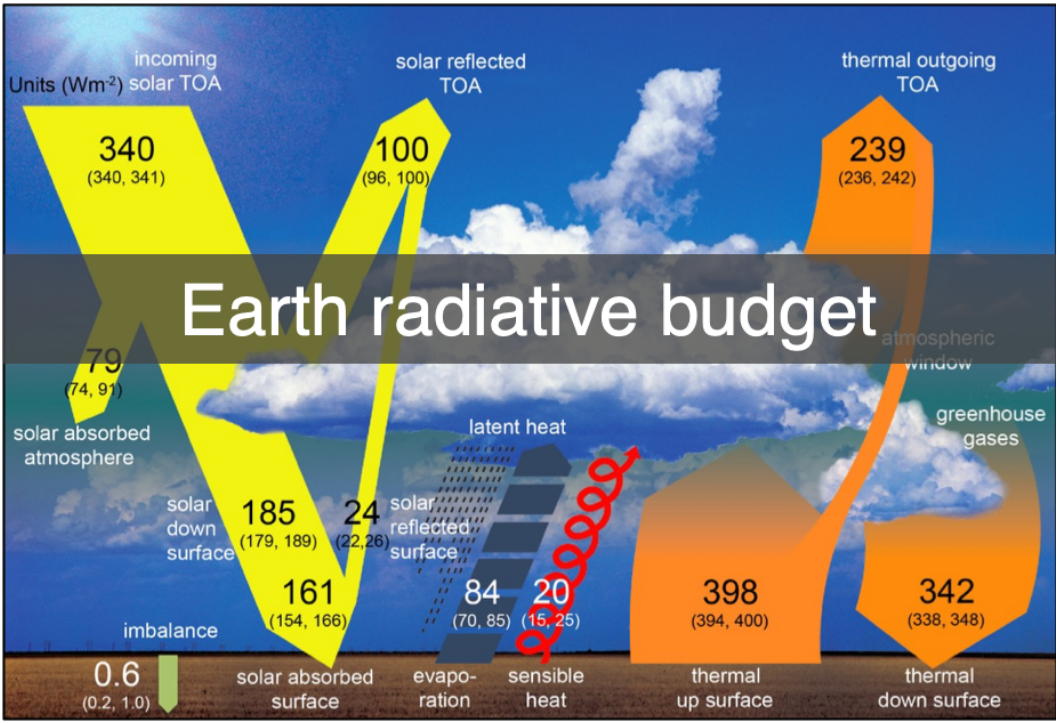
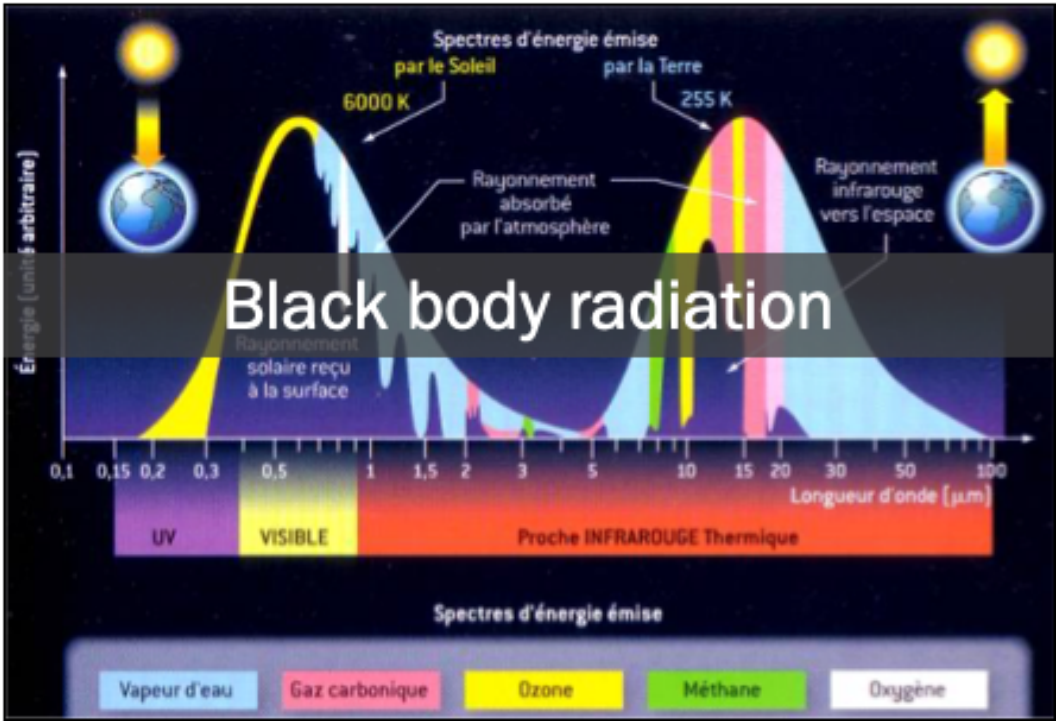

Units (Wm^{-2})
incoming solar TOA
340
(340, 341)
solar reflected TOA
100
(96, 100)
thermal outgoing TOA
239
(236, 242)
Earth radiative budget
79
(74, 91)
solar absorbed atmosphere
atmospheric window
greenhouse gases
latent heat
solar down surface
185
(179, 189)
24
(22,26)
solar reflected surface
161
(154, 166)
84
(70, 85)
20
(15, 25)
398
(394, 400)
342
(338, 348)
imbalance
0.6
(0.2, 1.0)
solar absorbed surface
evapo-ration
sensible heat
thermal up surface
thermal down surface

Earth radiative budget

The sun irradiates the Earth with an average flux of 340 W/m2 in the visible range. Part of this radiation is reflected (albedo of 30%), the other part warms the Earth which then emits infrared radiation.

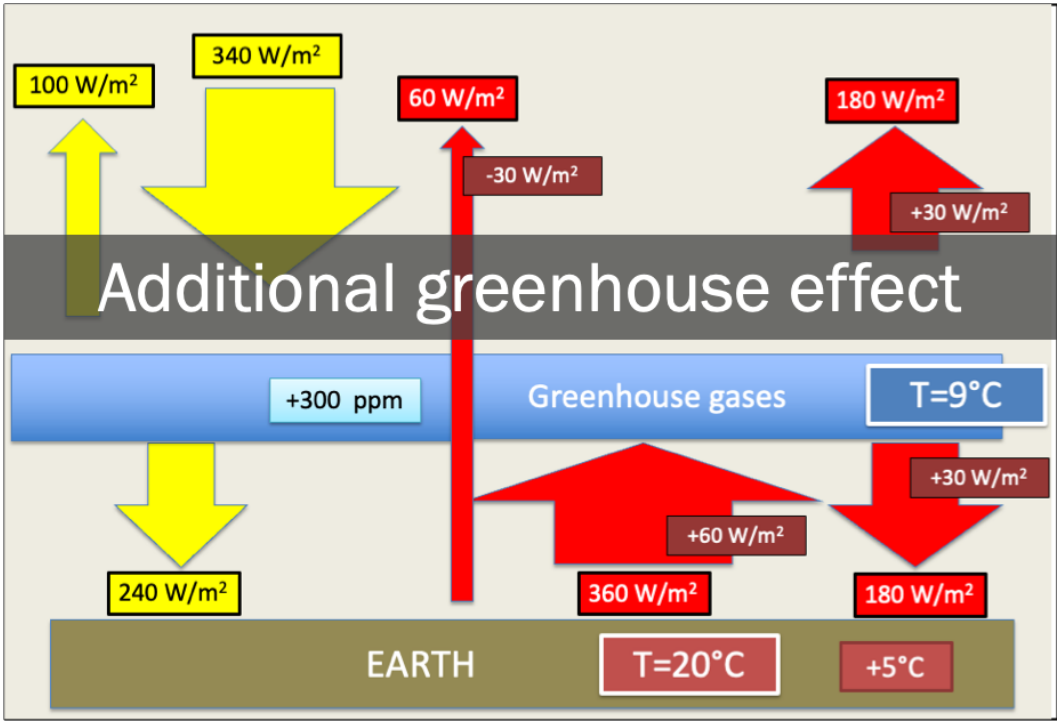
Part of this radiation is absorbed by greenhouse gases and re-emitted towards the ground.


Spectres d'énergie émise
par le Soleil
6000 K
par la Terre
255 K
Rayonnement
absorbé
par l'atmosphère
Rayonnement
infrarouge
vers l'espace
Énergie (unités arbitraire)
Black body radiation
Rayonnement
solaire reçu
à la surface
0,1 0,15 0,2 0,3 0,5 1 1,5 2 3 5 10 15 20 30 50 100
Longueur d'onde (µm)
UV
VISIBLE
Proche INFRAROUGE Thermique
Spectres d'énergie émise
Vapeur d'eau
Gaz carbonique
Ozone
Méthane
Oxygène

Black body radiation

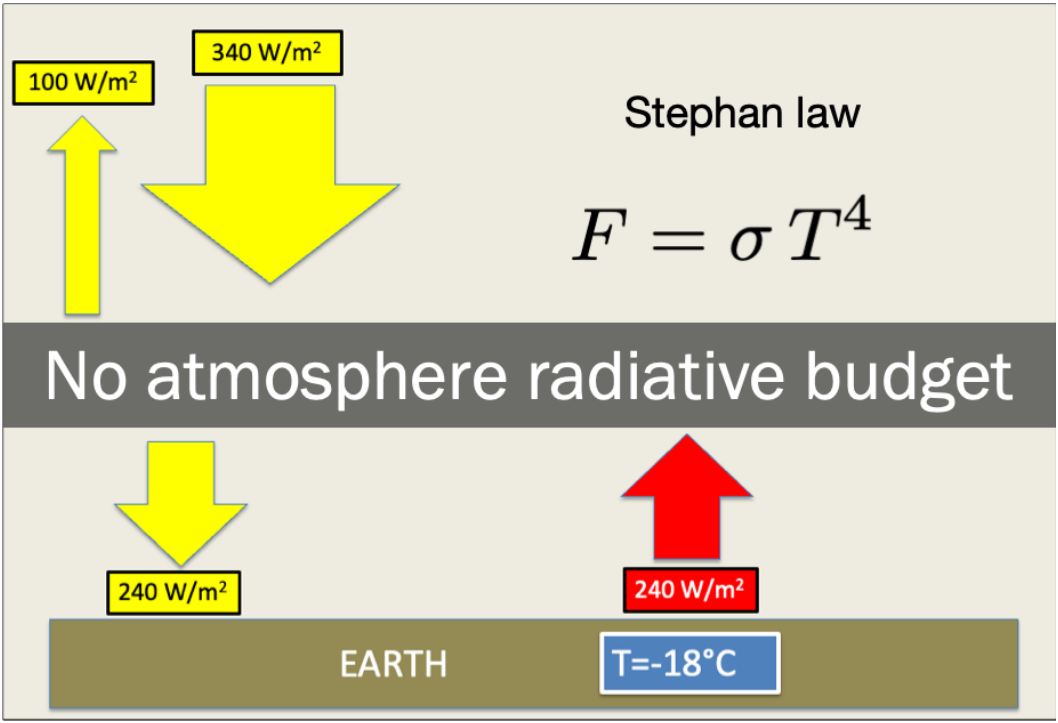
A body emits a spectrum of electromagnetic waves that depends on its temperature.

The Sun (6000 °K) emits in the visible spectrum. The Earth (288°K) emits in the infrared spectrum.


100 W/m²
340 W/m²
60 W/m²
-30 W/m²
180 W/m²
+30 W/m²
Additional greenhouse effect
+300 ppm
Greenhouse gases
T=9°C
+30 W/m²
+60 W/m²
240 W/m²
360 W/m²
180 W/m²
EARTH
T=20°C
+5°C

Additional greenhouse effect

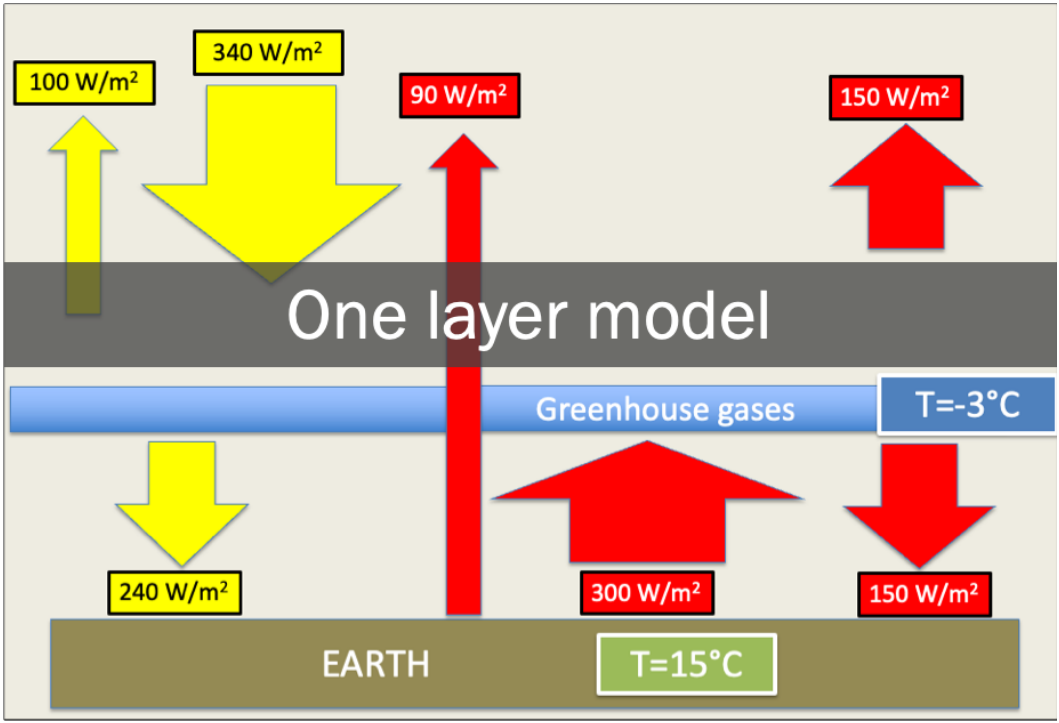
If the concentration of greenhouse gases increases, more of the Earth's infrared radiation is re-emitted to the ground. The temperature rises to reach a new equilibrium in the radiation balance between the incident solar flux and the infrared flux sent to space.


100 W/m²
340 W/m²
Stephan law
$F = \sigma T^4$
No atmosphere radiative budget
240 W/m²
240 W/m²
EARTH
T=-18°C

No atmosphere radiative budget

In the absence of an atmosphere, the Earth's temperature would be T=255°K according to Stephan's law for black bodies.

The solar radiation absorbed by the Earth (240 W/m2) is re-emitted as infrared radiation.


100 W/m²
340 W/m²
90 W/m²
150 W/m²
One layer model
Greenhouse gases
T=-3°C
240 W/m²
300 W/m²
150 W/m²
EARTH
T=15°C

One-layer model

In this simplistic model, much of the Earth's infrared radiation is absorbed by greenhouse gases and then re-emitted in equal amounts to the ground and to space.

The ground temperature is warmer for this balance.

Active Multimedia Conference

Université Fédérale Toulouse Midi-Pyrénées

INP N7

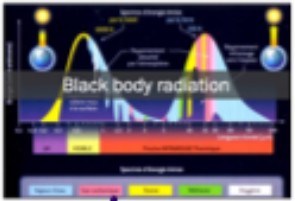
Climate PBL

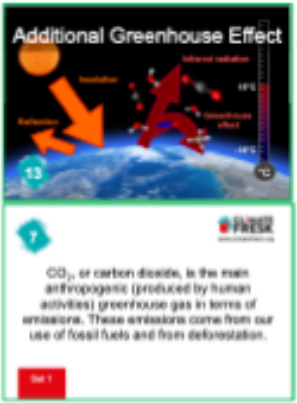
Mini-fresk based on the concept of serious games:

CL!MATE FRESK

Additional greenhouse effect

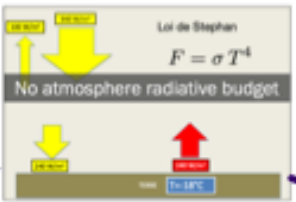
This mini-fresk describes the greenhouse effect and the warming of the Earth due to the increase in greenhouse gases.

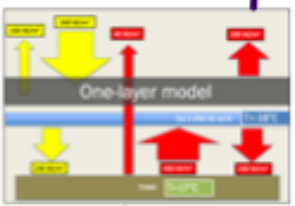

Black body radiation

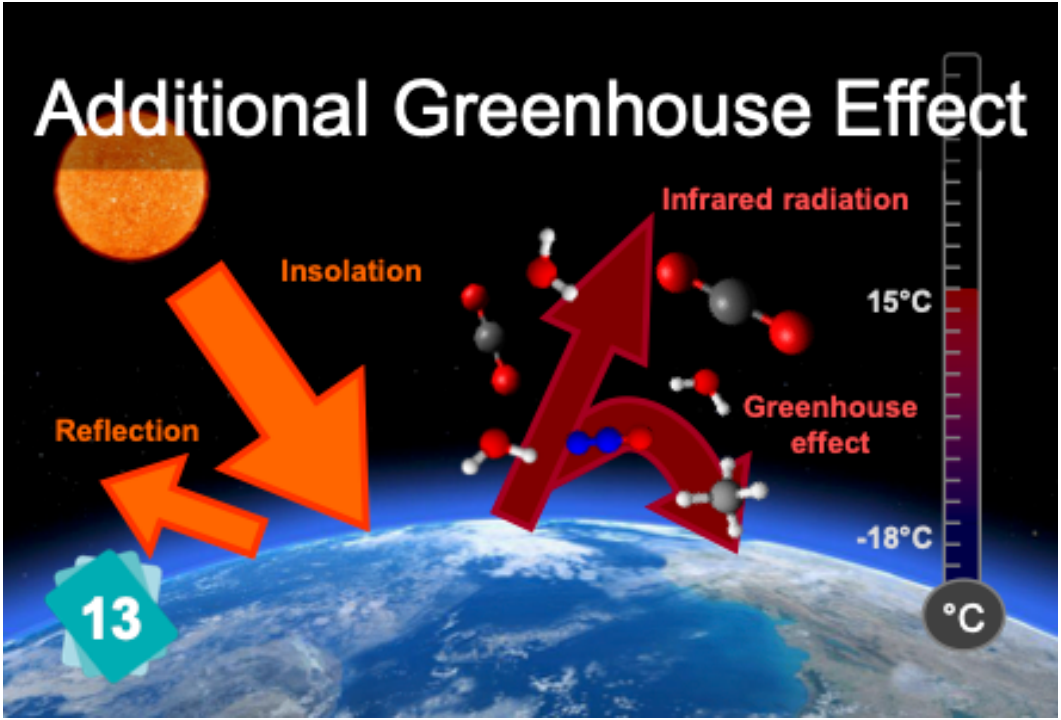

Additional Greenhouse Effect
Insolation
Reflection
Infrared radiation
Greenhouse effect
13
7
CO_2, or carbon dioxide, is the main anthropogenic (produced by human activities) greenhouse gas in terms of emissions. These emissions come from our use of fossil fuels and from deforestation.
Set 1


Additional greenhouse effect


Earth radiative budget


Loi de Stephan
$F = \sigma T^4$
No atmosphere radiative budget


One-layer model


Additional Greenhouse Effect
Infrared radiation
Insolation
15°C
Greenhouse effect
Reflection
-18°C
°C
13

13

CLIMATE FRESK
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The greenhouse effect is a natural phenomenon - incidentally, the most common GHG is water vapour. Without the greenhouse effect, the planet would be 33°C colder and life as we know it would not be possible.
But CO_2 and other GHGs related to human activities amplify the greenhouse effect and unbalance the climate.

Set 1