# 4. Greenhouse gases as regulator of the earth's temperature

What influence do greenhouse gases have on the Earth's temperature?

The radiation power of the sun at the upper edge of the atmosphere at perpendicular irradiation is about 1366 W/m², the so called solar constant. However, since only half of the earth is illuminated by the sun and it has a spherical shape, it is only illuminated by an average of **340 W/m²** (watts per m²) . Approx. 30% of the solar radiation is reflected e.g. by ice surfaces and white clouds in the direction of space. The remaining energy of **238 W/m** is then absorbed by the ground and re-radiated in form of invisible heat radiation (in the infrared spectrum). The amount of radiated energy is equal to the amount of radiated energy - the earth is in radiation equilibrium!
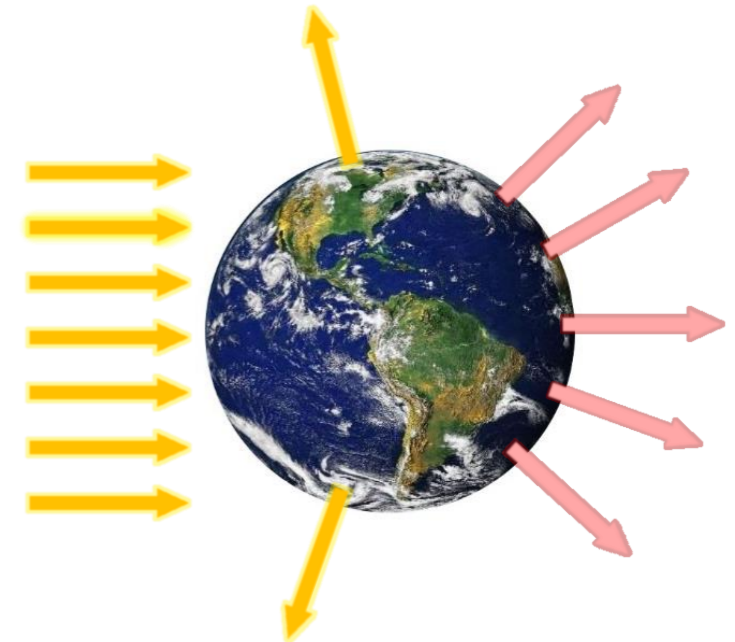
Unsere Frage lautet: Welche Temperatur hätte eine Erde ohne Atmosphäre und im Strahlungsgleichgewicht ?

$$S = \sigma \cdot T^4$$

The answer is provided by **the Stefan-Boltzmann law**, which describes how much energy a body radiates per m² of its surface area per second at a certain temperature T. This law can be represented in diagram form (right). There we can read, for example, that boiling water emits a radiation intensity of 1100 W/m².

Representation of the Stefan-Boltzmann Law in a diagram.
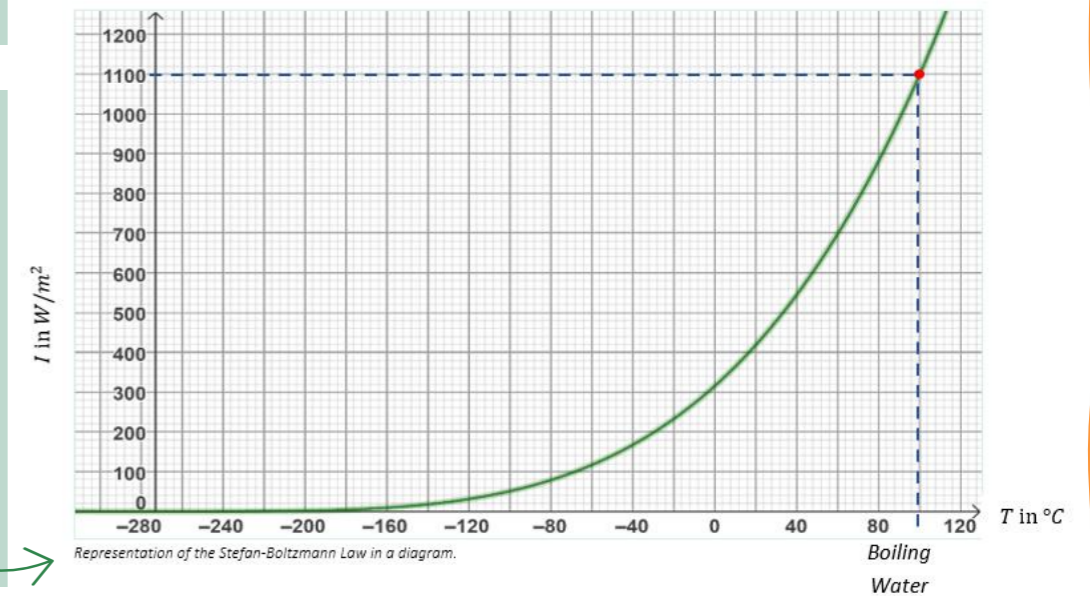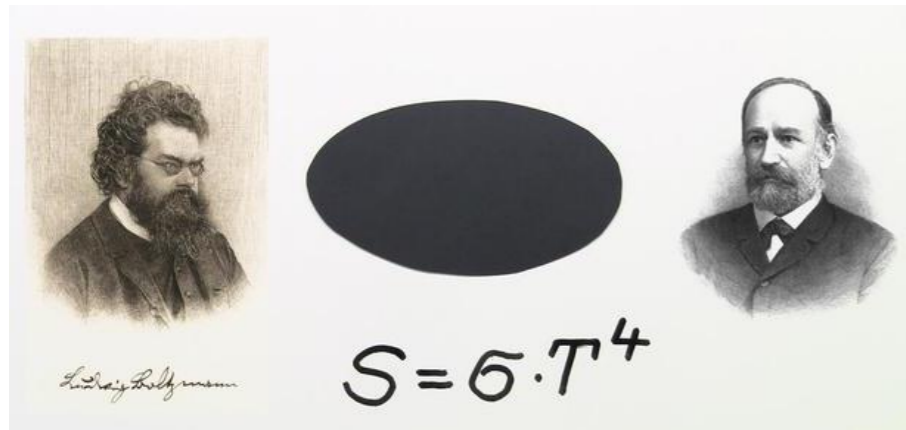
We can now determine the temperature of the earth in radiation equilibrium and without atmosphere in the diagram: It would be very cold! According to the diagram **-18°C**! Without atmosphere the earth would be a white ice ball! But earth is a beautiful planet with an average temperature of **15°C**! Where does this difference come from? It is proved that the heat radiation of the earth's surface is not completely radiated into space, but is absorbed by the hothouse lanes of the earth's atmosphere to 76 % and is radiated again evenly in all directions - approx. half in the direction of the universe, the other half in the direction of the earth's surface. The latter provides a difference of 33 °C and much more heat!