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The Real Origin of Climate Change and the Feasibilities of Its Mitigation

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Abstract

The actual treatise represents a synopsis of six important previous contributions of the author, concerning atmospheric physics and climate change. Since this issue is influenced by politics like no other, and since the greenhouse-doctrine with CO_2 as the culprit in climate change is predominant, the respective theory has to be outlined, revealing its flaws and inconsistencies. But beyond that, the author's own contributions are focused and deeply discussed. The most eminent one concerns the discovery of the absorption of thermal radiation by gases, leading to warming-up, and implying a thermal radiation of gases which depends on their pressure. This delivers the final evidence that trace gases such as CO_2 don't have any influence on the behaviour of the atmosphere, and thus on climate. But the most useful contribution concerns the method which enables to determine the solar absorption coefficient β_s of coloured opaque plates. It delivers the foundations for modifying materials with respect to their capability of climate mitigation. Thereby, the main influence is due to the colouring, in particular of roofs which should be painted, preferably light-brown (not white, from aesthetic reasons). It must be clear that such a drive for brightening-up the World would be the only chance of mitigating the climate, whereas the greenhouse doctrine, related to CO_2, has to be abandoned. However, a global climate model with forecasts cannot be aspired to since this problem is too complex, and since several climate zones exist.

Keywords

IR-Absorption of Gases, Thermal Radiation of Gases, Solar Absorption Coefficient of Coloured Bodies, Albedo, Temperature Measurements

1. Introduction

In the year 1956, the perception of a greenhouse effect due to atmospheric carbon-dioxide appeared for the first time in public, namely in a *Time Magazin* article entitled "One Big Greenhouse". It referred to a publication in the *American Scientist* of *Gilbert N. Plass* [1] and explained the global temperature-enhancement as well as the shrinking of glaciers. Plass adapted IR-measurements to the theory of *Sven Arrhenius*, published in 1896 [2], who had used on his part the absorption measurements of *John Tyndall*, published more than thirty years before [3], applying them to the Stefan-Boltzmann relation which had meanwhile been published. However, already in the work of Arrhenius some serious errors are latent which will be discussed later.

The alleged proof for the correctness of this theory was delivered 25 years later by an article in the *Scientific American* of the year 1982 [4]. Therein, the measurements of *C.D. Keeling* were reported which had been made at two remote locations, namely at the South Pole and in Hawaii, and according to which a continuous rise of the atmospheric CO_2-concentration from 316 to 336 ppm had been detected between the years 1958 and 1978 (cf. **Figure 1**), suggesting coherence between the CO_2-concentration and the average global temperature.

But apart from the fact that these CO_2-concentrations are quite minor (400 ppm = 0.04%), and that a constant proportion between the atmospheric CO_2-concentration and the average global temperature could not be asserted over a longer period, it should be borne in mind that this conclusion was an *analogous* one, and *not* a *causal* one, since solely a temporal coincidence existed. Rather, other influences could have been effective which happened simultaneously, in particular the increasing urbanisation, influencing the structure and the coloration of large parts of Earth surface.

However, this contingency was, and still is, categorically excluded. Solely the two possibilities are considered as explanation of the climate change: either the anthropogenic influence due to CO_2-production, or a natural one which cannot be influenced. A third influence, the here suggested one, namely the one of colours, is a priori excluded, even though nobody denies the influence of colouring on the surface temperature of Earth and the existence of urban heat islands, and although the increase of winds and storms cannot be explained by the greenhouse theory.

Subsequently, intensive research activities emerged, accompanied by a flood of publications, and culminating in several text books. Several climate models were presented with different scenarios and diverging long-term forecasts. Thereby, the fact was disregarded that indeed no global climate exists but solely a plurality of climates, or rather of micro-climates and at best of climate-zones, and that the Latin word "clima" (as well as the English word "clime") means "region". Moreover, an average global temperature is not really defined and thus not measurable because the temperature-differences are immense, for instance with regard to the geographic latitude, the altitude, the distinct conditions over sea and over land, and not least between the seasons and between day and night. Moreover, the term "climate" implicates rain and snow as well as winds and storms which, in the long-term, are not foreseeable. In particular, it should be realized that atmospheric processes are energetically determined, whereto the temperature contributes only a part.

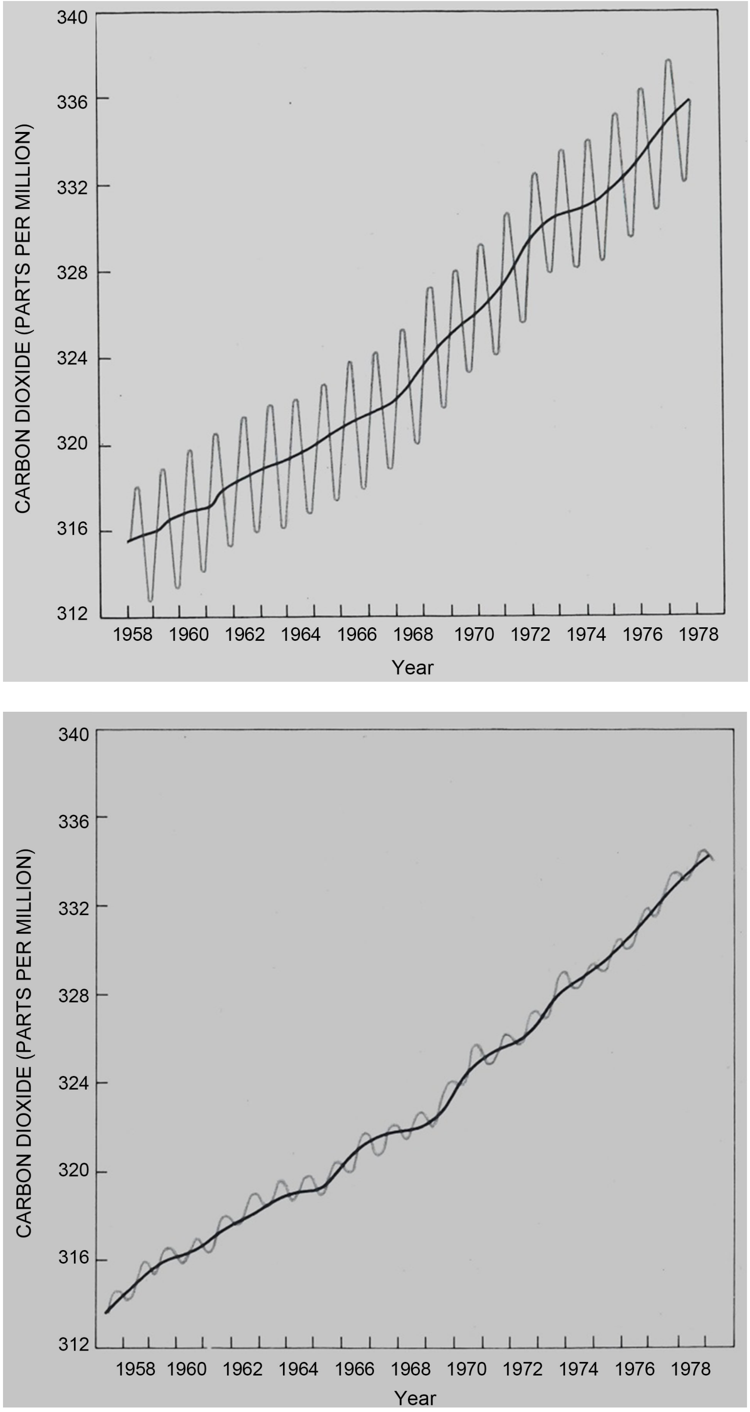

Figure 1. The increasing CO_2-concentration in the atmosphere at Mauna Loa in Hawaii (upper diagram) and at the South Pole (lower diagram) between 1958 and 1978, according to C.D. Keeling, cited in [4]. The weak lines mean real values expressing seasonal variations, the strong lines mean average values.

Since around 2005 several books appeared which significantly contributed to establish the greenhouse theory in the public opinion. Thereby the CO_2 got, in a way, the status of a climate standard, *i.e.* it served as a measure to describe the condition of the climate. Hereto, the book of *Tim Flannery* entitled "The Weather makers", published in 2005, has to be mentioned. But in particular, the book and the film of the former US vice president and presidential candidate *Al Gore*, published in 2006 and entitled "An Inconvenient Truth", had a striking success. They were awarded by the Nobel Peace Prize and by an Oscar, that which extended the credibility even though it was not scientifically grounded. Since then, the reduction of the anthropogenic CO_2-emission is believed as the only and not disputable method in order to mitigate climate change by replacing the fossil energy sources by renewable energies, preferably into alternative ones such as photovoltaic and wind power.

However, already well in advance institutions were founded which aimed at mitigating climate change through political measures. Thereby, climate change was equated with the industrial CO_2 production, although physical evidence for such a relation was not given. It was just a matter of belief. In this regard, in 1992 the UNFCCC (United Nations Framework Convention on Climate Change) was founded, supported by the IPCC (Intergovernmental Panel on Climate Change). In advance, side by the side with the UNO, numerous so-called COPs (Conferences on the Parties) were hold: the first one in 1985 in Berlin, the most popular one in 1997 in Kyoto, and the most important one in 2015 in Paris, leading to a climate convention which was signed by representatives of 195 nations. Thereby, numerous documents were compiled, altogether more than 40,000. But actually these documents didn't fulfil the standards of scientific publications since they were not peer reviewed.

Since the climate convention of Paris in 2015, climate even has deteriorated, in spite of the measures which had been taken. This gave rise to climate protection activists such as *Greta Thunberg*. The debate became even more emotional and far from any scientific background. Indeed, the greenhouse doctrine had in so far a counterproductive effect on climate as it prohibited effective measures such as brightening urban surfaces.

2. The Historical Inducement for the Greenhouse Theory and Their Flaws

The scientific literature about the greenhouse theory is so extensive that it is difficult to find a clearly outlined and consistent description. Nevertheless, the publications of *James E. Hansen* [5] and of *V. Ramanathan et al.* [6] may be considered as authoritative. Moreover, the textbooks [7] [8] and [9] are worth mentioning. Therein it is assumed that Earth surface, which is heated up by sun irradiation, emits thermal radiation into the atmosphere, warming it up due to heat absorption by "greenhouse gases" such as CO_2 and CH_4. Thereby, counter-radiation occurs which induces a so-called *radiative transfer*. This aspect involved the rise of numerous theories (e.g. [10] [11] [12]). But the co-existence of theories is in contrast to the scientific principle that for each phenomenon solely one explanation or theory is admissible.

Already simple thoughts may lead on to question this theory. For instance: Supposing the present CO_2-concentration of approx. 400 ppm (parts per million) = 0.04%, one should wonder how the temperature of the atmosphere can depend on such an extremely low gas amount, and why this component can be the predominant or even the sole cause for the atmospheric temperature. This would actually mean that the temperature would be situated near the absolute zero of −273˚C if the air would contain no CO_2 or other greenhouse gases.

Indeed, no special physical knowledge is needed in order to realize that this theory cannot be correct. However, the fact that it has settled in the public mind, becoming an important political issue, requires a more detailed investigation of the measuring methods and their results which delivered the foundations of this theory, and why misinterpretations arose. Thereto, the two subsequent points have to be particularly considered: The *first point* concerns the photometrical measurements on gases in the electromagnetic range of thermal radiation which initially *Tyndall* had carried out in the 1860s [13], and which had been expanded to IR-measurements evaluated by *Plass* nineteen years later [14]. The *second point* concerns the application of the Stefan/Boltzmann-law on the Earth-atmosphere system firstly made by *Arrhenius* in 1896 [2], and more or less adopted by modern atmospheric physics. Both approaches are deficient and would question the greenhouse theory without requiring the authors own approaches. Thus it is indicated to outline them at first.

2.1. The Photometric and IR-Measurement Methods for CO_2

As the view on Tyndall's equipment (shown in **Figure 2**) reveals, much less materials and devices were obtainable in the 1860's than they are readily available nowadays. E.g., the lightbulb was invented only 1879 by Edison. Anyway, the heat source which was needed for those measurements should work at many lower temperatures than a lightbulb does, namely at approx. 100˚C. Thereto, so-called *Leslie-cubes* were used (in the figure indicated with c), consisting of hollow metal cubes which were filled with water and heated by Bunsen burners up to the desired temperature (usually up to the boiling point of water). Moreover, no photo-sensors existed in order to measure the radiation intensity. However, thermocouples were already available which enabled the measurement of temperature differences, but requiring an additional Leslie-cube as a reference. Therewith, the intensity-decrease of the thermal radiation could be determined, due to the embedded gas, which enabled to draw conclusions with respect to its absorption behaviour. Thereby, it turned out that some gases such as CO_2 absorb thermal radiation, in contrast to nitrogen and oxygen.

Later on, these findings were principally adapted to IR-spectroscopic measurements, mainly reported (but not self-made) by *Plass* [14], which meanwhile

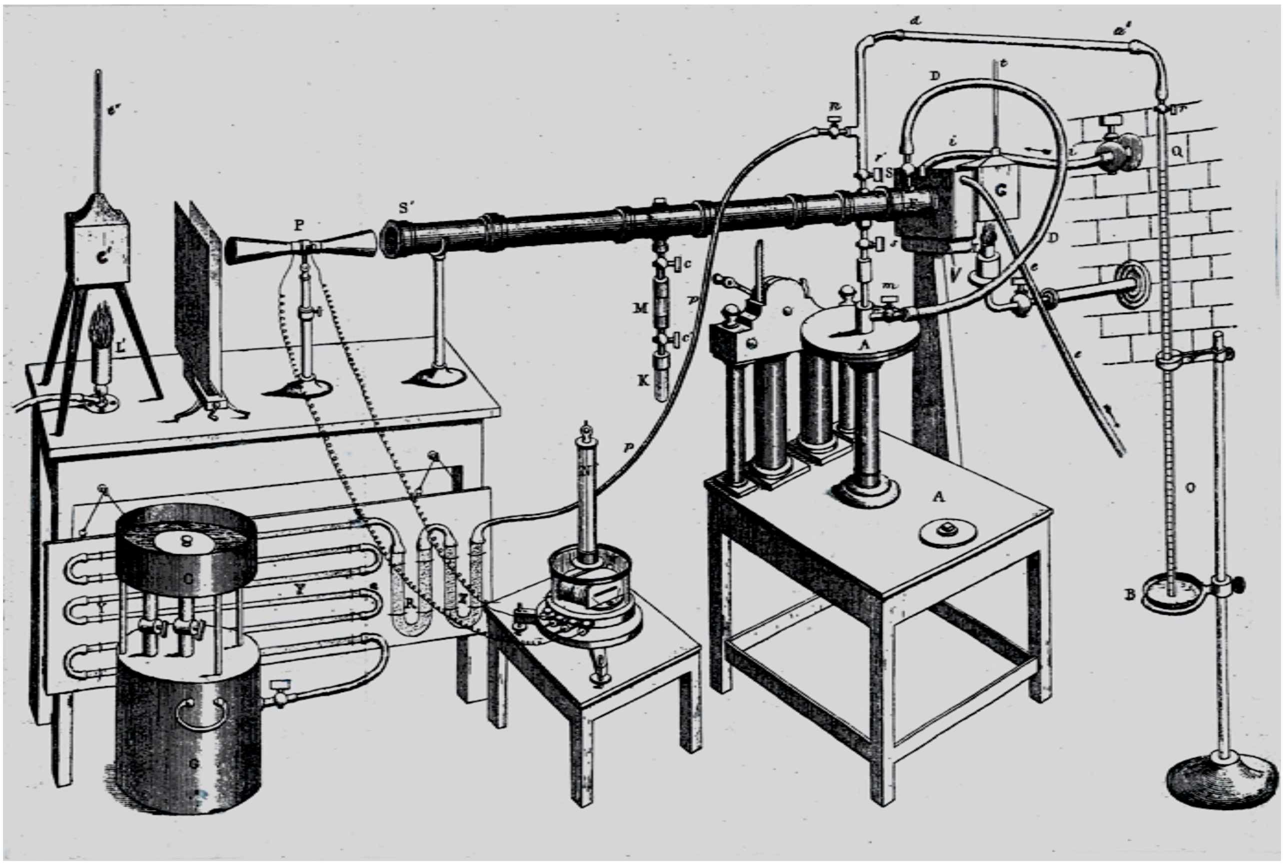

Figure 2. Equipment of Tyndall in order to measure the absorption of the thermal radiation by gases [13]; see also **Figure 1** in [21].

had come up in chemical labs for analytical purposes. In contrast to the method of Tyndall where a light ray with a wide wavelength range had been used, in this case light rays with a narrow wave length range where applied. Thereto, the light was generated by a lamp and restricted by means of a prism and an aperture engendering light with a well-defined wave length. In particular, very high gas pressures and extraordinary long tubes were used (see the respective citations in [15]).

By variation of the wave length and measuring the respective absorption, the spectrum of a substance can be evaluated. This IR-spectroscopic method is widely used in order to characterize organic chemical substances and chemical bonds, usually in solution. But even there this method is not suited for quantitative measurements, *i.e.* the absorption of the IR-active substance is not proportional to its concentration as the Beer-Lambert law predicts. It probably will even less be the case in the gaseous phase and, all the more, at high pressures which were applied in order to imitate the large distances in the atmosphere in the range of several (up to 10) kilometres. Thereby it is disregarded that the pressure of the atmosphere depends on the altitude above sea level, which prohibits the assumption of a linear progress.

Moreover, it is disregarded that at IR-spectrographs the effective radiation intensity is not known, and that in the atmosphere a gas mixture exists where the CO_2 amounts solely to a little extent, whereas for the spectroscopic measurements pure CO_2 was used. Nevertheless, in the text books for atmospheric physics the Beer-Lambert law is frequently mentioned, however without delivering concrete numerical results about the absorbed radiation.

In both cases solely the *absorption degree* of the radiation was determined, *i.e.* the decrease of the radiation intensity due to its run through a gas, but *never its heating-up*, that means its temperature increase. Instead, it was assumed that a gas is necessarily warmed up when it absorbs thermal radiation. According to this assumption, pure air, or rather a 4:1 mixture of nitrogen and oxygen, is expected to be not warmed up when it is thermally irradiated since it is IR-spectroscopically inactive, in contrast to pure CO_2.

However, no physical formula exists which would allow to calculate such an effect, and no respective empirical evidence was given so far. Rather, the measurements which were recently performed by the author delivered converse, surprising results.

2.2. The Impact of Solar Radiation onto the Earth Surface and Its Reflexion

Besides, a further error is implicated in the usual greenhouse theory. It results from the fact that the atmosphere is only partly warmed up by direct solar radiation. In addition, it is warmed up *indirectly*, namely via Earth surface which is warmed up due to solar irradiation, and which transmits the absorbed heat to the atmosphere either by thermal conduction or by thermal radiation. Moreover, air convection contributes a considerable part. This process is called Anthropogenic Heat Flux (AHF). It has recently been discussed by Lindgren [16]. However, herewith a more fundamental view is outlined.

The *thermal radiation* corresponds to the radiative emission of a so-called "black body". Such a body is defined as a body which entirely absorbs electromagnetic radiation in the range from IR to UV light. Likewise, it emits electromagnetic radiation all the more as its temperature grows. Its radiative behaviour is formulated by the law of *Stefan* and *Boltzmann*, whose empiric part was published 1886 by Stefan [17] (who evaluated the results of cooling-down experiments with two differently large thermometer-balls, got by *Dulong* and *Petit* and published in 1817 [18]; equipment see **Figure 3**), whereas the theoretic verification was delivered 1884 by Boltzmann [19].

According to this law, the radiation wattage Φ of a black body is proportional to the fourth power of its absolute temperature. Usually, this wattage is related to the area, exhibiting the dimension W/m^2. The *Stefan/Boltzmann-constant σ* represents the proportionality factor and amounts to 7.67×10^{-16} $Jm^3 \cdot K^{-4}$. Thus there is (1)

$$\Phi = \sigma \cdot T^4 \tag{1}$$

whereby T = absolute temperature [K].

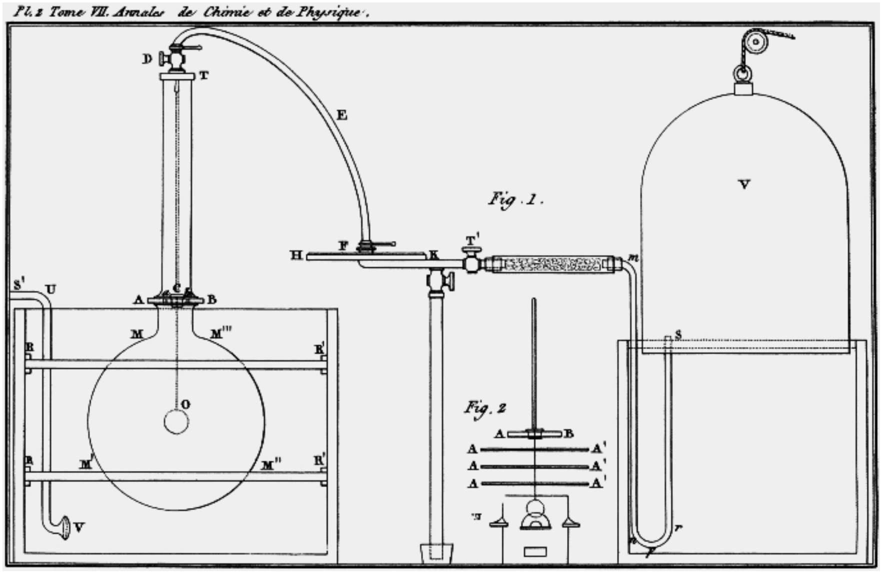

Figure 3. Equipment of Dulong and Petit, according to [18].

This formula does not allow making a statement about the wave-length or the frequency of the emitted light. This is only possible by means of Max Planck's formula which was published in 1900. According to that, the frequencies of the emitted light tend to be the higher the temperature is. At low temperatures, only heat is emitted, *i.e.* IR-radiation. At higher temperatures the body begins to glow: first of all in red, and later in white, a mixture of different colours. Finally, UV-radiation emerges. The emission spectrum of the sun is in quite good accordance with Planck's emission spectrum for approx. 6000 K.

The here relevant model implies three agents: Firstly, a *radiation source* generating light with the intensity Φ; secondly, a *black body* which is irradiated by this radiation source and which is thereby warmed up to a constant temperature T_2, whereby the absorbed radiation is completely converted into heat; and thirdly, an *additional black body* which is in radiative contact with the warmed-up black body but which is kept at a constant initial temperature T_1. Thereby, the absorbed and the emitted radiation of the warmed-up body are in equilibrium. Thus, the Stefan/Boltzmann-law turns into (2):

$$\Phi = \sigma \cdot \left(T_2^4 - T_1^4\right) \tag{2}$$

If the irradiated body is not black but coloured, it adsorbs only a part of the radiation, being expressible by the *solar absorption coefficient* β_s which depends on the kind of the coloration. Thus Equation (2) coverts to Equation (3):

$$\Phi \cdot \beta_s = \sigma \cdot \left(T_2^4 - T_1^4\right) \tag{3}$$

This model can be applied on Earth surface considering it as a coloured opaque body: On one side, with respect to its thermal emission, it behaves like a black body fulfilling the Stefan/Boltzmann-law. On the other side, it adsorbs only a part β_s of the incident solar light, converting it into heat, whereas the complementary part is reflected. However, the intensity of the incident solar light on

Earth surface $\Phi_{surface}$ is not identically equal with its extra-terrestrial intensity beyond the atmosphere[1] but depends on the sea level since the atmosphere absorbs a part of the sunlight. Remarkably, *the atmosphere behaves like a black body, too*, but solely with respect to the emission: On one side, it radiates inwards to the Earth surface, and on the other side, it radiates outwards in the direction of the rest of the atmosphere. If the thermal inward (or counter) radiation of the atmosphere is neglected since it is in equilibrium with the thermal outward radiation of the Earth, Equation (4a) is valid:

$$\Phi_{surface} \cdot \beta_s = \sigma \cdot \left(T_{Earth}^4 - T_{air}^4 \right) \tag{4a}$$

Therein, T_{Earth} corresponds to T_2, while T_{air} corresponds to T_1. Ordinarily, instead of the absorption-coefficient β_s, the complementary *solar reflexion-coefficient* $\alpha_s = 1 - \beta_s$ is used (often called "Albedo") since at field measurements solely the latter one is determinable, defined as the ratio between the incident and the emitted radiation. Therefore, Equation (4b) is used instead of Equation (4a):

$$\Phi_{surface} \cdot \left(1 - \alpha_s \right) = \sigma \cdot \left(T_{Earth}^4 - T_{air}^4 \right) \tag{4b}$$

Figure 4 shows an example of a commercially available "Albedometer". It is equipped with two electronic radiometers, one upwards and the other downwards.

However, this method implies three considerable snags:

• Firstly, T_{Earth} means the *constant limiting temperature* of the Earth surface which is attained when the sun had constantly shone onto the same parcel and with the same intensity. But this is never the case, except at thin plates which are thermally insulated at the bottom and at the sides, since the position of the sun changes permanently.

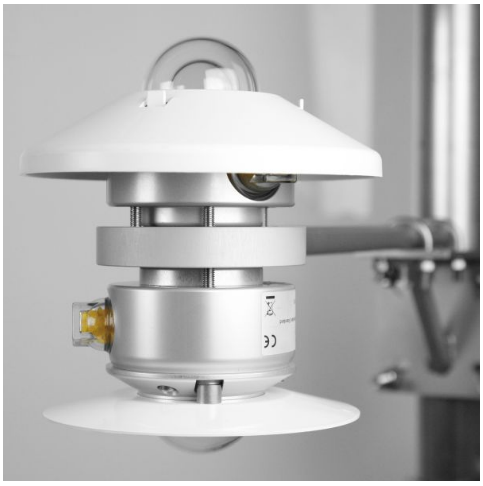

Figure 4. Commercially available Albedometer, equipped with two electronic radiometers (one upwards and the other downwards).

[1]Commonly, its extra-terrestrial value is assumed to be invariant, namely 1360 Wm^{-2}. However, this cannot be true since the distance between Earth and Sun varies during the elliptic Earth orbit around the Sun, which implies a variation of the light intensity.

• Secondly, this formula does not allow making a statement about the *rate* of the warming up-process, which depends on the heat capacity of the involved plate, too. This is solely possible using the author's approach (see Chapter 3). Nevertheless, it is often attempted (e.g. in [35]), not least within radiative transfer approaches.

• Thirdly, it is principally impossible to determine the absolute values of the solar reflection coefficient α_s with an Albedometer or a similar apparatus, because the intensity of the incident solar light is independent of the distance to the surface, whereas the intensity of the reflected light depends on it. Thus, the herewith obtained values depend on the distance from Earth surface where the apparatus is positioned. So they are not unambiguous but only relative.

The considerations of *Arrhenius* allege being based on Stefan's law, too, applied on the whole Earth [2]. However, they are unintelligible, not least because the solar absorption coefficient appears on the wrong side of the relevant equation, actually in the square.

In the modern approach of *Hansen et al.* [5] the Earth is apprehended as a coherent black body, disregarding its segmentation in a solid and a gaseous part, and thus disregarding the contact area between Earth surface and the atmosphere where the reflexion of the sunlight takes place. As a consequence, in Equation (4b) the expression with T_{air} disappears, whereas a total Earth temperature appears which is not definable and not determinable. This approach has been widely adopted in the textbooks, even though it is wrong (see also [15]). Altogether, the matter of fact was neglected that the proportionality of the radiation intensity to the absolute temperature to the fourth is solely valid if a constant equilibrium is attained.

In contrast, the subsequently described method enables the direct detection of the colour dependent solar absorption coefficient $\beta_s = 1 - \alpha_s$ using well-defined plates. Furthermore, the time/temperature-courses are mathematically modelled up to the limiting temperatures. Finally, relative field measurements are possible based on these results.

3. The Measurement of Solar Absorption-Coefficients with Coloured Plates

Within the here described and in [20] published lab-like method, not the reflected but the absorbed sun radiation was determined, namely by measuring the temperature courses of coloured quadratic plates (10 × 10 × 2 cm^3) when sunlight of known intensity came vertically onto these plates. The temperatures of the plates were determined by mercury thermometers, while the intensity of the sunlight was measured by an electronic "Solarmeter" (KIMO SL 100). The plates were embedded in Styrofoam and covered with a thin transparent foil acting as an outer window in order to minimize erratic cooling by atmospheric turbulence (**Figure 5**). Their heat capacities were taken from literature values. The colours as well as the plate material were varied. Aluminium was used as a reference material, being favourable due to its high heat capacity which entails a low heating rate and a homogeneous heat distribution. For comparison, additional measurements were made by wooden plates, bricks and natural stones. For enabling a permanent optimal orientation towards the sun, six plate-modules were positioned on an adjustable panel (Figure 6).

Thereby it has to be supposed that the plates emit thermal radiation all the more as its temperature increases, until a limiting equilibrium temperature is attained where the radiation and the emission intensities are equal. However, during the usual irradiation period of 30 minutes this equilibrium temperature was not attained, so that only the heating-up rate could be determined, namely by evaluating the initial slopes of the time/temperature curves.

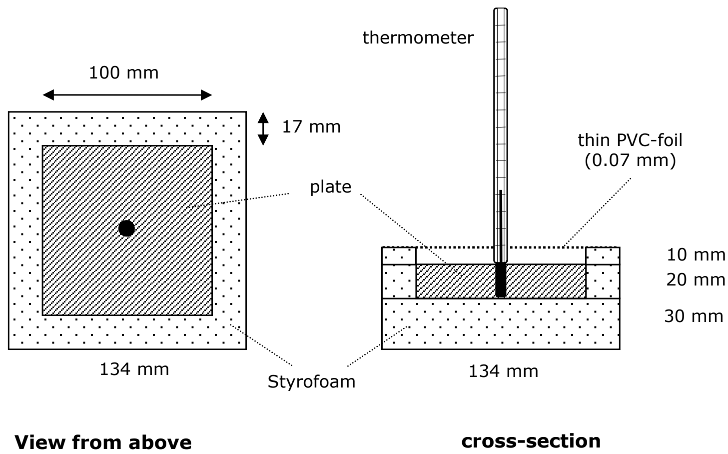

Figure 5. Plate embedded into Styrofoam [20].

Figure 6. Panel comprising six modules containing different-coloured plates [20].

In Figure 7 such curves are rendered for six typical colours using aluminium plates. At plates with lower heat capacities such as wood, the warming-up proceeded faster involving steeper curves (Figure 8). Obviously, in that case the curves began to decline in the further course since the ratio between the thermal emission intensity and the thermal absorption intensity was greater. However, the proportions of the initial slopes kept constant.

In order to calculate the colour-specific solar absorption-coefficients β_s which depends on the heat capacity of the plate, the following relation for the warming-up rate can be applied. It is determined by the irradiation density of the sunlight, the solar absorption coefficient of the relevant colour, and the thermal admittance of the plate. Within the initial linear range of the curve, the resulting temperature T is given by Equation (5):

$$\frac{T - T_0}{t} = \frac{\Phi \cdot \beta_s}{C_A} \tag{5}$$

T = temperature of the plate [K] or [˚C].

T_0 = starting temperature of the plate [K] or [˚C].

t = time [s].

Φ = irradiation density of the sunlight at the surface [$W \cdot m^{-2}$] where 1 W = 1 $J \cdot s^{-1}$.

β_s = solar absorption-coefficient.

C_A = thermal admittance of the plate [$J \cdot g^{-1} \cdot K^{-1}$],

$$C_A = c_m \cdot \rho \cdot d \cdot 10^4$$

c_m = mass specific heat capacity of the plate material [$J \cdot g^{-1} \cdot K^{-1}$],

ρ = density of the plate material [$g \cdot cm^{-3}$],

d = thickness of the plate [cm].

The evaluation of the curves of Figure 7 yielded the colour specific solar absorption-coefficients β_s rendered in Figure 9. They were independent of the plate material. Remarkably, the value for green was relatively high.

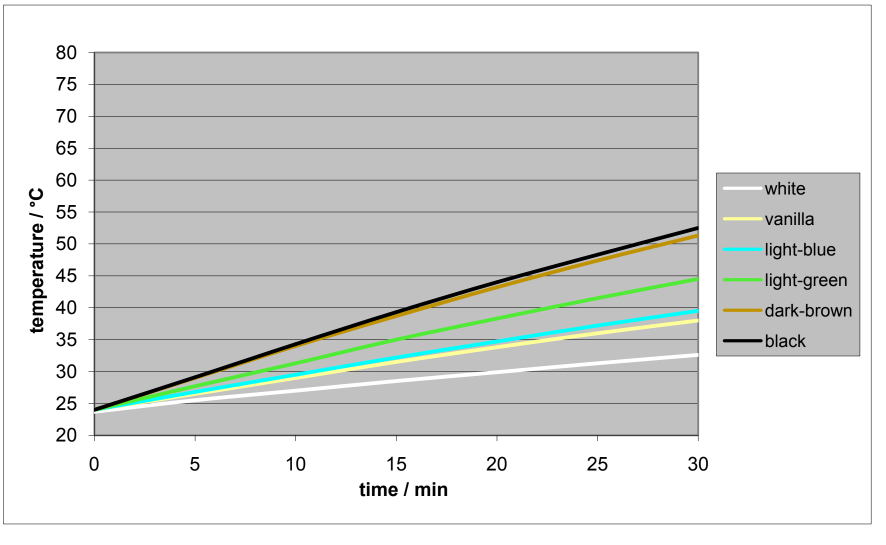

Figure 7. Warming-up of aluminium plates at 1040 W/m² [20].

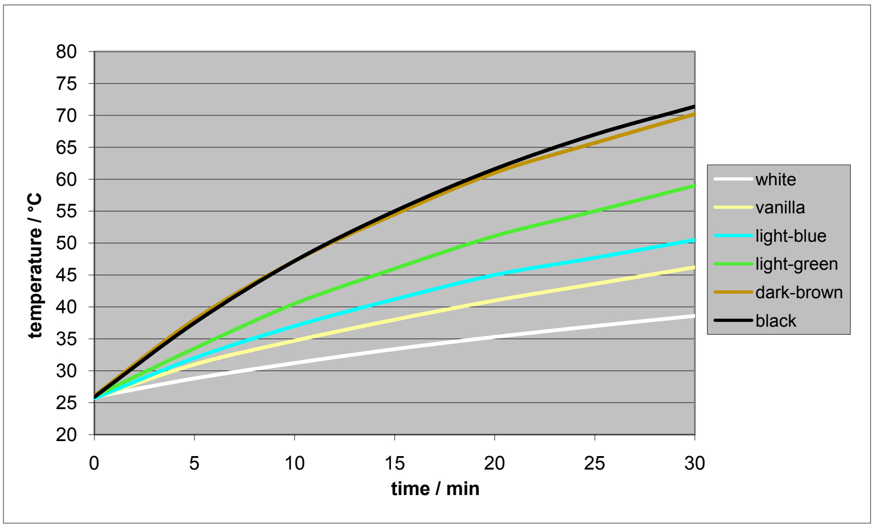

Figure 8. Warming-up of wood plates at 970 W/m² [20].

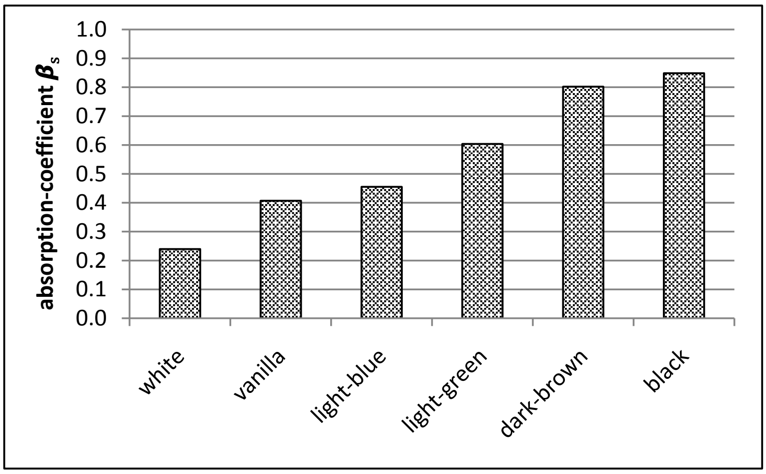

Figure 9. Solar absorption-coefficients β_s [20].

If the sunlight irradiation and thus the warming-up process would be continued, finally constant limiting temperatures are attained. However, when 20 mm thick aluminium plates are used, the hereto needed time would be too long, exceeding the constantly available sunshine period during a day[2]. Instead, separate cooling-down experiments were made, allowing a mathematical modelling of the whole process including the determination of the limiting temperatures.

Those experiments were made in a partly darkened room with a known constant ambient temperature between 20˚C - 25˚C, using the same module (namely a plate embedded in Styrofoam and overlaid with a thin PVC-foil). In contrast to the heat capacity of the material, the colour of the plate was irrelevant. Initially, each plate was heated in an oven on to a temperature above 60˚C. Afterwards, temperature readings were made at regular intervals, for aluminium of 15 minutes, and for wood and brick of 5 minutes (since the latter ones cooled down more rapidly). The results for four different plate types are rendered in **Figure 10**.

[2]Respective measurements were made afterwards, using 8 mm aluminium plates [24].

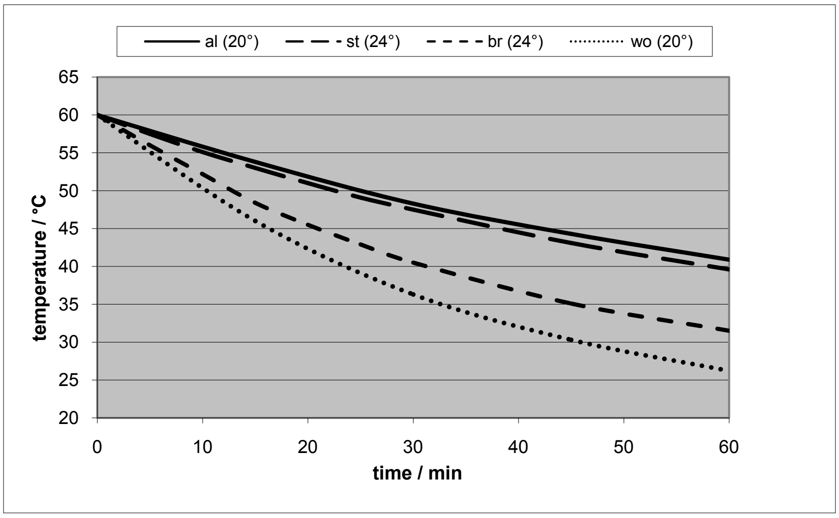

Figure 10. Cooling-down of different materials (in brackets: ambient temperature) [20]. al = aluminium 20 mm; st = stone 20.5 mm; br = brick 14.5 mm; wo = wood 17.5 mm.

The cooling-down process could be mathematically described by formula (6), implying the solution of a differential equation:

$$T = T_{am} + \left(T_{in} - T_{am}\right) \cdot \mathrm{e}^{-\frac{B \cdot A}{m \cdot c_m} t} \tag{6}$$

T_{am} = ambient room temperature.

T_{in} = initial surface temperature of the plate.

B = heat transfer coefficient [$W \cdot m^{-2} \cdot K^{-1}$].

A = surface area of the plate [m^2].

m = mass [g].

The size of the ***heat transfer coefficient B*** [$\mathbf{W \cdot m^{-2} \cdot K^{-1}}$] was determined graphically by a linear plot according to formula (7):

$$\ln\left(\frac{T_{in} - T_{am}}{T - T_{am}}\right) = \frac{B \cdot A}{m \cdot c_m} t \tag{7}$$

For the four tested materials, the numerical values amounted to

Aluminium	8.8
Stone	9.7
Brick	9.0
Wood	7.4

In spite of a slow variation, it seemed appropriate to assume for ***B*** an invariant value of approx. **9** $\mathbf{W \cdot m^{-2} \cdot K^{-1}}$. Naturally, this value considerably increases when the PVC-foil is absent.

Using this coefficient B, the equations for the heating-up process and the cooling-down process were combined, delivering formulas for the calculation of the time/temperature course (8) as well for the limiting temperature T_{lim} (9):

$$T = T_{am} + \frac{\beta_s \cdot \Phi}{B}\left(1 - \mathrm{e}^{-\frac{B \cdot A}{m \cdot c_m} t}\right) \tag{8}$$

$$T_{lim} = T_{am} + \frac{\beta_s \cdot \Phi}{B} \quad (9)$$

These limiting temperature values are in good accordance with the empirical values reported in [24] and with the Stefan/Boltzmann-values. As obvious from the respective diagrams in **Figure 11** and **Figure 12**, the limiting temperatures are independent of the plate-materials, whereas the heating rates strongly depend on them.

In principal, it is also possible to model combined heating-up and cooling-down processes [20]. However, this presumes constant environmental conditions which normally do not exist.

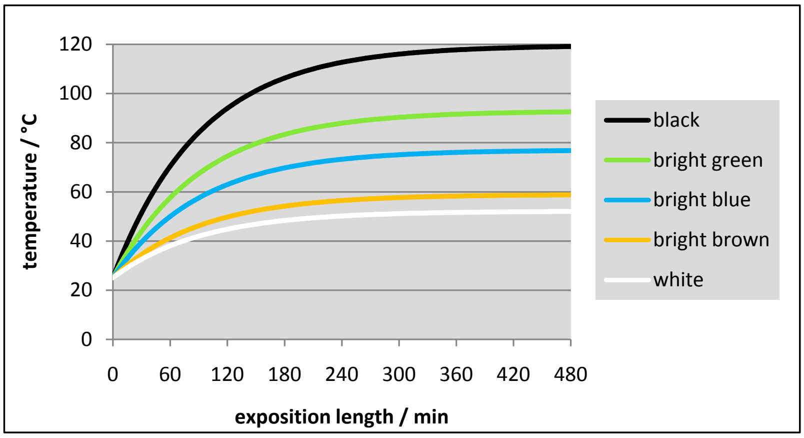

Figure 11. Modelled temperature courses for 20 mm thick aluminium plates at 1000 W/m² [20].

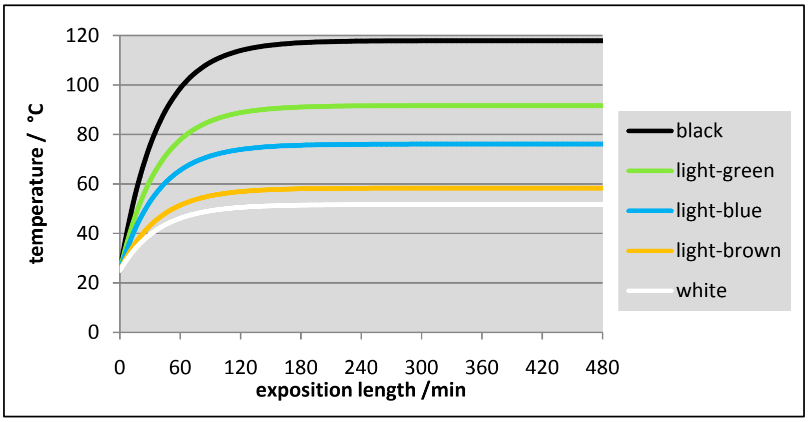

Figure 12. Modelled temperature courses for 14.5 mm thick brick plates at 1000 W/m² [20].

4. Thermal Gas Absorption Measurements

If the warming-up behaviour of gases has to be determined by temperature measurements, interference by the walls of the gas vessel should be regarded since they exhibit a significantly higher heat capacity than the gas does, which implicates a slower warming-up rate. Since solid materials absorb thermal radiation stronger than gases do, the risk exists that the walls of the vessel are directly warmed up by the radiation, and that they subsequently transfer the heat to the gas. And finally, even the thin glass-walls of the thermometers may disturb the measurements by absorbing thermal radiation.

By these reasons, quadratic tubes with a relatively large profile (20 cm) were used which consisted of 3 cm thick plates from Styrofoam, and which were covered at the ends by thin plastic foils. In order to measure the temperature course along the tube, mercury-thermometers were mounted at three positions (beneath, in the middle, and atop) whose tips were covered with aluminium foils. The test gases were supplied from steel cylinders being equipped with reducing valves. They were introduced by a connecter during approx. one hour, because the tube was not gastight and not enough consistent for an evacuation. The filling process was monitored by means of a hygrometer since the air, which had to be replaced, was slightly humid. Afterwards, the tube was optimized by attaching adhesive foils and thin aluminium foils (see **Figure 13**). The equipment and the results are reported in [21].

The initial measurements were made outdoor with twin-tubes in the presence of solar light. One tube was filled with air, and the other one with carbon-dioxide. Thereby, the temperature increased within a few minutes by approx. ten degrees till constant limiting temperatures were attained, namely simultaneously at all positions. Surprisingly, this was the case in both tubes, thus also in the tube which was filled with ambient air. Already this result delivered the proof that the greenhouse theory cannot be true. Moreover, it gave rise to investigate the phenomenon more thoroughly by means of artificial, better defined light.

Figure 13. Solar-tube, adjustable to the sun [21].

Accordingly, the subsequent experiments were made using IR-spots with wattages of 50 W, 100 W and 150 W which are normally employed for terraria (**Figure 14**). Particularly the IR-spot with 150 W lead to a considerably higher temperature increase of the included gas than it was the case when sunlight was applied, since its ratio of thermal radiation was higher. Thereby, variable impacts such as the nature of the gas could be evaluated. The disadvantage of this method consisted in the fact that the intensity of artificial light, contrary to the one of sunlight, normally decreases along such a tube. In principal inversely proportional to the square of the distance, which complicated the assessment of the effective local radiation intensity. However, this gradient could be minimized by optimizing the tube-texture.

Due to the results with IR-spots at different gases (air, carbon-dioxide, the noble gases argon, neon and helium), essential knowledge could be gained. In each case, the irradiated gas warmed up until a stable limiting temperature was attained. Analogously to the case of irradiated coloured solid plates, the temperature increased until the equilibrium state was attained where the heat absorption rate was identically equal with the heat emission rate.

As evident from the diagram in **Figure 15**, the initial observation made with sunlight was approved that pure carbon-dioxide was warmed up almost to the same degree as air does (whereby ambient air only scarcely differed from a 4:1 mixture between nitrogen and oxygen). Moreover, noble gases absorb thermal radiation, too. As subsequently outlined, a theoretical explanation could be found thereto.

Interpretation of the Results

Regarding the initial slopes of the time/temperature-curves in the diagram of **Figure 15**, it becomes evident that the heating rates are identical equal in all cases, *i.e.* that they are independent of the gas type. However, significant differences arose at the limiting temperatures, which obviously was due to differences in the radiation power. Since then the absorbed radiation power exhibits the same size as the emission power, the latter one (which is not directly measurable) can be determined by the former one (which is directly measurable, namely by determining the light intensity at that position).

According to *the kinetic gas theory*, the thermic emission power of gases is proportional to the *collision frequency F* of the gas particles. Thereby, the *size* of the particles, or rather their *cross sectional area σ*, is relevant, together with the *pressure p* and the (*absolute*) *limiting temperature T*, corresponding to Equation (10):

$$F \sim p \cdot \sigma \cdot \sqrt{T/M} \quad M = \text{mole mass} \tag{10}$$

Using the limiting temperatures given in **Figure 15**, and using the literature values for the cross sectional areas of the noble gases helium, neon and argon, formula (1) could be roughly verified since the gas pressure and the radiation power of the IR-spot were constant.

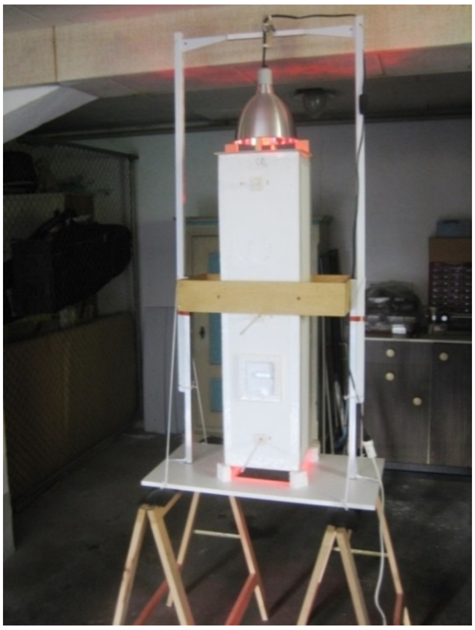

Figure 14. Heat-radiation tube with IR-spot [21].

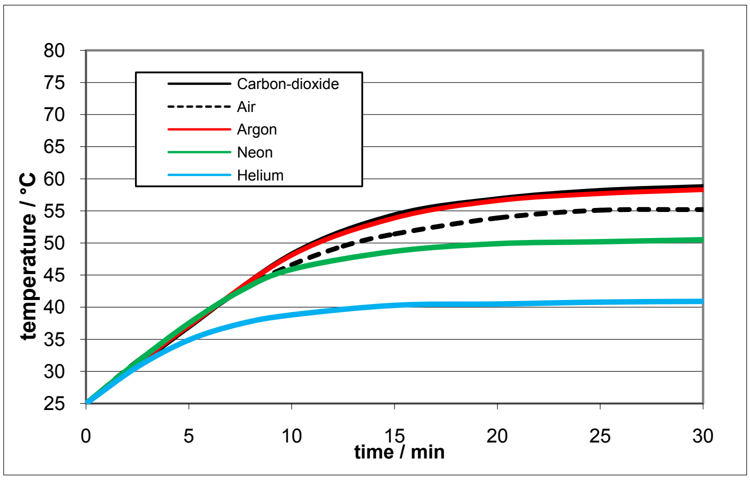

Figure 15. Time/temperature-curves for different gases [21] (150 W-spot, medium thermometer-position).

Moreover, comparison of the results obtained by the IR-spots, on the one hand, and those obtained with solar radiation, on the other hand, corroborated the conclusion that comparatively short-wave IR-radiation was involved (namely between 0.9 and 1.9 μm). However, subsequent measurements with a hotplate (<90˚C), placed at the bottom of the heat-radiation tube ([15], Figure 16), yielded that long-wave thermal radiation (which is expected at bodies with lower temperatures such as Earth surface) induces also temperature increase of air and of carbon-dioxide, cf. Figure 17.

Thus, the herewith discovered absorption effect at gases proceeds over a relatively wide wave-length range, in contrast to the IR-spectroscopic measurements where only narrow absorption bands appear. This effect is not exceptional, *i.e.* it occurs at all gases, also at noble gases, and leads to a significant temperature increase, even though it is spectroscopically not detectable. This temperature increase overlays an eventual temperature increase due to the specific IR-absorption since the intensity ratio of the latter one is very small.

This may be explained as follows: In any case, an *oscillation of particles*, induced by thermal radiation, acts a part. But whereas in the case of the specific IR-absorption the *nuclei inside the molecules* are oscillating along the chemical bond (which must be polar), in the here relevant case the *electronic shell inside the atoms*, or rather the electron orbit, is oscillating implicating oscillation energy. Obviously, this oscillation energy can be converted into kinetic translation energy of the entire atoms which correlates to the gas temperature, and vice versa.

Figure 16. Heat radiation tube with a hot-plate [15].

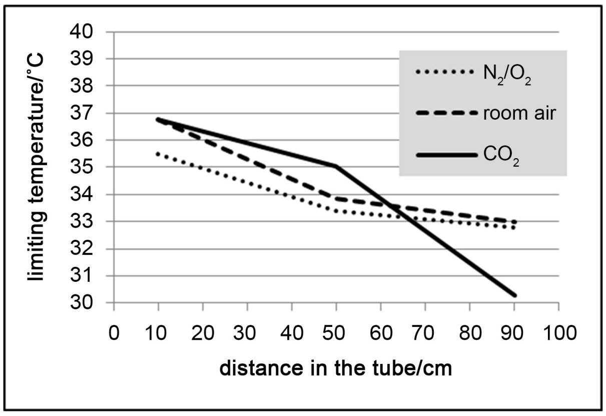

Figure 17. Temperature courses of air, a N_2/O_2 mixture (4:1), and of CO_2 in a heat radiation tube with a hot-plate [15].

In order to explain the oscillation of the electronic shell, *quantum mechanics* has to be adduced, preferably considering the simplest case, namely helium. The problem seems to be quite intricate; at least it has not been solved so far using the traditional quantum mechanics based on Heisenberg's uncertainty principle implying electronic probabilities of presence, instead of well-defined electron-trajectories. However, the approach assuming such well-defined electron-trajectories, which has been recently developed by the author [22], promises to find the solution, but the respective work is still in progress.

Meanwhile, these empirical findings were principally confirmed by the work of *Seim* and *Olsen* [23] which had been carried out independently. In that case a quadratic tube from Styrofoam was used, too. However, it was divided in two chambers which were filled with different gases. One cell was filled with air, and the other one with CO_2 or with argon, respectively. A metal plate, which was warmed up by a 500 W halogen-lamp, served as heat source. Even though the theoretic background, based on a radiative transfer model, is questionable, the empiric result is remarkable since it also exhibits limiting temperatures, whereby air behaved similar to CO_2 and to argon.

5. The Altitude-Paradox of the Atmospheric Temperature

The statement that it's colder in the mountains than in the lowlands is trivial. Not trivial is the attempt to explain this phenomenon since the reason is not readily evident. The usual explanation is given by the fact that rising air cools down since it expands due to the decreasing air-pressure. However, this cannot be true in the case of plateaus, far away from hillsides which engender ascending air streams. It appears virtually paradoxical in view of the fact that the intensity of the sun irradiation is much greater in the mountains than in the lowlands, in particular with respect to its UV-amount. Thereby, the intensity decrease is due to the scattering and the absorption of sunlight within the atmosphere, not only within the IR-range but also in the whole remaining spectral area. If such an absorption, named Raleigh-scattering, didn't occur, the sky would not be blue but black.

However, the direct absorption of sunlight is not the only factor which determines the temperature of the atmosphere. Its warming-up via Earth surface, which is warmed up due to absorbed sun-irradiation, is even more important. Thereby, the heat transfer occurs partly by heat conduction and air convection, and partly by thermal radiation. But there is an additional factor which has to be regarded: namely the thermal radiation of the atmosphere. It runs on the one hand towards Earth (as counter-radiation), and on the other hand towards Space. Thus the situation becomes quite complicated, all the more the formal treatment based on the Stefan/Boltzmann-relation would require limiting equilibrated temperature conditions. But in particular, that relation does not reveal an influence of the atmospheric pressure which obviously acts a considerable part.

In order to explain and to empirically verify the respective correlations, particularly the influence of the atmospheric pressure, both here presented methods [20] and [21] were used, instead of the Stefan/Boltzmann-relation: the thermal radiation law implying the air-pressure, on one hand, and the measuring method with coloured aluminium-plates on the other hand (namely white, light-blue, light green and black ones). However, because it was necessary to attain the limiting temperatures within the available measuring time, thinner plates were used, namely 8 mm (instead of 20 mm) thick ones [24].

According to the theoretically deduced Equation (11), the thermal emission power Φ of a gas is proportional to the collision frequency of its particles, which depends on the gas pressure and on the cross sectional area σ as well as on the mass of the particles. Since in the case of air both predominant molecules, namely those of nitrogen and of oxygen, are very similar in size and mass, Φ can be expressed by Equation (11):

$$\Phi_{emission\ atm} = p_{atm} \cdot A \cdot \sqrt{T_{atm}} \tag{11}$$

A = atmospheric emission constant.

Therein the constant A is not readily known, but it may be empirically determined at two different positions by varying the atmospheric pressure and detecting the respective limiting temperatures in the presence of sunlight. At each such position, the intensity of the absorbed sunlight is identical equal with the intensity of the emitted radiation of the atmosphere, yielding Equation (12):

$$\Phi_{sunlight} \cdot \beta_s = c_m \cdot m_{plate} \cdot \left(T_{plate,lim} - T_{atm}\right) = p_{atm} \cdot A \cdot \sqrt{T_{atm}} \tag{12}$$

In order to study the dependency on the atmospheric pressure, it would be desirable solely varying the pressure, whereas the other terms remain constant by varying the altitude of the measuring station above sea level which implicates a variation of the intensity of the sunlight and of the ambient atmosphere temperature, too.

The here reported measurements were made at two locations in Switzerland, namely at Glattbrugg (close to Zürich), 430 m above sea level, and at the top of the Furka pass, 2430 m above sea level. Using the barometric height formula, the respective atmospheric pressures were approx. 0.948 and 0.748 bar.[3] At any position, two measurements were made in the same space of time.

Figure 18 renders the data of one measurement pair. Obviously, the limiting temperatures were not ideally attained within 90 minutes. Moreover, the evaluation of the data didn't provide strictly invariant values for A. But this is reasonable in view of the fact that the sunlight intensity was not entirely constant during that period, and that its spectrum depends on the altitude over sea level. Nevertheless, for the ***atmospheric emission constant A*** an approximate value of **22 $W \cdot m^{-2} \cdot bar^{-1} \cdot K^{-0.5}$** could be found.

These findings indeed confirm that in a way a greenhouse-effect occurs, since the atmosphere thermally radiates back to Earth surface. But this radiation has

[3]The values delivered by the official measuring stations are not useful since they are reduced to sea level

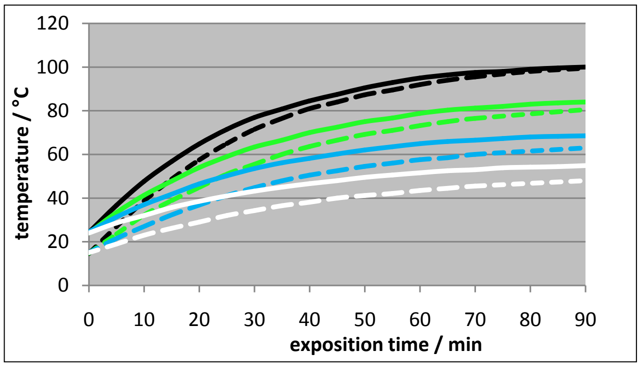

Figure 18. Comparison of the temperature courses during two measurements [24] (continuous lines: Glattbrugg; dotted lines: Furka).

nothing to do with trace gases such as CO_2. It rather depends on the atmospheric pressure which diminishes at higher altitudes.

If the oxygen content of the air would be considerably reduced, a general reduction of the atmospheric pressure and, as a consequence, of the temperature would proceed. This may be an explanation for the appearance of glacial periods. However, other explanations are possible, in particular the temporary decrease of the sun activity.

Over all it can be stated that climate change cannot be explained by ominous greenhouse gases such as CO_2, but mainly by artificial alterations of Earth surface, particularly in urban areas by darkening and by enlargement of the surface (so-called roughness). These urban alterations are not least due to the enormous global population growth, but also to the character of modern buildings tending to get higher and higher, and employing alternative materials such as concrete and glass. As a consequence, respective measures have to be focussed, firstly mentioning the previous work, and then applying the here presented method.

6. Recommendable Measures

In the context of the current climate discussion, local microclimates and the phenomenon of the so-called urban heat islands represent considerable topics implying real chances for improving the micro climatic conditions by artificial measures. Such measures affect pavements, fronts and – in particular – roofs, being customarily called "cool roofs". However, no significant efforts have been made so far, in spite of the considerable research which had been conducted for a long time, and in spite of the recently made proclamation in *Nature* by Hannah Huag [25].

Luke Howard was the first to provide evidence that air temperatures are often higher in the city of London than in its surrounding countryside, namely 190 years ago [26]. But only after the Second World War, this issue was taken up [27], while a series of investigations followed, sampling the temperature distributions of many cities, and considering different influences such as surface geometry, wind convection and water transfer. In order to be better able explaining the surface boundary effects due to solar radiation particularly in cities, for around the year 2000 several mathematic models were proposed, e.g. by Mills [28], Grimmond and Oke [29], Masson [30], Kusaka *et al.* [31], and Erell and Williamson [32]. A review about the application of urban climate research in the design of cities is given by Erell [33]. In particular, the work of H. Akbari and M. Pomerantz *et al.* from the *Lawrence Berkely National Laboratory* in California has to be mentioned [34] [35] [36], as well the one of L. Douros, M. Santamouris and I. Livada from the University of Athens [37] [38] [39]. Further quotations are given at the homepage of the "Heat Island Group" (Berkeley University) [40].

As evident from paper [36], these authors were so much engrossed in the greenhouse theory that they considered the influence of the albedo inferior compared to the one of CO_2, solely being able to partly offset it and to save air-conditioning energy. The same objective is found at the "Cool Roof Councils" [41] and [42]. But in particular, a global model simulation was delivered as the alleged proof that the albedo effect would be negligible compared to the CO_2-effect, just by the "Heat Island Group" who was ever engaged in colour-dependent surface effects [43]. According to those, global cooling due to albedo effects ranged from 0.01 to 0.07 K, which corresponds to a CO_2 equivalent emission reduction of 25 - 150 billion tonnes of CO_2, indeed a discouraging result which compromises any efforts to improve the surface albedo, thus being counterproductive. However, both results cannot be maintained if the here described criteria are applied, apart from the finding that global modelling is not feasible.

Besides, these investigations implied several deficiencies with respect to the measurement and the calculation methods, as well to the characterisation feasibilities of the materials. In particular, the albedo values as well as the warming-up and the cooling-down rates were not correct from the already alleged reasons.

In summary, it can be stated that the former knowledge does not contain any significant aspects which exceed the feasibilities being included in method [20]. It enables measures which are more detailed described in the author's own publication [44], or which are obvious and generally known. They are briefly described below. However, in view of the complexity of the processes it appears impossible establishing a global climate-model which enables reliable prognoses, even when these novel perceptions are considered.

In urban areas, which are considered as the primary culprit in climate change, and which are the main subject of this treatment, three types of surfaces occur: pavements, facades at buildings, and roofs. Thereto, besides the surface colouring several further criteria have to be considered. They are briefly discussed hereinafter.

6.1. Colouring

It represents the governing criterion for any climate mitigation measures, and the herein presented method for determining the colour-dependent solar absorption coefficients β_s. The coefficients which are relevant for buildings and pavements are rendered in **Figure 19**. Certainly, different tinges are feasible.

However, additional criteria have to be regarded, first of all the aesthetic one.

Therefore, white roofs are not recommended. Rather, light-brown bricks exhibit not only low β_s-values (cf. **Figure 20**), but they are pleasing, too, in particular at ancient buildings (**Figure 21**). Painting roofs, in particular gabled ones, would be the easiest way in order to mitigate climate. It is advisable to document the effect with thermal images taken by a thermographic camera.

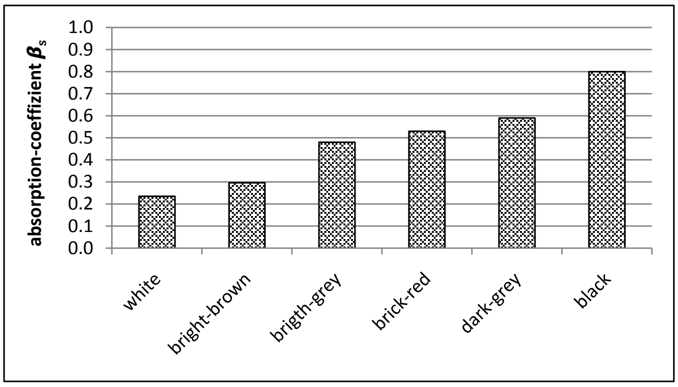

Figure 19. Solar absorption-coefficients being relevant for buildings and pavements.

Figure 20. Red-brick original with β_s = 0.53 (left) and coloured with β_s = 0.30 (right).

Figure 21. Guild-house "zur Zimmerleuten" in Zürich (Switzerland).

On the other hand, too bright building facades, in particular white ones, reflect the sunlight versus the ground, fortifying its warming-up, whereas too bright pavements of roads may glare the car drivers. In Los Angeles, California, a reflecting white coating for streets named "CoolSeal" is propagated [45], but long-term experiences were not reported.

6.2. Heat Capacity of Walls and Bricks

As evident from the behaviour of solar-irradiated plates, their warming-up rates do not only depend on their colouring but also on their heat capacity (c.f. Chapter 3, referred to [20]). Analogously, building-walls with low heat capacity warm up faster than ones with high heat capacity. For instance: a wall from wood warms up faster than a wall from stone of the same thickness. Therefore, wood-walls faster heat up the surrounding atmosphere than stone-walls do. Reversely, they faster cool-down in the absence of solar irradiation.

6.3. Heat Conductivity of Walls and Bricks

Similarly, the heat conductivity of the house-wall influences insofar its heating-up rate, and likewise the one of the surrounding atmosphere, as it implicates a slower removal of the heat. Thermal insulation materials such as Styrofoam exhibit not only low heat conductivity but also low heat capacity. Thus their surface temperature rises faster in the presence of solar irradiation. As a consequence, such insulation materials rather should be mounted inside the stone walls and not outside, as it is normally the case for house-walls, since that would reduce the size of the rooms. However, on roofs the thermal insulation is mounted usually inside.

6.4. Transparency of the Building Materials

More than ever, glass is not only used for windows but also for building material since it is lighter and less flawed than concrete. However, glass walls as well as windows act as heat traps, requiring cooling devices and thus additional energy, unless they are covered by blinds.

6.5. Weathering Resistance of Bricks

As evident from **Figure 22**, bricks normally are not wreathing resistant, becoming darker over time. Thus they should be impregnated.

6.6. Urban Canyons and Macro-Roughness

As schematically apparent from **Figure 23**, absorption of sunlight is amplified by a macro-rough Earth surface which is generated by urban canyons, in particular by skyscrapers. They represent the urban heat islands, inducing up-winds that are schematically drafted in **Figure 24**. Mega-cities such as Chongqing in China (**Figure 25**) aggregate all the negative influences which are responsible for global climate change. Due to their complexity, and due to the fact that these buildings already exist being and cannot to be spirited away, a solution of this problem seems to be very intricate. Possibly, the reflexion behaviour of such facades can be reduced by devices similar to blinds.

Figure 22. Aged roof with some recently replaced bricks.

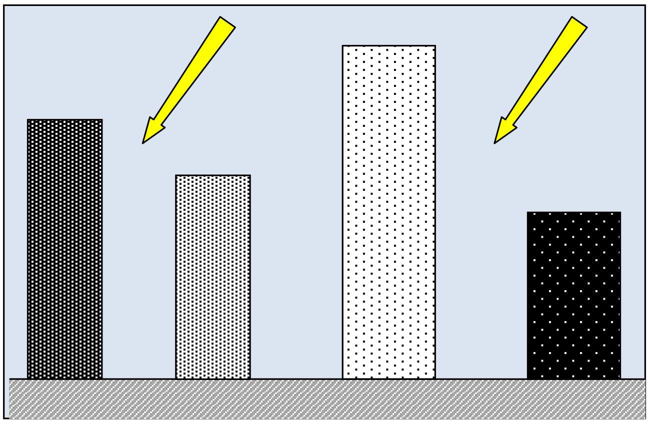

Figure 23. Schematic figure of sunlight-incidence at varyingly high buildings.

Figure 24. Up-winds induced by an urban heat island.

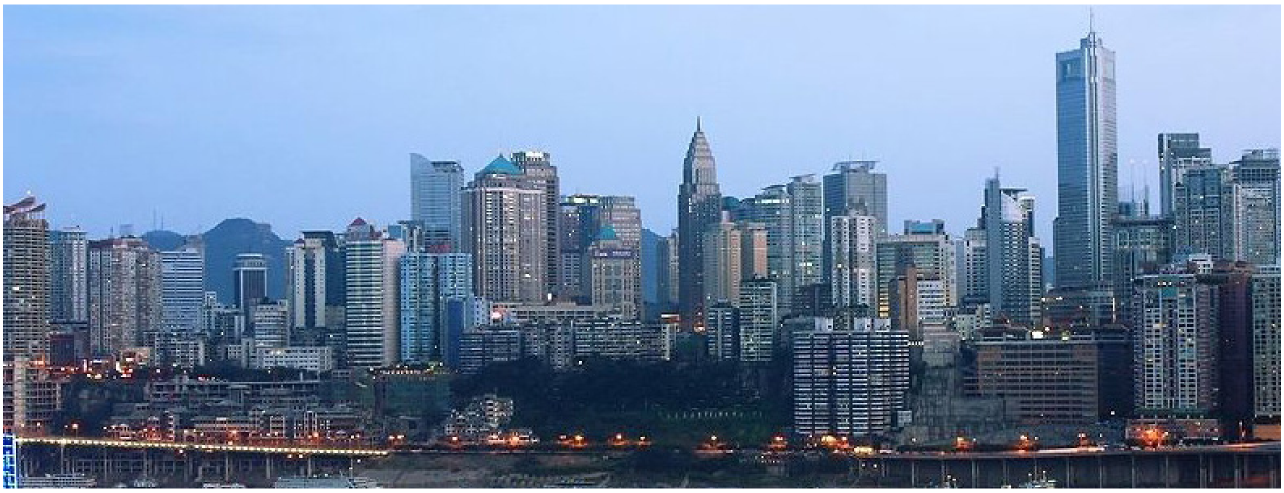

Figure 25. Skyline of the Mega-City Chongqing in China (32 million inhabitants).

7. Conclusions

The herewith summarized work of the author concerns atmospheric physics with respect to climate change, comprising three specific and interrelated points based on several previous publications: The first one consists in a critical discussion and refutation of the customary greenhouse theory; the second one outlines the method for measuring the thermal-radiative behaviour of gases; and the third one describes a lab-like method for the characterization of the solar-reflective behaviour of solid opaque bodies, in particular for the determination of the colour-specific solar absorption coefficients.

As to the first point, three main flaws were revealed: firstly, the insufficiency of photometric methods in order to determine the heating-up of gases in the presence of thermal radiation; secondly, the lack of a causal relationship between the CO_2-concentration in the atmosphere and the average global temperature, based on the reasoning that the empiric simultaneous increase of its concentration and of the global temperature would prove a causal relationship instead of an analogous one; and thirdly, the inadmissible application of the Stefan/Boltzmann-law to the entire Earth (including the atmosphere) versus Space, instead of the application onto the boundary between the Earth surface and the atmosphere.

As to the second point, the discovery has to be taken into account according to which *every* gas is warmed up when it is thermally irradiated, even noble gases, attaining a limiting temperature where the absorption of radiation is in equilibrium with the emitted radiation. In particular, pure CO_2 behaves similarly to pure air. Applying kinetic gas theory, a dependency of the emission intensity on the pressure, on the root of the absolute temperature, and on the particle size could be found and theoretically explained by oscillation of the electron shell.

As to the third point not only a lab-like measuring method for the colour dependent *solar absorption coefficient* β_s was developed, but also a mathematical modelling of the time/temperature-course where coloured opaque plates are irradiated by sunlight. Thereby, the (colour-dependent) warming-up and the (colour-independent) cooling-down are detected separately. Likewise, a limiting temperature occurs where the intensity of the absorbed solar light is identical equal with the intensity of the emitted thermal radiation. In the absence of wind-convection, the so-called *heat transfer coefficient B* is invariant. Its value was empirically evaluated, amounting to approx. 9 $W \cdot m^{-2} \cdot K^{-1}$. Therewith, the (colour-dependent) limiting temperature can be computed for each β_s-value, whereas the heating-up rate requires the knowledge of β_s and the heat-capacity. The calculated limiting temperatures coincide quite well with the measured ones, as well with those derived by the Stefan/Boltzmann-law. Obviously, such values and model-processes cannot easily be applied to walls and pavements or other material surfaces, since additional factors such as heat-capacity and heat-conductivity act a part, all the more wind convection or rain, or synergetic effects by adjacent buildings. However, they deliver valuable information with respect to measures which may be taken with respect to climate change mitigation.

Finally, the theoretically suggested dependency of the atmospheric thermal radiation intensity on the atmospheric pressure could be empirically verified by measurements at different altitudes, namely in Glattbrugg (430 m above sea level and on the top of the Furka-pass (2430 m above sea level), both in Switzerland, delivering a so-called *atmospheric emission constant A* ≈ 22 $W \cdot m^{-2} \cdot bar^{-1} \cdot K^{-0.5}$. It explained the altitude-paradox of the atmospheric temperature and delivered the definitive evidence that the atmospheric behavior, and thus the climate, does not depend on trace gases such as CO_2. However, the atmosphere thermally reradiates indeed, leading to something similar to a Greenhouse effect. But this effect is solely due to the atmospheric pressure.

Therefore, and also considering the results of Seim and Olsen [23], the customary greenhouse doctrine assuming CO_2 as the culprit in climate change has to be abandoned and instead replaced by the here recommended concept of improving the albedo by brightening parts of the Earth surface, particularly in cities, unless fatal consequences will be hazarded.

It seems evident that the first step should consist in brightening (gable)-roofs by in-situ-painting the bricks, preferably light-brown, since this would be the easiest and cheapest way to achieve progress. Of course, tinting variations should be admissible. Besides, that would beautify the landscape and provide more individual comfort. Certainly, millions of roofs will have to be treated till a global effect will be observable. But somewhere, or better at multiple locations, new grounds has to be broken, which certainly will be copied by others. It must be clear that such a drive of brightening-up the World would be the only chance of mitigating climate change. However, a global climate model with forecasts cannot be aspired to since this problem is too complex, and since several climate zones exist.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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