Greenhouse versus living room model

Sjaak Uitterdijk
sjaakenlutske@hetnet.nl

Summary- Measurements and registrations indicate that the increase in global temperature is already during 150 years equal to 0,05 °C with every increase of 1 TeraWatt (~30 ExaJoule/year) worldwide generated power. This article describes the thermo dynamical research regarding the possibility of a direct increase of global temperature as a result of the power generated by mankind's activities. Indicative calculations show that such a scenario should not be excluded on beforehand. Moreover: the greenhouse model is eventually such an intricate one that irrefutable evidences regarding its validity are not given yet. The importance of the possible validity of the living room model, as introduced in this article, is that present measurements to reduce CO_2 *emissions might be fully irrelevant. Eventually, whichever model might be the correct one, the most fundamental reason for the increasing global temperature is the explosively growing world population.*

Introduction

In this article, the global energy consumption will be translated into *direct* heat developments. With simple indicative thermodynamic calculations it is made plausible that direct, without the intervention of CO_2, heat developments could be the explanation for the increase in global temperature. That could mean that not the greenhouse effect causes the increase in global temperatures, but the direct heating of the atmosphere and thus of the earth's surface.

The energy consumption by mankind's activities

In [2], it is reasoned that the curve-fitting of the registered worldwide energy consumption, as shown in fig. 5 in [2] (copied in fig. 1 below), most likely corresponds to the actual consumption.

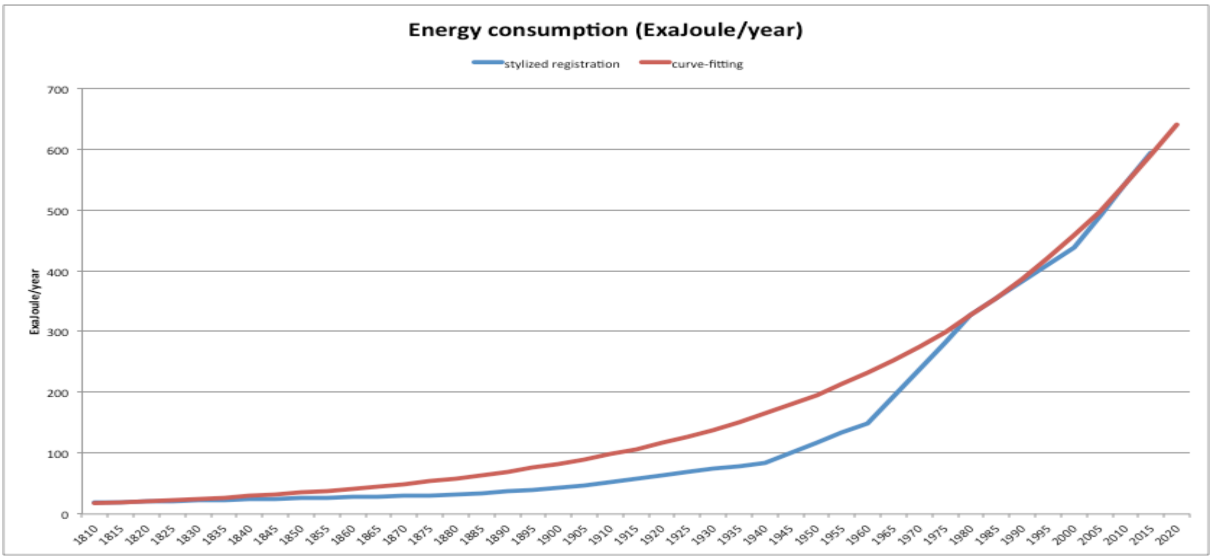


Figure 1. Worldwide energy consumption from 1810 to 2010/2020

In [2] it is also shown that at least during 150 years the increase in global temperature is 0.05 °C per each TeraWatt power generated by mankind's activities. (*1 TeraWatt ~30 ExaJoule/year)*

Because each Joule consumed energy is eventually converted into heat, hereinafter is examined, supported by thermo-dynamic calculations, if this energy consumption can lead *directly* to the measured increase in global temperature.

The concept of heat transfer

There are three types of heat transfer, wherein each heat transfer is shown by the letter Φ and the dimension W/m^2, being a heat power density.

Conduction **$\Phi = \lambda \Delta T/\Delta x$**

Conduction is heat transfer within the substance, in which heat flows from particles with higher kinetic energy to particles with less energy. The heat flow is dependent on the temperature difference ΔT across the distance Δx and the thermal conductivity of the material in question, which is indicated by the heat conduction coefficient λ.
The shown relationship is the law of Fourier. The dimension of λ is W/m/K.

Convection **$\Phi = \alpha (T-T_{sur})$**

This heat transfer is by means of displacement of a liquid or gas, different in temperature relative to its surroundings. The heat flow can be expressed by the heat transfer coefficient α.
The relationship is called Newton's Law of Cooling. The dimension of α is $W/m^2/K$.

Radiation **$\Phi = \sigma (T^4 - T^4_{sur})$**

This is heat transfer between two bodies, which are not in contact with each other, without the use of an intermediate substance. The one body is warm, thereby emits electromagnetic radiation and loses heat. The other body absorbs a part of the incoming radiation and converts it into heat.
The shown relationship is the Stefan-Boltzmann Law. The dimension of σ is $W/m^2/K^4$

The above three types of heat transfer will briefly be discussed considering the heat that is ultimately generated by the burning of fossil fuels, in relation to the isolation of the atmosphere.

Radiation:
The type of heat that is considered here is the heat that increases the temperature in the atmosphere directly. Therefore, it is believed that radiation, such as emitted from a warmed-up earth's crust, does not need to be further investigated here.

Conduction:
This phenomenon is only applicable to air if it is stationary. The usual definition of the so-called heat resistance is $\Delta T/\Phi$, leading to $\Delta x/\lambda$ being the resistance in case of *"conduction".* The heat resistance is, in case the air is stationary, determined by the thickness d (= Δx) of the layer and the heat conduction coefficient λ of the air, according to $R = d/\lambda$. If it would be applicable as such for the atmosphere, in the vertical direction, it would constitute an extremely large insulation because of both the large d (10 to 20 km) and the small λ. Order of magnitude: 10^6 m^2K/W.
This extremely high resistance confirms that *"conduction"* can be disregarded in examining this situation.

Convection:
Based on Newton's Law of Cooling the heat resistance in case of convection equals $1/\alpha$.
The meaning of $1/\alpha$ is the following. An object in a warmer environment, for example a stone in the outside air, causes a heat flow from environment to stone, having a heat resistance of $1/\alpha$.
The value of the so-called heat transfer coefficient α in such a situation ranges from 1-10 $W/m^2/K$. If air is blown over the stone α is 10-100 $W/m^2/K$.
The words 'from' and 'to' in the text "from environment to stone" can be reversed of course.
The basic idea behind Newton's Law of Cooling is that dT/dt is proportional to $T-T_{sur}$. Therefore, the law shows that once $T-T_{sur}$ gets smaller during the cooling/warming, Φ also gets smaller. So we have, in fact, to write: $\Phi(t) = \alpha(T-T_{sur})(t)$, or $\Phi(t) = \alpha(T(t) - T_{sur})$, in the situation that T_{sur} does not change significantly, for example, because of its size.

In the situation to be investigated there is a constant heat generated near the earth's surface, which is transferred by means of the heat flow Φ to the atmosphere. This heat flow is approximated as constant during a year. In that year, the difference $T-T_{sur}$ may also be considered as constant.

In summary, we consider any year in the last 200 years, in which mankind and his industry generates a constant heat flow Φ_{year}. The year 1800 is used as a reference for both the increase in global temperature as for the variable Φ_{year}. The temperature T_{sur} is thus assigned to the year 1800 and $T-T_{sur}$ as the increase in global temperature since 1800. From now on $T-T_{sur}$ is written as ΔT_{year}.

The graph below shows Φ_{year} and ΔT_{year} in the period 1810-2010. ΔT_{year} is a measured quantity. Φ_{year} is a registered quantity. For ΔT_{year} the curve-fitting as shown in [1] is selected. The variable Φ_{year} is also shown as a curve fitting and similar to the one in figure 1.

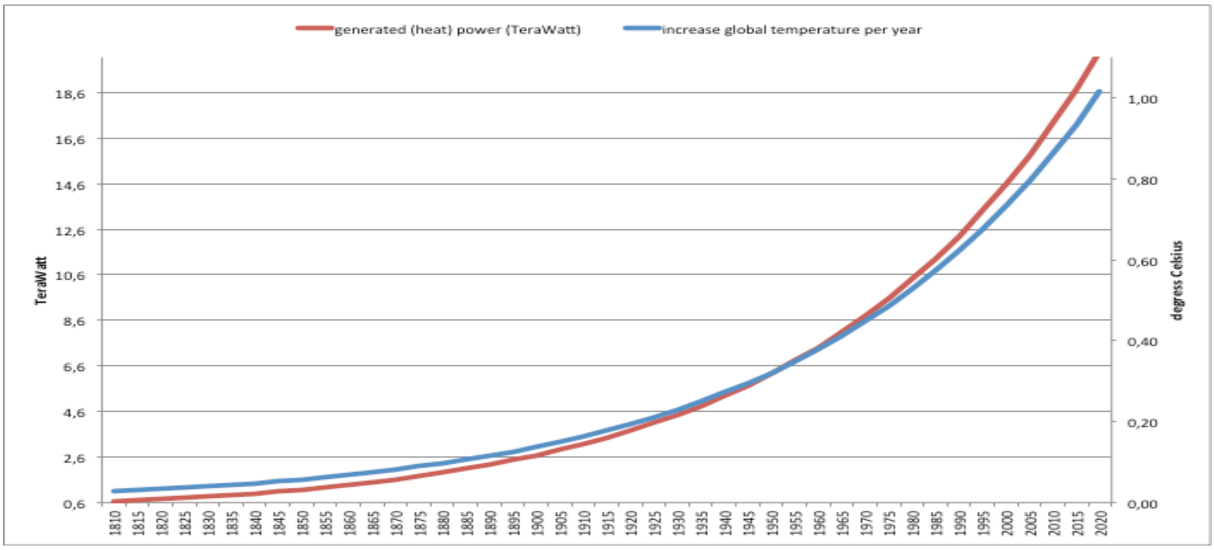


Figure 2. Generated power versus increase in global temperature

For each year yields $\alpha_{year} = \Phi_{year}/\Delta T_{year}$. The primary requirement, to establish the likelihood of the convection model, is that α is sufficiently constant over 200 years.
The graph below shows α_{year} divided by the average of α_{year} during these 200 years.

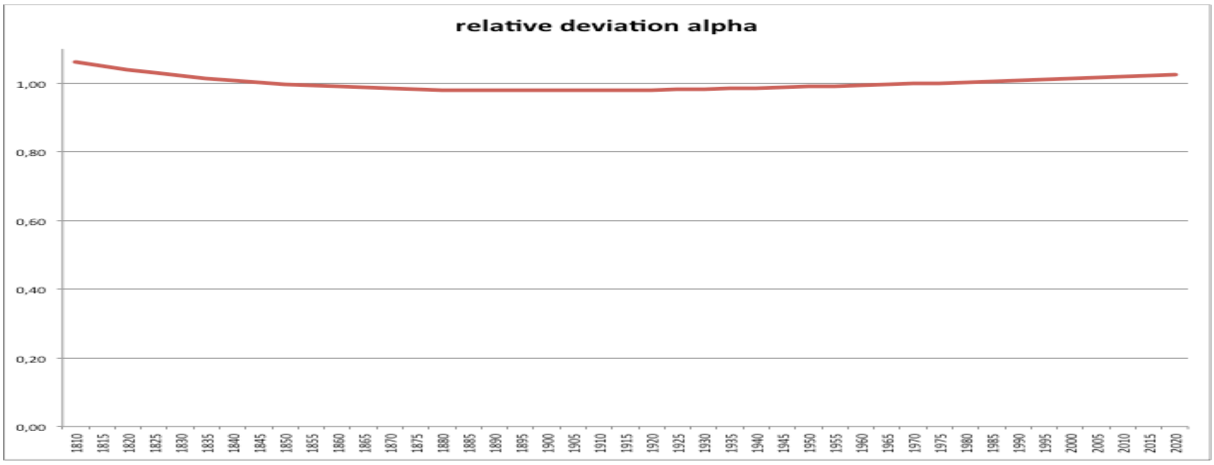


Figure 3. Relative deviation of α

The largest deviation is in 1810: 1.06. The data belonging to that year are relatively most unreliable, as well as due to the small absolute value, as to fact that these values are obtained by extrapolations.

The average absolute value of α is 0.039, rounded 0.04 ± 0.002 $W/m^2/K$
The corresponding resistance value is 25 m^2K/W.

This is for two reasons an encouraging finding regarding the applicability of the convection model. Firstly, the resistance value is indeed many orders of magnitude smaller than the one for the conduction model; secondly, the value is more than adequate constant over 200 years.

The constancy of α over the past 200 years, independent of the size of the heat power density, allows us to apply the relation $\Delta T = \Phi/\alpha$. That is to say: given the value of α and the indirectly registered heat power density, the increase in the overall temperature is simply Φ/α.

The value of α is indeed much lower than the smallest value in the range shown above: 1-10. The fundamental difference between that situation and the situation under consideration is that the object (earth) is enormous large compared to the surrounding (atmosphere), while the range 1-10 is related to an object that is at least small compared to the surrounding.
Scaled to the size of a football 20 km atmosphere is reduced to a layer of 0.3 mm!
Besides that, the earth is not a colder or warmer object relative to the atmosphere, but an object with a heat generator on its surface. So, it is not unexpected that the calculated heat transfer coefficient for the situation under consideration is quite different from the range 1-10.
But most likely not in the direction of a higher value, because that is obtained with blowing air.

In the next chapter an estimate is made of the part of the atmosphere that will be heated and a calculation is carried out of the energy necessary to heat that part to an increase of 1°C, necessarily to be considered in a completely isolated situation.

The most difficult job after that is to ‘fit’ this calculation in the just treated convection model, assuming that it would be possible at all.

The concept of heat capacity and specific heat capacity

Specific heat capacity is the amount of heat needed to raise the temperature of 1 kilogram of a certain stuff by 1 Kelvin, represented by the symbol c [J/kg/K].

Heat capacity is the amount of heat needed to raise the temperature of m kilogram of a certain stuff with specific heat capacity c by 1 Kelvin, represented by the symbol C [J/K], with $C= m.c$.

The amount of heat needed to raise the temperature of m kilogram of a certain stuff with specific heat capacity c by ΔT Kelvin, is given by $m \,.\, c \,.\, \Delta T$.

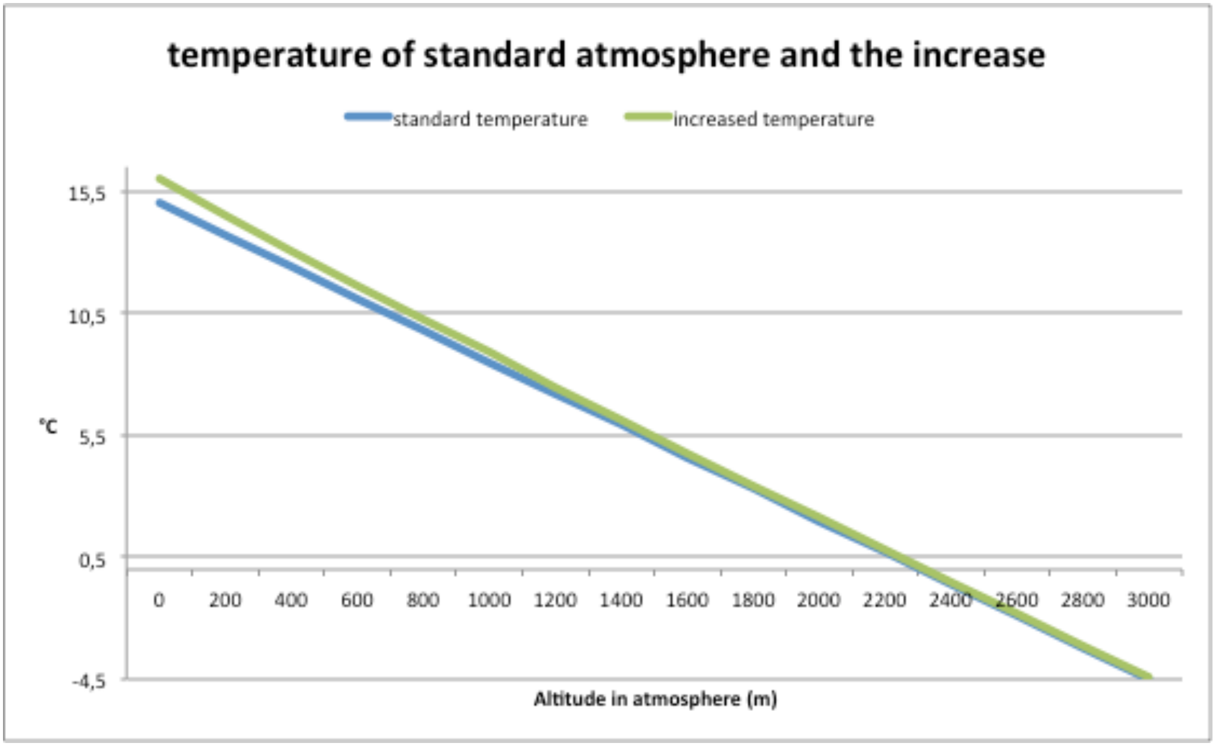
Fundamentally the variable c depends on the temperature. In the situation to be considered ΔT is small enough (~ 1°C) to assume c to be constant.

The relation $\Delta Q = C.\Delta T$ will be applied to the estimated part of the atmosphere that will be heated. It can safely be assumed that ΔT decreases as a function of altitude in the atmosphere.
It is assumed that the function $e^{-h/hc}$ is representative for this decrease.
Thus, $\Delta T(h) = \Delta T_0\, e^{-h/hc}$, with ΔT_0 the increase of the global temperature, measured close to the earth's surface, using the global temperature as it was two centuries ago as reference.

The standard atmosphere has a temperature of 15 °C at the surface and decreases by 2 °C per 300 meters as a function of the height, over the range 0-12 km.

However this gradient ($-6{,}5.10^{-3}$ °C/m) provides no guidance for calculating the constant h_c.

The figure below shows the example of $h_c = 1000$ meters, with 15 °C as the reference for 1 °C increase in global temperature at the earth's surface.



Figuur 4 (h_c is 1000 meter)

The density is linearly dependent on the height with a density of 0 at 20 km altitude. See [2] Air at a density of 1.3 kg/m³ has a specific heat capacity c of 10^3 J/kg/K.

The more rarefied the air is the smaller is the density D.

$$D(h) = 1.3*(1-5h*10^{-5}) \qquad [\mathrm{kg/m^3}]$$

The volume in which the mass has to be heated can now be expressed as:

$$V = O_a * \int (1-5h*10^{-5}) * e^{-h/hc}\, dh \qquad 0 \le h \le 20000 \text{ m}$$

with O_a the surface of the earth.

Thus, the energy ΔQ with which the atmosphere is being heated, can be represented by:

$$\Delta Q = 1300 * V * \Delta T_0 \qquad [\mathrm{Joule}]$$

Applying partial integration, $\int -he^{-h/hc}\, dh$ is found to be $h_c(h+h_c)e^{-h/hc}$

So $V = O_a * h_c\, [e^{-h/hc}\, \{5*10^{-5} * (h+h_c) - 1\}]_0^{20000}$

Assuming $h_c << 20000$: $V \sim O_a * h_c * \{1 - h_c/20000\} \sim O_a * h_c$

A good approximation of ΔQ thus is:

$$\Delta Q = 1300 * O_a * h_c * \Delta T_0 \qquad [\text{Joule}]$$

On the other hand, ΔQ can also be calculated as $\Phi * O_a * \Delta t$ with Δt the time (in seconds) needed to achieve the necessary energy ΔQ with the registered power $\Phi . O_a$ (17 TeraWatt in 2010).

In 2010 the ΔT_0 was about 0.85 °C.
Therefor $1300 * \Delta T_0$ in the equation above will be rounded to 1000 J/m^3, so:

$$\Phi . O_a * \Delta t_{sec} = 1000 * O_a * h_c$$

The earth's surface is $5 * 10^{14}$ m^2, resulting in:

$$h_c = 10^{-3} * 17 * 10^{12} / 5 * 10^{14} * 24 * 3600\ \Delta t_{day} \sim 3 \Delta t_{day}$$

This relationship is shown in the table below, with h_c in meters and Δt_{day} in days:

h_c	Δt_{day}
10	3
100	33
1000	333
10000	3333

Table 1

Recapitulated: The imaginary situation is considered that two centuries ago, all of a sudden 17 TeraWatt of heat power, evenly spread over the earth surface, has been switched on in a completely isolated atmosphere on space side. The height of this isolating ceiling is of great importance, however unknown. The just shown calculations show that if this height is given the symbol h_c, the whole volume between earth surface and this ceiling is raised 1°C in $h_c/3$ days.

N.B. This result is based on generally accepted physical laws!
Continuing this heating would further raise the temperature. Stopping the heating would leave the temperature at the level achieved, because of the assumed infinite isolation.

In reality heat ultimately leaks to space, requiring a (much) longer time to reach this situation. The present real situation has been reached in 200 years, with a continuously increasing non-stop power, ending at 17 TeraWatt in 2010. Given these 200 years and compared with the determined single year listed in table 1, in case h_c would be 1000 meter, this result gives the impression that the current situation can easily be achieved with the given continuously generated heat power.
This conclusion is emphasized by the fact that seemingly the convection model, given the constant heat transfer coefficient during the past 200 years, is a correct model.

The configuration "*earth-atmosphere-heating near earth's surface*" shows a striking resemblance with the configuration: "*living room-outdoors-floor heating*", with a constant outdoors temperature and constant floor heating, resulting in a constant room temperature.

For that reason this heating model is named living room model.

The greenhouse model

An infinite number of words are written about the greenhouse model. The question is: which words are the correct ones? There is at least agreement about the following items:

- The global temperature will not vary as long as there is balance between the incoming radiation, from the sun, and the outgoing radiation.
- The global temperature will rise if the outgoing radiation is blocked more than the incoming.
- The so-called greenhouse gases block the outgoing radiation more than the incoming.
- Both carbon dioxide and water vapour are greenhouse gases.

Citation from [3]:
"This and other basic principles indicate that warming associated with increased concentrations of the other greenhouse gases also will increase the concentration of water vapour ………….
Because water vapour is a greenhouse gas, this results in further warming and so is a positive feedback that amplifies the original warming." The text continues with:
"Eventually other earth processes offset these positive feedbacks, stabilizing the global temperature at a new equilibrium and preventing the loss of Earth's water through a Venus-like runaway greenhouse effect.".
Such an "explanation" represents the general unfamiliarity with the matter.

"When ranked by their direct contribution to the greenhouse effect, the most important compounds are water vapour (36-72%) and carbon dioxide (9-26%)".

The fifth agreement is that the earth's energy budget is an extremely complicated process, due to the impression that changes in whatever variable seem to change all variables, inclusive the original one. So a model of a dynamic earth's energy budget is sensitive to incorporations of wishful thinking, consciously or not.

The sensitivity of the balance between the incoming and outgoing radiation must be extremely high, given the fact that the electro-magnetic power densities of these radiations are extremely high compared to the direct heat power density: hundreds of W/m^2 versus dozens of mW/m^2 !

The crucial question thus is whether the validity of the greenhouse model can be demonstrated by means of reliable calculations.

Conclusions

Based on indicative thermo-dynamic calculations it is considered likely that the increase in the global temperature is caused directly by the heat released by the combustion of fossil fuels.

If this conclusion would be correct, the assumption that the increase in global temperature is indirectly caused by the combustion of fossil fuels, by means of the greenhouse effect, is at least doubtful.

De definitive conclusion is of crucial importance because the measures to tackle the climate problem would become of an entirely different type than the current one, aimed solely at reducing the CO_2 concentration in the atmosphere.

References.

[1] The relation between CO2, global temperature and world population,
Sjaak Uitterdijk, 29-1-2016 http://vixra.org/pdf/1601.0313v1.pdf

[2] Relation between CO2, global temperature and energy consumption,
Sjaak Uitterdijk, 8-10-2016 http://vixra.org/pdf/1610.0091v1.pdf

[3] https://en.wikipedia.org/wiki/Greenhouse_gas