THE "GREENHOUSE EFFECT" AS A FUNCTION OF ATMOSPHERIC MASS

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ABSTRACT
The main reason for claiming a scientific basis for "Anthropogenic Greenhouse Warming (AGW)" is related to the use of "radiative energy flux models" as a major tool for describing vertical energy fluxes within the atmosphere. Such models prescribe that the temperature difference between a planetary surface and the planetary average black body radiation temperature (commonly called the Greenhouse Effect, GE) is caused almost exclusively by the so called greenhouse gases. Here, using a different approach, it is shown that GE can be explained as mainly being a consequence of known physical laws describing the behaviour of ideal gases in a gravity field. A simplified model of Earth, along with a formal proof concerning the model atmosphere and evidence from real planetary atmospheres will help in reaching conclusions. The distinguishing premise is that the bulk part of a planetary GE depends on its atmospheric surface mass density. Thus the GE can be exactly calculated for an ideal planetary model atmosphere. In a real atmosphere some important restrictions have to be met if the gravity induced GE is to be well developed. It will always be partially developed on atmosphere bearing planets. A noteworthy implication is that the calculated values of AGW, accepted by many contemporary climate scientists, are thus irrelevant and probably quite insignificant (not detectable) in relation to natural processes causing climate change.

1. INTRODUCTION

The average global surface temperature minus the average infrared black body radiation temperature, as observed from space, defines the GE of a planet. The name GE is quite misleading since the physical processes causing warmth in a greenhouse have little in common with the processes causing warmth on a planetary surface. This nomenclature will be kept here solely because of its general, although improper use in scientific literature and news media.

On Earth the GE is +15–(–18) = +33 K. The GE on Mars that has little atmosphere is around 0 K but it is around +500 K on Venus that has dense atmosphere.

The theoretically deducible influence of gravity on GE has rarely been acknowledged by climate change scientists for unknown reasons. Its numerical value can be calculated using familiar knowledge in physics. To clarify concepts and simplify calculations, some restrictions in planetary atmospheric conditions are introduced in a thought experiment involving an idealised planetary body. This technique isolates the atmospheric mass influence and then determines the value of GE *when both the influence of radiative interaction with space and other extraterrestrial processes are omitted.* Also discussed is whether or not the model results are a fair approximation concerning the physical situation in real planetary atmospheres. The answer is a conditional yes – depending on the unique physical condition in which each specific planetary atmosphere dwells.

It is remarkable that the hypothesis claiming a quantitatively important AGW has survived for more than 100 years. Svante Ahrrenius first proposed it 1896 (ref. 1). His hypothesis was correctly questioned by contemporary scientists on the basis that it omitted important convective vertical energy fluxes. Since then the number of "greenhouse gases" have expanded and the models have been modified, but they are still mainly "radiative models". Water vapour (gas), the most important greenhouse gas, has not been treated as very important and as an independent forcing agent in such models. The radiative impacts of water droplets, fog, clouds, snow and ice crystals are poorly modelled. These are all excellent infrared emitters and therefore must influence the energy fluxes in other ways than radiative greenhouse gas models suggest. The importance of the surface atmospheric mass density in creating GE was first pointed out by myself in1998 (ref. 2 p. 31–32). This article is a result of my continued interest in this topic. The basic theoretical knowledge will be quoted from textbook literature. "An introduction to Dynamic meteorology" by James R. Holton (ref. 3) has been chosen as appropriate for this purpose.

2. GE IN A MODEL PLANET ATMOSPHERE

2.1 The model planet

A simplified model of Earth will be considered. The model planet does not rotate. It neither receives solar radiation nor emits infrared radiation into space. The model planet and its atmosphere are specified below. Assign the mass m0 to the atmosphere of Earth.

- The model planet globe (G) is spherical with a surface area (A) and a mass (M0) equal to the mass of Earth and with a radius (R0) equal to the average radius of Earth. Its surface is solid and there is no external gravity force or any other extraterrestrial force acting on it.
- G and the atmosphere (AT) are surrounded by a concentric, tight, black spherical shell with a surface area (S). The constant distance (D) between the surface with area A and the surface with area S is very small in relation to R0. Therefore, the gravity force (g) exerted by G is approximately constant between the surfaces with areas A and S.
- G has a dry atmosphere (AT) where all atmospheric constituents are ideal gases.
- The atmospheric mass (m) and the mass of the surface with area S are small in relation to M0. Therefore, the gravity field caused by m and the surface with area S can be neglected.
- The surfaces with areas A and S are thermally insulated preventing heat from entering into G and infrared radiation to reach space.

- AT is contained between the surfaces with areas A and S. The minimum allowed pressure of AT is 0.1 bar.
- The thermal heat storage capacities of the solid surface material, the shell and the insulation are negligible.

2.2 A proof

A. Axioms

The laws in physics are valid. A model planet atmosphere according to paragraph 2.1 is postulated. Equilibrium atmospheric conditions have been reached meaning that the average total energy of atmospheric molecules is constant. Effects of enthalpy and entropy are assumed to be negligible.

B. Statement

The GE is hypothesised to be independent of the amount of "greenhouse gases" in a dry atmosphere.

C. Proof

Three similar thought experiments are conducted by changing only the atmospheric mass. In the experiments, I–III, the atmospheric masses are m1=m0, m2=2m0 and m3=3m0 where m0 can be chosen within a wide range.

– The atmospheric mass per unit area is constant in each experiment. This is a consequence of the atmospheric mass being able to relocate itself and produce a uniform surface pressure, regardless of its initial physical conditions.
– The pressure differences between the surfaces with areas A and S are m0g/A, 2m0g/A and 3m0g/A in experiments I–III. The force of gravity will produce pressure differences that are proportional to m.

The energy content in the model atmosphere is fixed and constant since no energy can enter or leave the closed space. Nature will redistribute the contained atmospheric energy (using both convective and radiative processes) until each molecule, in an average sense, will have the same total energy. In this situation the atmosphere has reached energetic equilibrium. The crucial question is what temperature difference (GE) will exist between A and S?

The physical situation above is well known in meteorology from treating adiabatic processes. For such a process the sum of kinetic, internal and potential energy is constant by definition (ref. 2 p. 229). An adiabatically moving air parcel has no energy loss or gain to the surroundings. For example, when an air parcel ascends the temperature has to decrease because of internal energy exchange due to the work against the gravity field.

In an ideal gas atmosphere, the adiabatic temperature lapse rate has to be –g/cp where cp is the heat capacity of the gas (ref 2 p. 49). Theoretical calculations are well confirmed by observational evidence in the atmosphere of Earth. The adiabatic temperature lapse rate on Earth is thus –9.81/1004 = –0.0098 K/m. As James R. Holton concluded after deriving this result: "Hence, the dry adiabatic lapse rate is approximately constant throughout the lower atmosphere."

The temperature lapse rate in our model atmosphere also has to be –g/cp, since its atmosphere is organized adiabatically. Hence, it is possible to calculate the temperature difference (GE) between the surfaces with areas A and S in our three thought experiments. The solution is identical in all three experiments and its value is simply Dg/cp. Thus, the temperature difference (GE) between the surfaces with areas A and S is independent of density in the atmosphere. It also follows that it is independent of the absolute average temperature of the model atmosphere since the initial constant energy content of the atmosphere can be chosen arbitrarily.

Since no assumptions have been made concerning the gases except that they are ideal, the statement is proven valid. In fact the statement can be expanded and a more specific version is: *The greenhouse effect (GE), expressed as temperature lapse rate per meter, in a model atmosphere postulating energetic equilibrium, is constant and independent of the radiative properties of the ideal gases. It is also independent of the density of the atmosphere and of the absolute average temperature of the same.*

2.3 Model atmospheres contrasted with real ones

Observational evidence implies that the static situation in the model atmosphere is a good or a reasonable approximation of real atmospheres. This is very surprising since planetary atmospheres are energetically open systems, involving a number of energy flux processes. Perhaps this is one reason why the GE produced by gravity and atmospheric mass has not been discovered or at least included in earlier discussions of Global Warming issues and contexts.

Real atmospheres impose some constraints that have to be met by such models. The atmosphere should have a certain absolute minimum troposphere thickness. The atmosphere of Mars is too thin and thus lacks a measurable GE. In contrast, Venus, Jupiter, Saturn, Uranus and Neptune do have thick atmospheres and substantial GEs, according to observational evidence.

A sufficiently dense atmosphere will also dampen temperature variations related to daily and seasonal variations of irradiation. This dampening effect is small on Mars and large on Venus. The day and night temperature difference of Venus' upper troposphere is only around 5K although night and day lengths are equal to several Earth months.

Real atmospheres are also not dry, since clouds occur and thus condensation processes exist. Observational evidence from Earth and theoretical deductions imply that the dry adiabatic lapse rate in such cases has to be replaced by the "pseudo adiabatic temperature lapse rate" (ref. 2 p. 332). This will always have a lower numerical value (around 0.0070 instead of 0.0098 K/m on Earth) than the dry "ideal" one. It can also be argued that a cloud cover will help in redistributing and levelling out the atmospheric energy content below the upper cloud surface. Liquids and solid matter (raindrops, ice crystals, fog and snow flakes) radiate more effectively than "greenhouse gases".

This is readily evidenced by the conditions on Mars and also Earth. A dominant infrared radiation from the planetary surface directly into space will hinder the capability of the atmosphere to reach an adiabatic energetic equilibrium. Our model is a better model if the planetary atmosphere is dense. Interestingly, the model atmosphere will develop a state of energetic equilibrium regardless of whether light directly hits the planetary surface or not. This provides an explanation of why Venus has an (quasi or wet) adiabatic temperature lapse rate in its troposphere. Only 2.5% of solar irradiation can reach its surface. Even less radiation is reaching the surface of the great planets. Still, it seems that observed temperature lapse rates of their atmospheres are close to the calculated theoretical pseudo adiabatic temperature lapse rates.

The minimum absolute atmospheric temperature is mostly reached at an atmospheric density around 0.1 bar in all the planetary atmospheres mentioned above, except on Mars. This fact implies that the maximum radiation into space mainly is emitted from high altitudes in dense atmospheres. This layer has been named Atmosphere-Space Interface in my thesis (ref 2 p. 42–44). If that is the case, the surface temperature of a planet can be found by calculating "backwards". The reason being that the average black body temperature of the planetary atmosphere is uniquely determined by irradiation and albedo values. The surface temperature of Venus can be calculated readily in this manner. This temperature has little to do with the fact that 95% of its atmosphere consists of the "greenhouse" gas carbon dioxide. The 500 K GE is completely explained by it having a 92 times thicker atmosphere than the Earth.

3. ATMOSPHERIC MASS AND CLIMATE CHANGE

It should be noted that the existence and magnitude of atmospheric mass induced GE has nothing to do with climate change. Climate change is not caused by changes in atmospheric mass on Earth. I do not deny that many processes are affecting climate change. Important processes include albedo changes, Milancovitch variables changing irradiation, unknown extraterrestrial factors, global mean wind speed, variations of the production of Mobile Polar Highs (as described by professor Marcel Leroux, ref. 4) just to mention some.

However, this paper only considers an atmosphere consisting of ideal gases and that is a closed system. The Earth's atmosphere differs from this consideration in that it contains gases that are not ideal and water enters and leaves it (i.e. evaporation and precipitation). It is acknowledged that these differences will have some effect on the magnitude of the Earth's GE.

4. CONCLUSIONS

The main conclusion, derived from the model atmosphere of this paper, is the fact that there *has to exist a substantial greenhouse effect (GE) which is mass dependent and which will develop independently of the amount of greenhouse gases in any real planetary atmosphere.*

The generally claimed importance of "greenhouse" gases rests on an unproven hypothesis (ref 1). The hypothesis is based on radiative models of energy fluxes in our atmosphere. These are inadequate, since radiative processes within the atmosphere are poorly described, convective energy fluxes are often inadequately described or omitted, and latent heat fluxes are poorly treated. The whole GE in these models is wrongly claimed being caused by "greenhouse gases". The considerations in this paper indicate that effects of the greenhouse gases, other radiative effects, and convection effects all might modulate GE to a minor unknown extent.

Hence, the atmospheric mass exposed to a gravity field is the cause of the substantial part of GW. The more atmospheric mass per unit planetary area, the greater GE has to develop. Otherwise Newton's basic gravity model has to be dismissed.

The GE described here has to exist and dominate on planets where the above mentioned restrictions are fulfilled. This is the case on Venus, Jupiter, Saturn, Uranus and Neptune. Also, the restrictions are partly fulfilled within our own atmosphere. Exactly how well should be a target for future research.

The reasoning above opens up a quite new insight. Climate change might primarily be caused by changes in the absolute mean temperature of the whole atmosphere while retaining an approximately constant temperature difference (GE) between the planetary surface and the radiative interface to space. The published calculated magnitudes of AGW are simply falsifiable artefacts, and in any case much too large. If there is a measurable AGW caused by variation in "greenhouse gases" it should be sought in processes affecting the absolute average temperature of the whole atmosphere.

This paper has purposely been kept more qualitative than quantitative to avoid elaborate formula and explanations – and to make it easy for all to digest. The more theoretically competent readers should have few problems if they wish to perform quantitative calculations for themselves, following the guidelines presented here.

5. ACKNOWLEDGEMENT

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6. REFERENCES

1 Arrhenius. S. 1896. *On the influence of carbonic acid in the air upon the temperature on the ground.* The Philosophic Magazine 41, 237–276.

2 Jelbring, H. R. Thesis 1998. *Wind Controlled Climate.* Paleogeophysics & Geodynamics, Stockholm University. 111pp.

3 Holton, J. R. 1979. *An Introduction to Dynamic Meteorology.* Academic Press, London and New York. 391pp.

4 Leroux, M. 1996 (French), 1998 (English), *Dynamic Analysis of Weather and Climate*, Wiley/Praxis series in Atmospheric Physics, John Wiley & Sons, Publishers. 365pp.