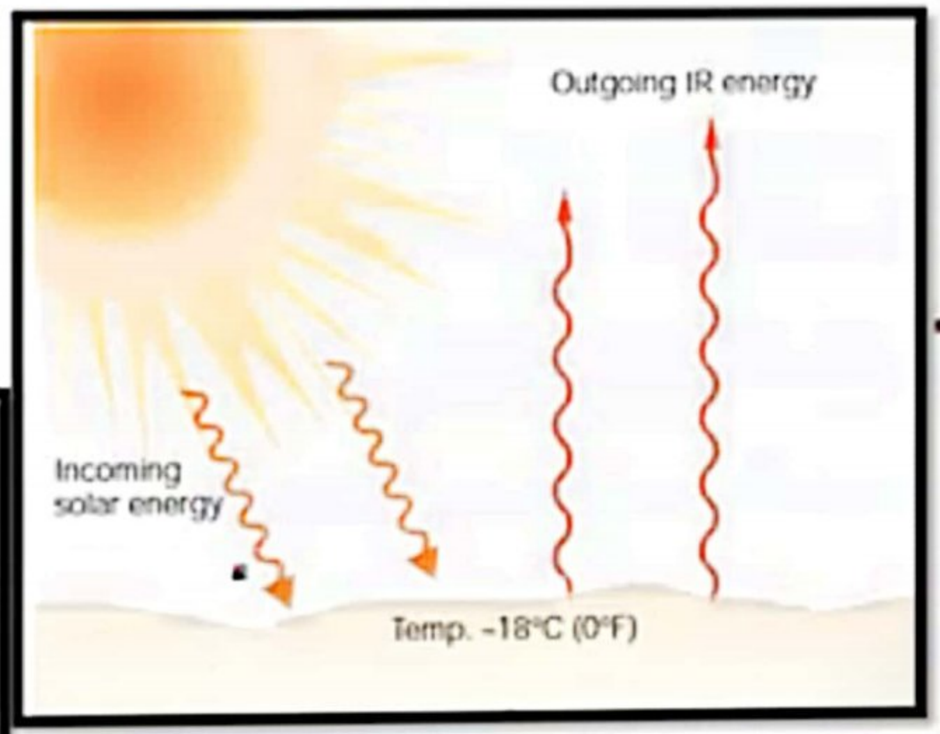
Continuous **emission of photons** → Leads to → **Continuous band of radiations, having certain wavelength.**

Insolation (shortwave) - electromagnetic radiation.

Outgoing radiation (longwave) - infrared radiation.





Insolation distribution

Decreases from equator towards poles

Temporal variation of insolation received - **different latitudes** (different time)

Sizeable portion - loss

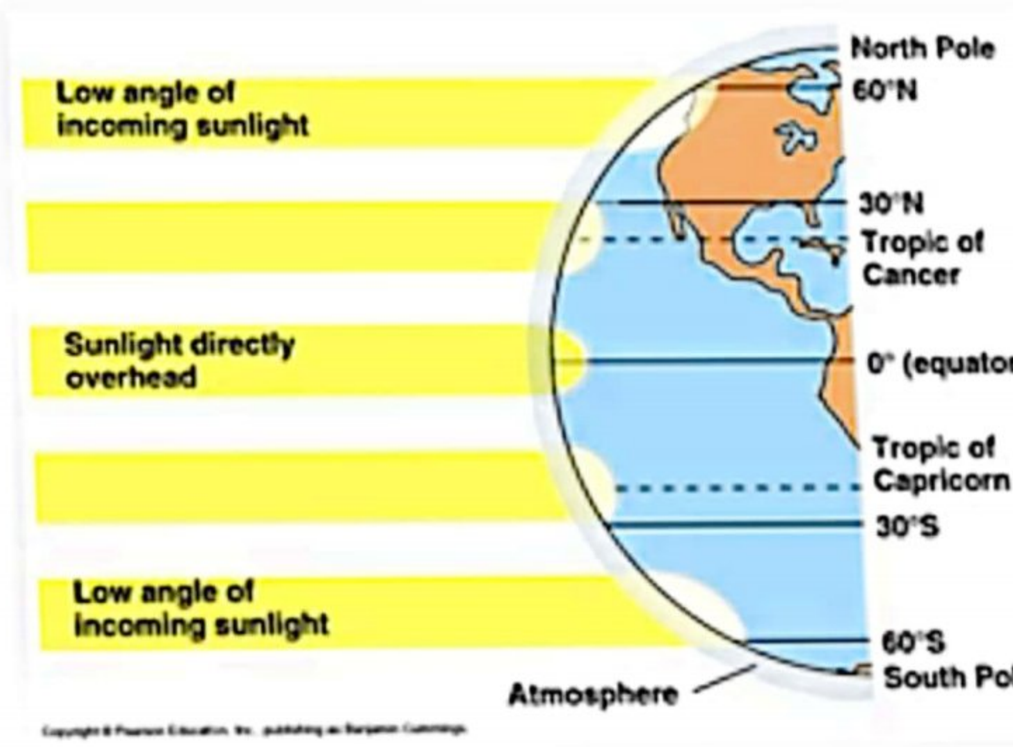
Cloudiness,
Atmospheric scattering,
Reflection,
Absorption

1. **Low latitude or Tropical zone.**

Between Tropic of Cancer and Capricorn

Experience overhead Sun twice.

Highest insolation - year (avg.)

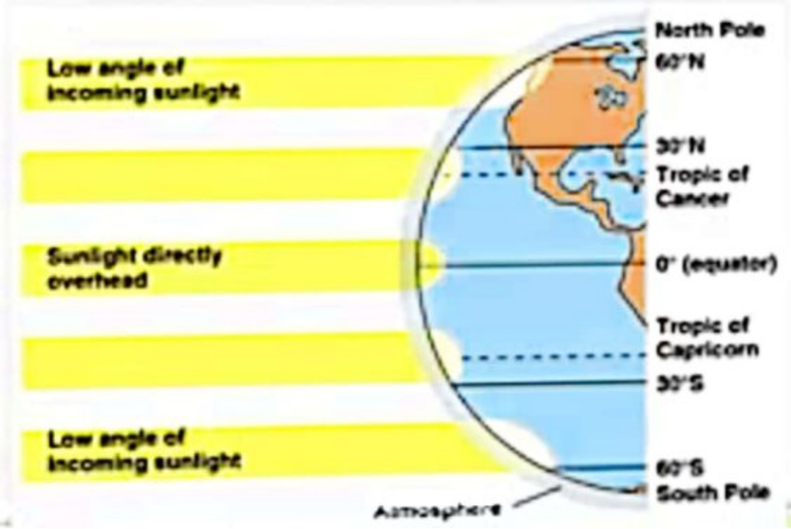


2. Mid latitude zone

Between 23 degree and 66 degree

Receives maximum insolation - summer solstice(N. Hemisphere)
- winter solstice (S. Hemisphere)

minimum insolation - Equinox. (21 March, 23 September)

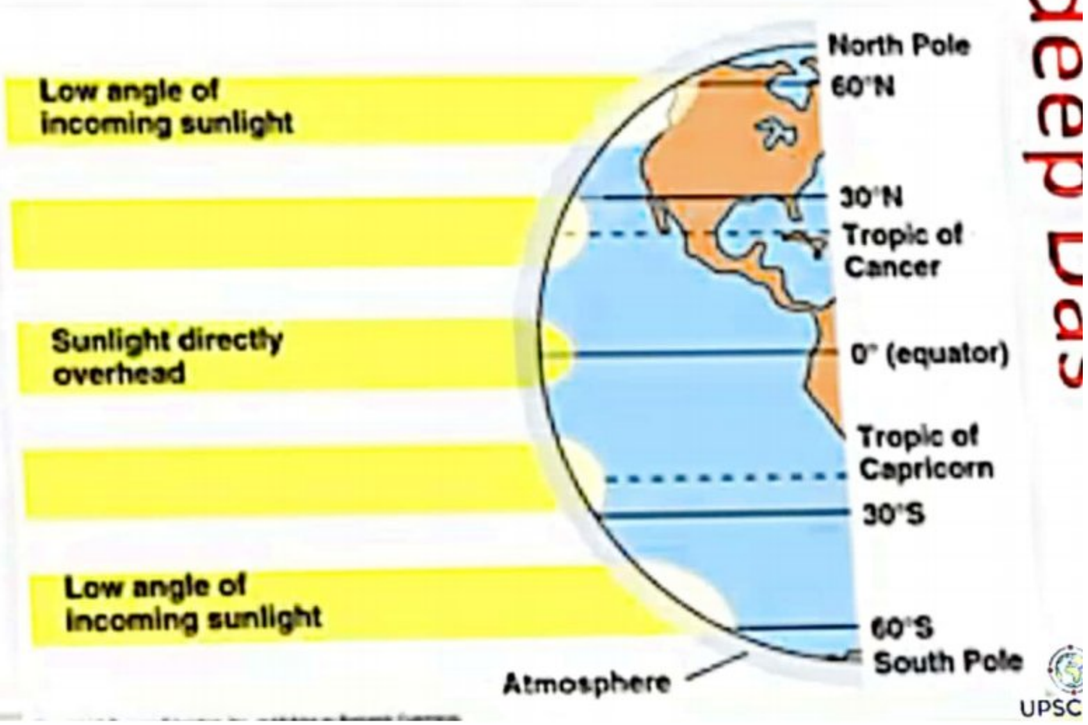


3. Polar zone

Between 66 degree and poles.

Insolation respectively low - compared to other zones.

Sometimes insolation becomes zero



Factors that affect solar insolation :

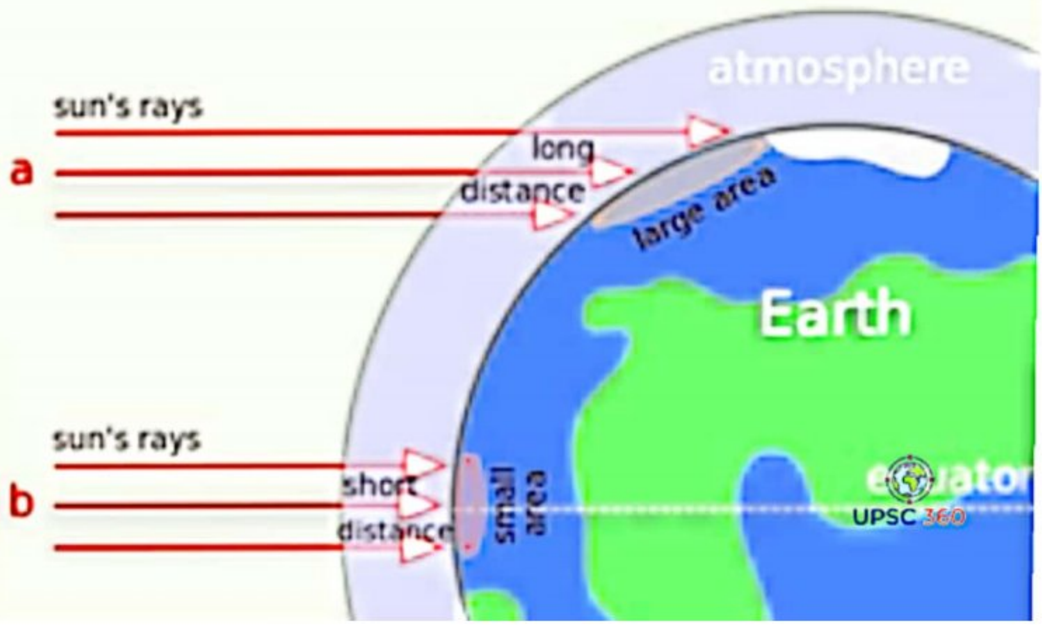
1. Angle of the Sun's Rays:

Vertical (90 Degree) - equator

Slanting - pole wards.

Energy received per unit area.

- **Oblique rays spread - larger area**
- **Vertical rays - minimum surface area**



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2. Length of day

Larger insolation - long day duration, short night duration.

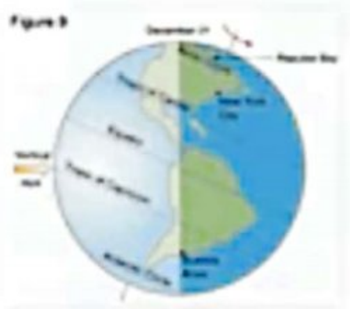
Less insolation - long night duration, short day duration.

At equator - day length (always 12 hours) - **circle of illumination** - divide equator - two half.

Summer solstice (21june) :

Day length increases poleward - N. Hemisphere.

Daily length decreases - S. Hemisphere.



...Vice versa – Winter Solstice

North Pole - day duration (6 months) - 21 March - 23 September

South Pole - day duration (6 months) - 23 September - 21 March

Inspite of 6 months sunlight - insolation received- less

1. Parallel to ground surface.
2. Ice cover reflects most of solar radiation

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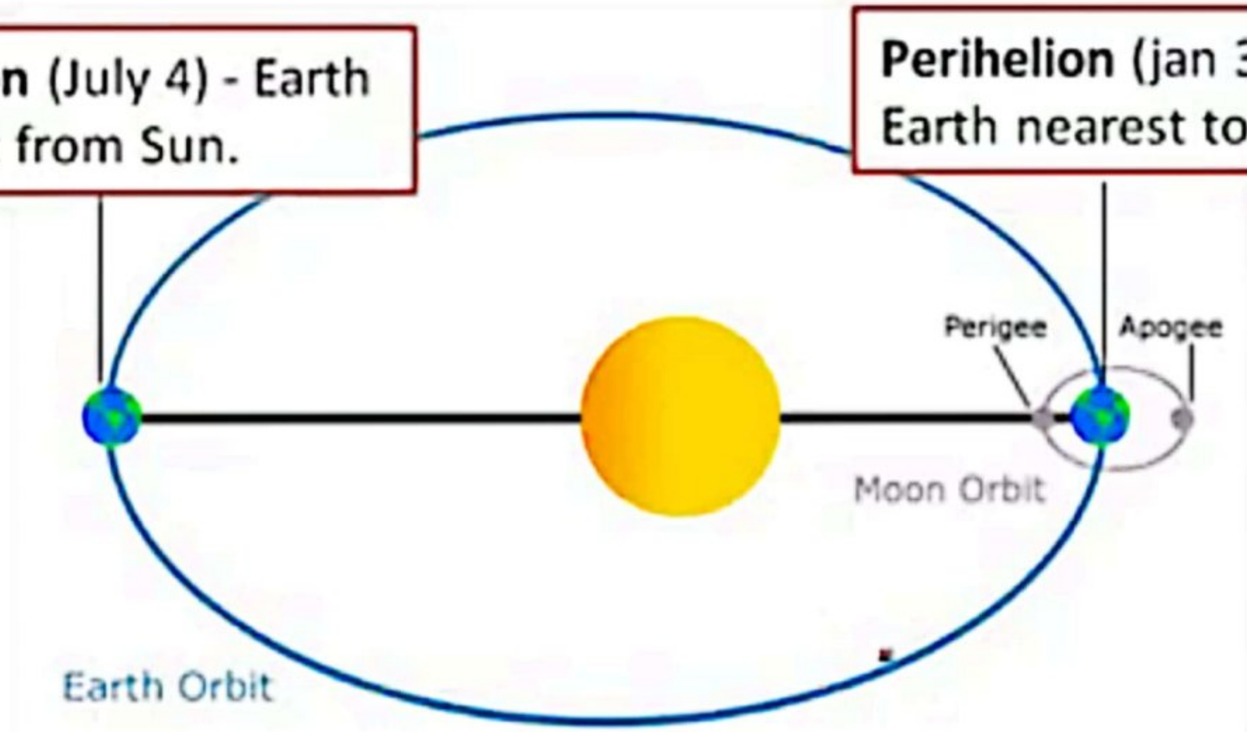
3. Distance between Earth and Sun

Changes during the course of year - Earth revolves in **elliptical path.**

But, in January - winter (N. Hemisphere).

So, **distance** between Earth and Sun - **doesn't matter much.**



Solar constant

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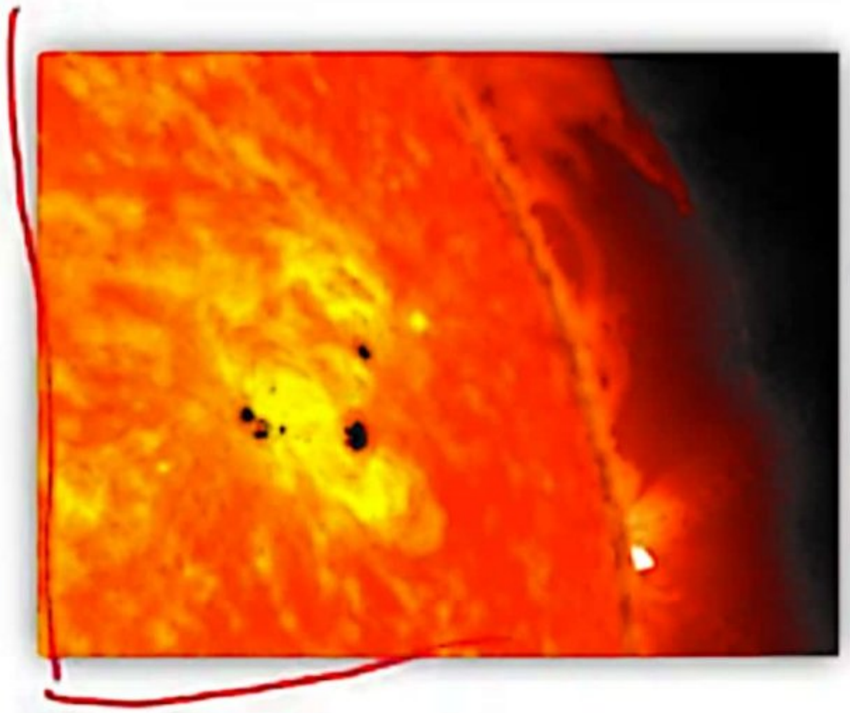
4. Sunspots

Created in **Solar outer surface** - periodic disturbances and explosions.

# of sunspots varies - year to year. (Variation - **cyclic** in nature(11 yr))

Solar energy radiated - **maximum** when solar spots number increases.



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5. Effects of Atmosphere

Electromagnetic solar radiation - **passes** through thick **layer** of **atmosphere.**

Partly **absorbed**, partly **reflected**, partly **scattered** → partly transmitted to earth surface.

Absorption

- If Total energy radiated from sun towards Earth = 100%.
- **14%** = absorbed by atmospheric gases (ozone, water vapour etc.)

Scattering

23% scattered by dust particles and haze.

6% - send back to **space.**

17% - reaches **earth surface**.

Scattering possible - dust particles suspended in air/ molecules of atmospheric gases - **shorter than the wavelength of solar radiation .**

Blue Light of incoming shorter wavelength is **more scattered** than **red** light.

Sky looks **blue** (more scattering).

Reddish Hue of sky - sunrise/ sunset - scattering of all colours except red/orange

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Reflection

Scattering by dust particles and water vapour molecules (called **diffused reflection**)

Send some portion of incoming solar energy **back to space**.
While some portion remains in **lower atmosphere.**

Some of scattered and diffuse solar energy - **reaches the ground surface.**

Diffused and scattered solar energy - Lower atmosphere enables us to see ;
Dark portion of moon
Pitch darkness of night

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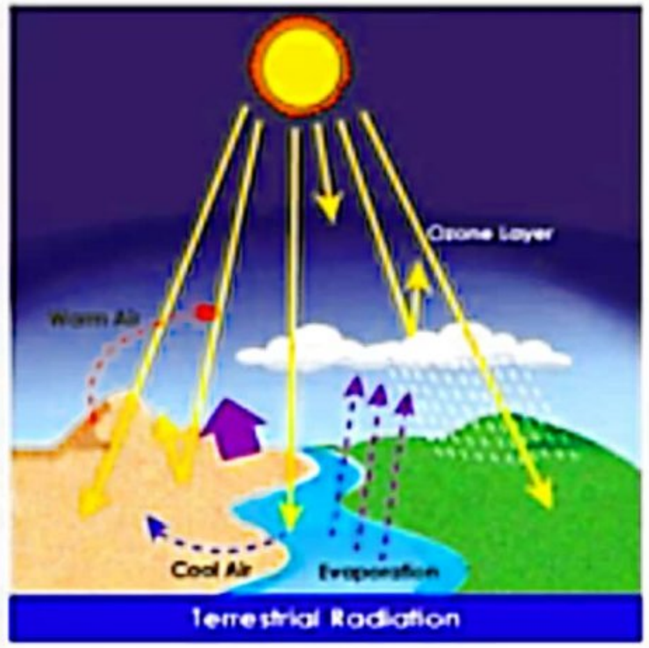
Some portion of incoming solar radiation - reflected back to space by high clouds (27%) , ice covered ground surface (2%) [**albedo**].

In **reality** process of absorption, scattering and Reflection are **very complex.**



Heat budget of the Earth

Balance between incoming **solar insolation** and outgoing **terrestrial radiation** .

Direct shortwave radiation (Heat Gain)

Diffused scattered radiation (Heat lost)

Maintains the **average annual temperature** of earth at **15 degree Celsius.**

1. **Incoming solar insolation**
2. **Outgoing terrestrial radiation**

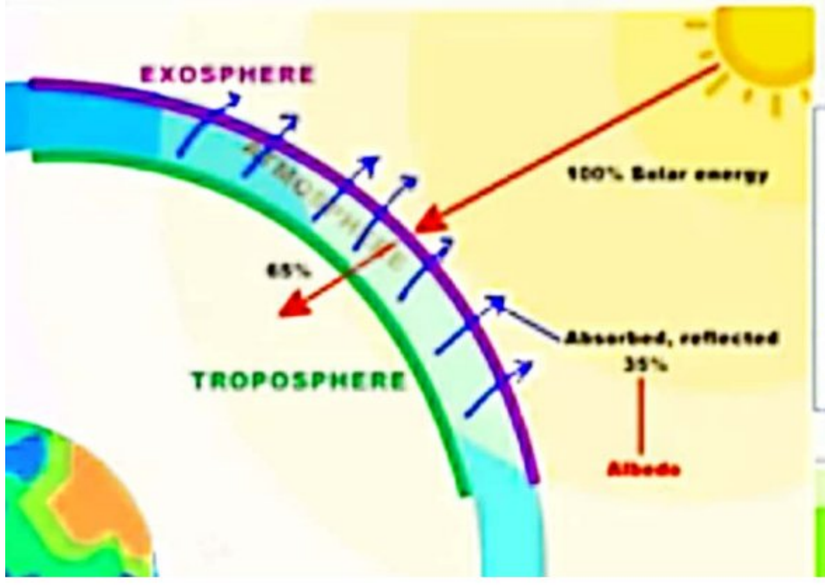
1. Incoming solar insolation

Solar energy radiated towards earth surface = 100 % (Say)

reflected by clouds = 27%
reflected by ground = 2%
scattered by dust particles = 6%

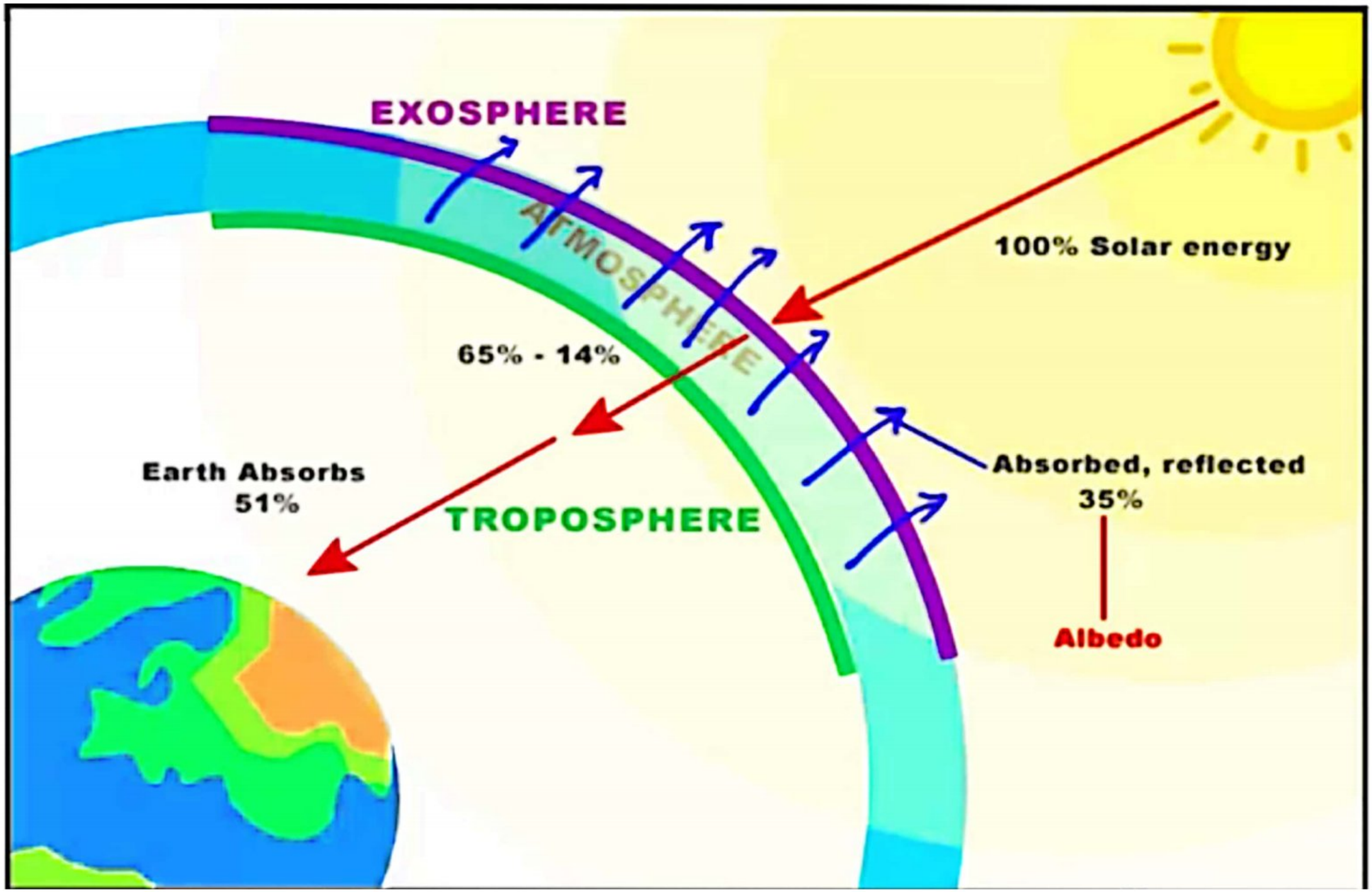
} 35%

Remaining solar energy = **65%**



51% = received by earth surface(direct radiation).

14% = absorbed by atmospheric gases (Ozone, oxygen etc.) & water vapour.



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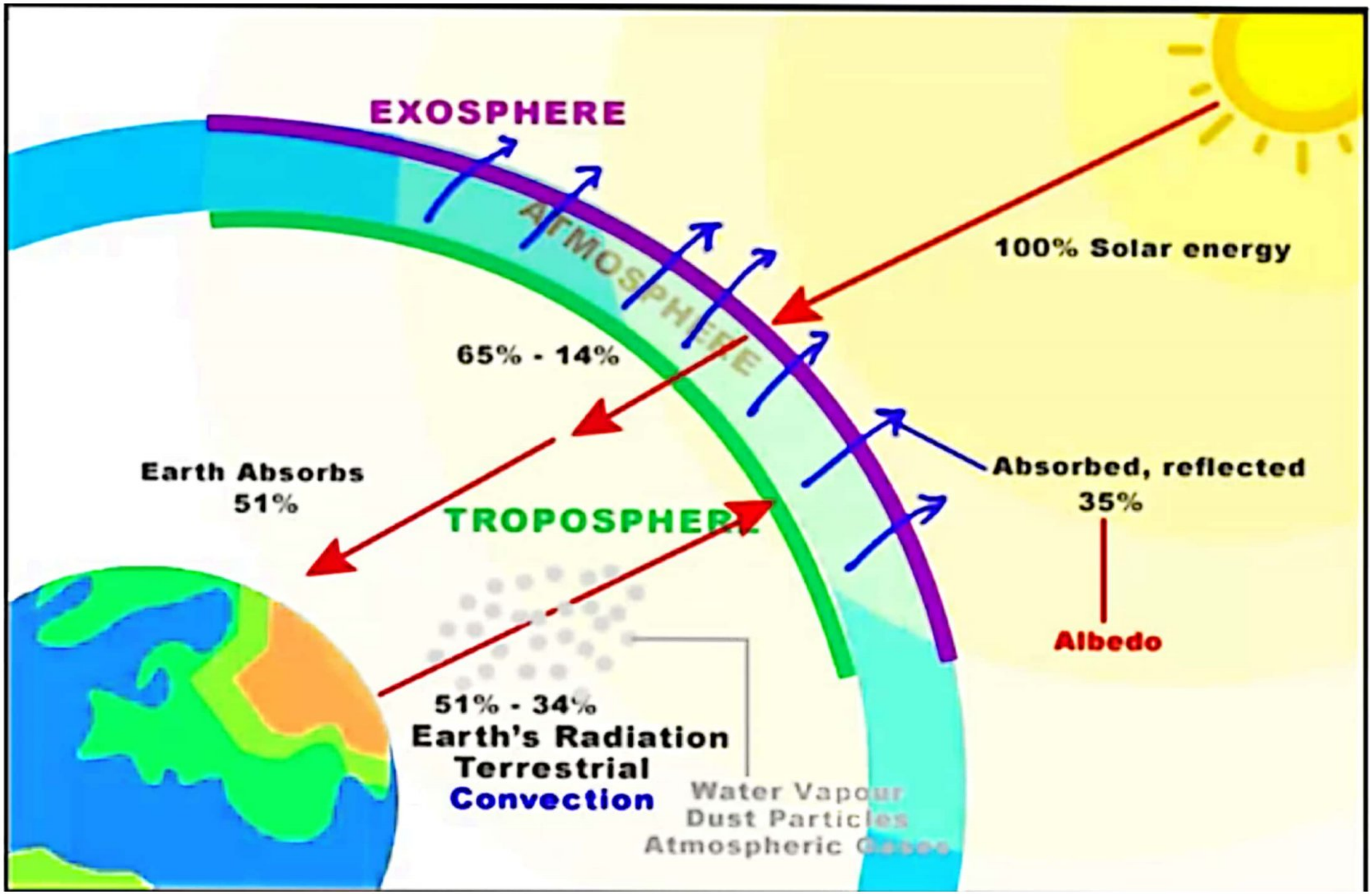

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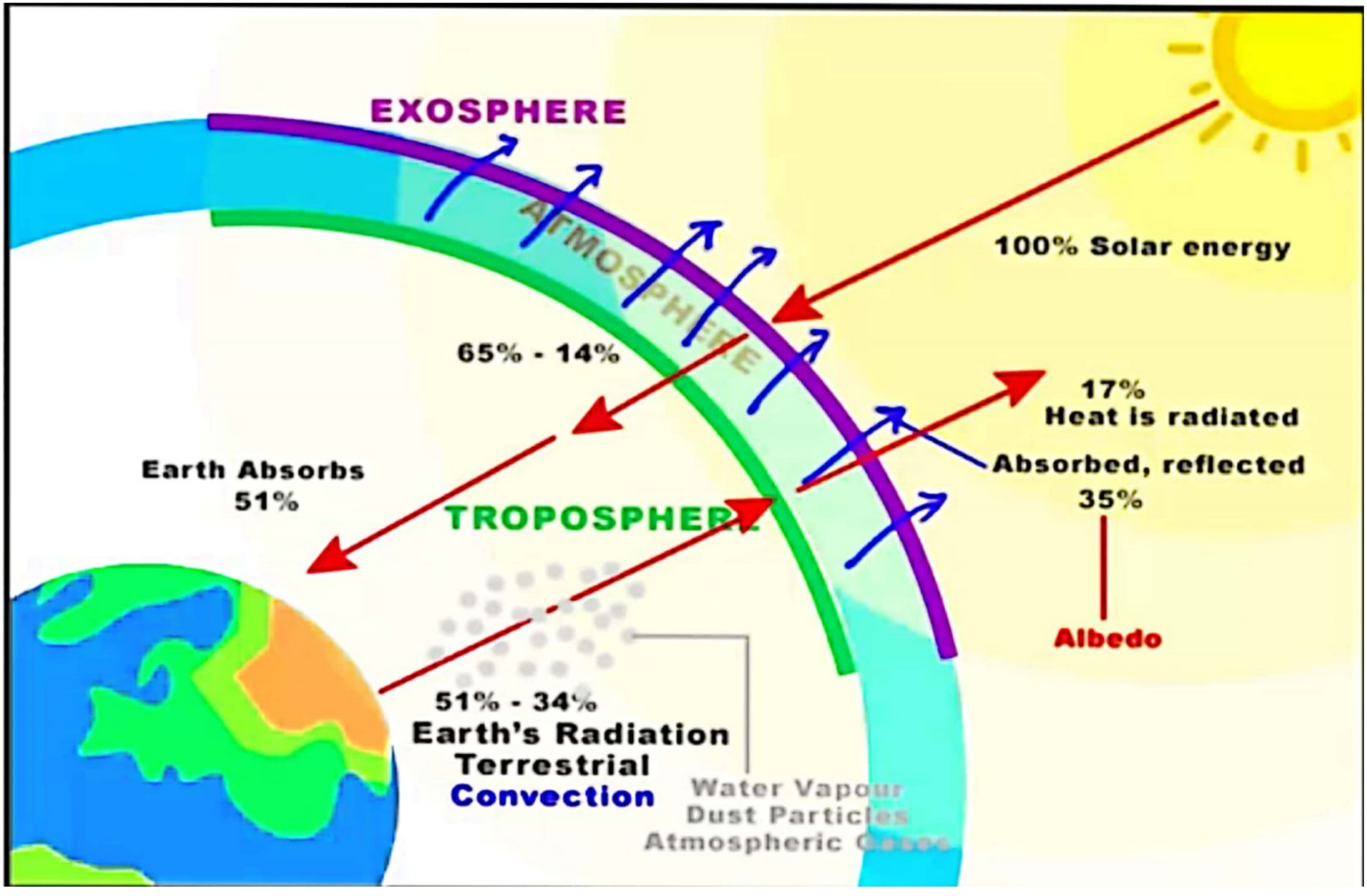

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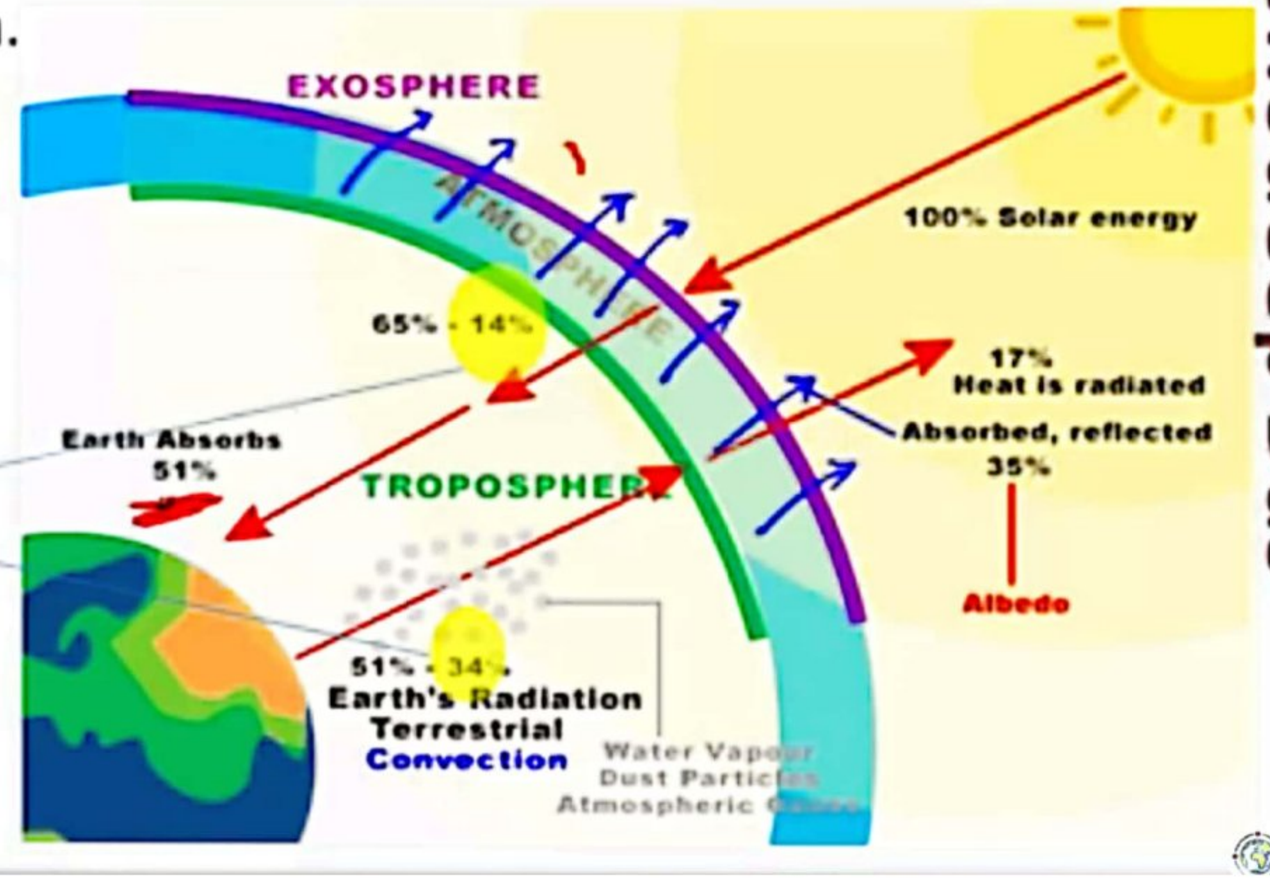
51%

- **34%** Direct solar radiation

- 17% Diffuse solar radiation.



48%

Also radiated back to space

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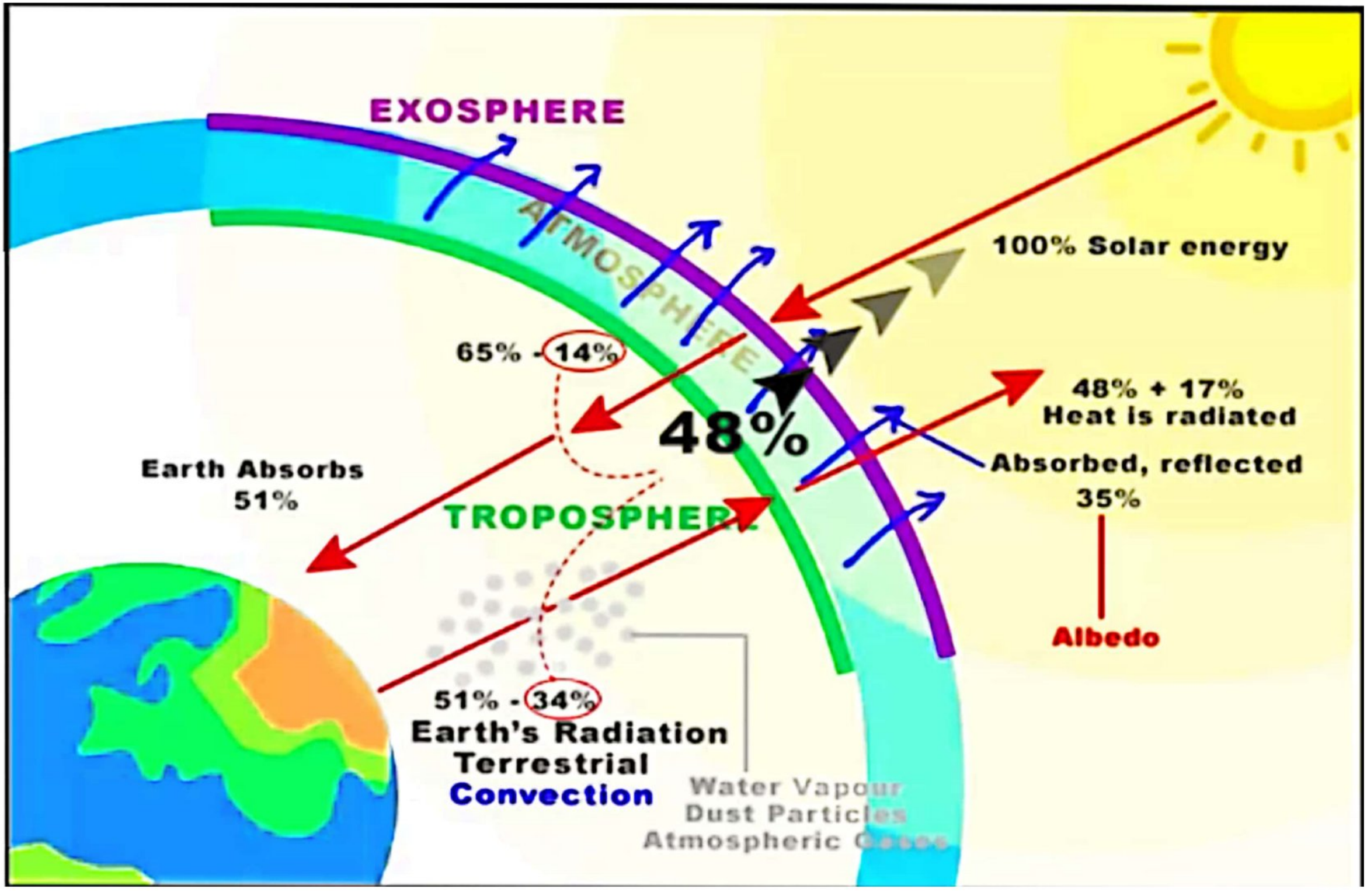

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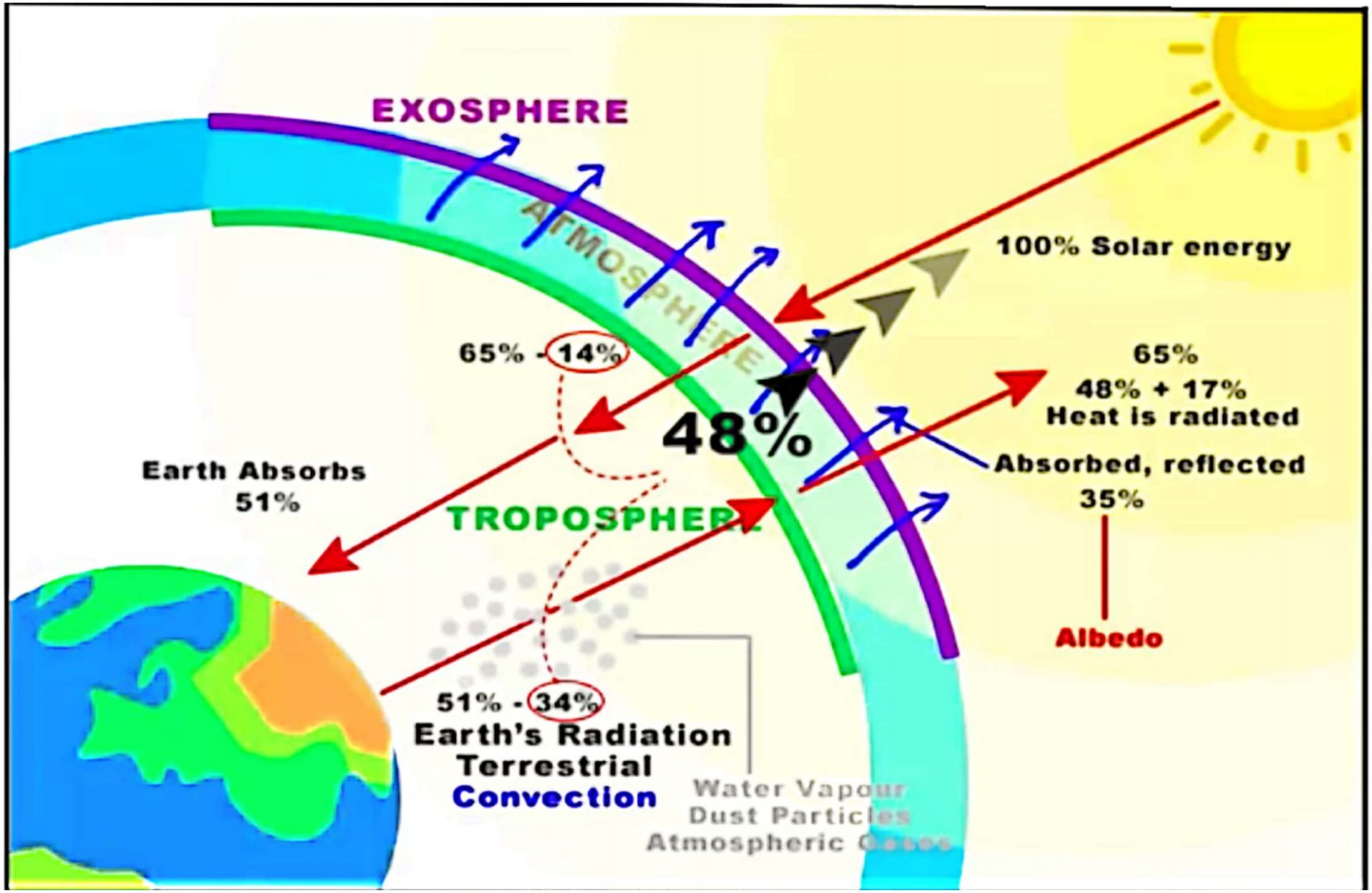

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