

Physics and Greenhouse Effect

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Kill a beaver – save a tree
– Environmental wisdom

Introduction

Did you hear anything about global warming? Sure you did! It's everywhere – radio, TV, internet, you name it. The idea is very simple, give us your money and we will save the planet. And new term “decarbonization”, I am very afraid of it, just because I am carbon based form of life.

Unfortunately, every publication related to global warming is just very emotional thing, without any trace of science. Consider this short article as my attempt to fill the gap between “warming” and “science”.

Greenhouse Effect

Greenhouse effect is fairly simple. The sun heat the Earth. The Earth radiate energy back to space. If we put some so called greenhouse gas on the way of energy outflow, then some part of energy will be absorbed by such gas. Part of absorbed energy radiated back to surface and warming it. The surface temperature rise until the energy of upward radiation balance this additional portion of downward energy. And the Earth get more energy than Sun sending to us.

Equilibrium

What I can't understand is the following. Imagine the Earth without greenhouse gases in atmosphere. The planet is in perfect equilibrium. The energy absorbed by the planet equals to the energy emitted.

Now let's add CO₂ in the atmosphere. The temperature will rise and so emitted radiation. We have a situation when emitted radiation is bigger than radiation absorbed by the planet.

Sun's Energy

The power density at the surface of the Sun could be estimated using Stefan-Boltzmann equation:

$$P_S = \sigma T^4 \quad (1)$$

where σ is Stefan-Boltzmann constant equals to 5.67×10^{-8} and T is the temperature of the Sun equals to 5800K. After calculation:

$$P_S \approx 63 \times 10^6 \text{ W} \cdot \text{m}^{-2} \quad (2)$$

This is the power density at the surface of the Sun. In the vicinity of Earth the power will be spread over the surface of the sphere with radius equals to the average distance from Sun to Earth.

$$4\pi R_S^2 P_S = 4\pi R_E^2 P_E \quad (3)$$

where R_S is the radius of the Sun (700 thousand kilometers), R_E is the orbital radius of the Earth (150 million kilometers) and P_E is power density at the Earth orbit. So:

$$P_E = P_S \frac{R_S^2}{R_E^2} \approx 1370 \text{ W} \cdot \text{m}^{-2} \quad (4)$$

Calculated data completely corresponds to the accepted theory.

The radiation from the Sun hit the surface of the Earth at different angles and in order to calculate the whole power at the Earth surface we should use “shadow” area of the Earth.

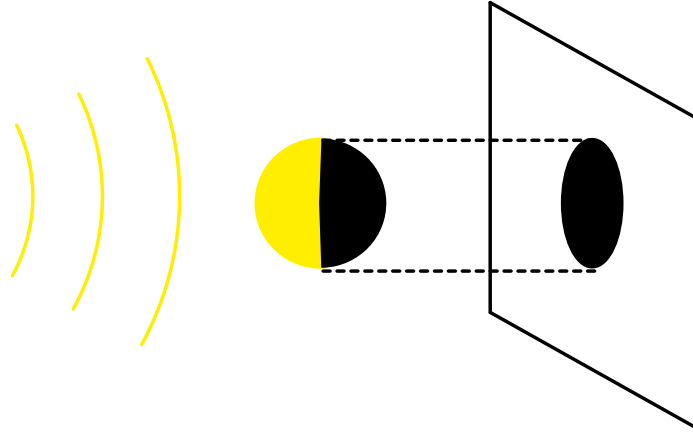


Fig.1 Shadow area = πr^2

The albedo of the planet Earth equals to 0.3 and only 0.7 of the incoming power will reach the surface.

And the total incident power will be:

$$P_I = 0.7 P_E \pi r^2 \approx 1.22 \times 10^{17} \text{ W} \quad (5)$$

Emission

The same amount of power is radiated by the Earth surface since the system is in equilibrium.

The equivalent temperature of the Earth could be also calculated from Stefan-Boltzman equation (1). To obtain power density, total power (5) should be divided by the whole surface of the Earth ($4\pi r^2$).

$$P_{rad} = \frac{P_I}{4\pi r^2} \approx 240 \text{ W}\cdot\text{m}^{-2} \quad (6)$$

And the Earth temperature according to (1) will be 255K (-18C). This value also match the current theory.

Theoretical value for the Earth temperature not matched to the average Earth temperature observable from space. The observable temperature is 288K (+15C). We will try to make following estimation using both temperature values.

IR Spectrum

Energy emitted from the Earth surface going through Earth's atmosphere, which contained carbon dioxide, the greenhouse gas.

What makes this gas greenhouse is its ability to absorb IR radiation. Below is IR transmittance spectrum of carbon dioxide from [NIST website](#):

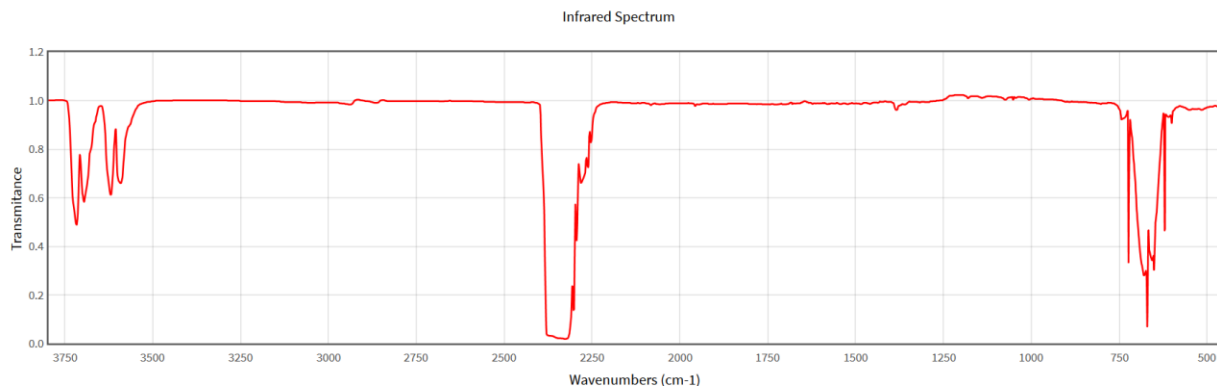


Fig.2 IR transmittance spectrum of carbon dioxide

Please note that carbon dioxide only could absorb radiation in very narrow band. It is absolutely transparent for all other wavelengths.

Blackbody Radiation

The energy emitted by Earth surface distributed according to wavelength. The relationship is given by Planck law:

$$B(\lambda, T) = \frac{2hc^2}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda kT}} - 1} \quad (7)$$

The graph of this relationship is shown below:

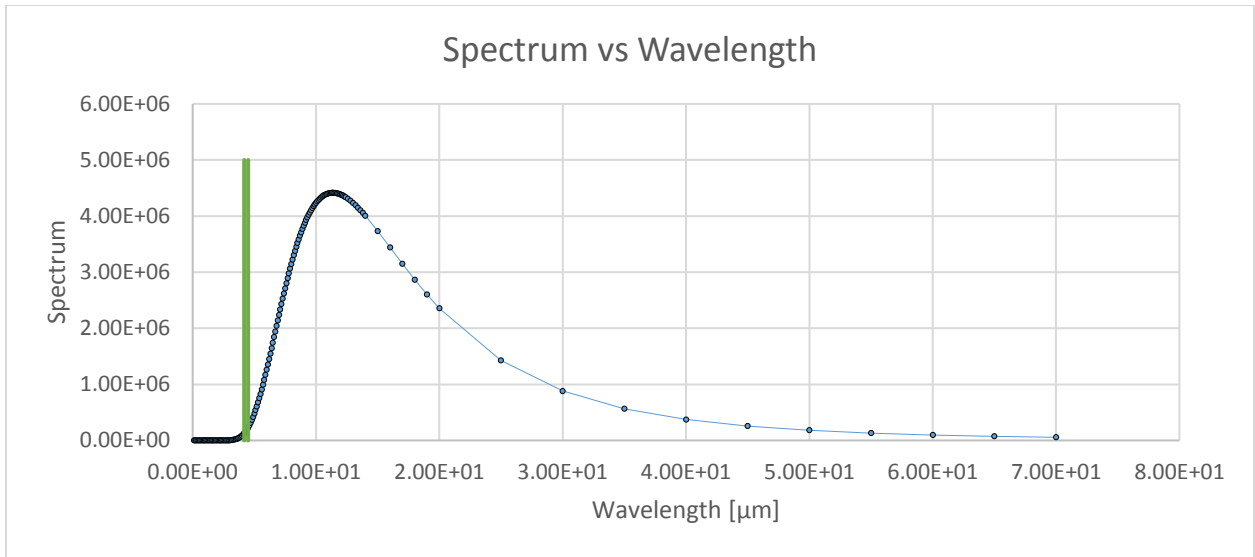


Fig.3 Blackbody radiation vs wavelength at 255K

Green area shows absorbance interval of carbon dioxide. Not every energy will be reemitted, but only energies which belong to this interval. Half of this energy will be returned back to surface.

Integration was done in Excel. The part of incoming radiation that will be returned back to Earth surface is as follow:

- 0.04% for 255K
- 0.1% for 288K

Just for comparison – insolation of the Earth vary between aphelion and perihelion by about 6.8%.

Climate Science

According to **Fig.3** and followed calculations, the small part of energy (well below 1%) is returned to Earth by greenhouses re-emission. Let's take a look on atmospheric balance according to [climate guys](#):

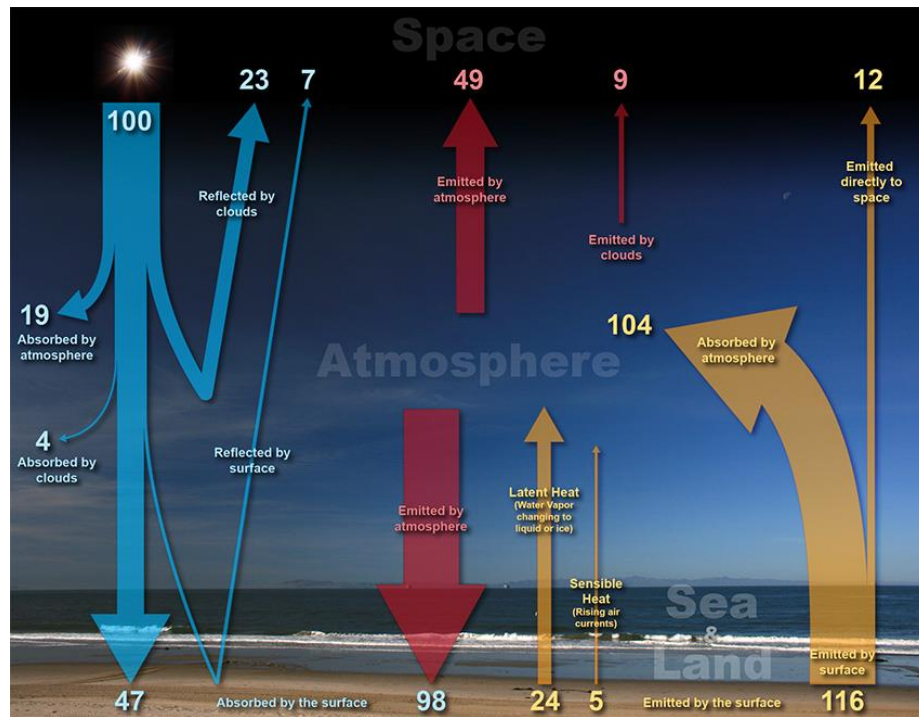


Fig.4 Earth energy balance

Almost identical picture could be found on [NASA website](#).

You could see that from 116 units emitted by surface, 104 was absorbed by atmosphere. Big contradiction to our finding of 0.1%!

It also everywhere in the literature, that greenhouse gases re-emit absorbed energy in all direction. Why do we have terrible imbalance on **Fig.4** between up and down direction for atmospheric emission?

Did anybody noticed that **Fig.4** looks exactly as *perpetuum mobile*? Indeed, we have 100 units of energy from the source (Sun), but inflow to Earth surface equals to 145 units!

The situation looks exactly the following:

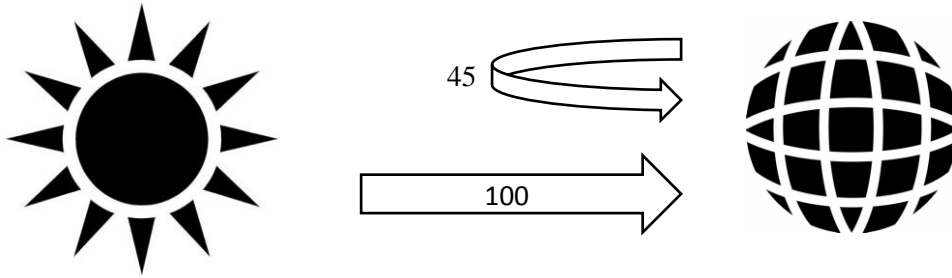


Fig.5 Another energy balance

You could see from above picture that number 45 had been subtracted and added back to the Earth's surface balance. Plus number, minus number and total balance was unchanged, but the surface received now 145 units instead of 100! No wonder we have global warming. If you change 45 number to 1000, you'll get global cooking.

It is also absolutely not clear how the heat from a cold body (atmosphere) is transferred to a warmer body (Earth surface).

You could easily see energy conservation law breaking in above figures. The energy received by Earth could not exceed incoming energy!

I have free idea for solar cell manufacturers. Just inject carbon dioxide inside solar cell and you will get 200% of efficiency!

Stefan-Boltzmann vs Domestic Sun

For climate modeling and heat flux calculation Stefan-Boltzmann formula (1) is the only source for energy estimation.

Could we rely on this formula? Not really. I am going to demonstrate my skepticism on the example of our domestic sun and it is here, on Earth, much closer than we are thinking.

The inner core of the Earth is that sun. It is obvious that heat flux from Earth's inner core does not accumulates somewhere in the middle, for billions years of Earth existence every layer of Earth should already be at equilibrium.

The parameters of inner core are the following:

- The surface temperature is 5700K
- Radius is 1220 km

Using Stefan-Boltzmann equation (1) we have:

$$P_{Core} = \sigma T^4 \approx 59.8 \times 10^6 \text{ W}\cdot\text{m}^{-2} \quad (8)$$

The result is very close to one from the Sun because the temperatures are almost the same.

Remember how we calculated the power density from the Sun (4). It's the ration of radii squared. Mean diameter of the Earth is 6370 km and we have:

$$P_{Earth} = P_{Core} \frac{R_{Core}^2}{R_{Earth}^2} \approx 2195448 \text{ W}\cdot\text{m}^{-2} \quad (9)$$

The Earth surface has heat from down under 6000 times more compare to the heat from the Sun! Who cares about carbon dioxide and radiative forcing from greenhouse gases? We don't even need the Sun itself.

Conclusion

The calculations using Stefan-Boltzmann formula are not correspond to reality. Based on this formula heat flow from Earth's inner core almost 6000 times more compare to one from the Sun.

Carbon dioxide re-emission could not contribute more that 0.1% of absorbed energy.

Carbon dioxide could not be the source of global warming.