Heating of the Sea by an unexpected source

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Summary - The basic principle of the greenhouse model is that the atmosphere, the oceans and seas are heated with the part of the energy radiated by the Sun that is retained in the atmosphere by greenhouse gases. But it is impossible, for reasons of physics, to heat the Sea from above, gradually descending to a great depth. So another source will have to be found for that measured heating.

1 Introduction

The generally accepted reasoning in the greenhouse model (GHM) is that the atmosphere, and the oceans and seas (Sea) are heated simultaneously and from the same source, with the result that the temperature of the Sea rises to a great depth, gradually decreasing to zero. However, this article shows that, from a physical point of view, it is impossible to heat the Sea in such a way to great depth. At most, a thin top layer of the Sea would be heated, which would then serve as a kind of thermal insulation to prevent heating at greater depths. Instead, the heat in the atmosphere will, via convection respectively radiation, largely disappear into the universe. The GHM states that a net difference between the incoming and outgoing heat flux in the atmosphere of about 1 W/m², valid for roughly the past ten years, is heating the atmosphere and the Sea as described. It appears that this claimed net heat flux is not based on measured incoming and outgoing fluxes. It was created solely to explain the increased thermal energy in the Sea, which in turn is derived from actually measured temperature increases in multiple layers. This article shows that the Sea is heated from great depth by the geothermal heat flux, gradually increasing from zero at great depth to a surface temperature equal to the temperature of the atmosphere.

2 Principle of the GHM

The GHM is based on the fact that half of the Earth is heated during the day and at the same time the other half at night emits that previously absorbed heat. That release is done to the universe through radiation. According to the GHM, cooling is more impeded by the atmosphere the more Greenhouse gases it contains. The defence that these Greenhouse gases should therefore hinder the much stronger incoming solar radiation more and should therefore cause the Earth to cool down is invalidated by the following reasoning.

The incoming radiation has a shorter wavelength than the cooling one. According to the GHM, this short-wave radiation is not blocked by the Greenhouse gases, while the long-wave radiation is. The spectrum of the solar radiation is maximum at a wavelength of ~ 600 nm. According to the GHM, the spectrum of the cooling radiation lies at a wavelength of ~ 20000 nm. It is not mentioned that the cooling starts primarily with convection through the atmosphere, to eventually be completed as radiation from the exosphere.

3 A closer look at spectra

Originally the idea, based on the above-described principle of the GHM, was that a thorough theoretical investigation of the spectrum of the radiation during cooling is essential. After this investigation was completed, it appeared to play no role. The result of the investigation is considered noteworthy. In brief:

The cooling hemisphere of the Earth can be regarded as a black radiator, with a temperature at the surface of 525 K (250 °C). The note on that surface is that the associated so-called exosphere is so thin that it borders on vacuum. By definition vacuum has no temperature. But only 1 molecule in any volume does! The temperature of that exosphere is very high indeed. The maximum of the spectrum of its radiation is, at a temperature of 250 °C, at a wavelength of ~ 10000 nm. So not at the 20000 nm alleged by the GHM. The temperature of a black radiator with a maximum at that wavelength is ~20 °C!
4 A closer look at the heat fluxes of the GHM

“Heat flux” stands for: “heat power per surface unit” and is therefore expressed in W/m².

The GHM focuses on heat fluxes, mainly in the form of radiation, which are intended to indicate the heating and cooling of the Earth. All this is done by means of figure 1, copied from reference [1], intended to provide insight. The yellow fluxes represent the heating and the red, upward, the cooling. The downward directed red ones, referred to as radiation from Greenhouse gases, are thought to determine the heating of both the atmosphere and the Sea.

In no way whatsoever can it be found that the net result must be the stated “net absorbed” 0.6 W/m². Further study of reference [1] also offers no guidance. It is therefore unbelievable that this small difference could have been derived from the much larger fluxes, with an accuracy that also suggests to be significant smaller than 0.1 W/m².

![Figure 1](image)

Reference [1] reports under the chapter “Climate Forcings and Global Warming”:

“The absorption of outgoing thermal infrared by carbon dioxide means that the Earth is still absorbing about 70 percent of the incoming solar energy, but an equivalent amount of heat is not emitted again. The exact amount of energy imbalance is very difficult to measure, but turns out to be slightly more than 0.8 watts per square meter. The imbalance is derived from a combination of measurements, including… observations of sea level rise and warming.”

In the next chapter it is made plausible that the last sentence should almost certainly have read: The imbalance is only deduced from the measured increased temperature of the Sea, transformed to warmth.

5 GHM and the heating of the Sea

Figure 2 is a copy of Figure 6 from reference [2]. It shows the heat absorbed by the Sea over the past 55 years. The period 1960 to 1985 doesn’t show a sufficiently reliable measured increase. For that reason, only the energy values for the period 1985 - 2015 have been considered. These can be read directly on the vertical axis.
Table I has been deduced from this information, with “bottom” changed to the mean depth of 3600 m.

<table>
<thead>
<tr>
<th>layer [m]</th>
<th>thickness [m]</th>
<th>volume [m$^3$]</th>
<th>Δenergy [J]</th>
<th>Δtemp. [mK]</th>
<th>ΔV [m$^3$]</th>
<th>Δheight [cm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-300</td>
<td>300</td>
<td>1.1E+17</td>
<td>13·10$^{22}$</td>
<td>300</td>
<td>6.8E+12</td>
<td>1.9</td>
</tr>
<tr>
<td>300-700</td>
<td>400</td>
<td>1.4E+17</td>
<td>7·10$^{22}$</td>
<td>120</td>
<td>3.6E+12</td>
<td>1.0</td>
</tr>
<tr>
<td>700-2000</td>
<td>1300</td>
<td>4.6E+17</td>
<td>10·10$^{22}$</td>
<td>50</td>
<td>4.9E+12</td>
<td>1.4</td>
</tr>
<tr>
<td>2000-3600</td>
<td>1600</td>
<td>5.7E+17</td>
<td>2·10$^{22}$</td>
<td>10</td>
<td>1.2E+12</td>
<td>0.3</td>
</tr>
<tr>
<td>totals</td>
<td>3600</td>
<td>1.3E+18</td>
<td>32·10$^{22}$</td>
<td>480</td>
<td>1.6E+13</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Table I deduced from figure 2

Given the variable ‘Δenergy’, the increase starting in 1870 will be determined mathematically. Examination of all relevant measured variables in the context of global warming shows that each variable, excluding Sea level rise, can be represented sufficiently by means of the function $A + B e^{t/61}$, with $t$ the year and $A$ and $B$ depending on the variable. In this case the totally increased energy in the Sea of $32·10^{22}$ J, which has been measured reasonably reliably over the past 30 years, can initially be calculated with the integral of $P_S(t) = 1.9·10^{-12} e^{t/61}$ TW.

The increase in heat over the past 150 years can now be calculated with the integral of $P_S(t)$, with the years 1870 resp. 2020 as boundaries. The outcome is $80·10^{22}$ J. This outcome is 2.5 times larger than the total value calculated in Table I. Since all calculations in that table are linear, the total temperature increase, to be interpreted as: at Sea surface and thus equal to the global temperature, is also $2.5 \times 480$ mK = 1.2°C. The actually measured global temperature increase in 2020 is 1°C. In view of the large number of years extrapolated to the past and in view of the accuracy of the measurements in those 30 years (see text under figure 2: “improved estimates”), the function $P_S(t)$ is adjusted by -20% to:

$$P_S(t) = 1.5·10^{-12} e^{t/61} \text{TW}.$$  

The mathematical expression for the measured global temperature increase is $13.5 + 4.4·10^{15} \exp(t/61)$. On this basis it can be calculated that from 1985 to 2015 this increase was equal to 380 mK, instead of 480 mK, which justifies the correction of -20% once again.

Given this $P_S(t)$, the increase of heat in the Sea as a function of time starting in 1870 can be calculated with $ΔE_S(t) = \int P_S(t) \, dt$, with the boundary condition $ΔE_S(1870) = 0$, leading to:

$$ΔE_S(t) = -6.2·10^{22} + 3·10^8 e^{t/61} \text{Joule}.$$
Back to the GHM. According to this model the Sea is heated from its surface, gradually decreasing to zero at great depth, while simultaneously the atmosphere is heated too, both due to alleged Greenhouse gases. The “net absorbed” 0.6 W/m², referred to in figure 1, belongs to the year 2010. The theoretical power applicable in that year is \( P_s(2010) \), being 306 TW. The surface of the Sea makes up 70% of the total Earth surface. The related heat flux is therefore 306 TW divided by this Sea surface. That result is indeed 0.6 W/m². But the GHM prescribes that this “net absorbed” heat flux belongs to the total Earth’s surface. After all, it originated in the total atmosphere “on the basis of” all prevailing heat fluxes. For that reason, the 0.6 W/m² in figure 1 is a factor 1.4 too low. However, as noted in the previous chapter, the correctness of this heat flux cannot be proven on the basis of measured values, certainly not with an accuracy suggested to be better than 0.1 W/m². Thus, this significantly incorrect outcome is not noticeable.

This consideration brings us to a shortcoming of the GHM with much more far-reaching consequences.

The heating of the Sea from above to a great depth should be considered impossible. Convection is out of the question because a thin layer of heated water keeps flowing at the surface. And conduction is not possible as can be proven with the associated law \( \Delta T = R \cdot \Phi \) with:

\[
\begin{align*}
\Phi & \quad \text{the applicable heat flux} \quad \text{W/m}^2 \\
R & \quad \text{the thermal resistance} \quad \text{K}/(\text{W/m}^2) \\
\Delta T & \quad \text{the temperature difference} \quad \text{K}
\end{align*}
\]

The heat resistance of the layer of water to be considered with thickness \( d \) meter is determined by \( R = \frac{d}{\lambda} \), with \( \lambda \) the specific thermal conductivity of water: 0.6 W/(m·K). The heat resistance \( R \) of a layer of water of 3600 m is therefore \( 3600/0.6 = 6000 \) K/(W/m²). Applying the heat flux 0.6 W/m² of the GHM to this, leads to a \( \Delta T \) of 3600 K. This result has to be interpreted as the impossibility of allowing such a heat flux to flow through such a layer of water by means of conduction.

This indicates the second most fundamental reason for the untenability of the GHM.

6 The Living Room Model

Having proven that it is impossible to heat the Sea from above up to large depth, the question remains which source is heating the atmosphere and which one the Sea.

The thermodynamic law of conservation of energy has the consequence that all energy consumed worldwide, of whatever nature such as solar, wind and nuclear energy, is eventually converted into heat. Also when basic energy is converted into kinetic energy, such as with propulsion. This kinetic energy is inevitably converted into heat by friction with the medium in which the propulsion takes place, and by the friction in the machine itself. If the propulsion results in an increase in the potential energy of the vehicle, as in the case of an airplane, or of a car driving up a mountain, this potential energy is still converted into heat as soon as the vehicle returns to its original height. The following comment on solar energy is of great importance.

The Sun is by far the predominant source of the heating of the Earth during the day. This heat is completely dissipated at night, resulting in a constant and perfect temperature of the atmosphere to create the present nature. One hundred “greenhouse gas molecules” more or less in 1 million air molecules will not disturb that equilibrium significantly.* By converting some of that solar energy into electrical energy, that portion will still be converted back to thermal energy in the atmosphere too and it will just as well be relinquished to the universe at night. That gives the impression that converting solar energy into electrical energy is the best solution to solve the problem of global warming. However, the practical problem is that as soon as that part of the solar energy makes a significant contribution to the solution of the global warming, millions of square kilometres of sun cells will have destroyed the present nature.

*The author considers this as the most fundamental reason for the untenability of the GHM.
Based on the heat capacity of the atmosphere (5·10^21 J/K), it can be calculated that only 14% of the energy consumed by mankind in the last 150 years has been sufficient to produce the temperature rise of 1 °C in the atmosphere. The remaining 86% has ended up outside the atmosphere via convection to the Earth's surface and/or via radiation to the universe.

It can be calculated that with that 86% (3·10^22 J) a thin upper layer from only 40 m depth in the Sea could gradually be heated from 0 to 1 °C at the surface, if that energy were actually absorbed by the Sea. Given the calculated total increased heat in the Sea during these 150 years of ΔE_5(2020) = 66·10^22 J, the former heat is hardly more than the accuracy with which the latter can be determined. It can therefore not be proven that this 86% was absorbed by the Sea. Neither that this is not the case.

Exploring the possible "leak" to the universe leads to the following consideration. Initially, the very bottom layer of the atmosphere is heated by mankind's energy consumption. The transfer to higher layers can easily be explained by the fact that warmer air flows upwards, formally referred to as convection. Such a kind of a "leak" is more obvious than the one by conduction. This statement can be proven as follows.

Applying again the conduction law ΔT = R·Φ, as described in 6, teaches that the heat resistance R of the atmosphere is at least 4·10^8 K/(W·m^2). For air, the following applies: λ = 0.024 W/(m·K) and the effective layer thickness d of the atmosphere may, in this case, be set at 10 km. The worldwide power used by mankind as a function of the year can be represented by the function 8.4·10^-14·exp(t/61) TW. As a result the heat flux in 2010 was 0.034 W/m^2. This Φ times 0.86 applied in ΔT = R·Φ results in a ΔT of ~ 10^6 K. And the higher the R, the higher the ΔT. Given the fact that the thermal resistance of the atmosphere increases with increasing altitude, this 10 km thickness is no longer so important. The interpretation of that high ΔT can again only by that said flux will apparently not pass through the atmosphere as conduction. This leaves "leakage" via convection to the outside of the atmosphere. High in the atmosphere, this heat is eventually converted into radiation to the universe.

Having arrived here, the increase in the temperature of the atmosphere has been explained by the energy consumption of mankind, but not yet the increase in temperature of the Sea to a great depth, which requires much more energy.

**7 The source of the heating of the Sea**

In view of the findings in the previous chapter, the heating of the Sea will only be able to take place from below, by means of convection.

The application of a heat pump with a so-called horizontal ground exchanger (at a depth of 2 meters) teaches that a continuous heat flux of 50 W/m^2 can be generated. But then the temperature at that depth drops from +10 °C to -5 °C. At such a place heat is in a forced way extracted from Earth. Incidentally, that temperature will return to its original value within a few hours when the heat extraction is stopped. The natural geothermal heat flux is most likely at least an order of magnitude lower than 50 W/m^2.

Using the variable ΔE_5(t), shown in chapter 5, it can be calculated that the increase of the energy content of the Sea during the past 150 years is 66·10^22 J. If this were to be achieved with a constant geothermal heat flux, this flux has to be 0.4 W/m^2. The corresponding calculations are:

\[ \text{Heat power} = 66·10^{22} \text{ W·s/150·(365·24·3600)} = 140 \text{ TW} \]
\[ \text{Heat flux} = \text{heat power} / 0.7\text{·area of Earth} = 0.4 \text{ W/m}^2 \]

Such a natural heat flux may be considered realistic, compared to the forced flux of 50 W/m^2.
In order to understand the influence of that geothermal heat flux on the temperature of the Sea, we consider a basically comparable situation: a river flowing into a sea. Mind the difference between sea and Sea! The level of that sea varies with the tide. The level of the river water in the estuary rises and falls without delay with the level of the sea. The further inland, the less remains in the river of that varying level in the estuary.

If we replace, in this reality, the height of that sea by the temperature of the atmosphere, then the temperature difference between atmosphere and the Sea is always zero at the transition, given the slow change in temperature of the atmosphere. Thus, as the long-term temperature of the atmosphere increases, the long-term temperature of the Sea at its surface increases by the same amount, through the supply of thermal energy in the form of geothermal heat flux. And for this reality also applies: the deeper into the Sea, the less remains of that increase in temperature at the surface.

Just for information: The amount of heat in the Sea is equal to its heat capacity of $5.2 \cdot 10^{24} \text{ J/K}$ multiplied by the average temperature of $\sim 280 \text{ K}$, being $15 \cdot 10^{28} \text{ J}$. The increased amount of heat in the Sea over the past 150 years ($66 \cdot 10^{22} \text{ J}$) is, in comparison to that, thus only about 0.5‰!

Summarized: The geothermal heat flux, that has existed for millions of years, once brought at some moment the Sea and the atmosphere to certain temperatures, equal to each other at the transition of both media. As mankind has raised the temperature of the atmosphere by $1 \degree \text{C}$, the geothermal heat flux does adjust the temperature at the surface of the Sea to this increase, gradually decreasing to 0 at the bottom.

8 The Sea level rise

Figure 3 shows the measured Sea level rise, as well as the corresponding function $-26 + 1.7 \cdot 10^{-6} \exp(t/120)$, that fits the measured values perfectly. The sea level rise mentioned in Table I is actually 2 times 4.6 is 9 cm, solely as a result of the expansion of the water during the past 150 years. The measured increase is approximately 25 cm. The missing 16 cm is a result of the melting of the snow on the mountains on the mainland and of the snow on both poles. Not of the melting of the ice on and around the poles, because when ice melts, its volume decreases by 10%. On the basis of the currently measured Sea level rise, it is therefore grossly exaggerated to predict that we have to take meters of increase into account. Figure 3 shows that if the prevailing increasing trend of global warming is maintained over the next 100 years, the Sea level will rise only 30 cm from the current level.

There are much bigger problems that threaten nature and mankind.
Conclusions

1. The Greenhouse Model has been exposed as an untenable theory, with the result that politicians have been misguided when it comes to tackling global warming.

2. The so-called Living Room Model, based on the premise that the energy consumption of mankind leads directly to the heating of the atmosphere and indirectly to the heating of the Sea, explains all the phenomena of the global warming.

3. The heating of the Sea is no more and no less than the adaptation of the temperature at its surface to that of the atmosphere by the so-called geothermal heat flux, the increase gradually decreasing to zero at the bottom of the Sea.

4. The rejection of the Greenhouse Model means that the current efforts in the field of sustainable energy generation to replace CO$_2$-producing fuels, will have no effect whatsoever on the pursued goal, because sustainably generated energy is also fully converted into heat.

5. The Living Room Model simply explains the hotspots on Earth. Hotspots are the areas where energy consumption per square meter is higher than the global average.

6. There is only one way for mankind to turn the tide: by drastically reducing global energy consumption. This can be done by aiming for the reduction of the average consumption per person and/or for decreasing the world population.

7. The CO$_2$ conferences will never lead to a reduction in global warming.

8. Only Energy conferences, with the aim of reducing mankind's energy consumption, have a chance of success.

References


[2] https://advances.sciencemag.org/content/3/3/e1601545