

ATMOSPHERIC ENERGY : THE HEAT BUDGET

COMPOSITION : Nitrogen 78%, Oxygen 21% Argon 1% and a minute % of Carbon Dioxide (CO₂), Ozone (O₃) and water vapour.

Atmospheric energy / Heat budget

INPUT The energy from the sun is called **Solar Radiation** or **Insolation**. The surface of the sun is at a temperature of 6000 C, causing the energy from it to be **Short Wave Radiation**. A set amount reaches the earth, the **Solar Constant**, about **2 cal/cm²/min**.

Only 45% of the sun's radiation is in the **visible spectrum**, there are also sizeable **ultra-violet** and **infra-red** elements.

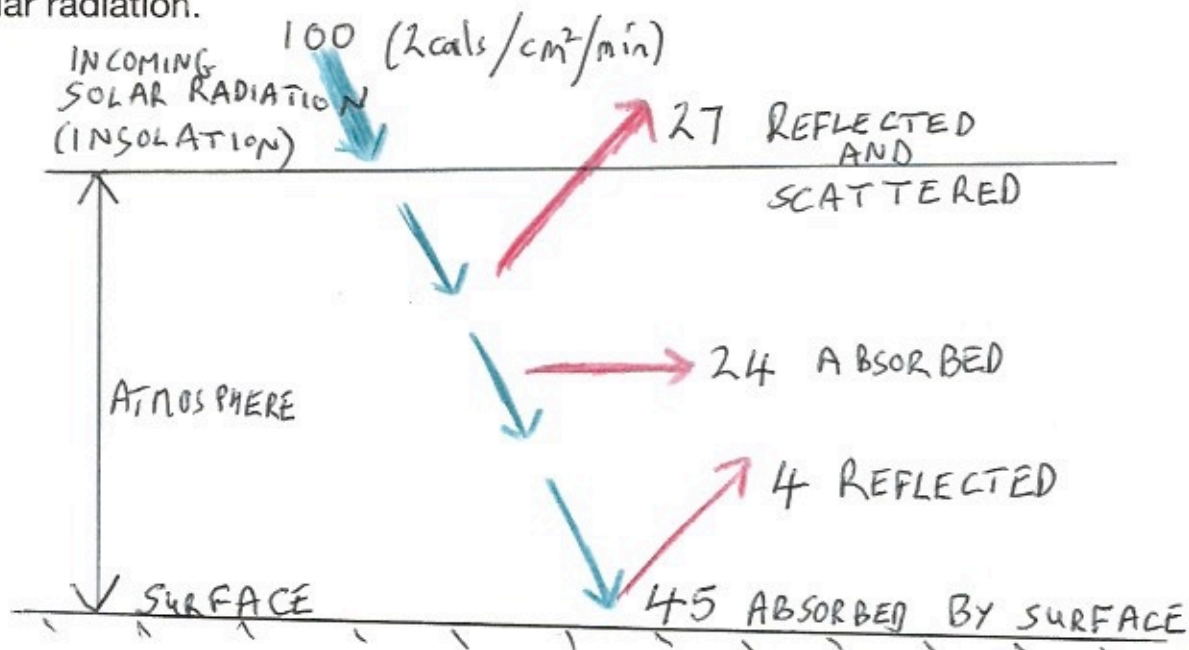
The Insolation from the sun must pass through the atmosphere to reach the earth. Approximately 27% is reflected and scattered back to space and around 4% is reflected by the surface.

The **Albedo** is the amount of the sun's energy reflected back by the earth and the atmosphere. This varies with the state of the atmosphere and the surface. Clouds = 50%, Forest = 7% and Desert about 35%

Up to 24% is absorbed by the atmosphere, by water vapour, Carbon Dioxide and Ozone (this cuts out much of the harmful ultra-violet radiation).

The shorter blue wavelengths tend to be scattered to give us a blue sky. When and why do you think the longer red wavelengths are scattered to give us a red sky?

Only 44% - 48% of the insolation from the sun is absorbed by the surface of the earth. Despite this the atmosphere is said to be relatively transparent to solar radiation.



OUTPUT The earth gives off the heat energy that it receives from the sun. Since the earth is much cooler than the sun (only around 15C) it emits **Long Wave Radiation** (day and night).

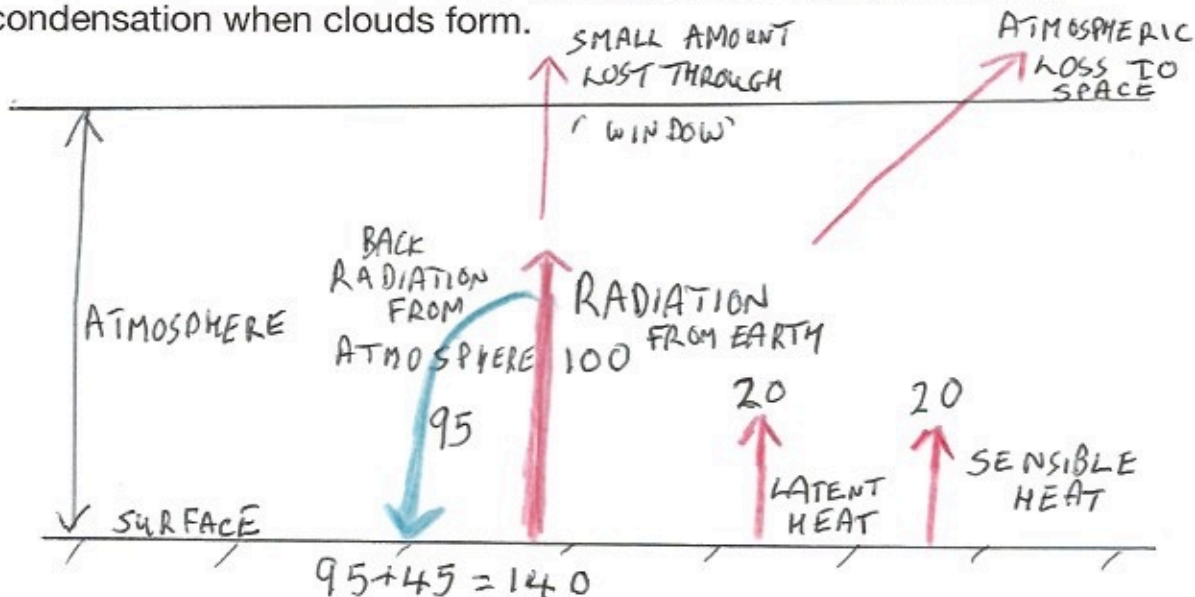
The atmosphere is less transparent to this long wave radiation and a great deal is **absorbed**. A small amount is lost to space through the **Radiation Window**, The wavelengths that are not easily absorbed. Cloud blocks a great deal of heat loss. What happens on a calm, clear night?

Conduction - heat is passed from the earth or the sea to the atmosphere.

Convection - and turbulence transfer heat up through the atmosphere.

Advection - transmits heat horizontally.

Latent Heat - Evaporation takes the latent heat of vaporisation from water surfaces and releases it into the atmosphere as the latent heat of condensation when clouds form.



This gain and loss of heat energy in the earth / atmosphere system is called the **Heat Budget**. In the short to medium term it is in **balance**.

The trapping of outgoing heat energy by the atmosphere (especially by carbon dioxide, methane and water vapour) is called the **Greenhouse Effect**. Incoming short wave radiation gets in, but much of the outgoing long wave radiation cannot get out and is retained.

This greenhouse effect allows a **global balance** of incoming and outgoing heat, the heat budget, and over short and medium terms the earth/ atmosphere system retains a fairly constant temperature. Over the longer term global temperature may vary, producing colder period called **ice ages** or even hotter periods. We have put more methane and carbon dioxide (greenhouse gases) into the atmosphere in recent time causing **Global Warming**.