THE GREENHOUSE EFFECT DOES EXIST!

Commentary on the paper:

Falsification Of
The Atmospheric CO_2 Greenhouse Effects
Within The Frame Of Physics [1]

Dipl.-physicist Jochen Ebel

12. November 2014

Contents

Preliminary Remark

Both Authors (Prof. Gerhard Gerlich and Dr. Ralf D. Tscheuschner) of the paper »Falsification of the atmospheric CO_2 greenhouse effects«[1], ask for a discussion of their theses. In a detailed discussion it must be clear what will be discussed. For such a task the relevant original texts have to be summarized or quoted. With so many necessary quotations the quotation seems to me a complete citation for the reader at the simplest. This advantage is likely to also be the reason that under § 51 of German copyright law that allowed full citations (`http://dejure.org/gesetze/UrhG/51.html`)[2]. The quotations are also so extensive necessary because Prof. Gerlich demanded the following of the Author of this in e-mails: »*If you „refute" something, you should cite in full the relevant passages and quote in such a way that the reader understands what is being quoted* [Wenn Sie etwas „widerlegen", sollten Sie die entsprechenden Stellen vollständig und für den Leser verständlich (nachvollziehbar) zitieren]« and »... *You must refrain from giving a wrong summary of my texts.* [... *unterlassen Sie endlich falsche Zusammenfassungen meiner Texte.*]«, respectively.

In order to avoid such groundless assumptions, the article, which appears unabridged on the Internet (`http://arxiv.org/PS_cache/arxiv/pdf/0707/0707.1161v4.pdf`[3]), will be quoted the original text can be done easily[4], as numbers of chapters, of equations and illustrations are retained. Page numbers and footnote numbers are different. Juxtaposition of quotations from the original language text and their translation was also done by the Authors in their work[5]

I am also participating with my comments in blog discussions, for example, in `http://atmoz.org/blog/2007/07/10/falsification-of-the-atmospheric-co2-greenhouse-effects/` Some of my here-mentioned statements have already been posted in that discussion.

With regard to the layout: the quoted text is in black, the comments (for greater clarity) are in a different colour (also noted mistakes). »Author« refers to the author of this paper, »Authors« refer to the authors of the commented text. That the present layout and the layout of the Authors' paper is similar, is probably due to the fact that the Authors also use Latex.

The observations (a) to (f) in the Authors' abstract (p. 9) are partially justified - but instead of giving proper definitions, »the baby was thrown out with the bath-water« i.e. the greenhouse effect exists and can be perfectly proven experimentally. For example, in the comprehensive literature, Albert Einstein's work [79] dealing with the radiation of gases, is missing. This work alone by Albert Einstein explains the greenhouse effect.

1) »falsification« in German can have many meanings: fraud, refutation, disproof etc.
2) the translated quotations are mainly based on Version 2.0.
3) The quotations are mainly based on Version 2.0.
4) Most are German readers and the German reader should understand it.
5) If there are translation mistakes (or any other mistakes, please send me an e-mail. I will take notice of the mistakes immediately. In cases where the translation cannot be unequivocal, I am asking the Authors for a clear formulation.)

From Einstein we also have the microscopy theory of interactions between radiation and the molecules of the greenhouse gases, upon which the Authors in section 4.1 on page 94 insist (paragraph after Equation (3 on page 14) and this is proven in section 4.4.3 on page 108.

Moreover, essential omissions are hinted at, but not explicitly mentioned.

Understanding the second law of thermodynamics is also important for understanding the greenhouse effect. See section 4.4.2 on page 107, which shows that the greenhouse effect does not violate the second law of thermodynamics - on the contrary: the denial of the greenhouse effect has as consequence the invalidation of the second law of thermodynamics: the non-existence of the greenhouse effect would result in the formation of spontaneous temperature deviations under isothermal conditions.

In particular, without the greenhouse effect essential features of the atmospheric temperature profile as a function of height cannot be described, i.e., the existence of the pause≪ above which an almost isothermal temperature curve is present and beneath which an almost adiabatic temperature curve occurs. See text in section 3.3.4 on page 42 and section 4.4 on page 105.

I hope that my paper will stimulate scientific discussion and not what the Authors find fault with in others. Quotation from p. 105:

> . . . has . . . inflammatory statements, personal attacks and offenses against authors as a part of their „scientific“ workflow.

Unfortunately, things have unfolded differently. Mistakes had not been pointed out to me by 30 January, yet time was available for polemics:

> Contrary to good custom, to write a commentary to a scientific work in such a way, that one latches into a foreign layout, is arrogant, not serious and without precedence in scientific discussions.

What is to be done? If I summarize, I summarize incorrectly, if I quote extensively, it contravenes established etiquette and on each occasion the answer is not given in a professional manner but polemically. I regard this as an excuse for not giving factual answers.

> **Supplement in the current version:** The commentary to their paper the authors led to write emails, which are cited in extracts in section 4.5 on page 112 and commented in section 4.5.1 on page 116.

0 The key to understanding

The fact that the greenhouse gases absorb infrared radiation, is rarely disputed - even by Gerlich and Tscheuschner not[6]. But a body that absorbs, must necessarily also emit (see section 3.7.11 on page 79). This fact causes a division of the atmosphere in two layers (see Figure -2 on the next page):

6) But see eMail of p. 113

- at bottom of the troposphere in which the vertical circulation prevails and in the temperature gradient is determined by the circulation and not by the radiation balance and
- above is the stratosphere where the temperature profile is determined by the balance of radiation (absorbed energy of radiation = emitted energy of radiation).

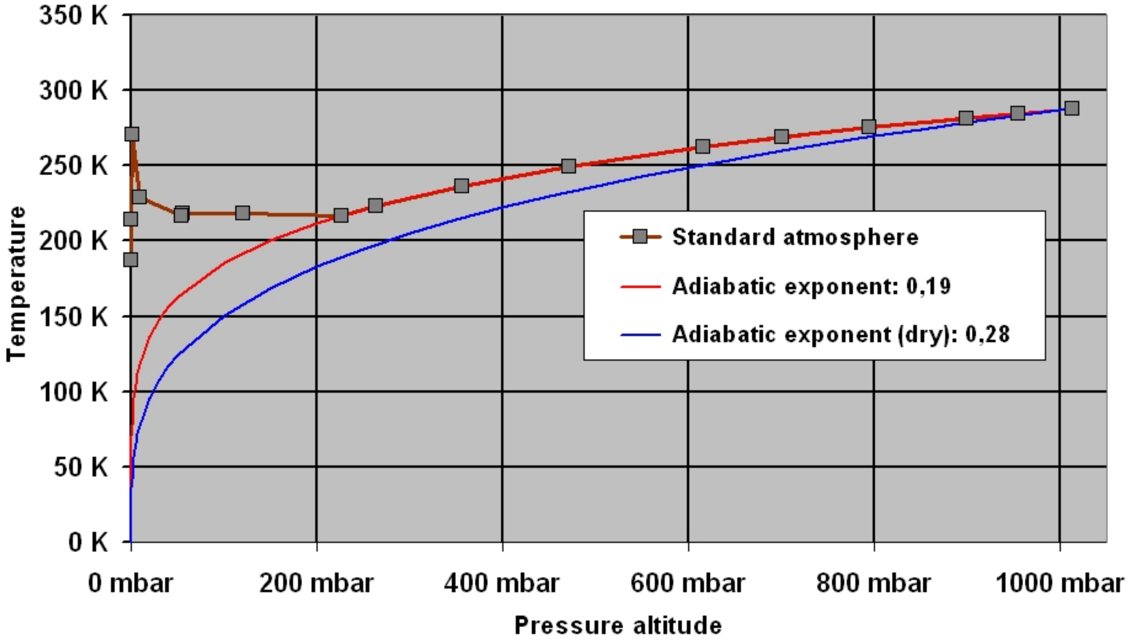

Figure -2: International standard atmosphere

Boundary conditions for radiation intensities in the atmosphere are the high level of infrared radiation upward from the warm Earth's surface and the infrared radiation downwards from outer space valued approximately zero. The total radiation from Earth into space must be equal to the absorbed radiation from the sun. Temporary variation from this equality, results in changes of temperatures which reach more or less quickly the equilibrium (depending on the storage capacity of air, solid earth, ocean). As a result of these conditions, the intensity upward $F_{\uparrow}$ decrease and intensity downward $F_{\downarrow}$ increase. Is a temperature profile determined based on a dormant adopted atmosphere, at any height to the balanced radiation (absorbed radiation energy = emitted radiation energy, the vertical curve part in Figure -1 on the following page(c) would be reach to the surface and the red area would be 0) so an temperature profile emerges which in the lower altitudes has a strong change of temperature with height (high temperature gradient) that initially slight air movements increase rapidly. – a bit warmer than the surrounding air rises always faster and a little colder than the surrounding air drops always faster. As a result, a temperature gradient adjusts that is just the borderline case : When the air rising , the result of pressure decrease is cooling exactly as fast as the cooling surrounding air.

Above rising air would cooling faster than the ambient temperature decreases - therefore the rising air returns back to its resting position and the air stratification is stable,

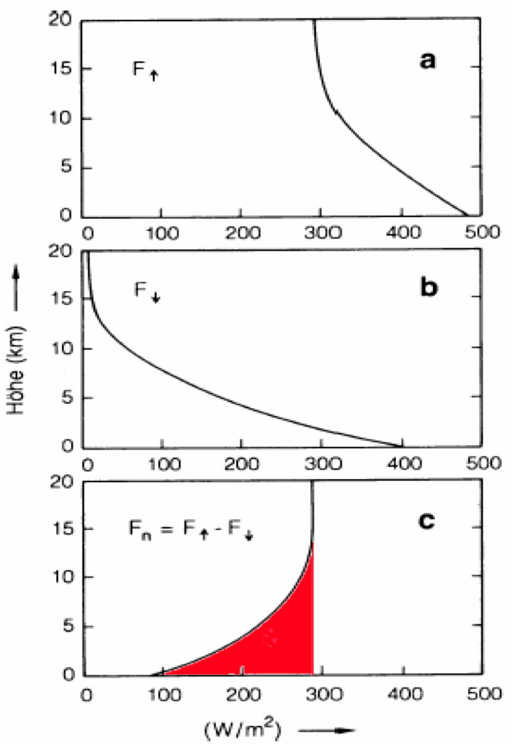

Figure -1: Radiation intensity upward (a) and downward (b) and the difference of both (c - net radiation flux). The image c is added with the convective heat (red area). (From [210, Abb. 1.22, S. 47])

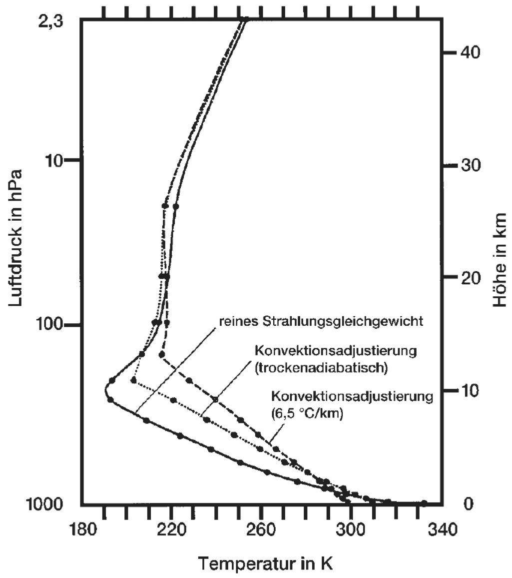

Figure 0: Temperature profile in the radiation balance without (solid line) and with adjusting of the convection on dry adiabatic temperature (dotted line) and observed mean lapse rate of 6.5°C/km (dashed line), calculated by MANABE und STRICKLER (1964). (From [36, Abb. 2-5])

Figure 0.

„Drive mechanism " for the vertical circulation in the troposphere is that the emission is bigger than the absorption and the cooled air sinks. At the Earth's surface the falling air will be warmed and humidified and rises. Thus heat (convective and latent) will be inserted in the atmosphere (the red area in Figure -1(c)).

How quickly the pressure (or height) is reached in the atmosphere at which the temperature is so high that the air stratification becomes unstable (the boundary between the troposphere and stratosphere - tropopause) depends on the absorption length of radiation in the atmosphere and with it from the concentration of greenhouse gases. The higher the concentration, the faster the critical value is reached.

Therefore, as a first approximation it can be assumed that the column pressure of greenhouse gases in the tropopause is constant. But this is only a very rough approximation, since the temperature in the stratosphere has to decrease: As the surface temperature increases, radiation of wavelengths that are barely absorbed in the atmosphere gets directly to space for a greater extent. Consequently, the temperature conditions change so that less heat from the greenhouse gases radiates into space. This has the consequence that with increasing concentration of the greenhouse gas the column pressure decreases.

The radiation conditions near the surface have practically no influence on the temperature profile. Arguments such as saturation of transparency through the atmosphere have no meaning.

In the paper by Gerlich and Tscheuschner the tropopause is mentioned three times, two times that the tropopause would be mistakenwith ionosphere, and once in another quote. A connection with the greenhouse effect is not produced - the seperation of the atmosphere is apparently given for Gerlich and Tscheuschner without cause.

The actual location of the tropopause vary in reality due to wind, etc.

Note: A temperature peak is still at low pressures. This is the result of UV absorption and ozon e formation. The UV is absorbed, but the absorbed energy is emitted in the infrared. Since the UV is absorbed the UV intensity decrease with an e-function, and for small temperature changes the emitted power is roughly proportional to the temperature. Based on this approach the following equation describes the observed temperature profile between 220 mbar ($\sim 11\,km$ height) and 1 mbar ($\sim 47\,km$ height) very well.

$$T = -56,5°C + 67,3\,K \cdot \exp\left(\frac{-p}{5,03\,mbar}\right) \qquad \text{(k-0-1)}$$

The Exponentialterm in this equation describes the heating (UV-ozone-process) from above. It follows that the heating from above can be ignored in case of pressures greater than 50 mbar ($< 20\,km$ altitude: < 3 mK) and is not responsible for the constant temperature in the stratosphere.

Abstract

The atmospheric greenhouse effect, an idea that authors trace back to the traditional works of Fourier 1824, Tyndall 1861, and Arrhenius 1896, and which is still supported in global climatology, essentially describes a fictitious mechanism, in which a planetary atmosphere acts as a heat pump driven by an environment that is radiatively interacting with but radiatively equilibrated to the atmospheric system. According to the second law of thermodynamics such a planetary machine can never exist. Nevertheless, in almost all texts of global climatology and in a widespread secondary literature it is taken for granted that such mechanism is real and stands on a firm scientific foundation . In this paper the popular conjecture is analyzed and the underlying physical principles are clarified. By showing that

(a) there are no common physical laws between the warming phenomenon in glass houses and the fictitious atmospheric greenhouse effects,
(b) there are no calculations to determine an average surface temperature of a planet,
(c) the frequently mentioned difference of 33°C is a meaningless number calculated wrongly,
(d) the formulas of cavity radiation are used inappropriately,

(e) the assumption of a radiative balance is unphysical,
(f) thermal conductivity and friction must not be set to zero, the atmospheric greenhouse conjecture is falsified.

1 Introduction

1.1 Problem background

Recently, there have been lots of discussions regarding the economic and political implications of climate variability, in particular global warming as a measurable effect of an anthropogenic, i.e. human-made, climate change [166], [18], [197], [106], [146], [190], [211], [105], [35], [131], [212], [121], [7]. Many authors assume that carbon dioxide emissions from fossil-fuel consumption represent a serious danger to the health of our planet, since they are supposed to influence the climates, in particular the average temperatures of the surface and lower atmosphere of the Earth. However, carbon dioxide is a rare trace gas, a very small part of the atmosphere found in concentrations as low as 0,03 Vol % (cf. Table 1 and Table 2 on the following page, see also Ref. [30]).[7)]

Date	CO_2 concentration [ppmv]	Source
March 1958	315.56	Ref. [138]
March 1967	322.88	Ref. [138]
March 1977	334.53	Ref. [138]
March 1987	349.24	Ref. [138]
March 1996	363.99	Ref. [138]
March 2007	377.3	Ref. [48]

Table 1: Atmospheric concentration of carbon dioxide in volume parts per million (1958 - 2007)

A physicist starts his analysis of the problem by pointing his attention to two (three) fundamental thermodynamic properties, namely

- the thermal conductivity λ, a property that determines how much heat per time unit and temperature difference flows in a medium;
- the isochoric thermal diffusivity a_v, a property that determines how rapidly a temperature change will spread, expressed in terms of an area per time unit.
- and with gases, whether heat transport through convection occurs (turbulent heat transport).

7) In a recent paper on „180 Years accurate CO_2 Gas analysis of Air by Chemical Methods“ the German biologist Ernst-Georg Beck argues that the IPCC reliance of ice core CO_2 figures is wrong [44], [45]. Though interesting on its own that even the CO_2 data themselves are subject to a discussion it does not influence the rationale of this paper which is to show that CO_2 is *completely* irrelevant.

Gas	Formula	U.S. Standard 1976 Ref. [138] [Vol %]	Hardy et al. 2005 Ref. [105] [Vol %]	Working hypothesis [Vol %]
Nitrogen	N_2	78.084	78.09	78.09
Oxygen	O_2	20.9476	20.95	20.94
Argon	Ar	0.934	0.93	0.93
Carbon dioxide	CO_2	0.0314	0.03	0.04

Table 2: Three versions of an idealized Earth's atmosphere and the associated gas volume concentrations, including the working hypothesis chosen for this paper

Both quantities are related by

$$a_v = \frac{\lambda}{\rho\, c_V} \tag{1}$$

the proportionality constant of the heat equation

$$\frac{\partial T}{\partial t} = a_v\, \Delta T \tag{2}$$

whereby T is the temperature, ρ the mass density, c_v the isochoric specific heat and ΔT the Laplace-operator applied to T. The Laplace-operator is the second order partial derivative of the temperature along space coordinates.

To calculate the relevant data from the gaseous components of the air one has to use their mass concentrations as weights to calculate the properties of the mixture „air" according to Gibbs thermodynamics [56], [116].[8)] Data on volume concentrations (Table 2) can be converted into mass concentrations with the aid of known mass densities (Table 3).

A comparison of volume percents and mass percents for CO_2 shows that the current mass concentration, which is the physically relevant concentration, is approximately 0.06 % and not the often quoted 0.03 % (Table 4 on the next page)

Gas	Formula	mass density ρ [kg/m^3]	Source
Nitrogen	N_2	1.1449	Ref. [138]
Oxygen	O_2	1.3080	Ref. [138]
Argon	Ar	1.6328	Ref. [138]
Carbon Dioxide	CO_2	1.7989	Ref. [138]

Table 3: Mass densities of gases at normal atmospheric pressure (101.325 kPa) and standard temperature (298 K)

8) The thermal conductivity of a mixture of two gases does not, in general, vary linearly with the composition of the mixture. However for comparable molecular weight and small concentrations the non-linearity is negligible [81].

Gas	Formula	x_v [Vol-%]	ρ (298 K) [kg/m^3]	x_m [Mass %]
Nitrogen	N_2	78.09	1.1449	75.52
Oxygen	O_2	20.94	1.3080	23.14
Argon	Ar	0.93	1.6328	1.28
Carbon dioxide	CO_2	0.04	1.7989	0.06

Table 4: Volume percent versus mass percent: The volume concentration x_v and the mass concentration x_m of the gaseous components of an idealized Earth's atmosphere

Gas	Formula	λ (200 K) [W/mK] Ref. [138]	λ (298 K) [W/mK] (interpolated)	λ (300 K) [W/mK] Ref. [138]	λ (400 K) [W/mK] Ref. [138]
Nitrogen	N_2	0.0187	0.0259	0.0260	0.0323
Oxygen	O_2	0.0184	0.0262	0.0263	0.0337
Argon	Ar	0.0124	0.0178	0.0179	0.0226
Carbon dioxide	CO_2	0.0096	0.0167	0.0168	0.0251

Table 5: Thermal conductivities of the gaseous components of the Earth's atmosphere at normal pressure (101.325 kPa)

From known thermal conductivities (Table 5), isochoric heat capacities, and mass densities the isochoric thermal diffusivities of the components of the air are determined (Table 6 on the next page). This allows to estimate the change of the effective thermal conductivity of the air in dependence of a doubling of the CO_2 concentration, expected to happen within the next 300 years (Table 7 on page 14).

It is obvious that a doubling of the concentration of the trace gas CO_2, whose thermal conductivity is approximately one half than that of nitrogen and oxygen, does change the thermal conductivity at the most by 0,03 % and the isochoric thermal diffusivity at the most by 0,07 %. These numbers lie within the range of the measuring inaccuracy and other uncertainties such as rounding errors and therefore have no significance at all. Surely neither the 'isochoric' heat capacity nor the thermal conductivity has a significant meaning for the greenhouse effect - to that extent this consideration contributes nothing.

1.2 The greenhouse effect hypothesis

Among climatologist s, in particular those who are affiliated with the Intergovernmental Panel of Climate Change (IPCC)[10], there is a „scientific consensus“ [12], that the relevant mechanism is the atmospheric greenhouse effect, a mechanism heavily relying on the assumption, that radiative heat transfer clearly dominates over the other forms of heat transfer such as thermal conductivity, convection, condensation *et cetera* [115],

9) In the original stands [Js/mK], correct would be [J/(s m K)]

10) The IPCC was created in 1988 by the World Meteorological Organization (WHO) and the United Nations Environmental Programme (UNEP).

Gas	c_p [J/kg K]	M_r [kg/mol]	R/M_r [J/kg K]	c_v [J/kg K]	ρ [kg/m^3]	λ [W/mK][9)]	a_v [m^2/s]
N_2	1039	28.01	297	742	1.1489	0.0259	$3{,}038 \cdot 10^{-5}$
O_2	919	32.00	260	659	1.3080	0.0262	$3{,}040 \cdot 10^{-5}$
Ar	521	39.95	208	304	1.6328	0.0178	$3{,}586 \cdot 10^{-5}$
CO_2	843	44.01	189	654	1.7989	0.0167	$1{,}427 \cdot 10^{-5}$

Table 6: Isobaric heat capacities c_p, relative molar masses M_r, isochoric heat capacities $c_V \approx c_p - R/M_r$ with universal gas constant R = 8.314472 J/(mol K), mass densities ρ, thermal conductivities λ, and isochoric thermal diusivities a_v of the gaseous components of the Earth's atmosphere at normal pressure (101.325 kPa)

[113], [112], [114], [111], [110], [164], [109].

In all past IPCC reports and other such scientific summaries the following point evocated in Ref. [113, p. 5], is central to the discussion:

> „One of the most important factors is the **greenhouse effect**; a simplified explanation of which is as follows. Short-wave solar radiation can pass through the clear atmosphere relatively unimpeded. But long-wave terrestrial radiation emitted by the warm surface of the Earth is partially absorbed and then re- emitted by a number of trace gases in the cooler atmosphere above. Since, on average, the outgoing long-wave radiation balances the incoming solar radiation, both the atmosphere and the surface will be warmer than they would be without the greenhouse gases . . . The greenhouse effect is real; it is a well understood effect, based on established scientific principles.“

To make things more precise, supposedly, the notion of *radiative forcing* was introduced by the IPCC and related to the assumption of *radiative equilibrium*. In Ref. [111, pp. 7-6], one finds the statement:

> „A *change* in average net radiation at the top of the troposphere (known as the tropopause), because of a change in either solar or infrared radiation, is defined for the purpose of this report as a *radiative forcing*. A radiative forcing perturbs the balance between incoming and outgoing radiation. Over time climate responds to the perturbation to re-establish the radiative balance. A positive radiative forcing tends on average to warm the surface; a negative radiative forcing on average tends to cool the surface. As defined here, the incoming solar radiation is not considered a radiative forcing, but a change in the amount of incoming solar radiation would be a radiative forcing . . . For example, an increase in atmospheric CO_2 concentration leads to a reduction in outgoing infrared radiation and a positive radiative forcing.“

However, in general „scientific consensus“ is not related whatsoever to scientific truth as countless examples in history have shown. „Consensus“ is a political term, not a

Gas	c_p [Massen%]	M_r [kg/mol]	R/M_r [J/kg K]	c_v [J/kg K]	ρ [kg/m^3]	λ [W/mK][9)]	a_v [m^2/s]
N_2	75.52	28.01	1039	742	1.1489	0.0259	$3{,}038 \cdot 10^{-5}$
O_2	23.14	32.00	929	659	1.3080	0.0262	$3{,}040 \cdot 10^{-5}$
Ar	1.28	39.95	512	304	1.6328	0.0178	$3{,}586 \cdot 10^{-5}$
CO_2	0.06	44.01	843	654	1.7989	0.0167	$1{,}427 \cdot 10^{-5}$
Air	100.00	29.10	1005	719	1.1923	0.02586	$3{,}0166 \cdot 10^{-5}$

Gas	c_p [Massen%]	M_r [kg/mol]	R/M_r [J/kg K]	c_v [J/kg K]	ρ [kg/m^3]	λ [W/mK][9)]	a_v [m^2/s]
N_2	75.52	28.01	1039	742	1.1489	0.0259	$3{,}038 \cdot 10^{-5}$
O_2	23.08	32.00	929	659	1.3080	0.0262	$3{,}040 \cdot 10^{-5}$
Ar	1.28	39.95	512	304	1.6328	0.0178	$3{,}586 \cdot 10^{-5}$
CO_2	0.12	44.01	843	654	1.7989	0.0167	$1{,}427 \cdot 10^{-5}$
Air	100.00	29.10	1005	719	1.1926	0.02585	$3{,}0146 \cdot 10^{-5}$

Table 7: The calculation of the isochoric thermal diffusivity $a_v = \lambda/(\rho\, c_V)$ of the air and its gaseous components for the current CO_2 concentration (0.06 Mass %) and for a fictitiously doubled CO_2 concentration (0.12 Mass %) at normal pressure (101.325 kPa)

scientific term. In particular, from the viewpoint of theoretical physics the radiative approach, which uses physical laws such as Planck's law and Stefan-Boltzmann's law that only have a limited range of validity [11)] that definitely does not cover the atmospheric problem, must be highly questioned [194], [49], [170], [169], [176]. For instance in many calculations climatologists perform calculations where idealized black surfaces e.g. representing a CO_2 layer and the ground, respectively, radiate against each other. In reality, we must consider a bulk problem, in which at concentrations of 300 ppmv at normal state still

$$\begin{aligned} N &\approx 3 \cdot 10^{-\,4} \cdot V \cdot N_L \\ &\approx 3 \cdot 10^{-\,4} \cdot (10 \cdot 10^{-\,6}\ m)^3 \cdot 2,687 \cdot 10^{25}\ \text{molecules}/m^3 \\ &\approx 3 \cdot 10^{-\,4} \cdot 10^{-\,15} \cdot 2,687 \cdot 10^{25}\ \text{molecules} \\ &\approx 8 \cdot 10^7 \end{aligned} \tag{3}$$

molecules are distributed within a cube V with edge length 10 μm, a typical wavelength of the relevant infrared radiation. [12)] In this context an application of the formulas of cavity radiation is sheer nonsense.

To what extent the particle density plays a role is shown by absorption experiments: When the absorption of a radiatively-active gas in a dilute mixture with a non-radiatively-active gas is measured, the absorption is proportional to the concentration -

11) The validity is not limited, but the requirements for validity must be observed and accordingly taken into account.

12) N_L is the well-known Loschmidt number [209].

if there were an electromagnetic many body interaction really present, such a measurement result would be incomprehensible. Yet the interaction of the particles plays a role, for the form of the absorption curve changes depending on the total pressure of all gases and their temperature - but this interaction is largely independent of the radiation field.

It cannot be overemphasized that a microscopic theory providing the base for a derivation of macroscopic quantities like thermal or electrical transport coefficients must be a highly involved many-body theory. Of course, heat transfer is due to interatomic electromagnetic interactions mediated by the electromagnetic field [13)]. But it is misleading to visualize a photon as a simple particle or wave packet travelling from one atom to another for example. Things are pretty much more complex and cannot be understood even in a (one-)particle- wave duality or Feynman graph picture.

On the other hand, the macroscopic thermodynamical quantities contain a lot of information and can be measured directly and accurately in the physics lab. It is an interesting point that the thermal conductivity of CO_2 is only one half of that of nitrogen or oxygen. In a 100 percent CO_2 atmosphere a conventional light bulb shines brighter than in a nitrogenoxygen atmosphere due to the lowered thermal conductivity of its environment. But this has nothing to do with the supposed CO_2 greenhouse effect which refers to trace gas concentrations. Global climatologists claim that the Earth's natural greenhouse effect keeps the Earth 33°C warmer than it would be without the trace gases in the atmosphere. 80 percent of this warming is attributed to water vapor and 20 percent to the 0.03 volume percent CO_2. If such an extreme effect existed, it would show up even in a laboratory experiment involving concentrated CO_2 as a thermal conductivity anomaly (How come? The greenhouse effect has practically nothing to do with thermal conductivity). It would be manifest itself as a new kind of 'superinsulation' violating the conventional heat conduction equation (Since the greenhouse effect has little to do with the heat conduction equation, there is no violation present.). However, for CO_2 such anomalous heat transport properties never have been observed. Correct - but anomalous heat transport characteristics are not necessary in the explanation of the greenhouse effect.

Therefore, in this paper, the popular greenhouse ideas entertained by the global climatology community are reconsidered within the limits of theoretical and experimental physics. Authors trace back their origins to the works of Fourier [85], [84] (1824), Tyndall [206], [204], [205], [202], [203] (1861) and Arrhenius [34], [33], [32] (1896). A careful analysis of the original papers shows that Fourier's and Tyndall's works did not really include the concept of the atmospheric greenhouse effect, whereas Arrhenius's work fundamentally differs from the versions of today. With exception of Ref. [32], the traditional works precede the seminal papers of modern physics, such as Planck's work on the radiation of a black body [170], [169]. Although the arguments of Arrhenius were seeming falsified by his contemporaries they were picked up by Callendar [63], [62], [61], [60], [59], [58], [57] and Keeling [127], [125], [130], [124], [128], [129], [126], the founders

13) Heat transfer occurs in gases mainly through collisions between gas molecules, which impact is essentially governed by an effective potential. This effective potential with its virtual photons causes the van-der-Waals effect (see page 19).

of the modern greenhouse hypothesis. [14] Interestingly, this hypothesis has been vague ever since it has been used. Even Keeling stated 1978 [124]:

> „The idea that CO_2 from fossil fuel burning might accumulate in air and cause warming of the lower atmosphere was speculated upon as early as the latter the nineteenth century (Arrhenius, 1903). At that time the use of fossil fuel was slight to expect a rise in atmospheric CO_2 to be detectable. The idea was convincingly expressed by Callendar (1938, 1940) but still without solid evidence rise in CO_2."

The influence of CO_2 on the climate was also discussed thoroughly in a number of publications that appeared between 1909 and 1980, mainly in Germany [15], [17], [16], [38], [42], [43], [64], [73], [77], [97], [4], [108], [143], [145], [141], [142], [144], [148], [150], [162], [159], [160], [158], [157], [161], [163], [181], [216]. The most influential authors were Möller [77], [162], [159], [160], [158], [157], [161], [163], who also wrote a textbook on meteorology [156], [155], and Manabe [143], [145], [141], [142], [144], [161]. It seems, that the joint work of Möller and Manabe [161] has had a significant influence on the formulation of the modern atmospheric CO_2 Greenhouse conjectures and hypotheses, respectively.

In a very comprehensive report of the US Department of Energy (DOE), which appeared in 1985 [5], the atmospheric greenhouse hypothesis had been cast into its nal form and became the cornerstone in all subsequent IPCC publications [115], [113], [112], [114], [111], [110], [164], [109].

Of course, it may be, that even if the oversimplified picture entertained in IPCC global climatology is physically incorrect, a thorough discussion may reveal a nonneglible influence of certain radiative effects (apart from sunlight) on the weather, and hence on its local averages, the climates, which may be dubbed the CO_2 greenhouse effect. But then three key questions will remain, even if the effect is claimed to serve only as a genuine trigger of a network of complex reactions:

1. Is there a fundamental CO_2 greenhouse effect in physics?
2. If so, what is the fundamental physical principle behind this CO_2 greenhouse effect?
3. Is it physically correct to consider radiative heat transfer as the fundamental mechanism controlling the weather setting thermal conductivity and friction to zero? What surely is not done in general, since, for example, convective heat transfer occurs turbulently and turbulence without friction is not possible.

The aim of this paper is to give

- an affirmative negative answer to all of these questions rendering them rhetoric.
- to initiate a thorough scientific discussion of the greenhouse effect? or
- to spread the negative answer.

14) Recently, von Storch critized the anthropogenic global warming scepticism by characterizing the discussion as „a discussion of yesterday and the day before yesterday" [166]. Ironically, it was Calendar and Keeling who once reactivated „a discussion of yesterday and the day before yesterday" based on already falsified arguments.

1.3 This paper

In the language of physics an effect is a not necessarily evident but a reproducible and measurable phenomenon together with its theoretical explanation. Neither the warming mechanism in a glass house nor the supposed anthropogenic warming is due to an effect in the sense of this definition:

- In the first case (the glass house) one encounters a straightforward phenomenon.

- In the second case (the Earth's atmosphere) one cannot measure something; rather, one only makes heuristic calculations. One can measure very precisely, see section 4.4.1 on page 105.

The explanation of the warming mechanism in a real greenhouse is a standard problem in undergraduate courses, in which optics, nuclear physics and classical radiation theory are dealt with. On this level neither the mathematical formulation of the first and second law of thermodynamics nor the partial differential equations of hydrodynamics or irreversible thermodynamics are known; the phenomenon has thus to be analyzed with comparatively elementary means.

However, looking up the search terms „glass house effect“, „greenhouse effect“, or the German word „Treibhauseekt“ in classical textbooks on experimental physics or theoretical physics, one finds - possibly to one's surprise and disappointment - that this effect does not appear anywhere - with a few exceptions, where in updated editions of some books publications in climatology are cited. One prominent example is the textbook by Kittel who added a „supplement“ to the 1990 edition of his Thermal Physics [132, on page 115] :

> “ The Greenhouse Effect describes the warming of the surface of the Earth caused by the infrared absorbent layer of water, as vapor and in clouds, and of carbon dioxide on the atmosphere between the Sun and the Earth. The water may contribute as much as 90 percent of the warming effect.“

Kittel “ supplement“ refers to the 1990 and 1992 books of J.T. Houghton et al. on Climate Change, which are nothing but the standard IPCC assessments [115], [112]. In general, most climatologic texts do not refer to any fundamental work of thermodynamics and radiation theory. Sometimes the classical astrophysical work of Chandrasekhar [65] is cited, but it is not clear at all, which results are applied where, and how the conclusions of Chandrasekhar fit into the framework of infrared radiation transfer in planetary atmospheres.

There seems to exist no source where an atmospheric greenhouse effect is introduced from fundamental university physics alone.

Evidently, the atmospheric greenhouse problem is not a fundamental problem of the philosophy of science, which is best described by the Münchhausen trilemma [15)], stating

15) The term was coined by the critical rationalist Hans Albert, see e.g. Ref. [14]. For the current discussion on global warming Albert's work may be particularly interesting. According to Albert new insights are not easy to be spread, because there is often an ideological obstacle, for which Albert coined the notion of immunity against criticism.

that one is left with the ternary alternative [16)]

infinite regression - dogma - circular reasoning

Rather, the atmospheric Greenhouse mechanism is a conjecture, which may be proved or disproved (According to the Authors assumption) already in concrete engineering thermodynamics [179], [82], [222]. Exactly this was done well many years ago by an expert in this field,

namely Alfred Schack, who wrote a classical textbook on this subject [179]. 1972 he showed that the radiative component of heat transfer of CO_2, though relevant at the temperatures in combustion chambers, can be neglected at atmospheric temperatures. The influence of carbonic acid on the Earth's climates is definitively unmeasurable [180].

The remaining part of this paper is organized as follows:

- In section 2 the warming effect in real greenhouses, which has to be distinguished strictly from the (in-) famous conjecture of Arrhenius, is discussed.
- section 3 on page 37 is devoted to the atmospheric greenhouse problem. It is shown that this effect neither has experimental nor theoretical foundations and must be considered as fictitious. The claim that CO_2 emissions give rise to anthropogenic climate changes has no physical basis.
- In section 4 on page 94 theoretical physics and climatology are discussed in context of the philosophy of science. The question is raised, how far global climatology fits into the framework of exact sciences such as physics.
- In section 4.4 on page 105, theoretical physics and the greenhouse effect are discussed from an experimental view point.
- The final section 5 on page 118 is a physicist's summary.

2 The warming mechanism in real greenhouses

2.1 Radiation Basics

2.1.1 Introduction

For years, the warming mechanism in real greenhouses, paraphrased as „the greenhouse effect“ , has been commonly misused to explain the conjectured atmospheric greenhouse effect. In school books, in popular scientific articles, and even in high-level scientific debates, it has been stated that the mechanism observed within a glass house bears some similarity to the anthropogenic global warming. Meanwhile, even mainstream climatologists admit that the warming mechanism in real glass houses has to be distinguished strictly from the claimed CO_2 greenhouse effect.

Nevertheless, one should have a look at the classical glass house problem to recapitulate some fundamental principles of thermodynamics and radiation theory. Later on,

16) Originally, an alternative is a choice between two options, not one of the options itself. A ternary alternative generalizes an ordinary alternative to a threefold choice.

the relevant radiation dynamics of the atmospheric system will be elaborated on and distinguished from the glass house set-up. Or the similarities will be established.

Heat is the (chaotic) kinetic energy of molecules and atoms and will be transferred by contact or radiation. Microscopically both interactions are mediated by photon s. In the former case, which is governed by the Coulomb resp. van der Waals interaction these are the virtual or o-shell photons, in the latter case these are the real or on-shell photons. The interaction between photons and electrons (and other particles that are electrically charged or have a nonvanishing magnetic momentum) is microscopically described by the laws of quantum theory. Hence, in principle, thermal conductivity and radiative transfer may be described in a unified framework. However, the non-equilibrium many body problem is a highly non-trivial one and subject to the discipline of physical kinetics unifying quantum theory and non-equilibrium statistical mechanics.

Fortunately, an analysis of the problem by applying the methods and results of classical radiation theory already leads to interesting insights.

2.1.2 The infinitesimal specific intensity

In classical radiation theory [65] the main quantity is the *specific intensity* I_ν. It is defined in terms of the *amount of radiant energy* dE_ν in a specified frequency interval $[\nu, \nu + d\nu]$ that is transported across an area element dF_1 in direction of another area element dF_2 during a time dt:

$$dE_\nu = I_\nu \; d\nu \; dt \; \frac{(r \; dF_1)(r \; dF_2)}{|r|^4} \tag{4}$$

where r is the distance vector pointing from dF_1 to dF_2 (Figure 1).

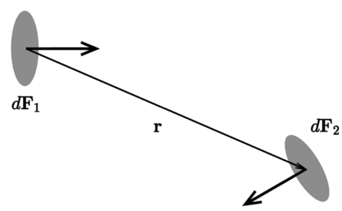

Figure 1: The geometry of classical radiation: A radiating infinitesimal area dF_1 and an illuminated infinitesimal area dF_2 at distance r.

For a general radiation field one may write

$$I_\nu = I_\nu(x, y, z; l, m, n; t) \tag{5}$$

where $(x; y; z)$ denote the coordinates, $(l; m; n)$ the direction cosines, t the time, respectively, to which I refers.

With the aid of the definition of the scalar product Equation (4 on the preceding page) may be cast into the form

$$dE_\nu = I_\nu \; d\nu \; dt \; \frac{(\cos\vartheta_1 \; dF_1)(\cos\vartheta_2 \; dF_2)}{r^2} \tag{6}$$

A special case is given by

$$\cos\vartheta_2 := 1 \tag{7}$$

With

$$\begin{aligned} \vartheta &:= \vartheta_1 \\ d\sigma &:= dF_1 \\ d\omega &:= dF_2/r^2 \end{aligned} \tag{8}$$

Equation (6) becomes

$$dE_\nu = I_\nu \; d\nu \; dt \; \cos\vartheta \; d\sigma \; d\omega \tag{9}$$

defining the pencil of radiation [65].

Equation (6), which will be used below, is slightly more general than Equation (9), which is more common in the literature. Both ones can be simplified by introducing an *integrated intensity*

$$I_0 = \int_0^\infty I_\nu \; d\nu \tag{10}$$

and a *radiant power* dP. For example, Equation (6) may be cast into the form

$$dP = I_0 \; \frac{(\cos\vartheta_1 \; dF_1)(\cos\vartheta_2 \; dF_2)}{r^2} \tag{11}$$

2.1.3 Integration

When performing integration one has to bookkeep the dimensions of the physical quantities involved. Usually, the area dF_1 is integrated and the equation is rearranged in such a way, that there is an intensity I (resp. an intensity times an area element IdF) on both sides of the equation. Three cases are particularly interesting:

(a) *Two parallel areas with distance a.* According to Figure 2 on the next page one may write

$$\vartheta_1 = \vartheta_2 =: \vartheta \tag{12}$$

By setting

$$r^2 = r_0^2 + a^2 \tag{13}$$

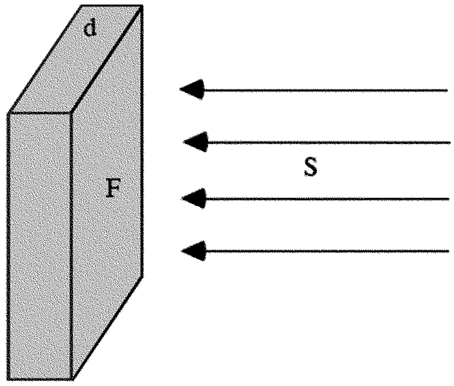

Figure 2: Two parallel areas with distance a.

$$2r\ dr = 2r_0\ dr_0 \tag{14}$$

$$\cos\vartheta = \frac{a}{r} \tag{15}$$

one obtains

$$\begin{aligned}
I_{parallel\ areas} &= \int_0^{2\pi}\int_0^{R_0} I_0 \frac{(\cos\vartheta)^2}{r^2} r_0\ dr_0\ d\varphi \\
&= \int_0^{2\pi}\int_0^{R_0} I_0 \frac{(a^2}{r^4} r_0\ dr_0\ d\varphi \\
&= \int_0^{2\pi}\int_a^{\sqrt{R_0^2+a^2}} I_0 \frac{a^2}{r^4} r\ dr\ d\varphi \\
&= 2\ \pi\ I_0\ a^2 \int_a^{\sqrt{R_0^2+a^2}} \frac{dr}{r^3} \\
&= \pi\ I_0\ a^2\ \left.\frac{-1}{r^2}\right|_a^{\sqrt{R_0^2+a^2}} \\
&= \pi\ I_0\ a^2\ \left(\frac{1}{a^2} - \frac{1}{R_0^2+a^2}\right) \\
&= \pi\ I_0\ \frac{R_0^2}{R_0^2+a^2}
\end{aligned} \tag{16}$$

(b) *Two parallel areas with distance* $a \to 0$

If the distance a is becoming very small whereas R_0 is kept finite one will have

$$I_{\text{parallel areas }(a\ \to\ 0)} = \lim_{a\ \to\ 0}\left(\pi\ I_0\ \frac{R_0^2}{R_0^2+a^2}\right) = \pi\ I_0 \tag{17}$$

This relation corresponds to the total half-space intensity for a radiation from an unit surface.

(c) *The Earth illuminated by the Sun*

With I_0^{Sun} being the factor I_0 for the Sun the solar total half-space intensity is given by I

$$I_{\text{Sun's surface}} = \pi \cdot I_0^{Sun} \tag{18}$$

Setting

$$a = R_{Earth's\ orbit} \tag{19}$$

$$R_0 = R_{Sun} \tag{20}$$

one gets for the solar intensity at the Earth's orbit

$$\begin{aligned} I_{Earth's\ orbit} &= \pi\ I_0^{Sun}\ \frac{R_{Sun}^2}{R_{Sun}^2 + R_{Earth's\ orbit}^2} = I_{\text{Sun's surface}}\ \frac{R_{Sun}^2}{R_{Sun}^2 + R_{Earth's\ orbit}^2} \\ &\approx I_{\text{Sun's surface}}\ \frac{R_{Sun}^2}{R_{Earth's\ orbit}^2} \approx \frac{I_{\text{Sun's surface}}}{215^2} \end{aligned} \tag{21}$$

2.1.4 The Stefan-Boltzmann law

For a perfect black body and a unit area positioned in its proximity we can compute the intensity I with the aid of the the Kirchhoff -Planck-function, which comes in two versions

$$B_\nu(T) = \frac{2h\nu^3}{c^2}\ \frac{1}{e^{\frac{h\nu}{kT}} - 1} \tag{22}$$

$$B_\lambda(T) = \frac{2hc^2}{\lambda^5}\ \frac{1}{e^{\frac{hc}{\lambda kT}} - 1} \tag{23}$$

that are related to each other by

$$B_\nu(T)d\nu = B_\nu(T)\frac{d\nu}{d\lambda}d\lambda = -\ B_\nu(T)\frac{c}{\lambda^2}d\lambda = -\ B_\lambda(T)d\lambda \tag{24}$$

with

$$\nu = \frac{c}{\lambda} \tag{25}$$

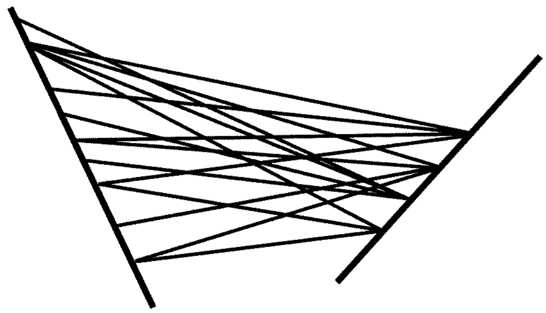

Figure 3: The geometry of classical radiation: Two surfaces radiating against each other.

where c is the speed of light, h the Planck constant, k the Boltzmann constant, λ the wavelength, ν the frequency, and T the absolute temperature, respectively. Integrating over all frequencies or wavelengths we obtain the Stefan-Boltzmann T^4 law

$$I = \pi \cdot \int_0^\infty B_\nu(T) d\nu = \pi \cdot \int_0^\infty B_\lambda(T) d\lambda = \sigma T^4 \tag{26}$$

with

$$\sigma = \pi \cdot \frac{2\pi^4 k^4}{15 c^2 h^3} = 5,670400 \cdot 10^{-8} \frac{W}{m^2 K^4} \tag{27}$$

One conveniently writes

$$S(T) = \sigma T^4 = 5,67 \cdot \left(\frac{T}{100\ K} \right)^4 \frac{W}{m^2} \tag{28}$$

This is the net radiation energy per unit time (Net radiation output) per unit area placed in the neighborhood of a radiating plane surface of a black body.

2.1.5 Conclusion

Three facts should be emphasized here:

- In classical radiation theory radiation is not described by a vector field assigning to every space point a corresponding vector. Rather, with each point of space many rays are associated (Figure 3). This is in sharp contrast to the modern description of the radiation field as an electromagnetic field with the Poynting vector field as the relevant quantity [120].

- The constant appearing in the T4 law is not an universal constant of physics. It strongly depends on the particular geometry of the problem considered.[17)]

17) For instance, to compute the radiative transfer in a multi-layer setup, the correct point of departure is the infinitesimal expression for the radiation intensity, not an integrated Stefan-Boltzmann expression already computed for an entirely different situation.

- The T^4-law will no longer hold if one integrates only over a filtered spectrum, appropriate to real world situations. This is illustrated in Figure 4. If the T^4 law were valid, both curves would collapse.

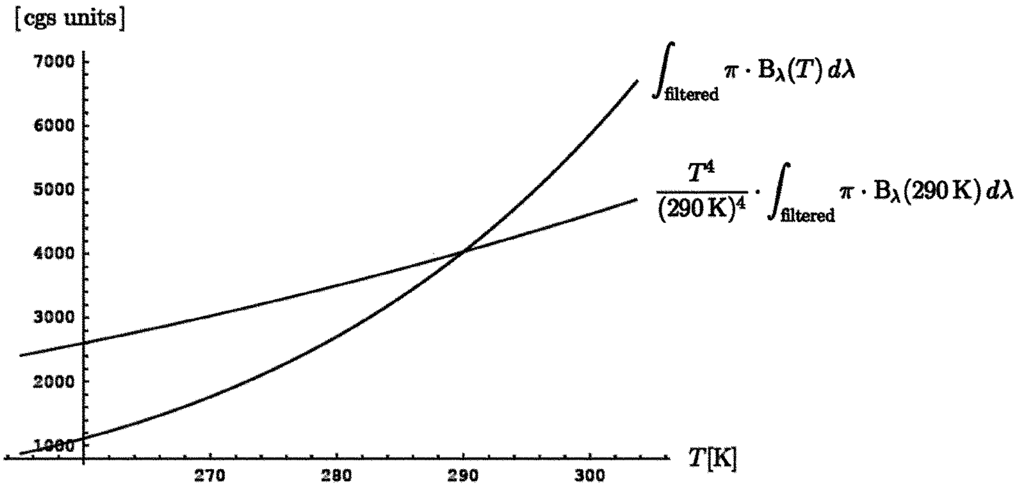

Figure 4: Black body radiation compared to the radiation of a sample coloured body. The non-universal constant σ is normalized in such a way that both curves coincide at $T = 290$ K. The Stefan-Boltzmann T^4 law does no longer hold in the latter case, where only two bands are integrated over, namely that of visible light and of infrared radiation from 3 μm to 5 μm, giving rise to a steeper curve.

Many pseudo-explanations in the context of global climatology are already falsified by these three fundamental observations of mathematical physics.

2.2 The Sun as a black body radiator

The Kirchhoff-Planck function describes an ideal black body radiator. For matter of convenience one may define

$$B_\lambda^{sunshine} = B_\lambda^{Sun} \cdot \frac{R_{Sun}^2}{R_{Earth's\ orbit}^2} = B_\lambda^{Sun} \cdot \frac{1}{215^2} \tag{29}$$

Figure 5 on the following page shows the spectrum of the sunlight, assuming the Sun is a black body of temperature T = 5780 K.

To compute the part of radiation for a certain wave length interval $[\lambda_1, \lambda_2]$ one has to

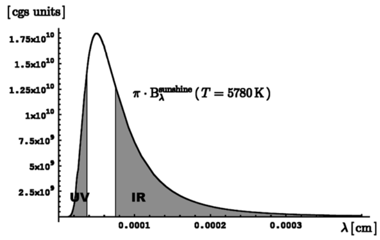

Figure 5: The spectrum of the sunlight assuming the sun is a black body at $T = 5780$ K.

evaluate the expression

$$\frac{\int_{\lambda_1}^{\lambda_2} B_\lambda^{sunshine}(5780\ K)d\lambda}{\int_0^{\infty} B_\lambda^{sunshine}(5780\ K)d\lambda} \tag{30}$$

Table 8 shows the proportional portions of the ultraviolet, visible, and infrared sunlight, respectively.

Band	Range [nm]	Portion [%]
ultraviolet	0 – 380	10,0
visible	380 – 760	44,8
infrared	760 – ∞	45,2

Table 8: The proportional portion of the ultraviolet, visible, and infrared sunlight, respectively.

Here the visible range of the light is assumed to lie between 380 nm and 760 nm. It should be mentioned that the visible range depends on the individuum.

In any case, a larger portion of the incoming sunlight lies in the infrared range than in the visible range. In most papers discussing the supposed greenhouse effect this important fact is completely ignored. As for the greenhouse effect, the distinction is between the transparent and absorbing characteristics of the atmosphere - the range"s position relative to human vision is therefore irrelevant.

2.3 The radiation on a very nice day

2.3.1 The phenomenon

Especially after a year's hot summer every car driver knows a sort of a glass house or greenhouse effect: If he parks his normally tempered car in the morning and the Sun shines in until he gets back into it at noon, he will almost burn his fingers at the steering wheel, if the dashboard area had been subject to direct Sun radiation. Furthermore, the air inside the car is unbearably hot, even if it is quite nice outside. One opens the window and the slide roof, but unpleasant hot air may still hit one from the dashboard while driving. One can notice a similar effect in the winter, only then one will probably welcome the fact that it is warmer inside the car than outside. In greenhouses or glass houses this effect is put to use: the ecologically friendly solar energy, for which no energy taxes are probably going to be levied even in the distant future, is used for heating. Nevertheless, glass houses have not replaced conventional buildings in our temperate climate zone not only because most people prefer to pay energy taxes, to heat in the winter, and to live in a cooler apartment on summer days, but because glass houses have other disadvantages as well. With vacuum insulated transparent sealed buildings this can change, but the costs are high.

2.3.2 The sunshine

One does not need to be an expert in physics to explain immediately why the car is so hot inside: It is the Sun, which has heated the car inside like this. However, it is a bit harder to answer the question why it is not as hot outside the car, although there the Sun shines onto the ground without obstacles. Undergraduate students with their standard physical recipes at hand can easily „explain“ this kind of a greenhouse effect: The main part of the Sun's radiation (Figure 6 on the following page) passes through the glass, as the maximum (Figure 7 on the next page) of the solar radiation is of bluegreen wavelength

$$\lambda_{bluegreen} = 0,5\mu m \tag{31}$$

which the glass lets through. This part can be calculated with the Kirchhoff- Planck-function.

Evidently, the result depends on the type of glass. For instance, if it is transparent to electromagnetic radiation in the 300nm- 1000nm range one will have

$$\frac{\int_{0,3\ \mu m}^{1\ \mu m} B_\lambda^{sunshine}(5780\ K)d\lambda}{\int_{0\ \mu m}^{\infty\ \mu m} B_\lambda^{sunshine}(5780\ K)d\lambda} = 77,2\ \% \tag{32}$$

In case of a glass, which is assumed to be transparent only to visible light (380 nm – 760 nm) one gets

$$\frac{\int_{0,380\ \mu m}^{0,760\ \mu m} B_\lambda^{sunshine}(5780\ K)d\lambda}{\int_{0\ \mu m}^{\infty\ \mu m} B_\lambda^{sunshine}(5780\ K)d\lambda} = 44,8\ \% \tag{33}$$

Because of the Fresnel reflection [120] at both pane boundaries one has to subtract 8 - 10 percent and only 60 - 70 percent (resp. 40 percent) of the solar radiation reach the ground.

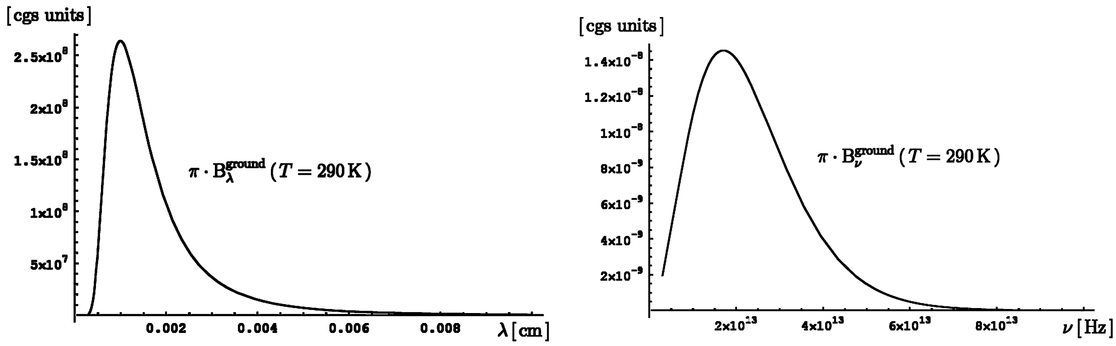

Figure 6: The unfiltered spectral distribution of the sunshine on Earth under the assumption that the Sun is a black body with temperature T = 5780 K (left: in wave length space, right: in frequency space).

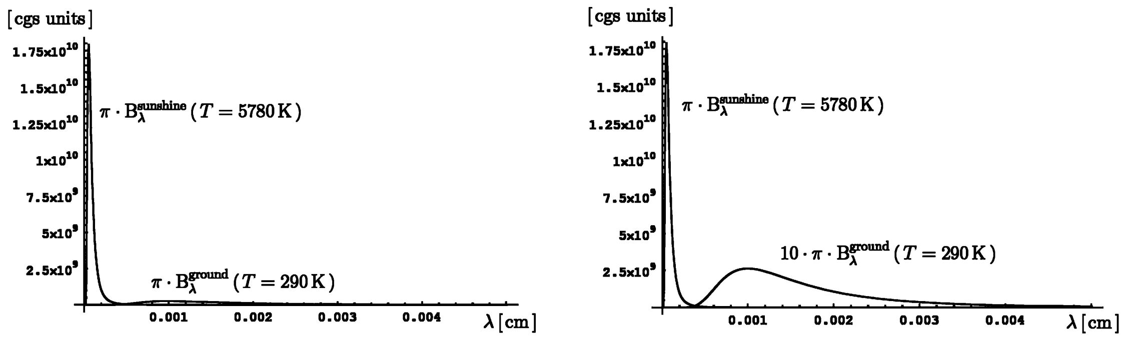

Figure 7: The exact location of the zero of the partial derivatives of the radiation intensities of the sunshine on Earth (left: in wave length space, right: in frequency space).

High performance tinted glass which is also referred to as spectrally selective tinted glass reduces solar heat gain typically by a factor of 0.50 (only by a factor of 0.69 in the visible range) compared to standard glass [20].

2.3.3 The radiation of the ground

The bottom of a glass house has a temperature of approximately 290K (Figure 8 on the following page). The maximum of a black body's radiation can be calculated with the help of Wien's displacement law (cf. Figure 9 on page 29 and Figure 10 on page 29)

$$\lambda_m ax(T) \cdot T = const. \tag{34}$$

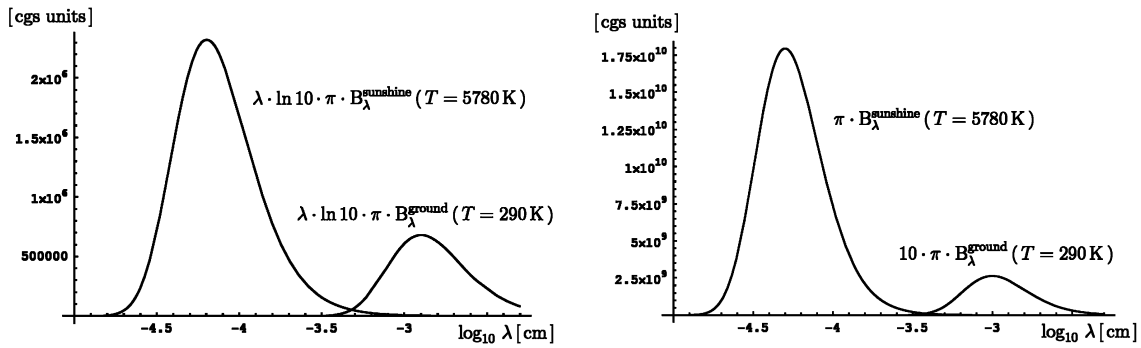

Figure 8: The unfiltered spectral distribution of the radiation of the ground under the assumption that the earth is a black body with temperature T = 290 K (left: in wave length space, right: in frequency space)

giving

$$\lambda_m ax(300K) = \frac{6000K}{300K} \cdot \lambda_m ax(6000K) = 10\ \mu m \tag{35}$$

This is far within the infrared wave range, where glass reflects practically all light, according to Beer's formula [214]. Practically 100 percent of a black body's radiation at ground temperatures lie above the wavelengths of 3.5 m. The thermal radiation of the ground is thus „trapped“ by the panes.

According to Wien's power law describing the intensity of the maximum wave- length

$$B_{\lambda_{max}}(T) \propto T^5 \tag{36}$$

the intensity of the radiation on the ground at the maximum is

$$\frac{T^5_{Sun}}{T^5_{\text{Earth's ground}}} \approx \frac{6000^5}{300^5} = 20^5 = 3,2 \cdot 10^6 \tag{37}$$

times smaller than on the Sun and

$$\frac{T^5_{Sun}}{T^5_{\text{Earth's ground}}} \cdot \frac{R^2_{Sun}}{R^5_{\text{Earth's orbit}}} \approx \frac{20^5}{215^2} \approx 70 \tag{38}$$

times smaller than the solar radiation on Earth.

The total radiation can be calculated from the Stefan-Boltzmann law

$$B_{total}(T) = \sigma \cdot T^4 \tag{39}$$

Hence, the ratio of the intensities of the sunshine and the ground radiation is given by

$$\frac{T^4_{Sun}}{T^4_{\text{Earth's ground}}} \cdot \frac{R^2_{Sun}}{R^5_{\text{Earth's orbit}}} \approx \frac{20^4}{215^2} \approx 3,46 \tag{40}$$

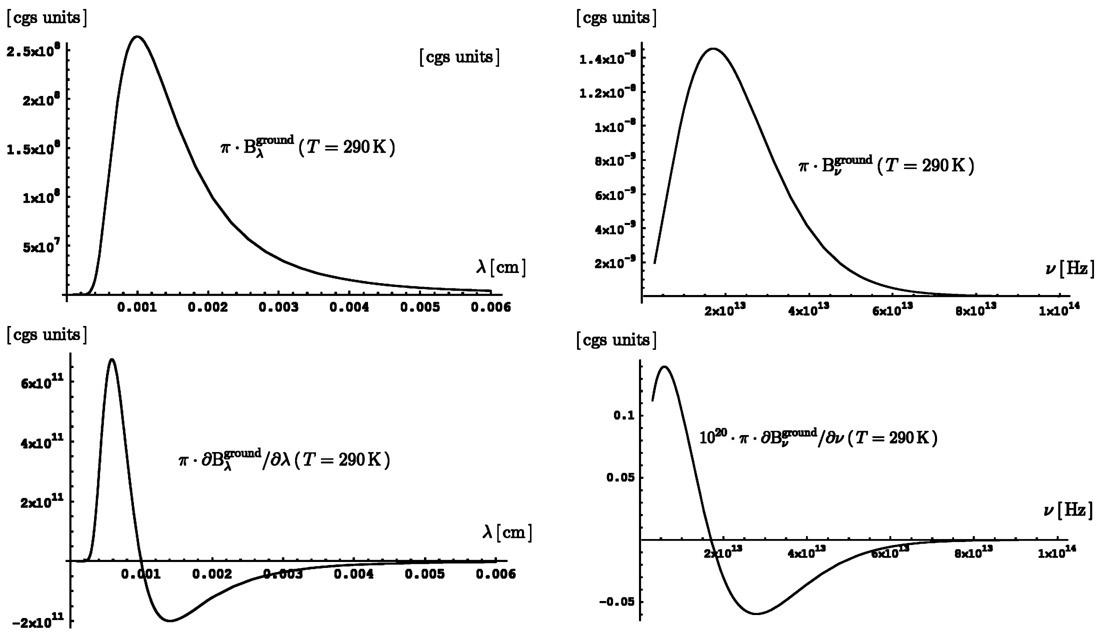

Figure 9: The radiation intensity of the ground and its partial derivative as a function of the wave length (left column) and of the frequency (right column).

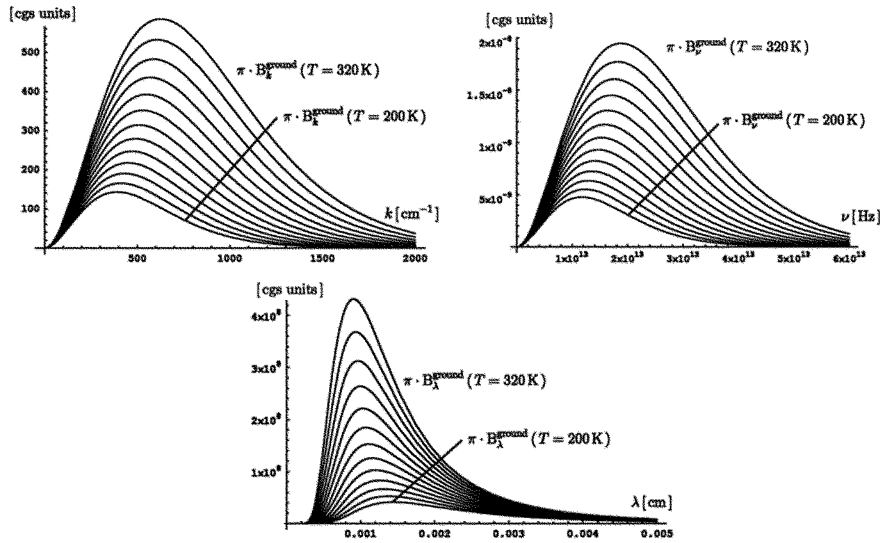

Figure 10: Three versions of radiation curve families of the radiation of the ground (as a function of the wave number k, of the frequency ν, of the wave length λ, respectively), assuming that the Earth is a black radiator.

Loosely speaking, the radiation of the ground is about four times weaker than the incoming solar radiation.

2.3.4 Sunshine versus ground radiation

To make these differences even clearer, it is convenient to graphically represent the spectral distribution of intensity at the Earth's orbit and of a black radiator of 290 K, respectively, in relation to the wavelength. (Figure 11 on the next page, Figure 12 on the following page, and Figure 13 on the next page). To fit both curves into one drawing, one makes use of the technique of super-elevation and/or applies an appropriate re-scaling. It becomes clearly visible,

- that the maxima are at 0.5 μm or 10 μm, respectively;
- that the intensities of the maxima differ by more than an order of ten;
- that above 0.8 μm (infrared) the solar luminosity has a notable intensity.

Figure 13 on the following page is an obscene picture, since it is physically misleading. The obscenity will not remain in the eye of the beholder, if the latter takes a look at the obscure scaling factors already applied by Bakan and Raschke in an undocumented way in their paper on the socalled natural greenhouse effect [36]. This is scientific misconduct as is the missing citation. Bakan and Raschke borrowed this figure from Ref. [140] where the scaling factors, which are of utmost importance for the whole discussion, are left unspecified. This is scientific misconduct as well.

2.3.5 Conclusion

Though in most cases the preceding „explanation“ suffices to provide an accepted solution to the standard problem, presented in the undergraduate course, the analysis leaves the main question untouched, namely, why the air inside the car is warmer than outside and why the dashboard is hotter than the ground outside the car. Therefore, in the following, the situation inside the car is approached experimentally.

2.4 High School Experiments

On a hot summer afternoon , temperature measurements were performed with a standard digital thermometer by the first author [92], [90], [91], [89], [88] and were recently reproduced by the other author.

In the summertime, such measurements can be reproduced by everyone very easily. The results are listed in Table 9 on page 32.

Against these measurements[18)] one may object that one had to take the dampness of the ground into account: at some time during the year the stones certainly got wet in the rain. The above mentioned measurements were made at a time, when it had not rained for weeks. They are real measured values, not average values over all breadths and lengths of the Earth, day and night and all seasons and changes of weather. These measurements are recommended to every climatologist, who believes in the CO_2-greenhouse effect,

18) The measurements are correct, but the interpretation is not.

Diagrams: diverse display formats of the unfiltered spectral distribution of the sunshine on Earth under the assumption that the Sun is a black body with temperature T = 5780 K *and* the unfiltered spectral distribution of the radiation of the ground under the assumption that the Earth is a black body with temperature T = 290 K, *both* in one ...

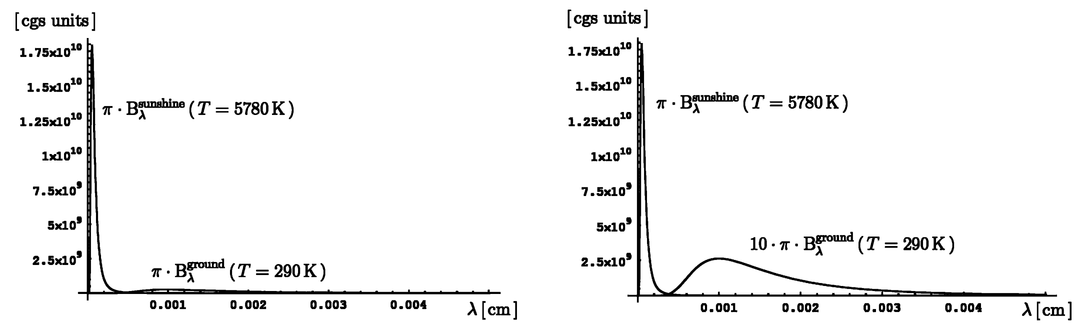

Figure 11: ... diagram (left: normal, right: super elevated by a factor of 10 for the radiation of the ground).

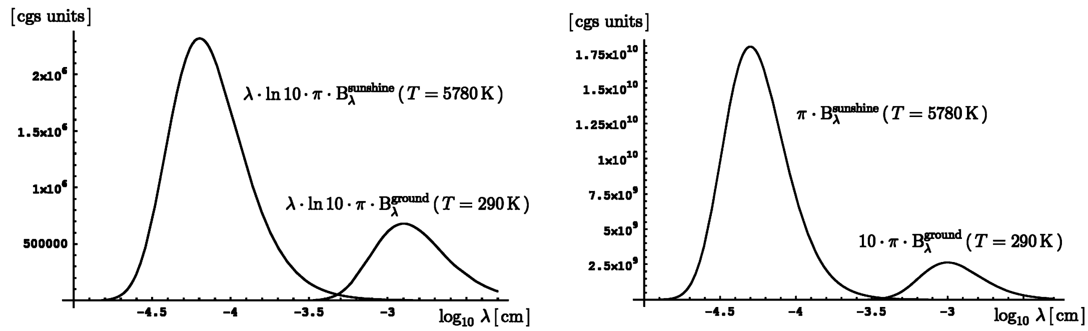

Figure 12: ... semi-logarithmic diagram (left: normalized in such a way that equal areas correspond to equal intensities, right: super elevated by a factor of 10 for the radiation of the ground).

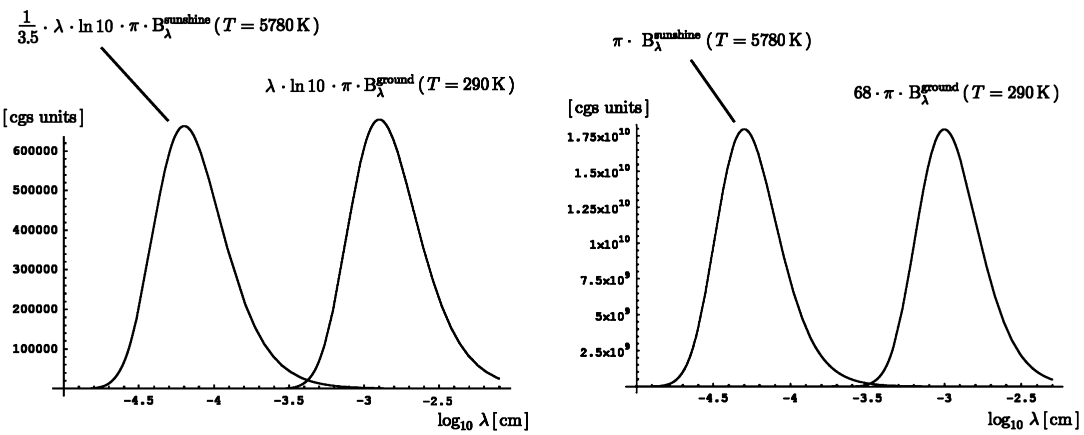

Figure 13: ... semi-logarithmic diagram (left: normalized in such a way that equal areas correspond to equal intensities with an additional re-scaling of the sunshine curve by a factor of 1/3.5, right: super elevated by a factor of 68 for the radiation of the ground).

Thermometer located ...	Temperature
inside the car, in direct Sun	71 °C
inside the car, in the shade	39 °C
next to the car, in direct Sun, above the ground	31 °C
next to the car, in the shade, above the ground	29 °C
in the living room	25 °C

Table 9: Measured temperatures inside and outside a car on a hot summer day.

because he feels already while measuring, that the just described effect has nothing to do with trapped thermal radiation. One can touch the car 's windows and notice that the panes, which absorb the infrared light, are rather cool and do not heat the inside of the car in any way. The outer as well as the inner walls of a heated room are cooler than the air in the room. If one holds his hand in the shade next to a very hot part of the dashboard that lies in the Sun, one will practically feel no thermal radiation despite the high temperature of 70°C, whereas one clearly feels the hot air. Above the ground one sees why it is cooler there than inside the car: the air inside the car „stands still" , above the ground one always feels a slight movement of the air. The ground is never completely plain, so there is always light and shadow, which keep the circulation going. This effect was formerly used for many old buildings in the city of Braunschweig, Germany. The south side of the houses had convexities. Hence, for most of the time during the day, parts of the walls are in the shade and, because of the thus additionally stimulated circulation, the walls are heated less.

It is warmer in the car, since the inside of a car without sunlight is as warm as the surroundings, because the transmitted sunlight adds heat in exactly the same way as an additional heater in the winter would warm up the car. How the energy for the additional heating is provided is not important. It can be provided

- by gasoline (Katalytic heater)
- electric cable from the garage (electric heating) or
- through solar energy (instead of the electric cable)

In order to study the warming effect one can look at a body of specific heat cv and width d, whose cross section F is subject to the radiation intensity S (see Figure 14 on the following page). One has by gross neglect of heat propagation over the thickness (see Equation (2 on page 11)) and neglect of back-radiation and convective heat loss (as shown in a few subsequent sections).

$$\rho F d c_V \frac{dT}{dt} = FS \tag{41}$$

or, respectively,

$$\frac{dT}{dt} = \frac{S}{\rho c_V d} \tag{42}$$

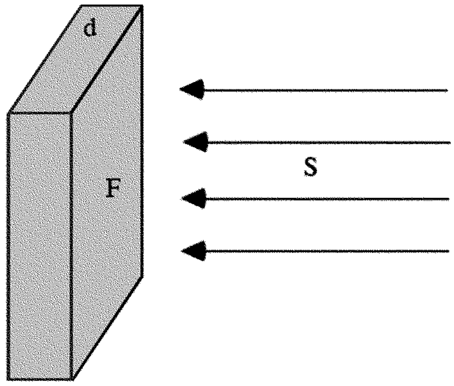

Figure 14: A solid parallelepiped of thickness d and cross section F subject to solar radiation

which may be integrated yielding

$$T = T_0 + \frac{S}{\rho c_V d}(t - t_0) \tag{43}$$

In this approximation, there is a linear rise of the temperature in time because of the irradiated intensity. One sees that the temperature rises particularly fast in absorbing bodies of small diameter: Thin layers are heated especially fast to high temperatures by solar radiation. The same applies to the heat capacity per unit volume:

- If the heat capacity is large the change of temperature will be slow.
- If the heat capacity is small the change in temperature will be fast.

Thus the irradiated intensity is responsible for the quick change of temperature, not for its value. This rise in temperature is stopped by the heat transfer of the body to its environment. This means that the body loses through heat transfer just as much energy as it absorbs through irradiated intensity - both quantities also balance, when the temperature is high enough, the energy flux is therefore a balanced quantity.

Especially in engineering thermodynamics the different kinds of heat transfer and their interplay are discussed thoroughly [179], [82], [222]. A comprehensive source is the classical textbook by Schack [179]. The results have been tested e.g. in combustion chambers and thus have a strong experimental background.

One has to distinguish between

- Conduction
- Convection
- Radiation
- Transfer of latent heat in phase transitions such as condensation and sublimation[19)]

19) Among those phenomena governed by the exchange of latent heat there is radiation frost, an striking example for a cooling of the Earth's surface through emission of infrared radiation. And at the same time a clear proof of the existence of back-radiation. When the cooling rate is measured, the existence of back-radiation is essential to explain the low cooling rate, see section 4.4 on page 105

Conduction, condensation and radiation, which slow down the rise in temperature work practically the same inside and outside the car. Therefore, the only possible reason for a difference in final temperatures must be convection (incorrect, the reason is the additional heating): A volume element of air above the ground, which has been heated by radiation, is heated up (by heat transfer through conduction), rises and is replaced by cooler air. This way, there is, in the average, a higher difference of temperatures between the ground and the air and a higher heat transmission compared to a situation, where the air would not be replaced. This happens inside the car as well, but there the air stays locked in and the air which replaces the rising air is getting warmer and warmer, which causes lower heat transmission. Outside the car, there is of course a lot more cooler air than inside. On the whole, there is a higher temperature for the sunlight absorbing surfaces (which serve as radiator) as well as for the air.

Of course, the exposed body loses energy by thermal radiation as well. The warmer body inside the car would lose more heat in unit of time than the colder ground outside, which would lead to a higher temperature outside, if this temperature rise were not absorbed by another mechanism! If one considers, that only a small part of the formerly reckoned 60 - 70 percent of solar radiation intensity reaches the inside of the car through its metal parts, this effect would contribute far stronger to the temperature outside! The „explanation“ of the physical greenhouse effect only with attention to the radiation balance would therefore lead to the reverse effect! The formerly discussed effect of the „trapped“ heat radiation by reflecting glass panes remains, which one can read as hindered heat transmission in this context. So this means a deceleration of the cooling process. However, as this heat transmission is less important compared to the convection, nothing remains of the absorption and reflection properties of glass for infrared radiation to explain the physical greenhouse effect. Neither the absorption nor the reflection coefficient of glass for the infrared light is relevant for this explanation of the physical greenhouse effect with every additional heating, but only the movement of air, hindered by the panes of glass.

The air inside the car is a fairly insignificant example of the heating effect: vacuum solar collector s reach 450°C (instead of 71°C), even though the form of the »car« interior is basically not much different.

Although meteorologists have known this for a long time [136], [47], some of them still use the physical greenhouse effect to explain temperature effects of planetary atmospheres. For instance in their book on the atmospheric greenhouse effect, Schönwiese and Diekmann build their arguments upon the glass house effect [186]. Their list of references contains a seminal publication that clearly shows that this is inadmissable [5].

2.5 Experiment by Wood

2.5.0 Explanations of the observations

In the following section, Wood assumes that the absorbed radiation is the cause of the greenhouse effect, but that it is not captured. He is right in this, but he has not pointed out the real cause.

For the following explanation, here is a simple question: Why is it warmer in a heated room than in the surroundings? Quite simply because the heat energy can only flow through the enclosing walls if there is an elevated inner temperature. Why do we keep the doors shut in winter? In order that the heat from the source of heating is not carried off by the cold air from outside.

Now to Wood[20]: Without solar radiation, the temperature in an enclosed space is the same as that of the surroundings. If now through solar radiation, as with any other form of heating, additional heat comes into the enclosure, the inner area must warm up until the heat flow through the walls is as great as the additional heat brought into the enclosure by the absorbed solar radiation. If it turns colder outside, more heating is therefore required, because the heat discharge increases (because of the heightened temperature gradient in the wall).

Inside temperatures do not depend on the method of heating, whether by electrical heating, by microwave radiation absorption (microwave in the kitchen) or by solar radiation through a transparent surface. The same heat capacities produce the same warming which shows itself, for example, in reduced need for heating when the sun shines into a room.

Vacuum solar collector s show in particular the importance of preventing heat escape. In their case, the "absorber" (indicated by Wood as the floor) is not only surrounded by a simple glass casing, but first by a vacuum. Heat cannot even be transferred through convection – but the temperatures reach up to 450°C, because only at this temperature is the heat loss through the casing as great as the absorbed heat.

The same mechanism is at work with the atmospheric greenhouse effect; of course it is somewhat more complicated, because the radiation characteristics of the atmosphere have to be examined carefully.

2.5.1 Text

Although the warming phenomenon in a glass house is due to the suppression of convection, say air cooling[21], it remains true that most glasses absorb infrared light at wavelength 1 μm and higher almost completely.

An *experimentum crucis*[22] therefore is to build a glass house with panes consisting of NaCl or KCl, which are transparent to visible light as well as infrared light. For rock salt (NaCl) such an experiment was realized as early as 1909 by Wood [217], [122], [182], [70]:

„There appears to be a widespread belief that the comparatively high tem-

20) In 1909 Wood could not know Einstein's work from the year 1916 [79]. Besides, Wood writes, that he had not thoroughly dealt with this problem himself.

21) A problem familiar to those who are involved in PC hardware problems.

22) An experimentum crucis is an experiment, of which the end result neither confirms nor contradicts a hypothesis. This designation goes back to F. Bacon. In research there are only a few cases where such a situation arises, where an experimentum crucis is possible. In general, the result of an experiment only advances the degree of confirmation of a hypotheses or rejects it. According to the Duhem-Quine Thesis, the definition of single propositions as experimentum crucis for a theory is not possible. [215]

perature produced within a closed space covered with glass, and exposed to solar radiation, results from a transformation of wave-length, that is, that the heat waves from the Sun, which are able to penetrate the glass, fall upon the walls of the enclosure and raise its temperature: the heat energy is re-emitted by the walls in the form of much longer waves, which are unable to penetrate the glass, the greenhouse acting as a radiation trap.

I have always felt some doubt as to whether this action played any very large part in the elevation of temperature. It appeared much more probable that the part played by the glass was the prevention of the escape of the warm air heated by the ground (- as is the case with every form of heating) within the enclosure. If we open the doors of a greenhouse on a cold and windy day, the trapping of radiation appears to lose much of its efficacy. As a matter of fact I am of the opinion that a greenhouse made of a glass transparent to waves of every possible length would show a temperature nearly, if not quite, as high as that observed in a glass house. The transparent screen allows the solar radiation to warm the ground, and the ground in turn warms the air, but only the limited amount within the enclosure. In the „open“, the ground is continually brought into contact with cold air by convection currents.

To test the matter I constructed two enclosures of dead black cardboard, one covered with a glass plate, the other with a plate of rock-salt of equal thickness. The bulb of a thermometer was inserted in each enclosure and the whole packed in cotton, with the exception of the transparent plates which were exposed. When exposed to sunlight the temperature rose gradually to 65°C, the enclosure covered with the salt plate keeping a little ahead of the other, owing to the fact that it transmitted the longer waves from the Sun, which were stopped by the glass. In order to eliminate this action the sunlight was first passed through a glass plate.

There was now scarcely a difference of one degree between the temperatures of the two enclosures. The maximum temperature reached was about 55°C. From what we know about the distribution of energy in the spectrum of the radiation emitted by a body at 55°C, it is clear that the rock-salt plate is capable of transmitting practically all of it, while the glass plate stops it entirely. This shows us that the loss of temperature of the ground by radiation is very small in comparison to the loss by convection, in other words that we gain very little from the circumstance that the radiation is trapped.

Is it therefore necessary to pay attention to trapped radiation in deducing the temperature of a planet as affected by its atmosphere? The solar rays penetrate the atmosphere, warm the ground which in turn warms the atmosphere by contact and by convection currents. The heat received is thus stored up in the atmosphere, remaining there on account of the very low radiating power of a gas. It seems to me very doubtful if the atmosphere is warmed to any great extent by absorbing the radiation from the ground, even under the most favourable conditions.

I do not pretend to have gone very deeply into the matter, and publish this note merely to draw attention to the fact that trapped radiation appears to play but a very small part in the actual cases with which we are familiar.“

This text is a recommended reading for all global climatologists referring to the greenhouse effect. Wood has certainly ≪not ... gone very deeply into the matter≫, therefore the stratification in the adiabatic atmosphere, in the tropopause etc plays no role, according to him.

2.6 Glass house summary

It is not the „trapped“ infrared radiation, which explains the warming phenomenon in a real greenhouse, but it is the suppression of air cooling[23) 24)] – as is the case with every form of heating.

3 The fictitious atmospheric greenhouse effects

3.1 Problem definition

After it has been thoroughly discussed, that the physical greenhouse effect is essentially the explanation, why air temperatures in a closed glass house or in a closed car are higher than outside, one should have a closer look at the fictitious atmospheric greenhouse effects.

Meanwhile there are many different phenomena and different explanations for these effects, so it is justified to pluralize here.

Depending on the particular school and the degree of popularization, the assumption that the atmosphere is transparent for visible light but opaque for infrared radiation is supposed to lead to

- a warming of the Earth’s surface *and/or*
- a warming of the lower atmosphere *and/or*
- a warming of a certain layer of the atmosphere *and/or*
- a slow-down of the natural cooling of the Earth’s surface

and so forth.

Unfortunately, there is no source in the literature, where the greenhouse effect is introduced in harmony with the scientific standards of theoretical physics. As already emphasized, the „supplement“ to Kittel’s book on thermal physics [132] only refers to the IPCC assessments [115], [112]. Prominent global climatologists (as well as „climate sceptics“) often present their ideas in handbooks, encyclopedias, and in secondary and tertiary literature. I can largely go along with this, but there are relevant technical journals. Also the fundamental experimental knowledge was first published in technical

23) As almost everybody knows, this is also a standard problem in PCs.
24) for how it really is, see section 2.5.0 on page 34

journals, for example, [170], [169] and [79]. Because of the numerous mistakes and inadequacies, this present paper does not refute in any case the real existing greenhouse effect.

3.1.1 On the Glass house/Atmospheric greenhouse effect analogy

When solar radiation drops, the additional heating in both cases drops. When the surroundings of both are colder, both cool down. Depending on the quality of the heat insulation and the temperature of the enclosure, this process occurs either quickly or slowly. The temperature and the heat insulation of the floor is in both cases similar, the lower atmosphere has no sidewalls, because it is a spherical shell. The greatest difference exists with the roof. The atmosphere is a thick layer which only cools slowly (less than 5 K in 12 hours), but is relatively cool (the intensity is about the equivalent of black body radiation at -40°C). What significance this radiation has can be seen by comparison with the airless moon, where no back-radiation exists. Other mechanisms do not come into play because the atmospheric temperature gradient accelerates rather than diminishes the cooling of the surface, and wind velocities are much slower than the movement of the edge of the sun"s shadow.

3.2 Scientific error versus scientific fraud

Recently, the German climatologist Graßl emphasized that errors in science are unavoidable, even in climate research [99]. And the IPCC weights most of its official statements with a kind of a „probability measure“ [18]. So it seems that, even in the mainstream discussion on the supposed anthropogenic global warming, there is room left for scientific errors and their corrections.

However, some authors and filmmakers have argued that the greenhouse effect hypothesis is not based on an error, but clearly is a kind of a scientific fraud.

Five examples:

- As early as 1990 the Australian movie entitled „The greenhouse conspiracy“ showed that the case for the greenhouse effect rests on four pillars [27]:
  1. the *factual evidence*, i.e. the climate records, that supposedly suggest that a global warming has been observed and is exceptional;
  2. the *assumption* that carbon dioxide is the cause of these changes;
  3. the *predictions of climate models* that claim that a doubling of CO_2 leads to a predictable global warming;
  4. the *underlined physics*.

  In the movie these four pillars were dismantled bringing the building down. The speaker states:

  > „In a recent paper on the effects of carbon dioxide, Professor Ellsaesser of the Lawrence Livermore Laboratories, a major US research establishment in California, concluded that a doubling of carbon dioxide would have little or no effect on the temperature at the surface and, if anything, might cause the surface to cool.“

The reader is referred to Ellsaesser's original work [80].

- Two books by the popular German meteorologist and sociologist Wolfgang Thüne, entitled *The Greenhouse Swindle* (In German, 1998) [201] and *Aquittal for CO_2* (In German, 2002) [200] tried to demonstrate that the CO_2 greenhouse effect hypothesis is pure nonsense.
- A book written by Heinz Hug entitled *Those who play the trumpet of fear* (In German, 2002), elucidated the history and the background of the current greenhouse business [117]
- Another movie was shown recently on Channel 4 (UK) entitled „The great global warming swindle“ supporting the thesis that the supposed CO_2 induced anthropogenic global warming has no scientific basis [24].
- In his paper „CO_2: The Greatest Scientific Scandal of Our Time“ the eminent atmospheric scientist Jaworowski made a well-founded statement [121].

On the other hand, Sir David King, the science advisor of the British government, stated that „global warming is a greater threat to humanity than terrorism“ (Singer)[25)], other individuals put anthropogenic global warming denier s in the same category as holocaust deniers, and so on. In an uncountable number of contributions to newspapers and TV shows in Germany the popular climatologist Latif[26)] continues to warn the public about the consequences of rising greenhouse gas (GHG) emissions [22]. But until today it is impossible to nd a book on non-equilibrium thermodynamics or radiation transfer where this effect is derived from first principles.

The main objective of this paper is not to draw the line between error and fraud, but to nd out where the greenhouse effect appears or disappears within the frame of physics. Therefore, in section 3.3 on the following page several different variations of the atmospheric greenhouse hypotheses will be analyzed and disproved really? The authors restrict themselves on statements that appeared after a publication by Lee in the well-known Journal of Applied Meteorology 1973, see Ref. [136] and references therein.

Lee's 1973 paper is a milestone. In the beginning Lee writes:

> „The so-called radiation 'greenhouse' effect is a misnomer. Ironically, while the concept is useful in describing what occurs in the earth's atmosphere, it is invalid for cryptoclimates created when space is enclosed with glass, e.g. in greenhouses and solar energy collectors. Specically, elevated temperatures observed under glass cannot be traced to the spectral absorbtivity of glass.
>
> The misconception was demonstrated experimentally by R. W. Wood [27)] more than 60 years ago (Wood, 1909) [217] and recently in an analytical manner by Businger (1963) [54]. Fleagle and Businger (1963) [83] devoted a section of their text to the point, and suggested that radiation trapping by the earth's atmosphere should be called 'atmosphere effect' to discourage use of the misnomer. Munn (1966) [154] reiterated that the analogy between

25) cf. Singer's summary at the Stockholm 2006 conference [166].
26) Some time ago one of the authors (R.D.T.) was Mojib Latif's teaching assistant in the physics lab.
27) Remarks of the Authors: see section 2.5.0 on page 34

‘atmosphere’ and ‘greenhouse’ effect ‘is not correct because a major factor in greenhouse climate is the protection the glass gives against turbulent heat losses’. In one instance, Lee (1966) [135], observed that the net flux of radiant energy actually was diminished be pore than 10 % in a 6-mil polyvinyl enclosure.

> In spite of the evidence, modern textbooks on meteorology and climatology not only repeat the misnomer, but frequently support the false notion that ‘heatretaining behavior of the atmosphere is analogous to what happens in a greenhouse’ (Miller, 1966) [151], or that ‘the function of the [greenhouse] glass is to form a radiation trap’ (Peterssen, 1958) [168]. (see also Sellers, 1965, Chang, 1968, and Cole, 1970) [187], [66], [69]. The mistake obviously is subjective, based on similarities of the atmosphere and glass, and on the ‘neatness’ of the example in teaching. The problem can be rectified through straightforward analysis, suitable for classroom instruction.“

Lee continues his analysis with a calculation based on radiative balance equations, which are physically questionable. The same holds for a comment by Berry [47] on Lee’s work. Nevertheless, Lee’s paper is a milestone marking the day after every serious scientist or science educator is no longer allowed to compare the greenhouse with the atmosphere [28)], even in the classroom, which Lee explicitly refers to.

3.3 Different versions of the atmospheric greenhouse conjecture

3.3.1 Atmospheric greenhouse effect after Möller (1973)

In his popular textbook on meteorology [156], [155] Möller claims:

> „In a real glass house (with no additional heating, i.e. no greenhouse) the window panes are transparent to sunshine, but opaque to terrestrial radiation. The heat exchange must take place through heat conduction within the glass, which requires a certain temperature gradient. Then the colder boundary surface of the window pane can emit heat. In case of the atmosphere water vapor and clouds play the role of the glass.“

Disproof: The existence of the greenhouse effect is considered as a necessary condition for thermal conductivity. This is a physical nonsense. Furthermore it is implied that the spectral transmissivity of a medium determines its thermal conductivity straightforwardly. This is a physical nonsense as well.

The fact that the covering of the greenhouse and solar collectors makes heat escape more difficult (with the consequence of a higher inner temperature) both shows the achieved results as well as the consequences of opening the door.

28) Without mention of boundary conditions, every comparison is wrong, but when explained in detail what is being compared, desired comparisons are permitted and worthwhile.

3.3.2 Atmospheric greenhouse effect after Meyer's encyclopedia

(1974)

In the 1974 edition of Meyer's Enzyklopädischem Lexikon one finds under „glass house effect" [19]:

> „Name for the influence of the Earth's atmosphere on the radiation and heat budget of the Earth, which compares to the effect of a glass house: Water vapor and carbon dioxide in the atmosphere let short wave solar radiation go through down to the Earth's surface with a relative weak attenuation and, however, reflect the portion of long wave (heat) radiation which is emitted from the Earth's surface (atmospheric backradiation)."

Disproof: Firstly, the main part of the solar radiation lies outside the visible light. Secondly, reflection is confused with emission. Thirdly, the concept of atmospheric backradiation relies on an inappropriate application of the formulas of cavity radiation. This will be discussed in section 3.5 on page 48

The point of intersection of roughly equal output between solar radiation and emission from the surface of the earth lies in the infrared region - but so also lies the border in wavelength between the transmitting and absorbing atmosphere, though this border is not precise. Reflection and emission are easily confused. With regard to back-radiation: it can first of all be measured and secondly calculated with the Einstein equation [79], but this often wrongly explained with the vacuum radiation alone. See section 4.1 on page 94

3.3.3 Atmospheric greenhouse effect after Schönwiese (1987)

The prominent climatologist Schönwiese states [186]:

> „. . . we use the picture of a glass window that is placed between the Sun and the Earth's surface. The window pane lets pass the solar radiation unhindered but absorbs a portion of the heat radiation of the Earth. The glass pane emits, corresponding to its own temperature, heat in both directions: To the Earth's surface and to the interplanetary space. Thus the radiative balance of the Earth's surface is raised. The additional energy coming from the glass pane is absorbed almost completely by the Earth's surface immediately warming up until a new radiative equilibrium is reached."

Disproof: That the window pane lets pass the solar radiation unhindered is simply wrong. Of course, some radiation goes sidewards. As shown experimentally in section 2.4 on page 30, the panes of the car window are relatively cold. This is only one out of many reasons, why the glass analogy is unusable. Hence the statement is vacuous.

The explanation is quite good (the atmosphere is also colder than Earth's surface) - but the effect of increasing CO_2 is difficult to explain with this. Besides, the effects are reversed: even without solar radiation the glass surface emits according to its (where applicable low) temperature; the additional energy is the transmitted solar radiation.

3.3.4 Atmospheric greenhouse effect after Stichel (1995)

Stichel (the former deputy head of the German Physical Society) stated once [195]:

> „Now it is generally accepted textbook knowledge that the long-wave infrared radiation, emitted by the warmed up surface of the Earth, is partially absorbed and re-emitted by CO_2 and other trace gases in the atmosphere. This effect leads to a warming of the lower atmosphere and, for reasons of the total radiation budget, to a cooling of the stratosphere at the same time.“

Disproof: This would be a Perpetuum Mobile of the Second Kind. A detailed discussion is given in section 3.9 on page 87. Furthermore, there is no total radiation budget, since there are no individual conservation laws for the different forms of energy participating in the game. The radiation energies in question are marginal compared to the relevant geophysical and astrophysical energies. Finally, the radiation depends on the temperature and not vice versa.

There is no Perpetuum Mobile of the Second Kind; even if it were so, this assertion should have already appeared in section 3.3.3 on the preceding page. The Authors of this paper have to deal with another confusion: a balance is not a conservation law. Balance means that something keeps changing until after reaching a certain equilibrium, the changes stop or become minimal. The changing quantity in the radiation balance case is the temperature: it changes until the energy loss is exactly as great as the energy gain - there is no energy left to warm or to cool the body in question: the temperature therefore remains the same. In addition there is an inaccuracy with regard to Stichel: TheStrahlungsbilanz radiation balance results from a reaction and is not the cause. The first consequence of the rise of CO_2 concentration is the following: at great heights the emission increases which leads to a cooling of the stratosphere, so its temperature falls. As a further consequence the height of the tropopause increases. Above the tropopause, absorption and emission largely compensate each other, although the downward pointed radiation sharply increases from 0. Beneath the tropopause compensation is no longer possible and emission becomes larger; since the energy difference between emission and absorption can only be covered by convective and latent heat transport, and heat conductance is not sufficient for it, a vertical airflow is induced. However, a vertical airflow results in an adiabatic temperature profile, as is roughly observed. A difference in temperature between an adiabatic curve and real temperature is brought about by heat loss, since a clear adiabatic temperature change does not alter the energy content of an air packet. The heat transport (i.e. the airflow) is driven by emission: the air cooled by emission sinks and forces the rising of warmer air.

3.3.5 Atmospheric greenhouse effect after Anonymous 1 (1995)

> „The carbon dioxide in the atmosphere lets the radiation of the Sun, whose maximum lies in the visible light, go through completely, while on the other hand it absorbs a part of the heat radiation emitted by the Earth into space because of its larger wavelength. This leads to higher near-surface air temperatures.“

Disproof: The first statement is incorrect since the obviously nonneglible infrared part of the incoming solar radiation is being absorbed (cf. section 2.2 on page 24). The second statement is falsified by referring to a counterexample known to every housewife: The water pot on the stove. Without water filled in, the bottom of the pot will soon become glowing red. Water is an excellent absorber of infrared radiation. However, with water filled in, the bottom of the pot will be substantially colder. Another example would be the replacement of the vacuum or gas by glass in the space between two panes. Conventional glass absorbs infrared radiation pretty well, but its thermal conductivity shortcuts any thermal isolation.

The refutation is obviously incorrect, since nothing is said about the radiation part in infrared - the radiation peak certainly lies in the visible region. With reference to the »water pot«, see commentary in section 3.8.3 on page 86

3.3.6 Atmospheric greenhouse effect after Anonymous 2 (1995)

> „If one raises the concentration of carbon dioxide, which absorbs the infrared light and lets visible light go through, in the Earth's atmosphere, the ground heated by the solar radiation and/or near-surface air will become warmer, because the cooling of the ground is slowed down.“

Disproof: It has already been shown in section 1.1 on page 10 that the thermal conductivity is changed only marginally even by doubling the CO_2 concentration in the Earth's atmosphere.

The statement in the »refutation« is meaningless, as thermal conductivity has no real importance with regard to the greenhouse effect.

3.3.7 Atmospheric greenhouse effect after Anonymous 3 (1995)

> „If one adds to the Earth's atmosphere a gas, which absorbs parts of the radiation of the ground into the atmosphere, the surface temperatures and near- surface air temperatures will become larger.“

Disproof: Again, the counterexample is the water pot on the stove; see section 3.3.5 on the preceding page.

An atmosphere is not a water pot and the water pot proves the greenhouse effect - see commentary in section 3.8.3 on page 86

3.3.8 Atmospheric greenhouse effect after German Meteorological

Society (1995)

In its 1995 statement, the German Meteorological Society says [28]:

> „As a point of a departure the radiation budget of the Earth is described. In this case the incident unweakened solar radiation at the Earth's surface is partly absorbed and partly reflected. The absorbed portion is converted

> into heat and must be re-radiated in the infrared spectrum. Under such circumstances simple model calculations yield an average temperature of about 18C at the Earth's surface ... Adding an atmosphere, the incident radiation at the Earth's surface is weakened only a little, because the atmosphere is essentially transparent in the visible range of the spectrum. Contrary to this, in the infrared range of the spectrum the radiation emitted form the ground is absorbed to a large extent by the atmosphere ... and, depending on the temperature, re- radiated in all directions. Only in the so-called window ranges (in particular in the large atmospheric window 8 - 13 m) the infrared radiation can escape into space. The infrared radiation that is emitted downwards from the atmosphere (the so-called back-radiation) raises the energy supply of the Earth's surface. A state of equilibrium can adjust itself if the temperature of the ground is rises and, therefore, a raised radiation according to Planck's law is possible. This undisputed natural Greenhouse effect gives rise to an increase temperature of the Earth's surface."

Disproof: The concept of an radiation budget is physically wrong. The average of the temperature is calculated incorrectly. Furthermore, an nonneglible portion of the incident solar radiation is absorbed by the atmosphere. Heat must not be confused with heat radiation. The assumption that if gases emit heat radiation, they will emit it only downwards is rather obscure. The described mechanism of re-calibration to equilibrium has no physical basis. The laws of cavity radiation do not apply to fluids and gases.

Why a radiation balance does exist is more clearly demonstrated on p. 85. That the atmosphere »only« emits downwards, is not stated in the text. Einstein"s equations [79] apply to the radiation of gases. See section 4.1 on page 94

3.3.9 Atmospheric greenhouse effect after Graßl (1996)

The former director of the World Meteorological Organization (WMO) climate research program, Professor Hartmut Graßl, states [100]:

> „In so far as the gaseous hull [of the Earth] obstructs the propagation of solar energy down to the planet's surface less than the direct radiation of heat from the surface into space, the ground and the lower atmosphere must become warmer than without this atmosphere, in order to re-radiate as much energy as received from the Sun."

Disproof: This statement is vacuous, even in a literal sense. One cannot compare the temperature of a planet's lower atmosphere with the situation where a planetary atmosphere does not exist at all. Furthermore, as shown in section 2.2 on page 24 the portion of the incoming infrared is larger than the portion of the incoming visible light. Roughly speaking, we have a fifty-fifty relation. Therefore the supposed warming from the bottom must compare to an analogous warming from the top. Even within the logics of Graßl's oversimplified (and physically incorrect) conjecture one is left with a zero temperature gradient and thus a null effect.

Here the Authors contradict their assertion made on another page of this paper (section 3.7.4 on page 68) where calculations are tacitly made without an atmosphere. Besides, the statement does not even contain the word »infrared«, the Authors, therefore, only contradict their own assumption.

3.3.10 Atmospheric greenhouse effect after Ahrens (2001)

In his textbook „Essentials in Meteorology: In Invitation to the Atmosphere" the author Ahrens states [13]:

> „The absorption characteristics of water vapor, CO_2, and other gases such as methane and nitrous oxide ... were, at one time, thought to be similar to the glass of a florists greenhouse. In a greenhouse, the glass allows visible radiation to come in, but inhibits to some degree the passage of outgoing infrared radiation. For this reason, the behavior of the water vapor and CO_2, the atmosphere is popularly called the greenhouse effect. However, studies have shown that the warm air inside a greenhouse is probably caused more by the airs inability to circulate and mix with the cooler outside air, rather than by the entrapment of infrared energy. Because of these findings, some scientists insist that the greenhouse effect should be called the atmosphere effect. To accommodate everyone, we will usually use the term atmospheric greenhouse effect when describing the role that water vapor and CO_2, play in keeping the earths mean surface temperature higher than it otherwise would be."

Disproof: The concept of the Earth's mean temperature is ill-defined. Therefore the concept of a rise of a mean temperature is ill-defined as well.

Criticizing definitions is not a refutation of the facts of the case.

3.3.11 Atmospheric greenhouse effect after Dictionary of

Geophysics, Astrophysics, and Astronomy (2001)

The Dictionary of Geophysics, Astrophysics, and Astronomy says [72]:

> „Greenhouse Effect: The enhanced warming of a planets surface temperature caused by the trapping of heat in the atmosphere by certain types of gases (called greenhouse gases; primarily carbon dioxide, water vapor, methane, and chlorofluorocarbons). Visible light from the sun passes through most atmospheres and is absorbed by the body's surface. The surface reradiates this energy as longerwavelength infrared radiation (heat). If any of the greenhouse gases are present in the body's troposphere, the atmosphere is transparent to the visible but opaque to the infrared, and the infrared radiation will be trapped close to the surface and will cause the temperature close to the surface to be warmer than it would be from solar heating alone."

Disproof: Infrared radiation is confused with heat. It is not explained at all what is meant by „the infrared radiation will be trapped“. Is it a MASER, is it „superinsulation“, i.e. vanishing thermal conductivity, or is it simple thermalization?

This is not a refutation, but only evidence of a bad explanation.

3.3.12 Atmospheric greenhouse effect after Encyclopaedia of

Astronomy and Astrophysics (2001)

The Encyclopaedia of Astronomy and Astrophysics defines the greenhouse effect as follows [2]:

> „The greenhouse effect is the radiative influence exerted by the atmosphere of a planet which causes the temperature at the surface to rise above the value it would normally reach if it were in direct equilibrium with sunlight (taking into account the planetary albedo). This effect stems from the fact that certain atmospheric gases have the ability to transmit most of the solar radiation and to absorb the infrared emission from the surface. The thermal (i.e. infrared) radiation intercepted by the atmosphere is then partially re-emitted towards the surface, thus contributing additional heating of the surface. Although the analogy is not entirely satisfactory in terms of the physical processes involved, it is easy to see the parallels between the greenhouse effect in the atmosphere-surface system of a planet and a horticultural greenhouse: the planetary atmosphere plays the role of the glass cover that lets sunshine through to heat the soil while partly retaining the heat that escapes from the ground. The analogy goes even further, since an atmosphere may present opacity 'windows' allowing infrared radiation from the surface to escape, the equivalent of actual windows that help regulate the temperature inside a domestic greenhouse.“

Disproof: The concept of the „direct equilibrium with the sunlight' is physically wrong, as will be not shown in detail in section 3.7 on page 58. The description of the physics of a horticultural greenhouse is incorrect. Thus the analogy stinks.

For analogy, see section 3.1.1 on page 38.

3.3.13 Atmospheric greenhouse effect after Encyclopaedia

Britannica Online (2007)

Encyclopaedia Britannica Online explains the greenhouse effect in the following way [21]:

„The atmosphere allows most of the visible light from the Sun to pass through and reach the Earth's surface. As the Earth's surface is heated by sunlight, it radiates part of this energy back toward space as infrared radiation. This radiation, unlike visible light, tends to be absorbed by the greenhouse gases in the atmosphere, raising its temperature. The heated atmosphere in turn radiates infrared radiation back toward the Earth's surface. (Despite its name, the greenhouse effect is different from the warming in a greenhouse, where panes of glass transmit visible sunlight but hold heat inside the building by trapping warmed air.) Without the heating caused by the greenhouse effect, the Earth's average surface temperature would be only about 18 C (0 F).“

Disproof: The concept of the Earth's average temperature is a physically and mathematically ill-defined and therefore useless concept as will be shown in section 3.7 on page 58.

The above »Disproof« is also no disproof. To be sure, the text of the encyclopedia is imperfect: greenhouse gases radiate only according to their temperature. But no cooling occurs after equilibrium has been established, because the returned energy is replaced by absorption and heat transfer.

3.3.14 Atmospheric greenhouse effect after Rahmstorf (2007)

The renowned German climatologist Rahmstorf claims [173]:

> „To the solar radiation reaching Earth's surface ... the portion of the long-wave radiation is added, which is radiated by the molecules partly downward and partly upward. Therefore more radiation arrives down, and for reasons of compensation the surface must deliver more energy and thus has to be warmer (+15 C), in order to reach also there down again an equilibrium. A part of this heat is transported upward from the surface also by atmospheric convection. Without this natural greenhouse effect the Earth would have frozen life-hostilely and completely. The disturbance of the radiative balance [caused by the enrichment of the atmosphere with trace gases] must lead to a heating up of the Earth's surface, as it is actually observed.“

Disproof: Obviously, reflection is confused with emission. The concept of radiative balance is faulty. This will be explained in section 3.7 on page 58.

In the quotation, reflection is not mentioned. Radiative balance is the condition after establishing an equilibrium. See commentary in section 3.7 on page 58.

3.3.15 Conclusion

It is interesting to observe,

- that until today the „atmospheric greenhouse effect“ does not appear
- in any fundamental work of thermodynamics,
- in any fundamental work of physical kinetics,
- in any fundamental work of radiation theory;
- that the definitions given in the literature beyond straight physics are very different and, partly, contradict to each other.

It is even more interesting to analyze the »disproofs«.

3.4 The conclusion of the US Department of Energy

All fictitious greenhouse effects have in common, that there is supposed to be one and only one cause for them: An eventual rise in the concentration of CO_2 in the atmosphere

> Both of these perspectives describe the process by which increases in the atmospheric abundance of *greenhouse gases* lead to warming at the Earth's surface. The term *greenhouse gases* refers to gases that are highly transparent to solar radiation but are relatively opaque to longwave radiation, similar to glass in a greenhouse. The process by which warming occurs in a greenhouse is different from that described above. In this regard the terms *greenhouse gas* and *greenhouse effect* are misnomers.

Figure 15: An excerpt from page 28 of the DOE report (1985)

is supposed to lead to higher air temperatures near the ground. For convenience, in the context of this paper it is called the CO_2-greenhouse effect.[29] Lee's 1973 result [136] that the warming phenomenon in a glass house does not compare to the supposed atmospheric greenhouse effect was confirmed in the 1985 report of the United States Department of Energy „Projecting the climatic effects of increasing carbon dioxide" [5]. In this comprehensive pre-IPCC publication MacCracken explicitly states that the terms „greenhouse gas" and „greenhouse effect" are misnomers [5], [71]. A copy of the last paragraph of the corresponding section on page 28 in shown in Figure 15.

The following should be emphasized:

- The warming phenomenon in a glass house and the supposed atmospheric greenhouse effects have the same participants, but in the latter case the situation is reversed.
- Methodically, there is a huge difference: For the physical greenhouse effect one can make measurements, look at the differences of the instruments readings and observe the effect without any scientific explanation and such without any prejudice.

For the fictitious atmospheric greenhouse effect one cannot watch allegedly anything, and only calculations are compared with one another: Formerly extremely simple calculations, they got more and more intransparent. Nowadays computer simulations are used, which virtually nobody can reproduce [9].

In the following the different aspects of the physics underlying the atmospheric situation are discussed in detail.

3.5 Absorption/Emission is not Reflection

3.5.1 An inconvenient popularization of physics

Figure 16 on the next page is a screenshot from a controversial award-winning „documentary lm" about „climate change" , specifically „global warming" , starring Al Gore,

29) The nomenclature naturally extents to other trace gases.

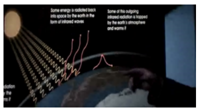

Figure 16: A very popular physical error illustrated in the movie „An Inconvenient truth“ by Davis Guggenheim featuring Al Gore (2006)

the former United States Vice President, and directed by Davis Guggenheim [98], [102]. This movie has been supported by managers and policymakers around the world and has been shown in schools and in outside events, respectively. Lewis wrote an interesting „A Skeptic's Guide to An Inconvenient Truth“ evaluating Gore's work in detail [137].

From the view of a trained physicist, Gore's movie is rather grotesque, since it is shockingly wrong. Every licensed radio amateur[30)] knows that what is depicted in Figure 16 would be true only,

- if the radiation graphically represented here was long wave or short wave radiation;
- if the reflecting sphere was a certain layer of the ionosphere [53].

Short waves (e.g. in the 20 m/14 MHz band) are reflected by the F layer of the ionosphere (located 120 - 400 km above the Earth's surface) enabling transatlantic connections (QSOs[31)]). Things depend pretty much on the solar activity, i.e. on the sun spot cycle, as every old man (OM [32)]) knows well. The reflective characteristics [33)] of the ionosphere diminish above about 30 MHz. In the very high frequency (VHF) bands (e.g. 2 m/144MHz band) one encounters the so called Sporadic-E clouds (90 - 120 km above the Earth's surface), which still allow QSOs from Germany to Italy, for example. On the other hand at the extremely low frequencies (ELF) (i.e. radio frequencies 3 - 30 Hz) the atmosphere of the Earth behaves as a cavity and one encounters the so called Schumann resonances [184]. These may be used to estimate a lower bound for the mass of the photon[34)] and, surprisingly, appear in the climate change discussion [87].

However, the radio signal of Al Gore's cellular phone (within the centimeter range) does not travel around the world and so does not Bluetooth, Radar, microwave and infrared radiation (i.e. electromagnetic waves in the sub millimeter range).

Ionosphere Radars typically work in the 6m Band, i.e. at 50 MHz. Meteorological Radars work in the 0.1 - 20 cm range (from 90 GHz down to 1.5 GHz), those in the 3 - 10 cm range (from 10 GHz down to 3 GHz) are used for wind finding and weather watch [3]. It is obvious, that Al Gore confuses the ionosphere with the tropopause, the region in the atmosphere, that is the boundary between the troposphere and the stratosphere. The latter one is located between 6 km (at the poles) and 17 km (at the equator) above

30) Callsign of R.D.T.: DK8HH

31) Abbreviation for ≫to initiate wireless conversation≪

32) ≫Old man≪ = symbol used by radio amateurs amongst themselves.

33) As great value is placed on exactness in this paper, we must add that what the ≫OM≪ indicates as reflection is as a rule a diffraction. The conditions for reflection (section 3.5.2 on the next page) are only fulfilled by floor reflection, but not in the ionosphere.

34) As a teaching assistant at Hamburg University/DESY, R.D.T. learned this from Professor Herwig Schopper.

the surface of the Earth. [35]

Furthermore, Al Gore confuses *absorption/emission* with *reflection*. Unfortunately, this is also done implicitly and explicitly in many climatologic papers, often by using the vaguely defined terms „re-emission“, „re-radiation“ and „backradiation“.

3.5.2 Reflection

When electromagnetic waves move from a medium of a given n_1 into a second medium with refractive index n_2, both reflection and refraction of the waves may occur [50]. In particular, when the jump of the refractive index occurs within a length of the order of a wavelength, there will be a reflection. The fraction of the intensity of incident electromagnetic wave that is reflected from the interface is given by the reflection coefficient R, the fraction refracted at the interface is given by the transmission coefficient T. The Fresnel equations, which are based on the assumption that the two materials are both dielectric, may be used to calculate the reflection coefficient R and the transmission coefficient T in a given situation. In the case of a normal incidence the formula for the reflection coefficient is

$$R = \left(\frac{n_2 - n_1}{n_2 + n_1} \right)^2 \tag{44}$$

In the case of strong absorption (large electrical conductivity σ) simple formulas can be given for larger angles γ of incidence, as well (Beer's formula):

$$R_s = \frac{(n_2 - n_1 \cos\gamma)^2 + n_2^2 \sigma^2 \cos^2\gamma}{(n_2 + n_1 \cos\gamma)^2 + n_2^2 \sigma^2 \cos^2\gamma} \tag{45}$$

and

$$R_p = \frac{(n_1 - n_2 \cos\gamma)^2 + n_2^2 \sigma^2 \cos^2\gamma}{(n_1 + n_2 \cos\gamma)^2 + n_2^2 \sigma^2 \cos^2\gamma} \tag{46}$$

When the jump of the refractive index occurs within a length of the order of a wavelength, there will be a reflection, which is large at high absorption. In the case of gases this is only possible for radio waves of a comparatively long wave length in the ionosphere, which has an electrical conductivity, at a diagonal angle of incidence. There is no reflection in the homogeneous absorbing range. As already elucidated in section 3.5.1 on page 48 this has been well-known to radio amateurs ever since and affects their activity e.g. in the 15 m band, but never in the microwave bands. On the other hand, most glasses absorb the infrared light almost completely at approximately 1 μm and longer wavelength: therefore, the reflection of the infrared waves for normal glasses is very high.

For dielectric media, whose electrical conductivity is zero, one cannot use Beer's formulas. This was a severe problem in Maxwell's theory of light.

---

35) Some climatologists claim that there is a CO_2 layer in the troposphere that traps or reflects the infrared radiation coming from the ground.

3.5.3 Absorption and Emission

If an area is in thermodynamical equilibrium with a field of radiation, the intensity E_ν (resp. E_λ) emitted by the unit solid angle into a frequency unit (resp. a wavelength unit) is equal to the absorptance A_ν (resp. A_λ) multiplied with an universal frequency function $B_\nu(T)$ (resp. a wavelength function $B_\lambda(T)$) of the absolute temperature T. One writes, respectively,

$$E_\nu = A_\nu \cdot B_\nu(T) \tag{47}$$

$$E_\lambda = A_\lambda \cdot B_\lambda(T) \tag{48}$$

This is a theorem by *Kirchhoff* . The function $B_\nu(T)$ (resp. $B_\lambda(T)$) is called the *Kirchhoff–Planck–function*. It was already considered in section 2.1.4 on page 22.

The *reflectance* is, respectively,

$$R_\nu = 1 - A_\nu \tag{49}$$

$$R_\lambda = 1 - A_\lambda \tag{50}$$

Figure 17: A cavity realizing a perfect black body.

and lies between zero and one, like the *absorptance* A_ν. If R is equal to zero and A is equal to one, the body is called a perfect black body. The emissivity is largest for a perfect black body. The proposal to realize a perfect black body by using a cavity with a small radiating opening had already been made by Kirchhoff and is visualized in Figure 17. For this reason, the emission of a black body for $A_\nu = 1$ (resp. $A_\lambda = 1$) is called *cavity radiation*. The emitted energy comes from the walls, which are being held at a fixed temperature. If this is realized with a part of a body's surface, it will become clear, that these points of view will only be compatible, if the electromagnetic radiation is emitted and absorbed by an extremely thin surface layer. For this reason, it is impossible to describe the volumes of gases with the model of black cavity radiation [36]. Since thermal radiation is electromagnetic radiation, this radiation would have to be caused by thermal motion in case of gases, which normally does not work effectively at room temperatures. At the temperatures of stars the situation is different: The energy

36) It is not necessary, as Einstein in 1916 already understood the radiative characteristics of gases [79]. See section 4.1 on page 94.

levels of the atoms are thermally excited by impacts. The situation is not different. In the atmosphere, too, the radiating energy levels are primarily activated by impact and correspond largely to the Maxwell-Boltzmann distribution.

3.5.4 Re-emission

In case of radiation transport calculations, Kirchhoff's law is „generalized" to the situation, in which the corresponding formula for the emission, or respectively, for the absorption (per unit length along the direction ds) is supposed to be applicable [37)]

$$\varepsilon_\nu ds = \alpha_\nu ds \cdot B_\nu(T) \tag{51}$$

The physical meaning of this „generalization" can be seen most easily, if the above mentioned Kirchhoff law is mathematically extracted out of this formula. For this, one may introduce

$$\varepsilon_\nu ds = E_\nu \delta(s - s_0) \tag{52}$$

$$\alpha_\nu ds = A_\nu \delta(s - s_0) \tag{53}$$

with a δ-density localized at the interface. Physically, this means that all of the absorption and emission comes out of a thin superficial plane. Just like with the correct Kirchhoff law, use is made of the fact, that all absorbed radiation is emitted again, as otherwise the volume area would raise its temperature in thermal balance.

The Kirchhoff's law has nothing to do with temperature changes. For example, if the incident radiation intensity is from a source with a higher temperature the reflective body heats up. The mathematical extraction is nonsense, because a δ-function at the point s_0 has the infinite value with the thickness 0. But ε can never be greater than 1. It is also not in conformity with reality. Proof: When a wall material will be ground sufficient thin every one will be translucent. Furthermore »ε« depends on the kind of surface - and even on the surface molecules and not only on the surface atoms. Molecules are not δ-function, this means that the thickness of the surface layer is not 0 as in a δ-function. Thus, in reality, any reflection etc. is a volume effect just like in the atmosphere - the density of a wall material is »only« more dense than the atmosphere.

This assumption is called the assumption of *Local Thermodynamical Equilibrium (LTE)*. Re-emission does never mean reflection, but, rather, that the absorption *does not cause any rise of temperature in the gas*. This interpretation of the LTE is wrong, LTE means that the distribution of excitations almost corresponds to the Maxwell-Boltzmann-distribution. Thereby, the emission is as a rule higher than the absorption, the loss of energy being covered by heat transport owing to airflow.

---

37) Perhaps there are such derivations? But they must be incorrect, because the radiative transfer equation comes correctly from the Einstein equation [79] and the second law of thermodynamics - see section 4.4.3 on page 108. To that extent the subsequent statements, based on a wrong derivation of the radiative transfer equation, are irrelevant.

An important physical difference to the correct Kirchhoff law lies in the fact, that there is no formula for the absorption per linear unit analogous to

$$R_\nu = 1 - A_\nu \tag{54}$$

With being the density of the medium one can define a *absorption coefficient* κ_ν and an *emission coefficient* j_ν, respectively, by setting

$$\alpha_\nu ds = \kappa_\nu \rho \tag{55}$$

$$\varepsilon_\nu ds = j_\nu \rho \tag{56}$$

The ratio of the emission to the absorption coefficient

$$S_n u = \frac{j_\nu}{\kappa_\nu} \tag{57}$$

describes the re-emission of the radiation and is called the *source function*. Emission and absorption are very closely connected and from this close connection, vacuum radiation [79] as well as the expansion/flow term are properly described (see section 4.1 on page 94). This close connection is experimentally described through energy conservation and the second law of thermodynamics. To that extent the close connection between the radiative transfer equation and Kirchhoff's law is not surprising.

3.5.5 Two approaches of Radiative Transfer

In a gas the radiation intensity of an area changes in the direction of the path element ds according to

$$-\frac{I_\nu}{ds} = \alpha_\nu \, I_\nu - \varepsilon_\nu \tag{58}$$

With the aid of the functions introduced in Equation (55) – Equation (57) this can be expressed as

$$\frac{1}{\kappa_\nu \rho} \, \frac{I_\nu}{ds} = I_\nu - S_\nu \tag{59}$$

This equation is called the *radiative transfer equation* .

Two completely different approaches show that this emission function is not just determined by physical laws [65]:

1. The usual one, i.e. the one in case of LTE, is given by the ansatz

$$S(x,\ y,\ z; l,\ m,\ n) = B_\nu(T(x,\ y,\ z; l,\ m,\ n)) \tag{60}$$

where the coordinates (x, y, z) and the direction cosines (l, m, n) define the point and the direction to which S_ν and B_ν (resp. T) refer. This approach is justified with the aid of the Kirchhoff-Planck-function B_ν and the „generalized“ Kirchhoff law introduced in Equation (51 on page 52). This assumption of *Local Thermodynamical Equilibrium (LTE)* is ruled out by many scientists even for the extremely hot atmospheres of stars. The reader is referred to Chandrasekhar's classical book on radiative transfer [65]. LTE does only bear a certain significance for the radiation transport calculations, if the absorption coefficients were not dependent on the temperature, which is not the case at low temperatures. The temperature dependence is so small that this dependence can almost be ignored - see the table of temperature coefficients obtained from measurement values (and extended by calculations) which is commonly available in the »HITRAN«–dataset [174]. What is changing is the average absorption factor, because along with temperature the wavelength distribution also changes - see diagram [133, p. 41ff]. (The variable in these diagrams is unfortunately not concentration, but pressure.) Nevertheless, in modern climate model computations, this approach is used unscrupulously [5].

2. Another approach [38] is the scattering atmosphere given by

$$S_\nu = \frac{1}{4\,\pi} \int_0^{\pi} \int_0^{2\pi} p(\delta,\ \varphi; \delta',\ \varphi') I_\nu(\delta',\ \varphi') \sin\delta'\ d\delta'\ d\varphi' \tag{61}$$

These extremely different approaches show, that even the physically well-founded radiative transfer calculations are somewhat arbitrary. Formally, the radiative transfer Equation (59 on the previous page) can be integrated leading to

$$I_\nu(s) = I_\nu(0)\ e^{-\ \tau(s,0)} + \int_0^{s} S_\nu(s')\ e^{-\ \tau(s,s')}\ \kappa_\nu \rho\ ds' \tag{62}$$

with the optical thickness

$$\tau(s, s') = \int_0^{s} \kappa_\nu \rho\ ds'' \tag{63}$$

The integrations for the separate directions are independent of one another. In particular, the ones up have nothing to do with the ones down. This is correct, but often something different is found. It cannot be overemphasized, that differential equations only allow the calculation of changes on the basis of known parameters. The initial values (or boundary condition s) cannot be derived from the differential equations to be solved.

In particular, this even holds for this simple integral. This is correct. For a solution, the radiative transfer equation is not sufficient here, as the energy content of the atmosphere varies according to assumed temperature profiles. The temperature profile can

38) Both approximations describe different states and must be added. Both terms are relevant with variable wavelengths: the stray term at short wavelengths (because the wavelength is of comparable size to the size of the particle), the emission term at long wavelengths (because the occupation of the excited states is high).

be determined through a variation calculation for minimal energy content. Boundary conditions are the following:

Radiation downwards: zero value at the upper boundary of the atmosphere.
Radiation upwards: temperature at the earth surface.

The variation calculation results in a tropopause with an isothermal temperature above it and an adiabatic temperature profile below it. See also commentary in section 3.3.4 on page 42 (p. 42).

If one assumes that the temperature of a volume element should be constant, one cannot calculate a rising temperature.

3.6 The hypotheses of Fourier, Tyndall, and Arrhenius

3.6.1 The traditional works

In their research and review papers the climatologists refer to legendary publications of Svante August Arrhenius (Feb. 19th 1859 - Oct. 2nd 1927), a Nobel Prize winner for chemistry. Arrhenius published one of the earliest, extremely simple calculations in 1896, which were immediately - and correctly - doubted and have been forgotten for many decades [34], [33], [32]. It is a paper about the influence of carbonic acid in the air on the Earth's ground temperature. In this quite long paper, Arrhenius put the hypothesis up for discussion, that the occurrences of warm and ice ages are supposed to be explainable by certain gases in the atmosphere, which absorb thermal radiation.

In this context Arrhenius cited a 1824 publication by Fourier[39] entitled „Mémoire sur les températures du globe terrestre et des espaces planétaires“ [85], [84] (≫Treatise on the Temperature of the Globe and its Planetary Space≪).

Arrhenius states incorrectly that Fourier was the first, who claimed that the atmosphere works like a glass of a greenhouse as it lets the rays of the Sun through but keeps the so-called dark heat from the ground inside.

The English translation of the relevant passage (p. 585) reads:

> We owe to the celebrated voyager M. de Saussure an experiment which appears very important in illuminating this question. It consists of exposing to the rays of the Sun a vase covered by one or more layers of well transparent glass, spaced at a certain distance. The interior of the vase is lined with a thick envelope of blackened cork, to receive and conserve heat. The heated air is sealed in all parts, either in the box or in each interval between plates. Thermometers placed in the vase and the intervals mark the degree of heat acquired in each place. This instrument has been exposed to the Sun near midday, and one saw, in diverse experiments, the thermometer of the vase

39) There is a misprint in Arrhenius' work. The year of publication of Fourier's paper is 1824, not 1827 as stated in many current papers, whose authors apparently did not read the original work of Fourier. It is questionable whether Arrhenius read the original paper.

reach 70, 80, 100, 110 degrees and beyond (octogesimal division [40)]). Thermometers placed in the intervals acquired a lesser degree of heat, and which decreased from the depth of the box towards the outside.

Arrhenius work was also preceded by the work of Tyndall who discovered that some gases absorb infrared radiation. He also suggested that changes in the concentration of the gases could bring climate change [206], [204], [205], [202], [203]. A faksimile of the front pages of Fourier's and Arrhenius often cited but apparently not really known papers are shown in Figure 18 on page 63 and in Figure 19 on page 64, respectively.

In which fantastic way Arrhenius uses Stefan-Boltzmann's law to calculate this „effect" , can be seen better in another publication, in which he defends his ice age-hypothesis [32]. See Figure 20 on page 65, Figure 21 on page 66, and Figure 22 on page 66.

First, Arrhenius estimates that 18.7 % of the Earth's infrared radiation would not be emitted into space because of its absorption by carbonic acid. This could be taken into account by reducing the Earth's effective radiation temperature T_{eff} to a reduced temperature $T_{reduced}$ [41)]. Arrhenius assumed [42)]

$$T_{eff} = 15\ ^\circ C = 288 K (64) \tag{64}$$

and, assuming the validity of the Stefan-Boltzmann law, made the ansatz

$$\frac{\sigma \cdot T^4_{reduced}}{\sigma \cdot T^4_{eff}} = \frac{(1 - 0,187) \cdot I_0}{I_0} \tag{65}$$

yielding

$$T_{reduced} = T_{eff} \cdot \sqrt[4]{1 - 0,187} \tag{66}$$

and

$$T_{reduziert} = \sqrt[4]{0,813} \cdot 288\ K = 273,47\ K \tag{67}$$

which corresponds to a lowering of the Earth's temperature of 14.5°C.

As one would probably not think that such an absurd claim is possible, a scan of this passage is displayed in Figure 21 on page 66 and Figure 22 on page 66.

The English translation reads:

„This statement could lead to the impression, that I had claimed that a reduction of the concentration of carbonic acid in the atmosphere of 20 % would be sufficient to cause ice-age temperatures, i.e. to lower the Europe's average temperature about four to five degrees C. To keep such an idea from

40) Reaumur-scale: The reaumur-scale was introduced in the year 1730 by Ferchault de Reaumur. With it, the interval between the boiling point of water (80°R) and the melting point of ice (0°R) is divided into 80 equal points. A temperature of 1°C equals a temperature difference of 4/5°R. The indicated temperatures are also 88°C, 100°C, 125°C, 138°C.

41) For an atmosphere without CO_2.

42) With T_{eff} the median temperature of the earth at the CO_2 - content of the atmosphere of the time.

spreading, I would like to point out that according to the old calculation a reduction of carbonic acid of 50 % would cause the temperature to fall for 4 (1897) or, respectively, 3.2 (1901) degrees. The opinion that a decrease of carbonic acid in the air can explain ice-age temperatures is not proved wrong until it is shown, that the total disappearance of carbonic acid from the atmosphere would not be sufficient to cause a lowering of temperatures about four to five degrees. It is now easy to estimate how low the temperature would fall, if the Earth's radiation rose in the ratio of 1 to 0.775, i.e. for 29 %, which matches the data of Messrs. Rubens and Ladenburg. An increase of emissions of 1 % would be equivalent to a decrease of temperatures of 0.72°C, as the average absolute temperature of the Earth is taken to be 15°C = 288 K. Therefore, one could estimate a lowering of the temperatures about 20,9°C as a result of the disappearance of carbonic acid from the atmosphere. A more exact calculation, which takes into account the small amount of radiation of the carbonic acid and of which I have given details in my paper of 1901, leads to slightly lower numbers. According to this calculation, 3.8 % out of the 22.5 % of terrestrial radiation, which are being absorbed by the carbonic acid in the atmosphere at its current state, are emitted into space by the carbonic acid, so the real decrease of terrestrial radiation would be 18.7 %. After the disappearance of the carbonic acid, instead of the current temperature of 15°C = 288 K, there would be an absolute temperature T, which is:

$$T^4 : (288\ K)^4 = (1 - 0,187) : 1 \tag{68}$$

being

$$T = 273,4\ K = 0,4\ ^\circ C \tag{69}$$

The current amount of carbonic acid would therefore raise the temperature of the Earth's surface for 14,6°C its disappearance from the atmosphere would result in a lowering of temperatures about three times as strong as the one, which caused the ice ages. I calculate in a similar way, that a decrease in the concentration of carbonic acid by half or a doubling would be equivalent to changes of temperature of -1,5°C or +1,6°C respectively."

It is an interesting point that there is an inversion of the burden of proof in Arrhenius' paper (The sentence: The opinion, that ...), which is typeset in boldface here, because it winds its way as a red thread through almost all contemporary papers on the influence of CO_2 of the so-called global climate.

This line of argument is characteristic of research. Until new knowledge has been obtained, the old science is unrestricted – Arrhenius explicitly stated this. Examples: Newtonian mechanics → theory of relativity; Newtonian corpuscle theory of light repudiated, Huygen"s wave theory → quantum theory.

3.6.2 Modern works of climatology

Callendar [63], [62], [61], [60], [59], [58], [57] and Keeling [127], [125], [130], [124], [128], [129], [126], the founders of the modern greenhouse hypothesis, recycled Arrhenius' „discussion of yesterday and the day before yesterday“[43] by perpetuating the errors of the past and adding lots of new ones.

In the 70s and 80s two developments coincided: A accelerating progress in computer technology and an emergence of two contrary policy preferences, one supporting the development of civil nuclear technology, the other supporting Green political movements. Suddenly the CO_2 issue became on-topic, and so did computer simulations of the climate. The research results have been vague ever since:

- In the 70s, computer simulations of the „global climate“ predicted for a doubling of the CO_2 concentration a global temperature rise of about 0.7 - 9.6 K [183].
- Later, computer simulations pointed towards a null effect[44]:
  - In the IPCC 1992 report, computer simulations of the „global climate“ predicted a global temperature rise of about 0.27 - 0.82 K per decade [112].
  - In the IPCC 1995 report, computer simulations of the „global climate“ predicted a global temperature rise of about 0.08 -0.33K per decade [110].
- Two years ago (2005), computer simulations of the „global climate“ predicted for a doubling of the CO_2 concentration a global temperature rise of about 2 - 12 K, whereby six so-called scenarios have been omitted that yield a global cooling [193].

The state of the art in climate modeling 1995 is described in Ref. [207] in detail. Today every home server is larger than a mainframe at that time and every amateur can test and modify the vintage code [149]. Of course, there exist no realistic solvable equations for the weather parameters. Meanwhile, „computer models“ have been developed which run on almost every PC [193], [149] or even in the internet [31].

To derive a climate catastrophe from these computer games and scare mankind to death is a crime.

3.7 The assumption of radiative balance

3.7.1 Introduction

Like the physical mechanism in glass houses the CO_2-greenhouse effect is about a comparison of two different physical situations [45]. Unfortunately, the exact definition of the atmospheric greenhouse effect changes from audience to audience, that is, there are many variations of the theme. Nevertheless, one common aspect lies in the methodology that a fictitious model computation for a celestial body without an atmosphere is compared to another fictitious model computation for a celestial body with an atmosphere [46]. For

43) a phrase used by von Storch in Ref. [166]

44) G.G. is indebted to the late science journalist Holger Heuseler for this valuable information [107].

45) Every general comparison is wrong; a comparison must contain what really has been compared - and some things can be compared - see section 3.1.1 on page 38.

46) This is not quite correct: A celestial body with a greenhouse-gas-free atmosphere is compared with a celestial body with a greenhouse gas atmosphere.

instance, „average“ temperatures are calculated for an Earth without an atmosphere and for an Earth with an atmosphere [47)]. Amusingly, there seem to exist no calculations for an Earth without oceans opposed to calculations for an Earth with oceans. However, in many studies, models for oceanic currents are included in the frameworks considered, and radiative „transport“ calculations are incorporated too. Not all of these refinements can be discussed here in detail. The reader is referred to Ref. [149] and further references therein. Though there exists a huge family of generalizations, one common aspect is the assumption of a radiative balance, which plays a central role in the publications of the IPCC and, hence, in the public propaganda. In the following it is proved that this assumption is physically wrong.

3.7.2 A note on „radiation balance“ diagrams

Preliminary Remarks: A balanced quantity is fundamentally different from a conserved quantity, but this difference is rarely indicated in the present paper. A conserved quantity is always the same, otherwise it would not be a conserved quantity. A balanced quantity does not even need to be exactly fulfilled (and is at the beginning rarely fulfilled). After a sufficient length of time, the mean value of the balance deviations should drift to zero. An example for this in this paper is the observation after Equation (43 on page 33).

From the definition given in section 2.1.2 on page 19 it is immediately evident that a radiation intensity I_ν is not a current density that can be described by a vector field $j(x,t)$. That means that conservation laws (continuity equations, balance equations, budget equations) cannot be written down for intensities [48)]. Unfortunately this is done in most climatologic papers, the cardinal error of global climatology, that may have been overlooked so long due to the oversimplication of the real world problem towards a quasi one-dimensional problem. Hence the popular climatologic „radiation balance“ diagrams describing quasi-one-dimensional situations (cf. Figure 23 on page 67) are scientific misconduct since they do not properly represent the mathematical and physical fundamentals.

Diagrams of the type of Figure 23 on page 67 are the cornerstones of „climatologic proofs“ of the supposed Greenhouse effect in the atmosphere [71]. They are highly suggestive, because they bear some similarity to Kirchhoff rules of electrotechnics, in particular to the node rule describing the conservation of charge [167]. Unfortunately, in the literature on global climatology it is not explained, what the arrows in „radiation balance“ diagrams mean physically. It is easily verified that within the frame of physics they cannot mean anything.

Climatologic radiation balance diagrams are nonsense, since they

47) This is not quite correct: The median temperature of the earth can be used because it is implicitly assumed that the earth has a greenhouse gas-free atmosphere which, through convective heat transport, to a large degree averages the temperatures.

48) This is also not done. Radiative balances are not conserved quantities but result after reaching a steady state through many change processes. This is the difference from conservation laws (for example, the law of energy conservation) whereby conservation always proves to be correct.

1. cannot represent radiation intensities, the most natural interpretation of the arrows depicted in Figure 23 on page 67, as already explained in section 2.1.2 on page 19 and section 2.1.5 on page 23;
2. cannot represent sourceless fluxes, i.e. a divergence free vector fields in three dimensions, since a vanishing three-dimensional divergence still allows that a portion of the field goes sidewards;
3. do not t in the framework of Feynman diagrams, which represent mathematical expressions clearly defined in quantum field theory [119].
4. do not t in the standard language of system theory or system engineering [23].

Kirchhoff-type node rules only hold in cases, where there is a conserved quantity (see foreword at the beginning of this section 3.7.2 on the preceding page and the underlying space may be described by a topological space that is a one-dimensional manifold almost everywhere, the singularities being the network nodes, i.e. in conventional electric circuitry [167], in mesoscopic networks [37], and, for electromagnetic waves, in waveguide networks[49)] [153], [147]. However, although Kirchhoff's mesh analysis may be successfully applied to microwave networks, the details are highly involved and will break down if dissipation is allowed [153], [147].

Clearly, neither the cryptoclimate of a glass house nor the atmosphere of the Earth's does compare to a waveguide network e.g. feeding the acceleration cavities of a particle accelerator. Therefore, the climatologic radiation balance diagrams are inappropriate and misleading, even when they are supposed to describe averaged quantities.

3.7.3 The case of purely radiative balance

If only thermal radiation was possible for the heat transfer of a radiation–exposed body one would use Stefan-Boltzmann's law

$$S(T) = \sigma T^4 \tag{70}$$

to calculate the ground temperature determined by this balance. The irradiance S has dimensions of a power density and σ is the Stefan-Boltzmann constant given by

$$\sigma = \frac{2\pi^5 k^4}{15 c^2 h^3} = 5,670400 \cdot 10^{-8} \frac{W}{m^2\ K^4} \approx 5,67 \left(\frac{T}{100}\right)^4 \frac{W}{m^2\ K^4} \cdot \frac{1}{T^4} \tag{71}$$

For example, the energy flux density of a black body a room temperature 300 K is approximately

$$S(T = 300\ K) = 459\ W/m^2 \tag{72}$$

One word of caution is needed here: As already emphasized in section 2.1.5 on page 23 the constant appearing in the T^4 law is *not* an universal constant of physics. Furthermore,

49) The second and the third type are beautifully related by the correspondence of the v. Klitzing resistance $R_{vK} \approx 25,813\ k\Omega$ with the characteristic impedance $Z_0 \approx 376,73\ \Omega$ via the Sommerfeld fine structure constant $\alpha = Z_0 = 2R_{vK} \approx 1/137,036$ [172].

a grey radiator must be described by a temperature dependent $\sigma(T)$ spoiling the T^4 law. [50].

Rigorously speaking, for real objects the Equation (70 on the preceding page) is invalid. Therefore all crude approximations relying on T^4 expressions need to be taken with great care. In fact, though popular in global climatology, they prove nothing!

In the balance equation

$$\sigma \cdot T^4_{Earth's\ ground} = \sigma \cdot T^4_{Sun} \cdot \frac{R^2_{Sun}}{R^2_{Earth's\ orbit}} \tag{73}$$

one may insert a general phenomenological normalization factor at the right side, leaving room for a ne tuning and inclusion of geometric factors.[51] Thus one may write

$$\sigma \cdot T^4_{Earth's\ ground} = \epsilon \cdot \sigma \cdot 5780^4 \cdot \frac{1}{46225} = \epsilon \cdot 1368 W/m^2 = \epsilon \cdot s \tag{74}$$

which yields

$$T_{Earth's\ ground} = \sqrt[4]{\epsilon} \cdot \frac{5780}{\sqrt{215}}\ K = \sqrt[4]{\epsilon} \cdot 394,2\ K \tag{75}$$

s is the solar constant. With the aid of Equation (75) one calculates the values displayed in Table 10.

ϵ	$T_{Earth's\ ground}$ [K]	$T_{Earth's\ ground}$ [°C]
1,00	394,2	121,2
0,70	360,6	87,6
0,62	349,8	76,8

Table 10: Effective temperatures $T_{Earth's\ ground}$ in dependence of the phenomenological normalization parameter ϵ.

Only the temperature measured in the Sun inside the car bears some similarity with the three ones calculated here. Therefore, the radiation balance does not determine the temperature outside the car! In contrast to this, Table 11 on the next page displays the „average effective“ temperatures of the ground, which according to climatological consensus are used to „explain“ the atmospheric greenhouse effect. The factor of a quarter

50) As was described in section 3.5.3 on page 51, physics does have a universal constant here. In order to allow for real bodies, Equation (70 on the previous page) is supplemented with a temperature-dependent emissivity $\varepsilon(T)$, which always lies between 0 (ideal white body) and 1 (ideal black body):

$$S(T) = \varepsilon(T) \cdot \sigma T^4$$

The $\varepsilon(T)$ is the over all wavelengths averaged A_λ (Equation (48 on page 51)) and the average of all frequencies A_ν (Equation (47 on page 51)). Weighting factor for the averaging, the $B(T)$ (see [39, Abb. 4], [10] and [185, Abb. 3.10, S. 61]). As average $\varepsilon(T)$ to the same limits as the A.

51) The factor ε is related to the albedo A of the Earth describing her reflectivity: $A = 1 - \varepsilon$. In the earlier literature one often finds $A = 0.5$ for the Earth, in current publications $A = 0.3$. The latter value is used here.

is introduced by „distributing“ the incoming solar radiation seeing a cross section σ_{Earth} over the global surface Ω_{Earth}

$$\frac{\sigma_{Earth}}{\Omega_{Earth}} = \frac{\pi \cdot R^2_{Earth}}{4\pi \cdot R^2_{Earth}} = \frac{1}{4} \tag{76}$$

The fictitious natural greenhouse effect is the difference the „average effective“ temperature of -18°C and the Earth's „observed“ average temperature of +15°C.

ϵ	$\mathrm{T}_{Earth's\ ground}$ [K]	$\mathrm{T}_{Earth's\ ground}$ [°C]
0,25 · 1,00	278,7	5,7
0,25 · 0,70	255,0	-18,0
0,25 · 0,62	247,4	-25,6

Table 11: Effective „average“ temperatures T_{ground} in dependence of the phenomenological normalization parameter incorporating a geometric factor of 0.25.

MÉMOIRE

SUR

LES TEMPÉRATURES DU GLOBE TERRESTRE ET DES ESPACES PLANÉTAIRES.

PAR M. FOURIER.

La question des températures terrestres, l'une des plus importantes et des plus difficiles de toute la philosophie naturelle, se compose d'éléments assez divers qui doivent être considérés sous un point de vue général. J'ai pensé qu'il serait utile de réunir dans un seul écrit les conséquences principales de cette théorie; les détails analytiques que l'on omet ici se trouvent pour la plupart dans les ouvrages que j'ai déjà publiés. J'ai désiré surtout présenter aux physiciens, dans un tableau peu étendu, l'ensemble des phénomènes et les rapports mathématiques qu'ils ont entre eux.

La chaleur du globe terrestre dérive de trois sources qu'il est d'abord nécessaire de distinguer.

1° La terre est échauffée par les rayons solaires, dont l'inégale distribution produit la diversité des climats.

2° Elle participe à la température commune des espaces planétaires, étant exposée à l'irradiation des astres innombrables qui environnent de toutes parts le système solaire.

1824. 72

Figure 18: The front page of Fourier's 1824 paper.

THE

LONDON, EDINBURGH, AND DUBLIN

PHILOSOPHICAL MAGAZINE

AND

JOURNAL OF SCIENCE.

[FIFTH SERIES.]

APRIL 1896.

XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* *By* Prof. SVANTE ARRHENIUS *.

I. *Introduction : Observations of* Langley *on Atmospherical Absorption.*

A GREAT deal has been written on the influence of the absorption of the atmosphere upon the climate. Tyndall † in particular has pointed out the enormous importance of this question. To him it was chiefly the diurnal and annual variations of the temperature that were lessened by this circumstance. Another side of the question, that has long attracted the attention of physicists, is this : Is the mean temperature of the ground in any way influenced by the presence of heat-absorbing gases in the atmosphere? Fourier‡ maintained that the atmosphere acts like the glass of a hot-house, because it lets through the light rays of the sun but retains the dark rays from the ground. This idea was elaborated by Pouillet § ; and Langley was by some of his researches led to the view, that "the temperature of the earth under direct sunshine, even though our atmosphere were present as now, would probably fall to −200° C., if that atmosphere did not possess the quality of selective

* Extract from a paper presented to the Royal Swedish Academy of Sciences, 11th December, 1895. Communicated by the Author.
† 'Heat a Mode of Motion,' 2nd ed. p. 405 (Lond., 1865).
‡ *Mém. de l'Ac. R. d. Sci. de l'Inst. de France*, t. vii. 1827.
§ *Comptes rendus*, t. vii. p. 41 (1838).

Phil. Mag. S. 5. Vol. 41. No. 251. *April* 1896. S

Figure 19: The front page of Arrhenius' 1896 paper.

MEDDELANDEN
FRÅN
K. VETENSKAPSAKADEMIENS NOBELINSTITUT
BAND 1. N:o 2.

Die vermutliche Ursache der Klimaschwankungen

von

SVANTE ARRHENIUS.

In seiner Bakerian Lecture vom 7. Febr. 1861 [1] gab Tyndall die Resultate einiger Untersuchungen über die relativ kräftige Absorption von Wärmestrahlen durch Wasserdampf und Kohlensäure. Auf Grund dieser Untersuchungen sprach er die Ansicht aus, dass Veränderungen im Gehalt der Atmosphäre an Kohlensäure und Wasserdampf »alle die Klimaschwankungen, welche durch die Untersuchungen der Geologen konstatiert sind, erklären könnten.»

Später habe ich versucht diese Idée über den thermischen Einfluss der atmosphärischen Absorption, welche von De Saussure, Fourier und Pouillet vor etwa hundert Jahren entwickelt wurde, weiter quantitativ zu entwickeln, indem ich zu berechnen versuchte, wie viele Grade Temperatursteigerung der Erdoberfläche einer bestimmten Schwankung des Kohlensäuregehalts der Atmosphäre entsprechen. Seitdem ich meine letzte Berechnung ausführte, sind einige Untersuchungen erschienen, welche diese interessante Frage berühren und welche ich nicht unerwähnt lassen möchte, da sie teilweise zu unrichtigen Schlussfolgerungen veranlassen könnten.

Die erste dieser Untersuchungen stammt von Hrn Koch. [3] Er beobachtete die Strahlung von einer 100° warmen Quelle,

[1] Neugedruckt in John Tyndall: Contributions to molecular physics London 1872. Die citierte Stelle findet sich auf S. 40.

[2] S. Arrhenius: Phil. Mag. (5) 41. 237, April 1896. Bihang der Stockh. Ak. d. Wiss. Bd. 22, Abth. 1 N:o 1, 1896, Drudes Annalen d. Phys. Bd. 4, 690, 1901, Öfversigt d. Stockh. Ak. 1901, N:o 1. p. 55 und 56.

[3] J. Koch: Öfversigt der Stockh. Ak. 1901. 475.

Figure 20: Excerpt (a) of Arrhenius' 1906 paper.

Diese Äusserung kann wohl die Vorstellung erwecken, als ob von mir geäussert worden wäre, dass eine Verminderung des Kohlensäuregehalts der Atmosphäre um 20 Prozent genügend wäre, um die Temperatur der Eiszeit hervorzurufen, d. h. um die mittlere Temperatur Europas, um vier bis fünf Grad C. zu erniedrigen. Um zu verhindern dass eine solche Vorstellung um sich greife, möchte ich hervorheben, dass nach der alten Berechnung eine Abnahme der Kohlensäuremenge um 50 Prozent eine Temperaturabnahme von 4 (1897) bzw. 3,2 (1901) Grad hervorrufen würde.

Die Ansicht, dass eine Kohlensäureabnahme der Luft die Temperatur einer Eiszeit erklären kann, wird nicht eher als unhaltbar erwiesen, als bis man zeigt, dass das vollkommene Verschwinden der Kohlensäure aus der Atmosphäre nicht genügend wäre, um eine Temperaturabnahme von vier bis fünf Grad hervorzurufen. Es ist nun leicht eine Schätzung auszuführen wie tief die Temperatur sinken würde, wenn die Strahlung der Erde im Verhältniss 1 zu 0,775, d. h. um 29 Prozent, steigen würde, was einigermassen den Daten von Hrn. Rubens und Ladenburg entspricht. Ein Steigen der Ausstrahlung um 1 Proz. entspricht einer Temperatursenkung von 0,72° C. ($= \frac{1}{4} \cdot \frac{1}{100} \cdot 288$, da die mittlere absolute Temperatur der Erdoberfläche zu 15° C. = 288° abs. angenommen wird). Man könnte demnach eine Temperatursenkung von etwa 20,9° als Folge des Verschwindens der Kohlensäure aus der Atmosphäre vermuten.

Figure 21: Excerpt (b) of Arrhenius' 1906 paper.

Eine genauere Rechnung, wobei die geringe Strahlung der Kohlensäure berücksichtigt wird, und wovon ich die Details in meiner Untersuchung von 1901 gegeben habe,[1] führt zu etwas niedrigeren Zahlen. Nach derselben würde von den 22,5 Prozent der Erdstrahlung, welche durch die Kohlensäure der Atmosphäre in ihrem jetzigen Zustand absorbiert werden, 3,8 Prozent wieder von der Kohlensäure in den Weltraum ausgestrahlt werden, so dass die wirkliche Verminderung der Erdstrahlung 18,7 Prozent betragen würde. Anstatt der jetzigen Temperatur von 15° C. = 288° abs. hätte man also nach Verschwinden der Kohlensäure eine absolute Temperatur T, für welche gilt:

$$T^4 : 288^4 = (1-0{,}187) : 1$$

woraus T = 273,4 abs. = 0,4° C.

Die jetzige Kohlensäuremenge würde demnach die Temperatur der Erdoberfläche um 14,6° C. erhöhen; ihr Verschwinden aus der Atmosphäre würde infolgedessen eine etwa drei mal so starke Temperaturerniedrigung als diejenige, welche für die Eiszeit charakteristisch war, hervorrufen.

In ähnlicher Weise berechne ich, dass eine Verminderung des Kohlensäuregehalts zur Hälfte oder eine Zunahme desselben auf den doppelten Betrag Temperaturänderungen von —1,5° C. bzw. + 1,6° C. entsprechen würde.

Figure 22: Excerpt (c) of Arrhenius' 1906 paper.

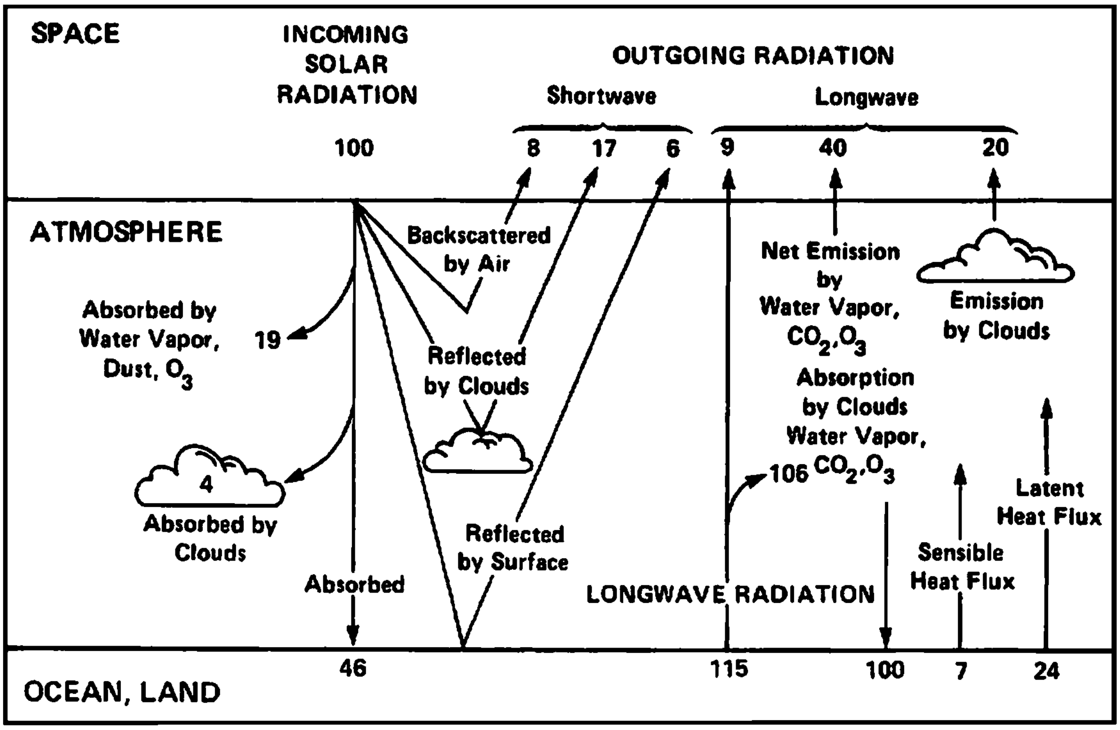

Figure 23: A schematic diagram supposed to describe the global average components of the Earth's energy balance. Diagrams of this kind contradict not to physics and do not need at any time to be exactly fulfilled, but are only essentially valid in an average over time..

In summary, the factor 0.7 will enter the equations if one assumes that a grey body absorber is a black body radiator, contrary to the laws of physics [52)]. Other choices are possible, the result is arbitrary. Evidently, such an average value has no physical meaning at all. This will be elucidated in the following subsection.

3.7.4 The average temperature of a radiation-exposed globe

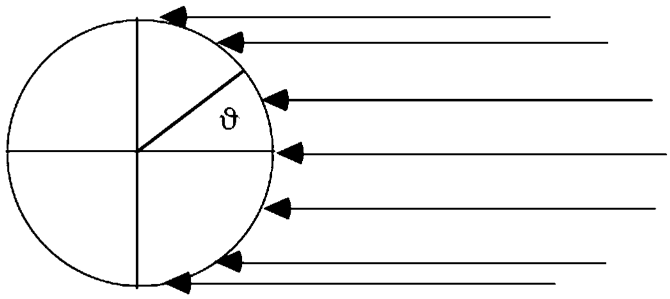

Figure 24: A radiation exposed static globe.

For a radiation exposed static globe [53)] (cf. Figure 24) the corresponding balance equation must contain a geometric factor and reads therefore

$$\sigma \cdot T^4 = \begin{cases} \epsilon \cdot S \cdot = \epsilon \cdot \sigma \cdot 5780^4/215^2 \cdot \cos\vartheta & if \quad 0 \leq \vartheta \leq \pi/2 \\ 0 & if \quad \pi/2 \leq \vartheta \leq \pi \end{cases} \tag{77}$$

It is obvious that one gets the effective temperatures if the right side is divided by σ. This in turn will determine the formerly mentioned „average“ effective temperatures over the global surface.

$$T_{eff}^4 = \frac{1}{4\pi} \iint\limits_{\text{surface}} T^4 \, d\Omega = \frac{1}{4\pi} \int\limits_0^{2\pi} \int\limits_0^{\pi} T^4 \sin\vartheta \, d\vartheta \, d\varphi \tag{78}$$

52) This is not contrary to the laws of physics: the wavelength-dependent emissivities are weighted to a median emission factor by the wavelength distribution of the radiation. Solar radiation and the emission from Earth's surface have, according to different temperatures, a different wavelength distribution. According to footnote [50)] (p. 61) different $\varepsilon(T)$ apply to both values. For the temperature of the sun, the value is $\varepsilon(5780K) \approx 0.7$; for the temperature of Earth's surface, the value is $\varepsilon(300\ K) > 0.9$ - this is almost a black body. The importance of the value at different temperatures is clearly seen at TiNOX [8], see $\varepsilon(Solar) = 0.947$, $\varepsilon(100°C) = 0.030$.

53) The globe must not have any atmosphere and the heat conductivity co-efficient must be 0 - for only under these unmentioned conditions are the subsequent derivations valid. Only under such conditions is local conservation of flux applicable, which is at the basis of these derivations. This means, for example, that the temperature is always 0 on the side from which the sun is absent. Such conditions correspond approximately to the moon, but not to the Earth.

Defining

$$\begin{aligned} \mu &:= \cos\vartheta \\ d\mu &:= -\sin\vartheta \; d\vartheta \end{aligned} \tag{79}$$

one gets

$$\begin{aligned} T_{eff}^4 &= \frac{-1}{4\pi}\int_0^{2\pi}\int_1^{-1} T^4 \; d\mu \; d\varphi = \frac{1}{4\pi}\int_0^{2\pi}\int_{-1}^{1} T^4 \; d\mu \; d\varphi \\ &= \frac{1}{4\pi}\int_0^{2\pi}\int_0^{1} \epsilon\cdot\frac{S}{\sigma}\cdot \; \mu d\mu \; d\varphi \\ &= \frac{1}{2}\cdot\epsilon\cdot\frac{S}{\sigma}\cdot\int_0^{1} \; \mu d\mu \; d\varphi = \frac{1}{4}\cdot\epsilon\cdot\frac{S}{\sigma} \\ &= \frac{1}{4}\cdot\epsilon\cdot(394,2)^4 \; K^4 \end{aligned} \tag{80}$$

This is the correct derivation of the factor quarter appearing in Equation (76 on page 62). Drawing the fourth root out of the resulting expression

$$\begin{aligned} T_{eff}^4 &= \sqrt[4]{\frac{\epsilon}{4}\cdot\frac{S}{\sigma}} = \sqrt[4]{\frac{\epsilon}{4}}\cdot 394.2 \; K \\ &= (1/\sqrt{2})\cdot\sqrt[4]{\epsilon}\cdot 394.2 \; K \\ &= 0.707\cdot\sqrt[4]{\epsilon}\cdot 394.2 \; K \end{aligned} \tag{81}$$

Such a calculation, though standard in global climatology, is plainly wrong. Namely, if one wants to calculate the average temperature (a sphere at rest and without atmosphere), one has to draw the fourth root first and then determine the average, though:

$$\begin{aligned} T_{phys} &= \frac{1}{4\pi}\int_0^{2\pi}\int_{-1}^{1} T \; d\mu \; d\varphi \\ &= \frac{1}{4\pi}\int_0^{2\pi}\int_0^{1} \sqrt[4]{\epsilon\cdot\frac{S}{\sigma}\cdot \; \mu d\mu \; d\varphi} = \frac{1}{2}\cdot\sqrt[4]{\epsilon\cdot\frac{S}{\sigma}}\cdot\int_0^{1} \; \sqrt[4]{\mu} d\mu \; d\varphi \\ &= \frac{1}{2}\cdot\sqrt[4]{\epsilon\cdot\frac{S}{\sigma}}\cdot\frac{4}{5} \\ &= \frac{2}{5}\cdot\sqrt[4]{\epsilon\cdot\frac{S}{\sigma}} \end{aligned} \tag{82}$$

finally yielding

$$\begin{aligned} T_{phys} &= \frac{2}{5}\cdot\sqrt[4]{\epsilon}\cdot 394,2 \; K \\ &= 0.4\cdot\sqrt[4]{\epsilon}\cdot 394,2 \; K \end{aligned} \tag{83}$$

Now the averaged temperatures T_{phys} are considerably lower than the absolute temperature's fourth root of the averaged fourth power (cf. Table 12 on the following page.

ϵ	T_{eff} [°C]	T_{phys} [°C]
1,00	5,7	-115
0,70	-18,0	-129
0,62	-25,6	-133

Table 12: Two kinds of „average“ temperatures T_{eff} and T_{phys} in dependence of the emissivity parameter ϵ compared.

This is no accident but a general inequality

$$\langle T\rangle = \int_X T dW \leq \sqrt[4]{\int_X T^4 dW} = \sqrt[4]{\langle T^4\rangle} \tag{84}$$

for a non-negative measurable function T and an probability measure W. It is a consequence of Hölder's inequality [118], [43], [64], [134]

$$\int_X fg d\mu \leq \left\{\int_X f^p d\mu\right\}^{1/p} \cdot \left\{\int_X g^q d\mu\right\}^{1/q} \tag{85}$$

for two non-negative measurable functions $f,\ g$ and non-negative integers $p,\ q$ obeying

$$\frac{1}{p} + \frac{1}{q} = 1 \tag{86}$$

In the case discussed here one has

$$p = 4, \qquad q = 4/3, \qquad g(x) \equiv 1 \tag{87}$$

and

$$f = T \tag{88}$$

Consistency of averages

The arithmetic mean value of all temperatures is defined as follows:

$$\overline{T} = \frac{\iint_{\text{surface}} T\ d\Omega}{\iint_{\text{surface}} d\Omega} \tag{k-88-2}$$

The temperature at each place can be expressed with the average value ($\overline{T}$) and its deviation from it (δT):

$$T = \overline{T} + \Delta T \tag{k-88-3}$$

With it the average value of the fourth power is determined (Note: There are different values, if the power exponent is under or behind the averaging dash.):

$$
\begin{aligned}
\overline{T^4} &= \frac{\iint\limits_{\text{surface}} T^4 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} = \frac{\iint\limits_{\text{surface}} \left(\overline{T} + \Delta T\right)^4 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} \\
&= \frac{\iint\limits_{\text{surface}} \left(\overline{T}^4 + 4\overline{T}^3 \Delta T + 6\overline{T}^2 \Delta T^2 + 4\overline{T}\Delta T^3 + \Delta T^4\right)^4 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} \\
&= \frac{\iint\limits_{\text{surface}} \overline{T}^4 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} + 4 \frac{\iint\limits_{\text{surface}} \overline{T}^3 \Delta T \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} + 6 \frac{\iint\limits_{\text{surface}} \overline{T}^2 \Delta T^2 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} + \\
&\quad + 4 \frac{\iint\limits_{\text{surface}} \overline{T} \Delta T^3 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} + \frac{\iint\limits_{\text{surface}} \Delta T^4 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} \\
&= \overline{T}^4 \frac{\iint\limits_{\text{surface}} d\Omega}{\iint\limits_{\text{surface}} d\Omega} + 4\,\overline{T}^3 \frac{\iint\limits_{\text{surface}} \Delta T \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} + 6\,\overline{T}^2 \frac{\iint\limits_{\text{surface}} \Delta T^2 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} + \\
&\quad + 4\,\overline{T} \frac{\iint\limits_{\text{surface}} \Delta T^3 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega} + \frac{\iint\limits_{\text{surface}} \Delta T^4 \, d\Omega}{\iint\limits_{\text{surface}} d\Omega}
\end{aligned}
\tag{k-88-4}
$$

The integrals are again averages:

$$
\overline{T^4} = \overline{T}^4 + 4\,\overline{T}^3\,\overline{\Delta T} + 6\,\overline{T}^2\,\overline{\Delta T^2} + \; 4\,\overline{T}\,\overline{\Delta T^3} + \overline{\Delta T^4} \tag{k-88-5}
$$

According to the definition of the average, $\overline{\Delta T} = 0$ is always valid and $\overline{\Delta T^3} \approx 0$ is also valid. With this we have:

$$
\begin{aligned}
\overline{T^4} &= \overline{T}^4 + 6\,\overline{T}^2\,\overline{\Delta T^2} + \; 4\,\overline{T}\,\overline{\Delta T^3} + \overline{\Delta T^4} \approx \overline{T}^4 + 6\,\overline{T}^2\,\overline{\Delta T^2} + \overline{\Delta T^4} \\
\frac{\overline{T^4}}{\overline{T}^4} &= 1 + 6\,\frac{\overline{\Delta T^2}}{\overline{T}^2} + \; 4\,\frac{\overline{\Delta T^3}}{\overline{T}^3} + \frac{\overline{\Delta T^4}}{\overline{T}^4} \approx 1 + 6\,\frac{\overline{\Delta T^2}}{\overline{T}^2} + \frac{\overline{\Delta T^4}}{\overline{T}^4}
\end{aligned}
\tag{k-88-6}
$$

This is valid for typical conditions for Earth's surface (the Earth does have an atmosphere, so that equation (82) cannot be used) ($210\ K \leq T \leq 310\ K$ or $-63°C \leq T \leq 37°C$):

$$
\overline{T} > 260\ K \qquad \text{und} \qquad |\Delta T|_{max} < 50\ K \tag{k-88-7}
$$

With this (even if there were only extreme values):

$$\frac{\overline{T^4}}{\overline{T}^4} < 1.15 \tag{k-88-8}$$

Because of the roots, the temperature difference is even smaller (Note: There are different values, if the power exponent is under or behind the averaging dash.):

$$\sqrt[4]{\frac{\overline{T^4}}{\overline{T}^4}} < \sqrt[4]{1.15} < 1.04 \tag{k-88-9}$$

The Herleitungen derivations of Equation (81 on page 69) and Equation (83 on page 69) apply to a globe without atmosphere. For a globe with atmosphere, the temperature variations cause air currents which reduce temperature variations (the air heated at warm places transports convective heat to cooler areas). In an extreme case the temperatures T_{atmo} are the same on the whole surface. With this, the emission in all areas of the Earth is even, the irradiation depends of course on the angle of the sun. Since the atmosphere distributes the energy over the whole surface, the total energy must be equally deposited. (Balance). Besides, differently weighted mean values of the emissivity are used. (See footnote – solar radiation ε_S and earth emission: ε_E):

$$\begin{aligned}
\varepsilon_E \iint\limits_{\text{surface}} T^4_{atmo}\, d\Omega &= \varepsilon_S \iint\limits_{\text{surface}} S^*(Ort)\, d\Omega \\
T^4_{atmo}\, \varepsilon_E \iint\limits_{\text{surface}} d\Omega &= \varepsilon_S \iint\limits_{\text{surface}} S^*(Ort)\, d\Omega \\
T^4_{atmo}\, \varepsilon_E\, 4\pi &= \varepsilon_S \iint\limits_{\text{surface}} S^*(Ort)\, d\Omega = \varepsilon_S \int\limits_0^{2\pi} \int\limits_0^{\pi/2} \frac{S}{\sigma} \cdot \cos\vartheta\, d\vartheta\, d\varphi \\
2\, \varepsilon_E\, T^4_{atmo} &= \varepsilon_S\, \frac{S}{\sigma} \cdot \int\limits_0^{\pi/2} \cos\vartheta\, d\vartheta
\end{aligned} \tag{k-88-10}$$

The last integral is solved analogously to Equation (79 on page 69) and Equation (80 on page 69):

$$T^4_{atmo} = \frac{1}{4} \cdot \frac{\varepsilon_S}{\varepsilon_E} \cdot \frac{S}{\sigma} \tag{k-88-11}$$

Because of the large ε_E the following is perhaps valid:

$$\frac{\varepsilon_S}{\varepsilon_E} \approx \epsilon \tag{k-88-12}$$

The preceding equations and Equation (80 on page 69) become therewith:

$$T_{atmo} \approx T_{eff} \tag{k-88-13}$$

The solution could have been made simpler: Earth's cross section »punches out« from solar radiation Earth's shadow. The energy, which is missing from the shadow, has been partially reflected from the earth and this part has not contributed to the heat budget of the Earth. The rest has been absorbed and must be taken correctly into account in the heat budget of the Earth.

3.7.5 Alleged Non-existence of the natural greenhouse effect

According to the consensus among global climatologists one takes the 18°C computed from the T^4 average and compares it to the fictitious Earth's average temperature of +15°C. The difference of 33°C is attributed to the *natural greenhouse effect*. As seen in Equation (83 on page 69) a correct averaging (an earth without an air cover) yields a temperature of –129°C. Evidently, something must be fundamentally wrong here. – to envisage therefore an earth without an atmosphere.

In global climatology temperatures are computed from given radiation intensities, and this exchanges cause and effect. The current *local* temperatures determine the radiation intensities and not vice versa. This is correct, but which temperature sets in depends on when the temperature change is stopped - see remark after Equation (43 on page 33). If the soil is warmed up by the solar radiation many different local processes are triggered, which depend on the local movement of the air, rain, evaporation, moistness, and on the local ground conditions as water, ice, rock, sand, forests, meadows, etc. [54] One square meter of a meadow does not know anything of the rest of the Earth's surface, which determine the global mean value. Thus, the radiation is locally determined by the local temperature. Neither is there a global radiation balance, nor a global radiation budget, even in the mean-field limit.

While it is incorrect to determine a temperature from a given radiation intensity, one is allowed to compute an effective radiation temperature T_{effrad} rad from T^4 averages representing a mean radiation emitted from the Earth and to compare it with an assumed Earth's average temperature T_{mean} Hölder's inequality says that the former is always larger than the latter

$$T_{effrad} > T_{mean} \tag{89}$$

provided sample selection and averaging (probability space) remain the same.

For example, if n weather stations distributed around the globe measure n temperature values $T_1, \ldots T_n$, an empirical mean temperature will be defined as

$$T_{mean} = \frac{1}{n}\sum_{i=1}^{n} T_i \tag{90}$$

For the corresponding black body radiation intensity one can approximately set

$$S_{mean} = \frac{1}{n}\sum_{i=1}^{n} \sigma T_i^4 =: \sigma T_{effrad}^4 \tag{91}$$

defining an effective radiation temperature

$$T_{effrad} = \sqrt[4]{\frac{1}{\sigma} S_{mean}} \tag{92}$$

54) Conversely, local conditions also determine the magnitude of radiation intensity.

One gets immediately

$$T_{effrad} = \sqrt[4]{\frac{1}{n} \sum_{i=1}^{n} T_{effrad}^4} \tag{93}$$

Hölder's inequality shows that one always has

$$T_{effrad} > T_{mean} \tag{94}$$

But the following numerical example shows that with, to a certain extent, real values, the difference is usually negligible. See remarks Equation (k-88-7 on page 71) et seq.

3.7.6 A numerical example

From Equation (93) one can construct numerical examples where e.g. a few high local temperatures spoil an average built from a large collection of low temperatures. A more realistic distribution is listed in Table 13 on the following page. The effective radiation temperature T_{effrad} is slightly higher than the average T_{mean} of the measured temperatures. According to Hölder's inequality this will always be the case. Thus there is no longer any room for a natural *greenhouse effect*, both mathematically and physically [55]:

- Departing from the *physically incorrect* assumption of radiative balance a *mathematically correct* calculation of the average temperature lets the difference temperature that defines the natural greenhouse effect explode.
- Departing from the *mathematically correct* averages of *physically correct* temperatures (i.e. measured temperatures) the corresponding effective radiation temperature will be *always higher* than the average of the measured temperatures.

3.7.7 Non-existence of a global temperature

In the preceding sections mathematical and physical arguments have been presented that the notion of a global temperature is meaningless. Recently, Essex, McKitrick, and Andresen showed [55]:

> „that there is no physically meaningful global temperature for the Earth in the context of the issue of global warming. While it is always possible to construct statistics for any given set of local temperature data, an infinite range of such statistics is mathematically permissible if physical principles provide no explicit basis for choosing among them. Distinct and equally valid statistical rules can and do show opposite trends when applied to the results of computations from physical models and real data in the atmosphere. A given temperature field can be interpreted as both 'warming' and 'cooling'

55) The end result is unfounded: The realistic temperatures are the temperatures with greenhouse effect - and even they show that with realistic temperatures the difference between T_{effrad} and T_{mean} is very small (0.48 K). But a temperature difference of 33 K is attributed to the greenhouse effect.

Weather Station	Instruments Reading T_i [°C]	Absolute Temperature T_i [K]	4th Power T_i^4	4th Root of 4th Power Mean T_{effrad} [K]	4th Root of 4th Power Mean T_{effrad}[°C]
1	0.00	273.15	5566789756		
2	10.00	283.15	6427857849		
3	10.00	283.15	6427857849		
4	20.00	293.15	7385154648		
5	20.00	293.15	7385154648		
6	30.00	303.15	8445595755		
Mean	15.00	288.15	6939901750	288,63	15.48

Table 13: An example for a measured temperature distribution from which its associated effective radiation temperature is computed. The latter one corresponds to the fourth root of the fourth power mean – and is only slightly greater than the average.

simultaneously, making the concept of warming in the context of the issue of global warming physically ill-posed."

Regardless of any ambiguities, a global mean temperature could only emerge out of many local temperatures. Without knowledge of any science everybody can see, how such a changing average near-ground temperature is constructed: There is more or less sunshine on the ground due to the distribution of clouds. This determines a field of local near-ground temperatures, which in turn determines the change of the distribution of clouds and, hence, the change of the temperature average, which is evidently independent of the carbon dioxide concentration. Mathematically, an evolution of a temperature distribution may be phenomenologically described by a differential equation. The averages are computed afterwards from the solution of this equation. However, one cannot write down a differential equation directly for averages [56].

3.7.8 The rotating globe

Since the time when Fourier formulated the heat conduction equation, a non- linear boundary condition describing radiative transfer of a globe with a sun– side and a dark side has never belonged to the family of – elementary – solvable heat conduction problems, even in the case of a non-rotating globe.

Regardless of solvability, one can write down the corresponding equations as well as their boundary conditions. If a rotating globe (Figure 25 on the next page) was exposed to radiation and only radiative heat transfer to its environment was possible, the initial

56) In this generality, the assertion is not to the point. For instance, particle motion in a gas is described by the laws of mechanics. As average values of momentum changes the pressure, for example, changes at the vessel wall. It is even more meaningful to solve certain questions with differential equations for the average.

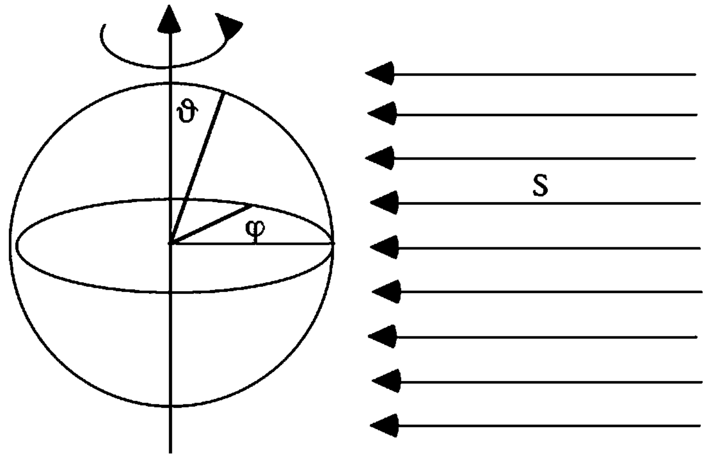

Figure 25: The rotating globe

problem of the heat conduction equation would have to be solved with the following boundary condition

$$-\lambda \frac{\partial T}{\partial n} = \begin{cases} \sigma T^4 - S \cdot \sin\vartheta\cos(\varphi - \omega_d t) & wenn \quad -\pi/2 \leq \varphi - \omega_d t \leq \pi/2 \\ \sigma T^4 & wenn \quad \pi/2 \leq \varphi - \omega_d t3 \leq \pi/2 \end{cases} \tag{95}$$

where

$$\frac{\partial}{\partial n} = n \cdot \nabla \tag{96}$$

denotes the usual normal derivative at the surface of the sphere and ω_d the angular frequency associated with the day-night cycle. By defining an appropriate geometry factor

$$\zeta(\vartheta, \varphi, \omega_d, t) = \sin\vartheta\cos(\varphi - \omega_d t) \tag{97}$$

and the corresponding Sun side area

$$A = \{(\varphi, \vartheta) | \zeta(\vartheta, \varphi, \omega_d, t) \geq 0\} \tag{98}$$

one can rewrite the expression as

$$-\lambda \frac{\partial T}{\partial n} = \begin{cases} \sigma T^4 - S \cdot \zeta(\vartheta, \varphi, \omega_d, t) & wenn \quad (\varphi, \vartheta) \in A \\ \sigma T^4 & wenn \quad (\varphi, \vartheta) \notin A \end{cases} \tag{99}$$

3.7.9 The obliquely rotating globe

The result obtained above may be generalized to the case of an obliquely rotating globe.

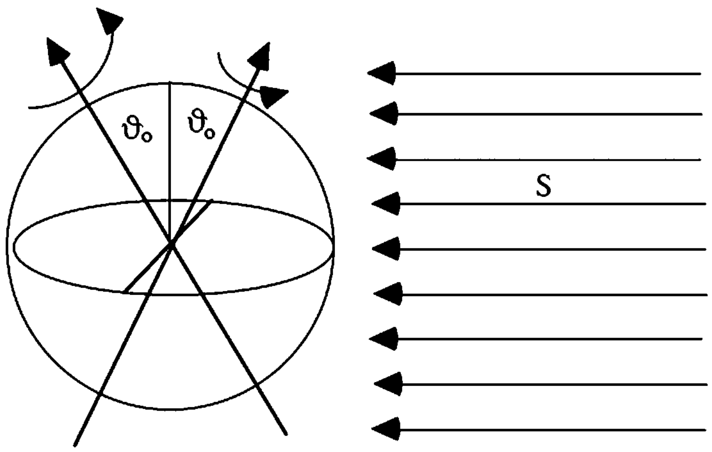

Figure 26: An obliquely rotating globe

For an obliquely rotating globe (Figure 26) one has

$$- \lambda \frac{\partial T}{\partial n} = \begin{cases} \sigma T^4 - S \cdot \xi(\vartheta_0, \vartheta, \varphi, \omega_y, \omega_d, t) & wenn \quad (\varphi, \vartheta) \in A \\ \sigma T^4 & wenn \quad (\varphi, \vartheta) \notin A \end{cases} \tag{100}$$

where $\partial/\partial n$ denotes the usual normal derivative on the surface of the sphere and ω_y, ω_d the angular frequencies with the year cycle and the day-night cycle, respectively.[57] The geometry factor now reads

$$\begin{aligned} \xi(\vartheta_0, \vartheta, \varphi, \omega_y, \omega_d, t) = \quad & [\quad \sin(\omega_y t)\cos(\omega_d t) + \cos(\omega_y t)\sin(\omega_d t)\cos\vartheta_0]\sin\vartheta\cos\varphi \\ & + [- \sin(\omega_y t)\sin(\omega_d t) + \cos(\omega_y t)\cos(\omega_d t)\cos\vartheta_0]\sin\vartheta\sin\varphi \\ & - [\quad \cos(\omega_y t)\sin\vartheta_0]\cos\vartheta \end{aligned} \tag{101}$$

and the expression for the sun-side surface is given by

$$A = \{(\varphi, \vartheta) | \xi(\vartheta_0, \vartheta, \varphi, \omega_y, \omega_d, t) \geq 0\} \tag{102}$$

Already the first unrealistic problem will be too much for any computer. The latter more realistic model cannot be tackled at all. The reasons for this is not only the extremely different frequencies ω_y and ω_d but also a very non–physical feature which affects the numeric as well: According to a famous law formulated by Wiener, almost all particles in this mathematical model which cause the diffusion, move on paths at infinitely high speeds [40], [41].

Rough estimates indicate that even these oversimplified problems cannot be tackled with any computer. Taking a sphere with dimensions of the Earth it will be impossible to solve this problem numerically even in the far future. Not only the computer would

57) Here sidereal time is used [72], [2].

work ages, before a „balanced“ temperature distribution would be reached, but also the correct initial temperature distributions could not be determined at all.

ω_y and ω_d can as a rule be perceived as harmonics of a four-year cycle (more accurate as leap years should not be necessary). The initial conditions should also be unimportant, as they soon decay. What is interesting is the periodicity. With this, the problem can be solved numerically in principle in a reasonable length of time. But why should such an unrealistic problem be solved? The effect of the atmosphere causes much greater changes.

3.7.10 The radiating bulk

The physical situation of a radiating volume where the radiation density

$$S(T) = \sigma T^4 \tag{103}$$

emitted through the surface shell originates from the volume's heat content, cannot be realized easily, if at all. However, it is interesting to study such a toy model in order to get a feeling about radiative equilibration processes which are assumed to take place within a reasonable time interval.

With disregard to the balancing processes inside, one gets the differential equation

$$V \; \rho \; c_V \; \frac{dT}{dt} = - \; \Omega \; \sigma \; T^4 \tag{104}$$

with V denoting the volume, ρ the density, c_v the isochoric specific heat, Ω the surface of the body. By defining

$$\eta = \frac{\Omega}{V} \tag{105}$$

the above equation can be rewritten as

$$\frac{dT}{dt} = - \; \frac{\eta\sigma}{\rho c_V} \cdot T^4 \tag{106}$$

For a cube with an edge length of a one has $\eta = 6/a$, for a globe with radius r one has $\eta = 3/r$ instead. For bodies with unit volumes $\eta = 6$ or $\eta = 4.8$, respectively. The differential equation is easily solvable. The solution reads

$$T(t) = T_0 / \sqrt[3]{1 + \frac{3\eta\sigma T_0^3}{\rho c_V} \; t} \tag{107}$$

At an initial temperature of 300 K with the values of ρ and c_v for air, one gets one half of the temperature value within three seconds for the standard cube (cf. Figure 27 on the next page) For iron the isochoric thermal diffusivity

$$a_v = \rho c_v \tag{108}$$

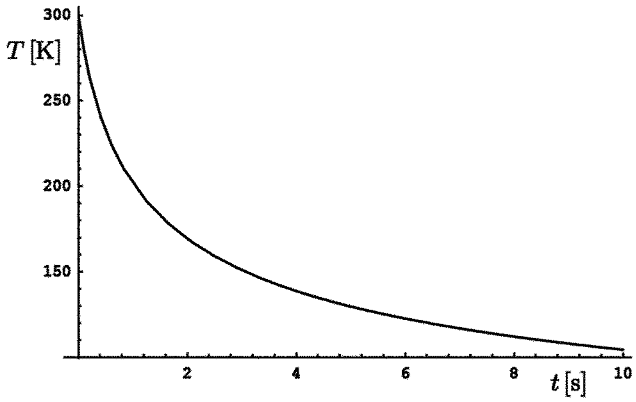

Figure 27: The cooling curve for a radiating standard cube

is about 3000 times higher than for air, the half time for the temperature decrease is approximately three hours. For air, even if only one of the cube's planes were allowed to radiate, one would get a fall in temperatures of seventy degrees within the first three seconds, and almost 290 degrees within ten hours - a totally unrealistic cooling processes.

Hence, this simple assessment will prove that one has to be extremely careful, if the radiation laws for black-body radiation, where the energy comes from the heated walls of the cavity, are to be used for gases, where the emitted electromagnetic radiation should originate from the movements of the gas molecules (cf. section 3.5 on page 48).

3.7.11 The comprehensive work of Schack

Professor Alfred Schack, the author of a standard textbook on industrial heat transfer [179], was the first scientist who pointed out in the twenties of the past century that the infrared light absorbing re gas components *carbon dioxide* (CO_2) and *water vapor* (H_2O) may be responsible for a higher heat transfer in the combustion chamber *at high burning temperatures* through *an increased emission in the infrared*. He estimated the emissions by measuring the spectral absorption capacity of carbon dioxide and water vapor. Worthy of note is here, that the Authors accept directly, without more ado, the derivation of the flux terms which they dispute in section 3.5.5 on page 53.

In the year 1972 Schack published a paper in Physikalische Blätter entitled „The influence of the carbon dioxide content of the air on the world's climate". With his article he got involved in the climate discussion and emphasized the important role of water vapor [180].

Firstly, Schack estimated the mass of the consumed fossil fuels up

$$m_{burned} = 5 \cdot 10^{12}\ kg = 5\ Gt\ C \tag{109}$$

per anno. Since 1 kg produces 10 m^3 waste gas with 15 % CO_2, a volume of

$$V_{CO_2} = 7.5 \cdot 10^{12}\ m^3 \tag{110}$$

is blown into the Earth's atmosphere, whose total volume under normal conditions (0°C and 760 mm Hg) is

$$V_{atmosphere} = 4 \cdot 10^{18}\ m^3 \tag{111}$$

It follows immediately that the increase of the CO_2 concentration is approximately $1.9 \cdot 10^{-6}$ *per anno*. About one half is absorbed by the oceans, such that the increase of CO_2 is reduced to

$$\frac{\Delta V_{CO_2}}{V_{CO_2}} = 0,95 \cdot 10^{-\ 6} \tag{112}$$

per anno.

With the „current“ (1972) atmospheric CO_2 volume concentration of

$$0,03\ \% = 300 \cdot 10^{-\ 6} \tag{113}$$

and an relative annual increase of

$$0,32\ \% = \frac{0,95 \cdot 10^{-\ 6}}{300 \cdot 10^{-\ 6}} \tag{114}$$

the CO_2 concentration in the atmosphere would rise by one third of current concentration within 100 years, supposed the fossil fuel consumption will remain constant.

Schack then shows that CO_2 would absorb only one seventh [58)] of the ground's heat radiation at most, if the water vapor had not already absorbed the infrared light in most situations. Furthermore, a doubling of the CO_2-content in the air would only halve the radiation's characteristic absorption length , that is, the radiation would be absorbed at a length of 5 km instead of at a length of 10 km, for example. But this is quite important, because the temperature of the atmosphere decreases with height and the greenhouse effect is chiefly an emission effect. The intensity of the back-radiation to the Earth's surface is therefore determined by the median temperature over a height region which is equal to the absorption length. By halving the absorption length, the median temperature therefore rises because of the decrease in height and with it the intensity of the back-radiation (see section 4.4.4 on page 110).

Schack discussed the CO_2 contribution only under the aspect that CO_2 acts as an absorbent medium. He did not get the absurd idea to heat the radiating warmer ground with the radiation absorbed and re-radiated by the gas. Here are for me two incomprehensible cracks in the observations of the Authors:

- It is also interesting what Schack really wrote in his paper - what was omitted:

  > The absorption of a thermal radiation through a gas is in the steady-state condition exactly equal to the heat radiation of this gas. If in this case discrepancies existed, temperature differences would form in a cavity containing this gas. This is impossible according to the second law of thermodynamics.

58) 1/7 = 14.3 % - one should observe the agreement with the 18.7 % of Arrhenius 1906 (in section 3.6.1 on page 55, p. 56)

Translation of [180]

> Die Absorption der ein Gas durchsetzenden Wärmestrahlung ist im Beharrungszustand genau gleich der Wärmestrahlung dieses Gases. Denn wenn hierbei Abweichungen beständen, würden sich in einem dies Gas erfüllenden Hohlraum von selbst Temperaturdifferenzen bilden, was nach dem zweiten Hauptsatz der Thermodynamik nicht möglich ist.

It shows that the universal radiation (also in the direction of warmer earth's surface) is not an issue to Schack, because the temperature of the greenhouse gases is lower than the temperature of the earth's surface, so the greenhouse gases should stronger radiate than a black body: There is a the steady-state condition and the lower half part absorbs the high intensity of the warm Earth's surface which must also be emitted according to Schack. This statement by Schack is also described by the radiation transfer equation.

- At the beginning of this section (68) the Authors accept the definition of the emission from absorption.
- In section 3.7.5, p.62, the Authors state correctly »*One square meter of a meadow does not know anything of the rest of the Earth's surface*« – but now the CO_2 is supposed to »*know*« that it must not radiate in the direction of the ground, because the ground is warmer. But when the CO_2 nevertheless radiates downward, the question arises: how does the ground-ward radiation vanish, when from heights smaller than the absorption length radiation is hardly absorbed.

In a comment on an article by the science journalist Rudzinski [175] the climatologist Oeschger objectioned against Schack's analysis of the influence of the CO_2 concentration on the climate that Schack had not calculated thoroughly enough [165]. In particular, he referred to radiation transport calculations. However, such calculations have formerly been performed only for the atmospheres of stars, because the processes in planetary atmospheres are far too complicated for such simple models. The goal of astrophysical radiation transport calculations is to calculate as many absorption lines as possible with one boundary density distribution and one temperature dependency with respect to the height with Saha's equation and many other additional hypotheses [208]. However, the boundary density of the radiation intensity cannot be derived from these calculations.

One should emphasize that Schack was the first scientist to take into account the selective emission by the infrared light absorbing re-gases for combustion chambers.

Essential for the greenhouse effect is therefore implicitly establishing that thermalisation is stronger in combustion chambers than in the atmosphere[59]. Nevertheless thermalisation is obviously no impediment to the calculated temperature emission. The firmness of the collision only influences the line shape of the absorption line, so that with the mixing of gases, a reciprocal dependence exists. See also [133, S. 40(38) – 55(53)]. Therefore one is driven to the verge of irritation when global climatologists blame him for not calculating complicatedly enough, simply because he saw the primitive physical concepts behind the equations for the radiation transfer.

59) The gas density and temperature are higher than in the atmosphere: therefore the time between two collisions of the gas particles is still considerably shorter than in the atmosphere.

3.8 Thermal conductivity versus radiative transfer

3.8.1 The heat equation

In many climatological texts it seems to be implicated that thermal radiation needs not be taken into account when dealing with heat conduction, which is incorrect [213]. Rather, always the entire heat flow density q must be taken into account. This is given by the equation

$$q = -\ \lambda \cdot grad\ T \tag{115}$$

in terms of the gradient of the temperature T. It is inadmissible to separate the radiation transfer from the heat conduction, when balances are computed. Remark: In the atmosphere the least density– (temperature–) differences give rise to such high air velocities that convective heat transport lies far above the resting heat conductance. Therefore, nothing changes, except that the heat transport becomes almost always turbulent (high Reynolds numbers [220, p. 118f]): The convective (especially turbulent) heat transport exceeds heat conduction by orders of magnitude ($\lambda_{turbulent} \equiv \ldots 10^7 \cdot \lambda_{resting}$ [220, S. 49ff]): Therefore heat conduction can practically always be disregarded at longitudes over few mm. This is thoroughly dealt with in the DIN EN ISO 1946 [224, appendix B], where radiation, heat conductance and convection are allowed for, because the longitudes lie in the transition region. Besides, for T the temperature deviation from the adiabatic curve, not the real temperature, is what is needed.

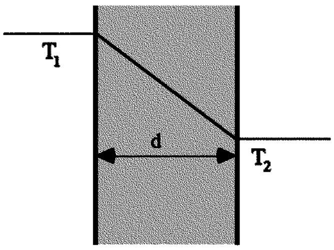

Figure 28: A simple heat transport problem.

In the following, a quasi one-dimensional experimental situation for the determination of the thermal conductivity is considered (Figure 28). With F being the cross section, d the distance between the two walls, and Q being the heat per time transported from 1 to 2, such that,

$$q_x = \frac{Q}{F} \tag{116}$$

we have

$$Q = F \cdot q_x = -\ \lambda \cdot F \cdot \frac{\partial T}{\partial x} = -\ \lambda \cdot F \cdot \frac{T_2 - T_1}{d} = \lambda \cdot F \cdot \frac{T_1 - T_2}{d} \tag{117}$$

in case of a stationary temperature distribution.

Q is produced and measured for the stationary situation by Joule heat (i.e. electric heat) at the higher temperature. The heat transfer by radiation cannot be separated from the heat transfer of kinetic energy. Of course, one tries to avoid the heat convection by the experimental arrangement [60]. Hence any effects of the thermal radiation (long wave atmospheric radiation to Earth) are simply contained in the stationary temperatures and the measured Joule heat.

In the non-stationary case the divergence of the heat flow no longer vanishes, and we have for constant thermal conductivity

$$div\ q = -\ \lambda \cdot div\ grad\ T = -\ \lambda \cdot \Delta\ T = -\ \rho\ c_V \frac{\partial T}{\partial t} \tag{118}$$

where ΔT is the Laplacean of the temperature (see Equation (2 on page 11)) and ρc_v the specific heat of unit volume. We finally obtain

$$\frac{\partial T}{\partial t} = \frac{\lambda}{\rho\ c_V}\ \Delta T \tag{119}$$

It is important to note, that the thermal conductivity is divided by ρc_v, which means that the isochoric thermal diffusivity [61]

$$a_v = \frac{\lambda}{\rho\ c_V} \tag{120}$$

of gases and metals can be of the the same order of magnitude, even if the thermal conductivities are completely different.

From the Equation (119) and Equation (120) follows the Equation (1 on page 11).

Unfortunately, the work on even the simplest examples of heat conduction problems needs techniques of mathematical physics, which are far beyond the undergraduate level. Because a concise treatment of the partial differential equations lies even outside the scope of this paper, the following statements should suffice: Under certain circumstances it is possible to calculate the space–time dependent temperature distribution with given initial values and boundary conditions. If the temperature changes have the characteristic length L_{char}, the characteristic time for the heat compensation process is

$$\frac{1}{t_{char}} = \frac{\lambda}{\rho\, c_V} \cdot \frac{1}{L_{char}^2} \tag{121}$$

If the radius of the Moon were used as the characteristic length and typical values for the other variables, the relaxation time would be equivalent to many times the age of the universe. Therefore, an average ground temperature (over hundreds of years) is no indicator at all that the total irradiated solar energy is emitted. If there were a difference, it would be impossible to measure it, due to the large relaxation times [62].

60) With this, this experiment has relevance only for the massive body of the Earth, for in the real atmosphere convective heat transport greatly exceeds resting heat transport.

61) Repetition of Equation (1 on page 11)

62) See commentary at the end of this section.

At long relaxation times, the heat flow from the Earth's core – of the surface – is an important factor for the long term reactions of the average ground temperature; after all, according to certain hypotheses the surfaces of the planetary bodies are supposed to have been very hot and to have cooled down. These temperature changes can never be separated experimentally from those, which were caused by solar radiation.

What is the purpose of such assertions? The long equilibrium time follows correctly from the validity of the heat conduction equation, but if the heat conduction equation is valid, then the other assumptions which result from the heat conduction equation are equally valid. The statement concerning the large equilibrium times with temperature changes at the Earth's surface only applies to Earth's core (which is in any case hotter) but it is not a question of the Earth's core temperatures, but a question of surface temperatures. Because of the thin surface layer, in comparison to Earth's radius, it is sufficient to calculate Equation (119 on the preceding page) (Equation (2 on page 11)) one dimensionally.

$$\frac{\partial T}{\partial t} = a_v \, \frac{\partial^2 T}{\partial x^2} \qquad \text{(k-121-14)}$$

This equation is derived from the validity of Equation (115 on page 82) which in a one dimensional style reads: With a temperature change at the Earth's surface, this heat current changes, which as a residual difference between incoming (for example through incident radiation) and outgoing heat output (for example, emission, convective heat passage, etc) is absorbed by the Earth. See also section 3.8.2 on page 86, where it is stated that the transition values were well measured. Since, as a rule, it is a question of small changes, it is sufficient to adopt a linear correlation.[63)] The linear correlation is expressed with a constant co-efficient α:

$$q = \alpha \cdot T \qquad \text{bzw.} \qquad T = \frac{q}{\alpha} \qquad \text{bzw.} \qquad \Delta q = \alpha \cdot \Delta T \qquad \text{(k-121-15)}$$

Solving (to equate q with q) for q results in:

$$\begin{aligned} -\lambda \cdot \frac{\partial T}{\partial x} &= \alpha \cdot T \\ \frac{\partial T}{\partial x} &= -\frac{\alpha}{\lambda} \cdot T \end{aligned} \qquad \text{(k-121-16)}$$

63) For even with a nonlinear correlation as the radiation, where perhaps Equation (70 on page 60) is valid, it becomes:

$$\begin{aligned} \Delta q &= \sigma(T+\Delta T)^4 - \sigma T^4 = \sigma[T^4 + 4T^3\Delta T + 6T^2(\Delta T)^2 + 4T(\Delta T)^3 + (\Delta T)^4 - T^4] \\ &= \sigma[4T^3\Delta T + 6T^2(\Delta T)^2 + 4T(\Delta T)^3 + (\Delta T)^4] = 4\sigma T^3 \Delta T\left[1 + 1.5\frac{\Delta T}{T} + \frac{(\Delta T)^2}{T^2} + \frac{(\Delta T)^3}{T^3}\right] \end{aligned}$$

With small temperature changes, all terms in brackets are small compared to 1, so that the linear part suffices.

Differentiation of this equation with respect to x gives with constant λ (assumed for the derivation of Equation (119 on page 83)):

$$\frac{\partial^2 T}{\partial x^2} = -\,\frac{\alpha}{\lambda} \cdot \frac{\partial T}{\partial x} \qquad \text{(k-121-17)}$$

The two previous equations are inserted into this equation and result in:

$$\frac{\partial^2 T}{\partial x^2} = \left(\frac{\alpha}{\lambda}\right)^2 \cdot T = \frac{\alpha}{\lambda^2} \cdot q \qquad \text{(k-121-18)}$$

The equation is inserted into the right side of the heat transport equation and the summary a_v is taken into account:

$$\frac{\partial T}{\partial t} = a_v \cdot \frac{\alpha}{\lambda^2} \cdot q = \frac{\alpha}{\lambda \rho c_v} \cdot q \qquad \text{(k-121-19)}$$

A typical value of lambda $\lambda \rho c_v$ is about $10^6\ W^2 s/(K^2 m^4)$ ($= b^2$ in [101, S. 145]) and $\alpha > 4\ W/(m^2 K)$ [224] (wind would worsen this, but because of general rising temperatures, the wind can remain ignored.) If the residual difference between incoming and outgoing heat transport were only $0.1\ W/m^2$, we have the amount:

$$\frac{\partial T}{\partial t} > \frac{4}{10^6} \cdot 0.1\ K/s = 4 \cdot 10^{-7}\ K/s = 0,03\ K/day = 12,6\ K/year \qquad \text{(k-121-20)}$$

These quick changes indeed occur daily, or are exceeded, i.e. the buffer effect of the Earth's surface is essential, but over the year the balance must be considerably better than $0.1\ W/m^2$. Since the absorbed radiation lies on average over $300\ W/m^2$, we can be confident of a balance to within one part in 3000. It also results from the equations that the heat flow change follows in every place from periodic temperature change. This is particularly obvious on the surface where temperature changes are much greater than temperature changes below the surface. This can already be somewhat noticed in a house cellar and especially in caves, where it suffices that these are a few meters under the Earth's surface. Temperature changes through the change of the surface heat flow decrease with depth - one can therefore see from the magnitude of temperature changes how long the changes of the surface heat flow last. Daily changes only reach a few dm in the depth, yearly changes a few m. With this we also find a magnitude for the balance time: for the daily change of the heat accumulation serves the heat capacity of a layer, which, at best, is only a few dm thick (usually even less), for the yearly changes also at best a few meters. At greater depths, the temperature change is so slow, that one can oneself observe the characteristic lengths of dozens of meters L_{char} (Equation (121 on page 83)) as a stationary heat flow. With the typical temperature increase towards the interior of the earth of 1K/30m (with large fluctuation depth) there occurs at the typical lambda - values a heat flow of under $0.1\ W/m^2$, in comparison with the average solar heat flow of over $300\ W/m^2$, so also 3000-fold.

3.8.2 Heat transfer across and near interfaces

In the real world things become even more complex through the existence of interfaces, namely

- solid-gas interfaces
- solid-liquid interfaces
- liquid-gas interfaces
- solid - all - interfaces
- etc.

for which a general theory of heat transport does not exist yet. The mechanisms of air cooling and water cooling and the influence of radiation have been studied in engineering thermodynamics [179], [82], [222] and are of practical interest e.g. in solar collectors, fire research, chemistry, nuclear engineering, electronic cooling, and in constructing reliable computer hardware [51], [177]. Obviously, there are of utmost importance in geophysics and atmospheric physics as well. Since they add an additional degree of complexity to the problem discussed here, they are not discussed further in this context.

3.8.3 In the kitchen: Physics-obsessed housewife versus IPCC

In section 3.3.5 on page 42 it was indicated how simple it is to falsify the atmospheric greenhouse hypotheses, namely by observing a water pot on the stove: Without water filled in, the bottom of the pot will soon become glowing red. However, with water filled in, the bottom of the pot will be substantially colder.

In particular, such an experiment can be performed on a glass-ceramic stove. The role of the Sun is played by the electrical heating coils or by infrared halogen lamps that are used as heating elements. Glas-ceramic has a very low heat conduction coefficient, but lets infrared radiation pass very well. The dihydrogen oxide in the pot, which not only plays the role of the „greenhouse gas“ but also realizes a very dense phase of such a magic substance, absorbs the infrared extremely well. Nevertheless, there is no additional „backwarming“ effect of the bottom of the pot. In the opposite, the ground becomes colder. Since nothing is said about the type of pot, the experiment would already be senseless, as water and infrared radiation do not even meet if, for example, a metal pot is chosen. For a more realistic experiment, the pot should consist of glass ceramics: And the effect of the counter radiation can then be well observed: At the beginning, when the water is still cold, the heater glows dark red, because from the cold water comes little back-radiation; with the heating of the water, the back-radiation rises and this occurs in such a way that the heater glows brighter, thus the temperature of the heater rises (although the heater has in addition a higher temperature than the water). As a rule, the temperature increase of the heater is less than the increase of the back-radiation, because the electric heat transmission decreases with rising temperature (the heater is often a cold conductor).

But the experiment can be even more accurate. Take an infrared thermometer (see Figure 32 on page 92) and hold it over the water surface. There are then absolutely no barriers which can influence the infrared radiation - and yet the temperature is accurately indicated, quite regardless of whether the water temperature is higher or lower than the temperature of the infrared thermometer.

There are countless similar experiments possible that immediately show that the atmospheric greenhouse picture is absolutely ridiculous from an educated physicist's point of view or from the perspective of a well-trained salesman offering high performance tinted glass that reduces solar heat gain mainly in the infrared [20]:

> „Daylight and view are two of the fundamental attributes of a window. Unfortunately, windows are also the source of significant solar heat gain during times when it is unwanted. Traditional solutions to reducing solar heat gain such as tinted glazing or shades mean that the amount of light is reduced as well. New glazings with low-solar-gain Low-E (spectrally selective) coatings can provide better solar heat gain reduction than tinted glass, with a minimal loss of visible light. This also means that views can be clearer and unobstructed.“

According to Table 8 on page 25, about half of the solar radiation falls in the visible and half in the infrared region. In this case, solar heat is reduced in both cases: with reduction both for visible and for infrared wavelengths.

Ironically, this works already in the case of dihydrogen oxide. Such experiments can be performed easily on every overhead projector, showing that the absorption of the infrared portion of the incoming radiation by water is a non-neglible and leads to a drop of the temperature of the illuminated surface dressed by an infrared absorbing layer that is transparent to visible light.

3.9 The laws of thermodynamics

3.9.0 The existence of counter-radiation

For proof of the existence of counter-radiation 4 Essential suffice:

1. The size of a heat flow between two bodies depends on the temperature difference between two bodies. Example: inside and outside of a thermos flask.

2. Quote from page 19: »Microscopically both interactions are mediated by photons.«

3. Photons transport a certain amount of energy according to their frequency (wavelength). This the definition of energy quanta ab initio most important part of the quantum theory.

4. quote from page 73: »One square meter of a meadow does not know anything of the rest of . . . «

Let as keep at the thermos flask (item 1). If the inside of the thermos flask »knows« nothing from the outside of the thermos flask (item 4), then photons are emitted by the interior wall as well as the exterior wall independently of each other (item 2), whose quantity must certainly depend on the temperature of the (concerning) surface and it also really do. Therefore the emission performance of each surface correspondent to the photons flux (item 3). Accordingly each surface emits a power which depends only on their own temperature and is independent of temperature and position of the surrounding body (follows from item 4) - but at the same time it absorbs the radiation of the surrounding bodies, which also »knows« nothing from the emission of their surroundings. As a result of the simultaneous emission and absorption only the difference between both is observable - that knew Prevost [171] already over 200 years ago and was mathematically expressed by Stefan [194] long before quantum theory [170]. The photon flux from cooler to warmer body is called counter-radiation and is existent, if it comes from the photon image. The name of counter-radiation follows from the fact that this radiation portion is contrariwise to the temperature gradient.

Only observable is the difference of ahead radiation and counter radiation - and that size does not infringe the second law of thermodynamics (see section 3.9.1), which base on the observable variables and has been built before the quantum theory [170], and even before 1887 [67], [68]. With the quantum theory, you can now have an image of the radiation, before quantum theory (from 1916 [79]) counter radiation was a pure calculation size. And based on a notional size calculation, the authors want to apply a law that only applies to observable sizes (second law of thermodynamics)????

The counter radiation thus exists, if the ahead radiation is assumed be independent of the environment. Thus

- either work only with observable variables, then the radiation power is independent from the environment mathematically difficult to handle and is then mathematically however as hereafter executed
- or
- work with unobserved variables and assume a radiation for all body that depends only on the temperature of the radiating body. This includes the counter radiation and leads to the corrected observable sizes.

Accordingly, the emission from the surface is to be determined. Thus

- either determine the emission of the Earth's surface, taking into consideration the temperature of the greenhouse gases (mathematically difficult to handle and is then mathematically however as hereafter executed)
- or
- determine the radiation of the Earth's surface without consideration of greenhouse gases and account the absorption of the counter-radiation from greenhouse gases.

Both methods result in the correct size - but a combination of emission from the surface without consideration of the environment and negation of the counter radiation is wrong.

Therefore an interference of dissipation of heat will always increase temperature of the body, which has to emit a delivered heat: The increase of the temperature of a filament (sample page 15) »shines brighter« or just the greenhouse effect.

3.9.1 Introduction

At the time of Fourier's publication [85], [84] the two fundamental laws of classical thermodynamics were not known. Formulated by Rudolf Clausius (January 2, 1822 - August 24, 1888), the founder of axiomatic thermodynamics, they read [67], [68]:

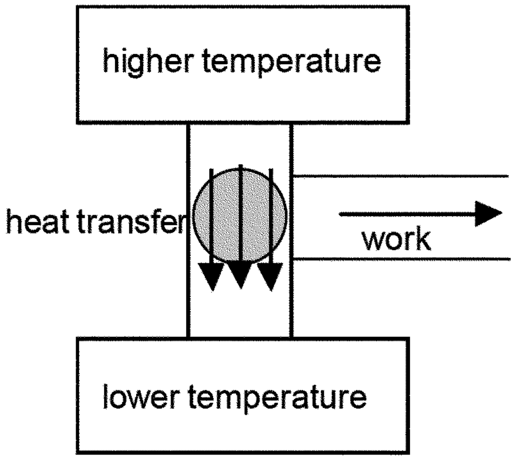

Figure 29: A steam engine works transforming heat into mechanical energy.

- **First law of thermodynamics:** *In all cases, when work is transformed into heat, an amount of heat in proportion to the produced work is used up, and vice versa, the same amount of heat can be produced by the consumption of an equal amount of work.*
- ○ Corollary: *Work can be transformed into heat and vice versa, where the amount of one is in proportion to the amount of the other.*

This is a definition of the mechanical heat equivalent.

- **Second law of thermodynamics:** *Heat cannot move itself from a cooler body into a warmer one. A heat transfer from a cooler body into a warmer one cannot happen without compensation.*
- ○ Corollary: *A heat transfer from a cooler body into a warmer one cannot happen without compensation.*

A fictitious heat engine which works in this way is called a perpetuum mobile of the second kind.

Clausius examines thoroughly, that the second law is relevant for radiation as well, even if image formations with mirrors and lenses are taken into account [67], [68].

3.9.2 Diagrams

It is quite useful to clarify the second law of thermodynamics with (self- explaining) diagrams.

- A steam engine works transforming heat into mechanical energy, whereby heat is transferred from the warmth to the cold (see Figure 29).

- A heat pump (e.g. a refrigerator) works, because an external work is applied, whereby heat is transferred from the the cold to the warmth (see Figure 30 on the following page).

- In a perpetuum mobile of the second kind heat is transferred from the cold to the warmth without external work applied (see Figure 31 on the next page).

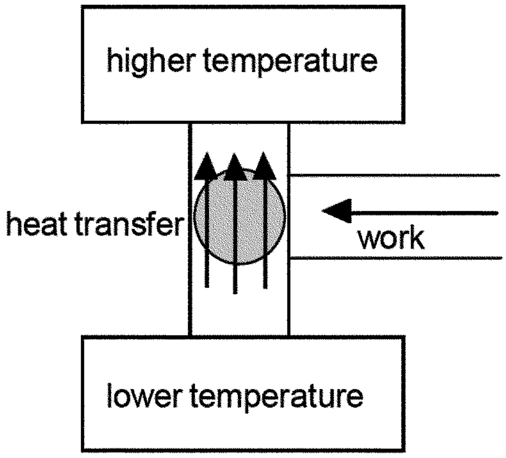

Figure 30: A heat pump (e.g. a refrigerator) works, because an external work is applied.

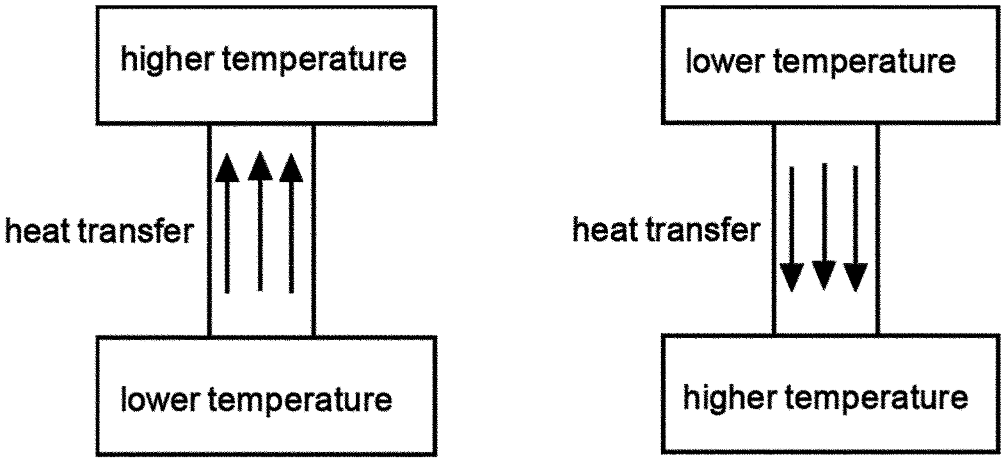

Figure 31: Any machine which transfers heat from a low temperature reservoir to a high temperature reservoir without external work applied cannot exist: A perpetuum mobile of the second kind is impossible.

3.9.3 A paradox

The use of a perpetuum mobile of the second kind can be found in many modern pseudoexplanations of the CO_2-greenhouse effect. Even prominent physicists have relied on this argumentation. One example was the hypothesis of Stichel already discussed in section 3.3.4 on page 42 [195].

The renowned German climatologist Rahmstorf has claimed that greenhouse effect does not contradict to the the second law of thermodynamics [173]:

> „Some 'sceptics' state that the greenhouse effect cannot work since (according to the second law of thermodynamics) no radiative energy can be transferred from a colder body (the atmosphere) to a warmer one (the surface). However, the second law is not violated by the greenhouse effect, of course, since, during the radiative exchange, in both directions the net energy flows from the warmth to the cold."

Rahmstorf's reference to the second law of thermodynamics is plainly wrong. The second law is a statement about heat, not about energy. Furthermore the author introduces an obscure notion of „net energy flow". The relevant quantity is the „net heat flow", which, of course, is the sum of the upward and the downward heat flow within a fixed system, here the atmospheric system. It is inadmissible to apply the second law for the upward and downward heat separately redefining the thermodynamic system on the fly.

The second law is not redefined in the Rahmstorf explanation. In Equation (70 on page 60), the emission of a body is named (correctly!) - and indeed implicitly as independent of the surroundings. The surroundings can also be warmer. Where, for example, should the radiation of a cooler sphere go, when it is in a hollow sphere of higher temperature? Why does the outer sphere cool more quickly, when the inner sphere is cooler? From where does the outer sphere gain the knowledge, that it must stop heating the inner sphere, when the temperature balance has been reached? The explanation becomes quite simple if one bears in mind, that the inner sphere also emits: When the inner sphere is very cold, it hardly emits, so that the strong emission of the outer hollow sphere is hardly compensated through a counter emission; with increasing temperature the inner sphere emits increasingly strongly until at temperature balance the inner sphere emits just as much output as is absorbed by the outer hollow sphere. This was already known by Prevost over 200 years ago [171]. When two opposite heat radiations are examined, the difference of both heats is exactly the net heat transfer.

A similar confusion is currently seen in the German version of Wikipedia [29]:

> „Some have problems with the energy that is radiated by the greenhouse gases towards the surface of the Earth (150W=m2 - as shown above) because this energy flows from a colder body (approx. 40 C) to a warmer one (Earth's ground approx. +15 C) apparently violating the second law of thermodynamics. This is a wrong interpretation, since it ignores the radiation of the Sun (even 6000 K). With respect to the total balance the second law is obeyed indeed."

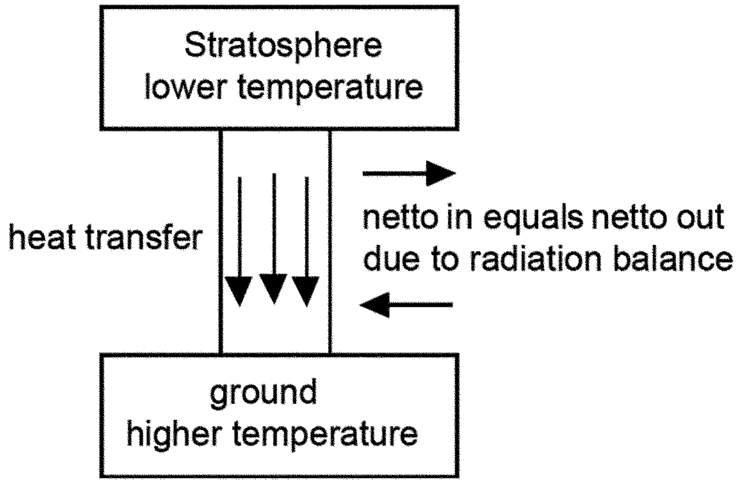

Figure 32: A machine which transfers heat from a low temperature reservoir (e.g. stratosphere) to a high temperature reservoir (e.g. atmosphere) without external work applied, cannot exist - even if it is radiatively coupled to an environment, to which it is radiatively balanced. A modern climate model is supposed to be such a variant of a perpetuum mobile of the second kind. Really? Example for radiation detection: The »high temperature reservoir« may be an infrared thermometer (radiation pyrgeometer) at room temperature (as is customary), while »lower temperature stratosphere« may be the inside of a just opened refrigerator. The radiation pyrgeometer will indicate the right temperature, although the temperature of the interior of the refrigerator is less than the temperature of the radiation pyrgeometer.

Obviously, the authors are confusing energy with heat. Heat is a form of energy. In addition, heat is often not used in a clearly defined way: as energy and as flux. Furthermore, the system in question here is the atmospheric system of the Earth including the Earth's ground. Since this system is assumed to be in radiative balance with its environment, and any other forms of energy and mass exchange with its environment are strictly prohibited, it defines a system in the sense of thermodynamics for which the second law holds strictly, even if it is considered as a subsystem of a larger embedding system. The second law is fulfilled in every subsystem. If radiation any volume element reaches the earth's surface, the radiation from the earth's surface will necessarily reach this volume element (described by Maxwell's equations, as well as by the quantum equations, both time-invariant and time-reversible). Because the temperature of the earth's surface is higher than the temperature of the atmospheric volume element the intensity of the heat flow from the Earth's surface to volume element is greater than the inverse flow. So the net heat flow is directed from the Earth to the volume element. It is a long assured knowledge that the heat flow from one body to another always depends on the temperature of the other body. The mathematical decomposition in two thermal streams, regardless of the temperature of the other body, is a mathematical abstraction.

Already Stefan wrote in 1879:

> The loss of heat of the inner ball caused by the conduction of the air could consider as the result of two thermal flows, one of the ball to the outer cover the second in the reverse direction, each independently from the other. The heat exchange by conduction is comparable to the exchange via radiation that occure between bodies with different temperatures.

Translation of [221, p. 400]

> Man kann also auch den durch die Leitung der Luft bedingten Wärmeverlust der inneren Kugel betrachten als Resultat von zwei Wärmeströmen, von denen der eine von der Kugel zur äußeren Hülle, der zweite in umgekehrter Richtung vor sich geht, jeder unabhängig von dem anderen. Es verhält sich also der Wärmeaustausch durch Leitung analog jenem, welcher zwischen verschieden warmen Körpern durch Strahlung vermittelt wird.

Incorrect is the allegation also with the following two facts:

- If one considers only the subsystem, the radiation of the Sun needs to be considered as an external impulse (»work« in Figure 30 on page 90.
- The formulation of the second law in terms of temperature is a limited popular description. More general is the description in terms of entropy - see section 4.2.10 on page 99. The entropy of a subsystem can decrease. Entropy decrease in a subsystem does not change the fact that for the full isolated system, entropy must always increase. »The entropy of single subsystems can in both kinds of processes absolutely decrease« [123, S. 44(48)].

The difference between heat, energy and work is crucial for the understanding of thermodynamics. The second law is a statement about this difference.

Wireless communication is quite a clear example of the radiation effect, with no temperature difference. As is self-evident to all, connections work independently of the temperature difference of the participating devices; some argue that the second law of thermodynamics is not valid or fulfilled for this sort of communication - but the laws of thermodynamics are universally valid.

3.9.4 Possible resolution of the paradox

It may be due to the following approximation that something is possible in climate models, which contradicts the second law of thermodynamics. In the field theoretical description of irreversible thermodynamics, the second law is found in the statement, that the heat flow density and the gradient of the temperature point into opposite directions

$$q = -\,\lambda \cdot \operatorname{grad} T \tag{122}$$

In this formula, the heat conduction necessarily is a positive definite tensor. In climate models it is customary to neglect the thermal conductivity of the atmosphere, which means to set it to zero [103].

$$\lambda = 0 \qquad (123)$$

This could explain, why the numerical simulations could produce small effects in contradiction to the second law of thermodynamics. To set the heat conduction to zero would not be a real violation of the second law of thermodynamics as it corresponds to an approximation of an ideal system: In spite of the temperature differences no heat flow could move from a warmer area to a colder one. It would be in accordance to the second law, if there were no temperature rise. In the past, the „predictions" of the climate models were pointing sometimes in this direction, as was shown in detail in section 3.6.2 on page 58.

4 Physical Foundations of Climate Science

4.1 Introduction

A fundamental theory of the weather and its local averages, the climates, must be founded on a reasonable physical theory. Under the premise that such a theory has already been formulated there are still two basic problems left unresolved, namely

- the embedding of the purely physical theory in a much more wider framework including the chemical and biological interactions within the geophysical realm,
- the correct physical account of a possible non-trivial radiative effect, which must go far beyond the famous black body approach, which is suggestive but does not apply to gases. This theory of the interaction between gas particles and radiation exists and was already formulated by Einstein in 1916 [79]. In this paper Einstein reasons why the why the interaction of radiation with gas particles only as a interaction of one gas particle with a photon is to be - a particle consideration so unnecessary, if not wrong. Its used by him and later named after him Einstein coefficients he could not calculate, that was only with later work on quantum theory.

A review of the issues of chemistry and biology such as the carbon cycle lies outside the perspective of this paper, but it must not be neglected. In his criticism of global warming studies by means of computer models the eminent theoretical physicist Freeman J. Dyson stated [76]:

> „The models solve the equations of fluid dynamics, and they do a very good job of describing the fluid motions of the atmosphere and the oceans. They do a very poor job of describing the clouds, the dust, the chemistry and the biology of fields and farms and forests. They do not begin to describe the real world that we live in. The real world is muddy and messy and full of things that we do not yet understand. It is much easier for a scientist to sit in an air- conditioned building and run computer models, than to put on

winter clothes and measure what is really happening outside in the swamps and the clouds. That is why the climate model experts end up believing in their own models.“

However, it can be shown that even within the borders of theoretical physics with or without radiation things are extremely complex so that one very quickly arrives at a point where verifiable predictions no longer can be made. Making such predictions nevertheless may be interpreted as an escape out of the department of sciences, not to say as a scientific fraud.

In the following the conservation laws of magnetohydrodynamics are reviewed. It is generally accepted that a Navier-Stokes -type approach or a simplified magnetohydrodynamics provides the backbone to climatological computer simulations [149], [178], [191]. In these frameworks neither the radiative budget equations can be derived, nor is it possible to integrate radiative interactions in a consistent way. Therefore it would conceptually be necessary to go into the microscopic regime, which is described by non-equilibrium multi-species quantum electrodynamics of particles incorporating bound states with internal degrees of freedom, whereby the rich structure and coexistence of phases have to be taken into account in the discussion of natural situations. From these only formally sketchable microscopic ab initio approaches there is no path known that leads to a family of more realistic phenomenological climate models [219].

4.2 The conservation laws of magnetohydrodynamics

4.2.1 Overview

The core of a climate model must be a set of equations describing the equations of fluid flow, namely the Navier-Stokes equations [178], [191]. The Navier-Stokes equations are nonlinear partial differential equations, which, in general, are impossible to solve analytically. In very special cases numerical methods lead to useful results, but there is no systematics for the general case. In addition, the Navier-Stokes approach has to be extended to multi-component problems, which does not simplify the analysis.

Climate modelers often do not accept that „climate models are too complex and uncertain to provide useful projections of climate change“ [152]. Rather, they claim that „current models enable [them] to attribute the causes of past climate change and predict the main features of the future climate with a high degree of condence“ [152]. Evidently, this claim (not specifying the observables subject to the prediction) contradicts to what is well-known from theoretical meteorology, namely that the predictability of the weather forecast models is (and must be) rather limited (i.e. limited to a few days) [218]. The limitations of weather forecasting models does not automatically imply the uselessness of a climate model. Here is an example from physics: pressure, temperature of a gas (equivalent to the climate) can very well be calculated from the gas equations. These data are the result of particle motions in the gas, which obey the laws of mechanics and of quantum theory. According to these laws, it is in principle impossible to forecast the particle distribution some time ahead (equivalent to the weather) - but pressure and so forth allow themselves to be well calculated.

The non-solvability of Navier-Stokes-type equations is related (but not restricted) to the chaotic character of turbulence. But this is not the only reason why the climate modeling cannot be built on a solid ground. Equally importantly, even the full set of equations providing a proper model of the atmospheric system (not to say atmospheric-oceanographic system) are not known (and never will) to a full extent. All models used for „simulation“ are (and have to be) oversimplified. However, in general a set of oversimplified nonlinear partial differential equations exhibits a totally different behavior than a more realistic, more complex system. Because there exist no strategy for a step-wise refinement within the spirit of the renormalization (semi-)group, one cannot make any useful predictions. The real world is too complex to be represented properly by a feasable system of equations ready for processing [219]. The only safe statement that can be made is that the dynamics of the weather is probably governed by a generalized Navier-Stokes-type dynamics.

Evidently, the electromagnetic interactions have to be included, leading straightly to the discipline of Magnetohydrodynamics (MHD) [74], [95], [189], [188]. This may be regarded as a set of equations expressing all the essential physics of a fluid, gas and/or plasma.

In the following these essential equations are reviewed. The purpose is twofold:

- Firstly, it should be made a survey of what budget relations really exist in the case of atmospheric physical systems.
- Secondly, the question should be discussed at what point the supposed greenhouse mechanism does enter the equations and where the carbon dioxide concentration appears.

Unfortunately, the latter aspect seems to be obfuscated in the mainstream approaches of climatology.

4.2.2 Electric charge conservation

As usual, electric charge conservation is described by the continuity equation

$$\frac{\partial \rho_e}{\partial t} + \nabla \cdot j = 0 \tag{124}$$

where ρ_e is the electrical (excess) charge density and j is the electrical (external) current density.

4.2.3 Mass conservation

The conservation of mass is described by another sort of continuity equation

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho v) = 0 \tag{125}$$

where ρ is the mass density and ρv is the density of the mass current.

4.2.4 Maxwell's equations

The electromagnetic fields are described by Maxwell's field equations that read

$$\nabla \cdot D = \rho_e \tag{126}$$

$$\nabla \times E = -\frac{\partial B}{\partial t} \tag{127}$$

$$\tag{128}$$

$$\nabla \cdot B = 0 \tag{129}$$

$$\nabla \times H = j + \frac{\partial D}{\partial t} \tag{130}$$

where the standard notation is used. They have to be supplemented by the material equations

$$D = \varepsilon\varepsilon_0 E \tag{131}$$

$$B = \mu\mu_0 H \tag{132}$$

where ε and μ are assumed to be constant in space and time, an assumption that was already made by Maxwell.

4.2.5 Ohm's law for moving media

Electric transport is described by Ohm's law for moving media

$$j - \rho_e v = \sigma(E + v \times B) \tag{133}$$

with σ being the electrical conductivity tensor. Expressed in terms of the resistivity tensor ρ this reads

$$\rho(j - \rho_e v) = E + v \times B \tag{134}$$

4.2.6 Momentum balance equation

Conservation of momentum is described by a momentum balance equation, also known as Navier-Stokes equation,

$$\frac{\partial}{\partial t}(\rho v) + \nabla \cdot (\rho v \otimes v) = -\nabla p - \rho\nabla\Phi + \rho_e E + j \times B + \nabla \cdot R + F_{ext} \tag{135}$$

where v is the velocity vector field, p the pressure field, Φ the gravitational potential, R the friction tensor, and F_{ext} are the external force densities, which could describe the Coriolis and centrifugal accelerations.

4.2.7 Total energy balance equation

The conservation of energy is described by

$$\begin{aligned} &\frac{\partial}{\partial t}\left(\frac{\rho}{2}|v|^2 + \frac{1}{2}H\cdot B + \frac{1}{2}E\cdot D + \rho\Phi + \rho u\right) + \\ &+\nabla\cdot\left(\frac{\rho}{2}|v|^2 v + E\times H + \rho\Phi v + \rho u v + p v - r\cdot R + \lambda\cdot\nabla T\right) = \\ &= \rho\frac{\partial\Phi}{\partial t} + F_{ext}\cdot v + Q \end{aligned} \tag{136}$$

where u is the density of the internal energy, T is the temperature field, and λ the thermal conductivity tensor, respectively. Furthermore a term Q has been added which could describe a heat density source or sink distribution.

4.2.8 Poynting's theorem

From Maxwell's equation with space-time independent ε and μ and one obtains the relation

$$\frac{\partial}{\partial t}\left(\frac{1}{2}H\cdot B + \frac{1}{2}E\cdot D\right) + \nabla\cdot(E\times H) = -\,j\cdot E \tag{137}$$

This relation is a balance equation. The Poynting vector field $E\times H$ may be interpreted as an energy current density of the electromagnetic field.

4.2.9 Consequences of the conservation laws

Multiplying Ohm's law for moving media (Equation (134 on the previous page)) with $(j-\rho_e v)$ one gets

$$\begin{aligned} (j-\rho_e v)\sigma(j-\rho_e v) &= j\cdot E + j\cdot(v\times B) - \rho_e v\cdot E \\ &= j\cdot E - v\cdot(j\times B) - \rho_e v\cdot E \end{aligned} \tag{138}$$

which may be rewritten as

$$j\cdot E = (j-\rho_e v)\sigma(j-\rho_e v) + v\cdot(j\times B) + \rho_e v\cdot E \tag{139}$$

Inserting this into Poynting's theorem (Equation (137)) one obtains

$$\begin{aligned} &\frac{\partial}{\partial t}\left(\frac{1}{2}H\cdot B + \frac{1}{2}E\cdot D\right) + \nabla\cdot(E\times H) = \\ &= -\,(j-\rho_e v)\sigma(j-\rho_e v) - v\cdot(\rho_e E + j\times B) \end{aligned} \tag{140}$$

On the other hand, if one applies the scalar product with v on the momentum balance equation Equation (135 on the previous page) one gets

$$\begin{aligned} &\frac{\partial}{\partial t}\left(\frac{\rho}{2}|v|^2\right) + \nabla\cdot\left(\frac{\rho}{2}|v|^2 v\right) = \\ &= -\,v\cdot\nabla p - \rho v\cdot\nabla\Phi + v\cdot(\rho_e E + j\times B) + v\cdot(\nabla\cdot R) + v\cdot F_{ext} \end{aligned} \tag{141}$$

Replacing $v \cdot (\rho_e E + j \times B)$ with Equation (140 on the preceding page) and doing some elementary manipulations one finally obtains

$$\begin{aligned} &\frac{\partial}{\partial t}\left(\frac{\rho}{2}|v|^2 + \frac{1}{2}H \cdot B + \frac{1}{2}E \cdot D + \rho\Phi\right) + \\ &\quad +\nabla \cdot \left(\frac{\rho}{2}|v|^2 v + E \times H - v \cdot R + pv + \rho\Phi v\right) = \\ &\quad = p\nabla \cdot v + \rho\frac{\partial \Phi}{\partial t} - Spur((\nabla \otimes v) \cdot R) - (j - \rho_e v)\sigma(j - \rho_e v) + F_{ext} \cdot v \end{aligned} \tag{142}$$

Hence, this relation is a consequence of the fundamental equations of magnetohydrodynamics. The heat density source term Q, the internal energy density u, and the divergence of the heat current density q are missing here.

4.2.10 General heat equation

With

$$du = \frac{p}{\rho^2}d\rho + Tds \tag{143}$$

for reversible processes one can substitute the density of the internal energy u by the density of the entropy s.

With the aid of Equation (136 on the previous page) and Equation (137 on the preceding page) one derives a differential equation for the entropy density s:

$$\begin{aligned} &\frac{\partial \rho s}{\partial t} + \nabla(\rho s v) = \\ &\quad = \frac{1}{T}Spur((\nabla \otimes v) \cdot R) + \frac{1}{T}(j - \rho_e v)\sigma(j - \rho_e v) \\ &\quad - \frac{1}{T}\nabla \cdot (\lambda \cdot \nabla T) + \frac{Q}{T} \end{aligned} \tag{144}$$

This is the generalized form of the heat equation.

Only with artificial heat densities Q in Equation (144) one can incorporate a hypothetical warming by radiation. There is no term that depends on the carbon dioxide concentration.

4.2.11 Discussion

The equations discussed above comprise a system of one-fluid equations only. One can (and must) write down many-fluid equations and, in addition, the averaged equations describing the turbulence. To get a realistic model of the real world, the above equations must be generalized to take into account

- the dependency of all relevant coefficients on space and time;
- the presence and coexistence of various species of fluids and gases;
- the inhomogenities of the media, the mixture and separation of phases.

In principle such a generalization will be feasable, if one cuts the domains of definition into pieces and treats the equations by a method of patches. Thus the final degree of complexity may be much larger than originally expected arriving at a system of thousands of phenomenological equations defining non-linear three-dimensional dynamics and heat transfer [93], [96], [11].

It cannot be overemphasized that even if these equations are simplified considerably, one cannot determine numerical solutions, even for small space regions and even for small time intervals. This situation will not change in the next 1000 years regardless of progress made in computer hardware. Therefore, global climatologists may continue to write updated research grant proposals demanding next-generation supercomputers ad infinitum. As the extremely simplified one-fluid equations are unsolvable, the many-fluid equations would be more unsolvable, the equations that include the averaged equations describing the turbulence would be still more unsolvable, if „unsolvable“ had a comparative.

Regardless of the chosen level of complexity, these equations are supposed to be the backbone of climate simulations, or, in other words, the foundation of models of nature. But even this is not true: In computer simulations heat conduction and friction are completely neglected, since they are mathematically described by second order partial derivatives that cannot be represented on grids with wide meshes. Hence, the computer simulations of global climatology **are not based on physical laws**.

The same holds for the speculations about the influence of carbon dioxide:

- Although the electromagnetic field is included in the MHD-type global climatologic equations, there are no terms that correspond to the absorption of electromagnetic radiation. But since there is no doubt that electromagnetic radiation is absorbed, these equations miss essentials - namely, for example, the incorporation of Einstein"s equations. (Siehe auch section 4.1 on page 94)
- It is hard if not impossible to nd the point in the MHD-type global climatologic equations, where the concentration of carbon dioxide enters the game. This is not surprising, since the equations miss essential parts (see first point).
- It is impossible to include the radiative transfer Equation (59 on page 53) into the MHD-type climatologic equations. This is not surprising, since the equations miss essential parts (see first point).
- Apparently, there is no reference in the literature, where the carbon dioxide concentration is implemented in the MHD-type climatologic equations. How come? See first point.

Since essentials were neglected, the following inference is not surprising.

Hence, one is left with the possibility to include a hypothetical warming by radiation by hand in terms of artificial heat densities Q in Equation (144 on the preceding page). But this would be equivalent to imposing the „political correctly“ requested anthropogenic rise of the temperature even from the beginning just saving an additional trivial calculation.

In case of partial differential equations more than the equations themselves the boundary conditions determine the solutions. There are so many different transfer phenomena, radiative transfer, heat transfer, momentum transfer, mass transfer, energy transfer, etc.

and many types of interfaces, static or moving, between solids, fluids, gases, plasmas, etc. for which there does not exist an applicable theory, such that one even cannot write down the boundary conditions [51], [177].

In the „approximated“ discretized equations artificial unphysical boundary conditions are introduced, in order to prevent running the system into unphysical states. Such a „calculation“ , which yields an arbitrary result, is no calculation in the sense of physics, and hence, in the sense of science. There is no reason to believe that global climatologists do not know these fundamental scientific facts. Nevertheless, in their summaries for policymakers, global climatologists claim that they can compute the influence of carbon dioxide of the climates.

The formulated equations are unnecessarily complex; on the other hand essential connections are missing, for instance, Einstein”s equations are not incorporated. These are important for interaction between gas particles and radiation, that is why inclusion of Q appears artificial here. For these reasons, the equations hardly contribute to climate research. (See also section 4.1 on page 94.)

4.3 Science and Global Climate Modelling

4.3.1 Science and the Problem of Demarcation

Science refers to any system of objective knowledge, in particular knowledge based on the scientific method as well as an organized body of knowledge gained through research [6], [25].

There are essentially three categories of sciences, namely

- formal sciences (mathematics),
- natural sciences (physics, chemistry, biology)
- social sciences

In natural sciences one has to distinguish between

a theory: a logically self-consistent framework for describing the behavior of certain natural phenomena based on fundamental principles;

a model: a similar but weaker concept than a theory, describing only certain aspects of natural phenomena typically based on some simplified working hypothesis;

a law of nature: a scientific generalization based on a sufficiently large number of empirical observations that it is taken as fully verified;

a hypothesis: a contention that has been neither proved nor yet ruled out by experiment or falsified by contradiction to established laws of nature.

A *consensus*, exactly speaking *a consensus about a hypothesis* is a notion which lies outside natural science, since it is completely irrelevant for objective truth of a physical law:

Scientific consens(us) is scientific nonsense.

The *problem of demarcation* is how and where to draw lines around science, i.e. to distinguish science from religion, from pseudoscience, i.e. fraudulent systems that are dressed up as science, and non-science in general [6], [26].

In the philosophy of science several approaches to the definition of science are discussed [6], [25]:

empirism[64)] (Vienna Circle): only statements of empirical observations are meaningful, i.e. if a theory is verifiable, then it will be scientific;

falsificationism (Popper): if a theory is falsifiable, then it will be scientific;

paradigm shift (Kuhn): within the process of normal science anomalies are created which lead eventually to a crisis finally creating a new paradigm; the acceptance of a new paradigm by the scientific community indicates a new demarcation between science and pseudoscience;

democratic and anarchist approach to science (Feyerabend): science is not an autonomous form of reasoning but inseparable from the larger body of human thought and inquiry: „Anything goes“.

Superficially, the last point provides a nice argument for computer modelers in the framework of global climatology. However, it is highly questionable whether this fits into the frame of physics. Svozil remarked that Feyerabend's understanding of physics was superficial [198]. Svozil emphasizes:

> „Quite generally, partly due to the complexity of the formalism and the new challenges of their findings, which left philosophy proper at a loss, physicists have attempted to developed their own meaning of their subject.“

Physics provides a fundament for engineering and, hence, for production and modern economics. Thus the citizen is left with the alternative (in the sense of a choice between two options)

(a) either to accept the derivation of political and economical decisions from an anarchic standpoint that eventually claims that there is a connection to experiment and observation, and, hence, the real world, when there is no such connection;

(b) or to call in the derivation of political and economical decisions from verifiable research results within the frame of physics, where there is a connection to experiment and observation, and hence, the real world.

Evidently, the option (b) defines a pragmatic approach to science, defining a minimum of common features, such that engineers, managers and policymakers have something to rely on: Within the frame of exact sciences a theory should

(a) be logically consistent;

(b) be consistent with observations;

(c) have a grounding in empirical evidence;

(d) be economical in the number of assumptions;

(e) explain the phenomena;

(f) be able to make predictions;

(g) be falsifiable and testable;
(h) be reproducible, at least for the colleagues;
(i) be correctable;
(j) be refinable;
(k) be tentative;
(l) be understandable by other scientists.

Can these criteria ever be met by a computer model approach of global climatology? Yes and no: The four colour problem was solved with a computer programme; the large number of spectral lines requires a computer, but the fundamental results must be reproducible. Besides, the model should come from climate and not from weather, although useful results are to be had even by way of a weather calculation. For comparison, the Author again avails himself of the gas laws: one can derive the pressure by way of the molecular motion of gas particles under collisions (momentum change). Although after a short time the motions no longer match the real particle motions (analogous to weather forecasting), the median value for pressure and so forth (analogous to climate) are, however, sufficient for agreement. Nevertheless, hardly anyone will derive the pressure in this way, but will directly utilize the gas laws.

4.3.2 Evaluation of Climatology and Climate Modelling

In contrast to meteorology climatology studies the averaged behavior of the local weather. There are several branches, such as paleoclimatology, historical climatology, and climatology involving statistical methods which more or less t into the realm of sciences. The problem is, what climate modelling is about, especially if it does refer to chaotic dynamics on the one hand, and the greenhouse hypothesis on the other.

The equations discussed in section 4.2 on page 95 may give an idea what the final defining equations of the atmospheric and/or oceanic system may look like. It has been emphasized that in a more realistic albeit phenomenological description of nature the system of the relevant equations may be huge. But even by simplifying the structure of equations one cannot determine solutions numerically, and this will not change, if one does restrict oneself on small spacetime domains.

There are serious solvability questions in the theory of non-linear partial differential equations and the shortage of numerical recipes leading to sufficient accurate results will remain in the nearer or farer future - for fundamental mathematical reasons. The Navier-Stokes equations are something like the holy grail of theoretical physics, and a brute force discretization with the aid of lattices with very wide meshes leads to models, which have nothing to do with the original puzzle and thus have no predictability value.

In problems involving partial differential equations the boundary condition determine the solutions much more than the differential equations themselves. The introduction of a discretization is equivalent to an introduction of artificial boundary conditions, a procedure, that is characterized in von Storch's statement „The discretization is the model“ [196]. In this context a correct statement of a mathematical or theoretical physicist would be: „A discretization is a model with unphysical boundary conditions.“ Discretizations of continua problems will be allowed if there is a strategy to compute stepwise refinements. Without such a renormalization group analysis a finite approximation does not lead to a physical conclusion. However, in Ref. [196] von Storch emphasized that this is by no means the strategy he follows, rather he takes the finite difference equations are as they are. Evidently, this would be a grotesque standpoint, if one considered the heat conduction equation, being of utmost relevance to the problem and being a second order partial differential equation, that cannot be replaced by a finite difference model with a lattice constant in the range of kilometers.

Generally, it is impossible to derive differential equations for averaged functions and, hence, an averaged non-linear dynamics [93], [96], [11], [94]. Example of frequently used averaged functions: the gas laws (including the Navier Stokes equations) which, as regards the molecular motions of the gas particles, are averaged calculations.

Thus there is simply no physical foundation of global climate computer models, for which still the chaos paradigma holds: Even in the case of a well-known deterministic dynamics nothing is predictable [139]. That discretization has neither a physical nor a mathematical basis in non-linear systems is a lesson that has been taught in the discussion of the logistic differential equation, whose continuum solutions differ fundamentally from the discrete ones [75], [192].

Modern global climatology has confused and continues to confuse fact with fantasy by introducing the concept of a scenario replacing the concept of a model. In Ref. [164] a clear definition of what scenarios are is given:

> Future greenhouse gas (GHG) emissions are the product of very complex dynamics systems, determined by driving forces such as demographic development, socioeconomic development, and technological change. Their future evolution is highly uncertain, Scenarios are alternative images of how the future might unfold and are an appropriate tool with which to analyze how driving forces may influence future emission outcomes and to access the associated uncertainties. They assist in climate change analysis, including climate modeling and the assessment of impacts, adaptation and mitigation. The possibility that any single emissions path will occur as described in scenarios is highly uncertain.

Scenario does not mean any uncertainty in the result (which is determined by the model), but uncertainty in the quantities of CO_2 to include in the model, because these quantities are politically dependent. It is the same problem with demographics; there one also works with scenarios because of politics. The scenario does not replace the model, but provides input parameters for the model.

Evidently, this is a description of a pseudo-scientific (i.e. non-scientific) method by the experts at the IPCC. The next meta-plane beyond physics would be a questionnaire among scientists already performed by von Storch [52] or, finally, a democratic vote about the validity of a physical law. Exact science is going to be replaced by a sociological methodology involving a statistical field analysis and by „democratic“ rules of order. In the preceding text two aspects are not neatly separated: the uncertainty in the input parameters in the model resulting from political decisions, and the quality of the models which have to comply with scientific criteria. This is in harmony with the definition of science advocated by the „scientific“ website RealClimate.org that has integrated inflammatory statements, personal attacks and offenses against authors as a part of their „scientific“ workflow.

4.3.3 Conclusion

A statistical analysis, no matter how sophisticated it is, heavily relies on underlying models and if the latter are plainly wrong then the analysis leads to nothing.

One cannot detect and attribute something that does not exist for reason of principle like the CO_2 greenhouse effect. The greenhouse effect exists - for the Authors it does not exist only because they reject basic knowledge like Einstein"s equations. [79]. (See also section 4.1 on page 94) There are so many unsolved and unsolvable problems in non-linearity and the climatologists believe to beat them all by working with crude approximations leading to unphysical results that have been corrected afterwards by mystic methods, flux control in the past, obscure ensemble averages over different climate institutes today, by excluding accidental global cooling results by hand [193], continuing the greenhouse inspired global climatologic tradition of physically meaningless averages and physically meaningless applications of mathematical statistics.

In conclusion, the derivation of statements on the CO_2 induced anthropogenic global warming out of the computer simulations lies outside any science.

4.4 Pyrgeometer and Back-Radiation, Greenhouse Effect

4.4.1 The Pyrgeometer and Back-Radiation

When examining the greenhouse effect, the existence or non existence of back-radiation, i.e. the radiation which radiates from the atmosphere in the direction of the earth, plays a great role. Before turning to a theoretical explanation, additions have to be made to the practical observation of the Authors (see footnote [19]), p. 33): »*...for a cooling of the Earth's surface through emission of infrared radiation*«. While the ground only cools minimally because of the Earth"s heat capacity, grass stalks growing on the ground, for example, cool much more quickly and more strongly, because they lack the heat capacity - which can be observed in suitable weather with hoar frost formation. See Equation (43 on page 33) for small d. For the final temperature of the grass stalks, the observation, which follows Equation (43 on page 33), is important. »*This rise in temperature is stopped by the heat transfer of the body to its environment*«. This means that for a thin body after a short time the temperature reaches a point at which the body gives off as much heat as it receives. When convective heat escape is prevented the heat balance must be a radiation equilibrium – it will not work any other way. This is exactly the principle of pyrgeometer s. Of course this does not use a grass stalk as the thin surface, but a foil. In order to prevent heat escape, the thin surface can be surrounded by a vacuum. The temperature of the thin surface (respectively, its temperature difference with regard to its surroundings) testifies to radiation balance in this way. The thin surface and the ground beneath it can be regarded as almost ideally black in the infrared region (and almost all radiation corresponds with the temperatures in question). Since including the exact emissivity only complicates the equation without bringing new knowledge, one can proceed from the black body, i.e. from the validity of the Stefan-Boltzmann law (Equation (70 on page 60)), without limiting generality. Because the temperature of the thin surface lies between the temperature of the ground and space, even with an incorrect interpretation of the second law of thermodynamics, this second law is fulfilled. With this, the temperature T_F at which temperature changes stop can be calculated for the thin surface, if one takes into account that the ground radiates from beneath according to its temperature T_E, and nothing comes from above, or eventually a back-radiation S_G.

The thin surface radiates upwards and downwards, according to its temperature (hence the factor of 2). Omitting the downward radiation (which allegedly infringes the second law) - when the pyrgeometer is covered with a sheath almost reaching the ground temperature - would lead to a calculated temperature of the foil which would be higher than the highest temperature (here the ground temperature) and this is not real and would break the second law of thermodynamics. There would also be no hoarfrost formed at night on grass, when the ground is warmer than the grass: the ground radiates according to its temperature; the emitted radiation of the grass stalks in the direction of space must then be exactly as great (otherwise more radiation would fall on the grass stalk than it emits, i.e. its temperature would have to rise). But it can only emit so much as the ground if it has the same temperature. If you include the radiation downwards, however, the observed hoarfrost formation can be explained. The ground radiation is absorbed and re-emitted upwards and downwards. Since the ground radiation is only absorbed from one side but emitted from two sides, the temperature of the grass must be below that of the ground, and this leads where applicable to nightly hoarfrost, observed by almost everyone on many an early morning.

The quantity for the surface itself follows from the Equation (43 on page 33). At the balanced temperature (which appears quickly on a thin surface, because the temperature change is then stopped, we have therewith the value):

$$\sigma T_E^4 + S_G = 2\sigma T_F^4 \quad \rightarrow \quad T_F^4 = T_E^4\left(\frac{1}{2} + \frac{S_G}{2\sigma T_E^4}\right) \quad \rightarrow \quad T_F = T_E\sqrt[4]{\frac{1}{2} + \frac{S_G}{2\sigma T_E^4}} \qquad \text{(k-144-21)}$$

or

$$S_G = 2\sigma T_F^4 - \sigma T_E^4 = \sigma T_E^4\left(\frac{2T_F^4}{T_E^4} - 1\right) \qquad \text{(k-144-22)}$$

There is now no problem to measure the temperatures very accurately, by which one can obtain the magnitude of the back-radiation. Without back-radiation, one ought to observe at $T_E = 293\ K \approx 20\ ^\circ C$ a temperature difference of 46.6 K – but this is not observed, so back-radiation must exist and its magnitude can be calculated from the equation. Remark: Experimental instruments are always somewhat removed from pure theory and therefore have measurement constraints. Through the appropriate choice of infrared-transparent window, the transmitted wavelength region can be limited so that solar radiation hardly participates, so that measurements can also be taken during the day. Surfaces are not ideally black and so on. Whoever wants to personally check the function of a pyrgeometer can hold warm bodies in different ways over it: then the pyrgeometer measures their radiation. Since many bodies in infrared are almost black and the temperature is known, the pyrgeometer indication can be compared with the theoretical values, i.e. whether the pyrgeometer indicates correctly, or no cheating is present, which many sceptics like to impute to climatologists, because the pyrgeometer does not »know« whether a sceptic or someone else manipulates it. At a university it should not be too difficult for a sceptic to obtain a pyrgeometer and to cool a surface with liquid nitrogen in order to check the radiation reading.

When the back-radiation reading agrees with the Stefan Boltzmann law – and this would be independent from how the pyrgeometer really functions, then it should also correctly indicate the atmospheric back-radiation, because, analogously to »*One square meter of a meadow does not know anything of the rest of the Earth's surface*« - (see section 3.7.5 on page 73) the pyrgeometer does not »know« whether the reflection comes from a more or less cooled surface or from the atmosphere.

I see another problem for the sceptics: When the existence of back-radiation is totally disputed, then section 2.1 on page 18 and especially Figure 3 on page 23 are also incorrect. Even the Poynting-theorem would be wrong, for when the boundary conditions are additionally accepted (they are missing in section 4.2.8 on page 98 and in section 4.2.11 on page 99, it is stated: »*In case of partial differential equations more than the equations themselves the boundary conditions determine the solutions.*«), nothing essentially different results: Output is transmitted from the warmer to the cooler reservoir - how much depends on the cooler body. This becomes particularly evident if one lets the temperature of the cooler part vary with time: the energy density of the field (*The Poynting vector field $E \times H$ may be interpreted as an energy current density of the electromagnetic field.* section 4.2.8 on page 98) is then also time dependent and the change moves from the cooler border to the warmer border, agreeing exactly with the characteristics of back-radiation. Now the Poynting-theorem is supposed to agree – therefore we have back-radiation which can be measured. Even the theory of relativity underlines this: information about the temperature change of the cooler surface can reach the warmer surface no faster than at the vacuum speed of light.

This back-radiation can also be »seen« with an infrared camera, pointed skywards at night. However, it must be noted that analysis software in the camera is often set up so that the characteristic radiation of the atmosphere between measuring object and camera is removed from the picture - for this purpose the camera software must know the distance and other parameters. If a great distance is given and the camera points upwards, the camera software eliminates exactly what one really wants to measure [39, illustration 5] and [185, table 3.8, p.64].

4.4.2 The second law and entropy

Since it has been established experimentally that back-radiation exists, the connection with the second law of thermodynamics has to be examined.

In the popular formulation, it indicates something about the energy flow between two temperature levels. In the exact physical formulation, it indicates that the entropy can never decrease in a closed system. This affirms nothing about temperatures - one can, for example, bring regions (not all) of the higher temperature reservoir to an even higher temperature. Example: Build photovoltaic modules into the reservoir with lower temperature. At suitable temperature conditions, these produce electrical energy which provide a laser with energy. The laser beam is directed to the reservoir with the higher temperature and heats it here and there to a higher temperature. The energy flux from the higher reservoir which is needed for the operation of the photovoltaic modules is of course higher than the laser flux from the lower to the higher level - the second law is thus still obeyed.

With entropy the second law only refers to probabilities: the smaller a system is, the greater the deviations can be. For example, the median velocity of the particles in a gas volume represents the temperature of these gases. Because of the chaotic motion of the particles, the median velocity of the particles can be higher in one half of a volume than in the other half, i.e. the temperature of one half is somewhat higher than in the other half - the higher the particle number is, the smaller is the possible variation. Because particle numbers are so large, this aspect plays no role in most of the considered volumes.

From all this follows: The second law is not independent; its validity results from all other laws of physics and it is not placed above them. If, therefore, no mistake can be found in other derivations, the mistake must lie in the wrong application of the second law.

4.4.3 Einstein and the radiative transfer equation

For the calculation of emission and the exchange of energy between gas and radiation, one must start with Einstein"s equations, which are also the essential physical basis of laser s which function at random temperatures. Because of the wavelength dependence of the coefficients, the Einstein equations for each wavelength is different:

$$\frac{dN_1}{dt} = N_2 \cdot A_{21} - N_1 \cdot B_{12} \cdot u + N_2 \cdot B_{21} \cdot u \qquad \text{(k-144-23)}$$

The symbols used in this formula have the following meanings:

- N_0: Density of all absorbing molecules = $N_1 + N_2$
- N_1: Density of molecules in the ground state
- N_2: Density of molecules in an excited state
- A_{21}: Einstein coefficient for spontaneous emission
- B_{12}: Einstein coefficient for induced absorption
- B_{21}: Einstein coefficient for induced emission
- u: Energy density of radiation (in space and frequency – or wavelength)

The left-hand side of the equation describes the change with time of the density of the ground level state on account of the processes on the right side: The ...

1. Term represents spontaneous emission (radiation): $N_2 \to N_1$
2. Term represents induced absorption: $N_1 \to N_2$, for example, through thermal radiation.
3. Term represents induced emission: $N_2 \to N_1$, for example, through thermal radiation.

The Einstein equations are valid for any temperatures, shown both by lasers which function at whatever temperature and also by the temperature independence of the Einstein coefficients - which is also confirmed by the fact that temperature is »only« a many-particle characteristic. A single particle has no temperature, therefore the temperature concept loses its meaning with a single particle.

Besides, Einstein in his work from 1916 [79] writes:

> The average $\overline{v^2}$ of our molecules, which the radiation from temperature T generates through interaction with them, must be the same as that average $\overline{v^2}$, which belongs to the gas molecule according to the gas laws at temperature T with respect to the kinetic gas theory. For the presence of our molecules could otherwise disturb the thermal balance between temperature radiation and any gas of the same temperature.

This means that the radiation energy density must not change when a path is traced in thermodynamic equilibrium: if a change should occur, it would be a temperature change - and the second law forbids this in the presence of thermodynamic equilibrium.

Yet since single particles cannot »know« what is happening around them, the particles absorb independently of whether the radiation with which they interact corresponds with their temperature or another - the absorption coefficient κ is therefore independent of the intensity. Yet since, on the other hand, the beam intensity S_T, when its intensity corresponds to the respective temperature, must be constant (see Einstein and the second law of thermodynamics) the gas, therefore, must emit an intensity j_T:

$$\frac{dS_T}{dz} = -\,\kappa \cdot S_T + j_T = 0 \tag{k-144-24}$$

Since the intensity of thermal radiation is given in advance by $B_v(T)$ from Planck"s law, the value must be:

$$0 = -\,\kappa \cdot B_\nu(T) + j_T \qquad \Rightarrow \qquad j_T = \kappa \cdot B_\nu(T) \tag{k-144-25}$$

With this, the radiative transfer equation for any intensity is S:

$$\frac{dS}{dz} = -\,\kappa \cdot S + \kappa \cdot B_\nu(T) \tag{k-144-26}$$

For intensities typical of the atmosphere, κ is not yet saturated and also B is almost dependent only on temperature (LTE - because of thermalisation). »Almost« means that a small deviation may be present, but the deviation is small. This has two reasons:

1. For the observed temperatures and wavelengths, the density of excitations from induced absorption is small in the thermal equilibrium, in comparison with excitations produced by collisions.
2. With the frequency of collisions, the decay time of a too high density of excitations as a consequence of induced absorption is very small (thermalisation).

4.4.4 The Intensity of the Back-radiation

When S lies above the thermal value, the gas must heat itself through excess absorption; when S lies beneath the thermal value, the gas must cool itself, through excess emission. Therefore, it is a question of the total effect over all wavelengths (or frequencies) and directions. If, therefore, cooling prevails, the cooled gas must sink. At the surface the gas is heated and rises again. Through this air motion, the adiabatic temperature profile is established in the atmosphere. For this reason radiation cannot be calculated from a radiative balance, but the temperature is adiabatically given in advance and the radiative transport equation is:

$$\frac{dS(z)}{dz} = -\,\kappa \cdot S(z) + \kappa \cdot B_\nu(T(z)) \qquad \text{(k-144-27)}$$

When increasing z means the direction upwards, the equation for downward radiation S_B reads:

$$\frac{dS_B}{dz} = \kappa \cdot S_B - \kappa \cdot B_\nu(T(z)) \qquad \text{(k-144-28)}$$

The Planck law is valid for the temperature dependence of B

$$B_\nu(T) = B_\nu(T_0)\frac{\mathrm{e}^{\frac{T_\lambda}{T_0}} - 1}{\mathrm{e}^{\frac{T_\lambda}{T_1}} - 1} \qquad \text{(k-144-29)}$$

From that $B_v(T_0)$ is the black body radiation at temperature T_0, also for example at the Earth"s surface and T_λ the Boltzmann temperature:

$$T_\lambda = \frac{h\nu}{k_\mathrm{B}} = \frac{hc}{k_\mathrm{B}\lambda} \qquad \text{(k-144-30)}$$

Through insertion of the numerical values we have

$$\begin{aligned} T_\lambda &= \frac{hc}{k_\mathrm{B}\lambda} = \frac{6,626 \cdot 10^{-34}\ Ws^2 \cdot 2,998 \cdot 10^8\ m/s}{1,381 \cdot 10^{-23}\ Ws/K \cdot \lambda} = \frac{0,01438\ K \cdot m}{\lambda} \\ &= \frac{14380\ K \cdot \mu m}{\lambda} \end{aligned} \qquad \text{(k-144-31)}$$

And this gives the values

λ	T_λ
4,3 μm	3344 K
15,0 μm	959 K

With an adiabatic atmosphere, the temperature falls with linear height ($\alpha \approx 6$ K/km):

$$T(z) = T_0 - \alpha z \qquad \text{(k-144-32)}$$

With this, the following differential equation for S_B:

$$\frac{dS_B}{dz} = \kappa \cdot S_B - \kappa \cdot B_\nu(T_0) \frac{e^{\frac{T_\lambda}{T_0}} - 1}{e^{\frac{T_\lambda}{T_0 - \alpha z}} - 1} \approx \kappa \cdot S_B - \kappa \cdot B_\nu(T_0)\ e^{-\frac{T_\lambda\ \alpha z}{T_0^2}} \qquad \text{(k-144-33)}$$

The solution of the differential equation for the approximation reads:

$$S_B = \frac{B_\nu(T_0)\ e^{-\frac{T_\lambda\ \alpha z}{T_0^2}}}{1 + \frac{T_\lambda\ \alpha}{T_0^2\ \kappa}} \qquad \text{(k-144-34)}$$

For $z = 0$, therefore at the height of the temperature T_0 (for example, on the ground) becomes simply (and analogous for the sky-directed radiation S_H, with emissivity of the Earth"s surface ε):

$$S_B = \frac{B_\nu(T_0)}{1 + \frac{T_\lambda\ \alpha}{T_0^2\ \kappa}} \qquad \text{bzw.} \qquad S_H = B_\nu(T_0) \left(\frac{1 - e^{-\ \kappa\ z}}{1 - \frac{T_\lambda\ \alpha}{T_0^2\ \kappa}} + \varepsilon\ e^{-\ \kappa\ z} \right) \qquad \text{(k-144-35)}$$

So it is shown without any simulation that with the increase of absorption (increase of CO_2 concentration - κ becomes greater), the back-radiation increases - no matter what caprioles the weather makes, the back-radiation is also increased with increased CO_2 concentration and the increased back-radiation causes moreover the ground temperature to be also elevated compared with the values without increased CO_2 concentration - again no matter what caprioles the weather makes with T_0. (Remark: the exact derivation is somewhat more complicated, since skew rays also have to be considered accordingly).

4.4.5 The Tropopause

The tropopause results quite simply from radiation. Since the Earth in the infrared is only approximately a black body, the upwards radiation is less, therefore is also $S_H(z = 0)$ – above equation – only

$$S_H(z=0) = \varepsilon \cdot B_\nu(T_0) \quad \text{(k-144-36)}$$

In order that absorption and emission remain in a thermal balance, it must be:

$$S_B + S_H \overset{!}{=} 2 \cdot B_\nu(T_0) \quad \text{(k-144-37)}$$

This is not fulfilled near the earth"s surface, because S_B as well as S_H are smaller than $B_\nu(T_0)$, i.e. The emission is greater than the absorption and from this it follows that the air is cooled and sinks. This is not tragic: the sunken air is heated at the Earth"s surface and rises, which produces the adiabatic temperature stratification. Things are different at great heights. S_H becomes always greater and $S_B + S_H$ would be for all wavelengths always greater than $2 \cdot B_\nu(T_0)$ (with the exception α where it would be 0), i.e. the absorption is greater than the emission, the air is heated and rises. But since no cooling mechanism equivalent to the heating mechanism at ground level exists at the top, an adiabatic temperature profile can no longer exist and it becomes the isothermal atmosphere, i.e. $\alpha = 0$ - and this is also observed, before UV - absorption comes into effect. The border between the adiabatic and isothermal temperature profile is the tropopause.

Without the strong emission beneath the tropopause, the existence of the tropopause cannot be explained (even less calculated) and is therefore also strong evidence of the greenhouse effect.

4.5 Emails of the authors

The commentary of their paper the authors led to write emails , in which they tried to rebut the comments. Since the emails sent to a large circle also explicit sent to addresses, which do not want to receive emails (the authors were informed), the technical part of the emails can be cited.

Prof. Gerlich [225] – Translation of the original:

> In the radiative transfer equation the change of intensity is given along a (straight) line by a so-called term of absorption subtracted of the term of reemission. About double prefixes in the second word I've always made my jokes. This is a little more detailed described in my Leipzig manuscript and also in the Falsification-Preprint. If the transmission is less than 1, this not yet means that the energy of the radiation field is converted into heat. Absorbed photons can also be emitted in all directions (not just back and forth). Excited atoms and molecules normally transit into in their ground state by emission of a photon, which is just "captured". In the classical picture oscillations of dipols emit radiation. Normally, it is called elastic scattering. There are also inelastic scattering and diffraction, which can not be described in the photon image. The reemission radiated of course in all possible directions, and therefore comes as no longer as measurable radiation on the floor. This is evident in the decreasing space angle of a surface element. This is the

famous, unfortunately not measurable counter radiation. Not measurable is not the same as non–existent in the field of physics.

With the image that light is an electromagnetic wave, which is in practice more than (quantitative) approved that, unlike the photon image, you obtain that a material with electrical conductivity can absorb (Beer's formula), while a dielectric is not absorbed. The carbonic acid gas is a dielectric, thus not convert the "captured" light waves into heat. [?: see section 3.7.11 on page 79 – (JE)] In the light quantum image it gets three terms for these processes: the induced absorption and the induced and spontaneous emission. This is the famous Quantum Theory of Light by P.A.M. Dirac. I give these formulas with copies from the famous book "Mathematical Foundations of Quantum Theory" by J. v. Neumann as an appendix. In this text is cited the Einstein paper, mentioned by Mr. Ebel.

The Schwarzschildt - equation cited nowadays by the greenhouse effect hysterics is a very special approximation of the radiation transport equations, as I described in my Leipzig lecture and the Falsification – Preprint. There are so many terrible equations, which can get with especially general approaches from a trivial differential equation (simple integral) even to integro - differential equations.

I would recommend for such model conceptions the much broader standard - textbook by A. Unsöld as a complement to Chandrasekhar: Physics of stellar atmospheres, Springer Verlag, Berlin etc. (1955), p. 106 – 111, 269 – 280, and 371 – 391.

It must be noted that the description of radiation transport are hypotheses: in astrophysics and geophysics are the models consensus hypothesis and not physical laws. One can only hope that physical laws will equitable composed together, which is not the case in the greenhouse hysteria. In physics we confine to ever lower space–time ranges, if you want to find new laws.

Prof. Gerlich [225] – original:

In der Strahlungstransportgleichung ist die Änderung der Intensität längs einer (geraden) Linie gegeben durch einen sogenannten Absorptionsterm von dem der Reemissionsterm abgezogen wird. Über die doppelten Vorsilben in dem zweiten Wort habe ich immer meine Witze gemacht. Dies ist etwas ausführlicher in meinem Leipzig-Manuskript und auch dem Falsification-Preprint ausgeführt. Wenn die Transmission kleiner als 1 ist, heißt dies noch lange nicht, daß die Energie des Strahlungsfeldes in Wärme umgewandelt wird. Absorbierte Photonen können auch wieder in alle Richtungen (nicht nur hin und zurück) emittiert werden. Angeregte Atome und Moleküle gehen normalerweise in ihren Grundzustand durch Aussendung eines Photons, das gerade "eingefangen" wurde, Über. Im klassischen Bild können die Dipolschwingungen Strahlung aussenden. Normalerweise nennt man das elastische Streuung. Es gibt noch unelastische Streuung und auch Beugung, was man im Photonenbild nicht beschreiben kann. Die Reemission geht natürlich in alle möglichen Richtungen und kommt deshalb als meßbare Strahlung nicht mehr auf dem Boden an. Dies sieht man an dem immer kleiner werden Raumwinkel eines Flächenelements. Das ist die berühmte, leider nicht meßbare Gegenstrahlung. Nicht meßbar ist in der Physik aber dasselbe wie nicht existent.

Mit dem in der Praxis mehr als (quantitativ) bewährten Bild, daß Licht elektromagnetische Wellen sind, die im Unterschied zu den Photonen gebeugt werden können, erhält man, daß ein Material mit elektrischer Leitfähigkeit absorbieren kann (Beersche Formeln), während ein Dielektrikum nicht absorbiert. Das Kohlendioxidgas ist ein Dielektrikum, wandelt also nicht die "eingefangenen" Lichtwellen in Wärme um. Im Lichtquantenbild bekommt man drei Terme für diese Vorgänge: die induzierte Absorption und die induzierte und spontane Emission. Dies ist die berühmte Lichquantentheorie von P. A. M. Dirac. Ich gebe diese Formeln mit Kopien aus dem berühmten Buch "Mathematische Grundlagen der Quantentheorie" von J. v. Neumann als Anlage an. In diesem Text kommt Einstein mit der von Herrn Ebel genannten Arbeit vor.

Die heutzutage von den Treibhaushysterikern zitierte Schwarzschildt–Gleichung ist eine sehr spezielle Näherung der Strahlungstransportgleichungen, wie ich es im meinem Leipzig-Vortrag und dem Falsification–Preprint ausführe. Es sind also schrecklich viele Gleichungen, die bei besonders allgemeinen Ansätzen aus einer trivialen Differentialgleichung (einfaches Integral) sogar zu Integro–Differentialgleichungen werden können.

Ich würde für diese Modellvorstellungen als Ergänzung zu Chandrasekhar das sehr viel breiter geschriebene Standard–Lehrbuch von A. Unsöld: Physik der Sternatmosphären, Springer Verlag, Berlin etc (1955), S. 106 – 111, 269 – 280, und 371 – 391 empfehlen.

Festzuhalten ist, daß es sich bei der Beschreibung des Strahlungstransports um Hypothesen handelt: in der Astrophysik und Geophysik sind die Modelle ein Hypothesenkonsens und nicht physikalische Gesetzmäßigkeiten. Man kann nur hoffen, daß physikalische Gesetzmäßigkeiten vernünftig zusammengebastelt werden, was bei der Treibhaushysterie nicht der Fall ist. In der Physik beschränkt man sich auf immer kleiner werdende Raum–Zeitbereiche, wenn man neue Gesetzmäßigkeiten finden will.

Dr. Tscheuschner [226] – Translation of the original:

Ebel wrote 21.03.2008

<START QUOTE> Also Dr. Borchert refer to Prof. Gerlich, who now has admitted that Einstein's work of 1916 is correct, and thus his own statement that the excited atoms radiate not uniformly in all directions, is definitely wrong. <QUOTE END >

Gerlich however wrote 18.02.2008

<START QUOTE> If the transmission is less than 1, this not yet means that the energy of the radiation field is converted into heat. Absorbed photons can also be emitted in all directions (not just back and forth). <END QUOTE>

Furthermore, in our work it was not debated whether Einstein's work of 1916 is right or wrong, because this has nothing to do with the themes of the work.

In addition, each radiation has its aperture distribution (dipole, quadrupole, etc.). In other words, "in all directions" has also to specified in more detail.

...

In addition, I would like to announce that all discussions narrowed to the IR radiation transport, are misleading even in the approach, because other physical mechanisms are more dominant. The CO2 greenhouse effect is nonsense, whatever in which variant.

When a computer-Global-climatologist should have a different opinion is still the possibility for him of writing a clean scientific work. Of course I also would work the paper over.

I can not help it that so many people are a sucker for this nonsense, who founded the so-called climate change.

Dr. Tscheuschner [226] – original:

Ebel schreibt am 21.03.2008

<ZITAT ANFANG> Auch beruft sich Dr. Borchert auf Prof. Gerlich, der inzwischen eingeräumt hat, daß Einsteins Arbeit von 1916 richtig ist und damit seine eigene Aussage, daß die angeregten Atome nicht in alle Richtungen gleichmäßig strahlen, definitiv falsch ist. <ZTAT ENDE>

Gerlich schrieb hingegen am 18.02.2008

<ZITAT ANFANG> Wenn die Transmission kleiner als 1 ist, heißt dies noch lange nicht, daß die Energie des Strahlungsfeldes in Wärme umgewandelt wird. Absorbierte Photonen können auch wieder in alle Richtungen (nicht nur hin und zurück) emittiert werden. <ZITAT ENDE>

Ferner wurde in unserer Arbeit nicht diskutiert, ob Einsteins Arbeit von 1916 richtig oder falsch ist, weil dies mit der Themenstellung der Arbeit nichts zu tun hat.

Im uebrigen hat jede Strahlung Ihre Keulen (Dipol, Quadrupol usw.) Das heisst, "in alle Richtungen" muss auch noch genauer spezifiziert werden.

...

Ergaenzend moechte ich mitteilen, das alle Diskussionen, die auf IR-Strahlungstransport verengt sind, schon im Ansatz verfehlt sind, weil andere physikalische Mechanismen dominanter sind. Der CO2-Treibhauseffekt ist Nonsense, egal in welcher Variante.

Wenn ein Computer-Global-Klimatologe eine andere Meinung haben sollte, besteht fuer ihn immer noch die Moeglichkeit, eine saubere wissenschafltiche Arbeit zu verfassen. Selbstverstaendlich wuerde ich die auch durcharbeiten.

Ich kann nichts dafuer, dass so viele Personen auf diesen Bloedsinn, der den sogenannten Klimaschutz begruendet, hereingefallen sind.

4.5.1 Comment to the emails of the authors

The authors asked the question »In addition, each radiation has its aperture distribution (dipole, quadrupole, etc.). In other words, “in all directions“ must also be specified more detailed. «Einstein has already answered these questions [79]:

> At each elementary process of emission ($Z_m \rightarrow Z_n$) a pulse of size $\frac{\varepsilon_m - \varepsilon_n}{c}$ will be transferred to the molecule. If the latter is isotropic, so we need to assume all directions as equally likely. If the molecule is not isotropic, so we get to the same statement, if the orientation alters over time according to the laws of random. By the way such premise shall also make to the statistical laws (B) and (B') of radiation, otherwise the constants B_n^m and B_m^n would depend on the direction what we can avoid by this assumption of isotropy or Pseudoisotropie (by determine the time mean) of the molecule.

Therefore I do not understand why the question is asked. Or, summarizing again - because due to equal distribution of the molecular directions all directions of the aperture are uniformly distributed the not-isotropic shape of the molecules doesn't become noticeable macroscopically.

Therewith the statement »Furthermore, our work is not debating whether Einstein's work of 1916 is right or wrong, because this is consistent with the themes of the work has nothing to do. «is also a diversion . If a fact, which have long backed fundamental insights to the topic of a paper, is not noted, deficiency of this paper should be constituted. But the deficiency goes further: »In the radiative transfer equation ... term of Reemission subtracted. About double prefixes in the second word I've always made my jokes.« It is not a »Reemissionsterm« but a term of emission, even also described with the Einstein equations and known for most of chemist:

A high irradiated intensity will be exponentially weakened at the transit of a absorbing medium by absorption. This fact is known as Lambert-Beer's law (For simplification here the agent-and concentration-dependent variables are summarized to a constant *Lambert*, $I(0)$ the initial intensity and $I(s)$ the intensity after the transited length s):

$$I(s) = I(0) \cdot \exp(-Lambert \cdot s) \qquad \text{(k-144-38)}$$

This law is the solution of differential equation:

$$\frac{d\,I}{d\,s} = -Lambert \cdot I = -Lambert \cdot (I) \qquad \text{(k-144-39)}$$

In this form, the law is valid only for higher intensities. In general, the transited medium (at least approximately) isothermal with a temperature T. If the law would be fully valid, the intensity would decrease to almost 0 after a long enough distance. But everyone who occupy oneself with absorption knows (or should know) that the intensity is not 0, but the thermal intensity of the corresponding temperature T reached. Something else would contradict the second law of thermodynamics.

If this limit of strong absorption is reached, the intensity will change no longer. That means it must affected the following:

$$\lim_{s \to \infty} \frac{d\ I}{d\ s} \to 0 \qquad \text{(k-144-40)}$$

This behavior is most easily reached through an additive term L:

$$\frac{d\ I}{d\ s} = -Lambert \cdot (I - L) = Lambert \cdot (L - I) \qquad \text{(k-144-41)}$$

In order that the above equation is compatible with the Planck's radiation formula, I and L should e.g. given in $W/(m^2\, \mu m)$.

In the isothermal cavity L and I are then equal and equal to the intensity of the cavity radiation, which are described with the Planck's formula. Hence it follows that L depends on the cavity temperature T. Therefore, the full equation read:

$$\frac{d\ I}{d\ s} = Lambert \cdot (L(T) - I) \qquad \text{(k-144-42)}$$

For the determination of the size of $L(T)$ no requirements were made for a prior absorption, so $L(T)$ is not a »term of reemission«, but a term of emission - and the whole equation is the radiative transfer equation. Examining the term of emission more precisely, it is found that L is not solely dependent on the temperature, but also some of the radiation intensities I - but the influence is so small that it can be ignored. Therefore we argue from the local thermal equilibrium (LTE).

Finally, the emission direction and wavelength shift are contemplated without molecular collisions.

4.5.2 Emission direction and wavelength shift

The particles in a gas collide at certain time intervals, always again. These time intervals are in the lower atmosphere so short that the excited molecule is usually no-excited after a collision. Energy and momentum, gathered by absorption, are distributed statistically in the volume of gas by many collisions (»thermalization«). A excited particles in a gas can lose energy and momentum by the emission of a photon. This loss is distributed also in the volume of gas through collisions. Hence absorbed photon and emitted photon are not in direct relationship with each other. Nevertheless it occures ta times that a molecule which absorbed a photon emits this photon prior to collisions. In the following, this rare case is contemplated.

During this process, the energy and momentum balance must be satisfied. For calculation a coordinate system is used in which the non-excited molecule rested in the zero point (ie, the coordinate system moves with a moving molecule). Furthermore, a two-dimensional consideration is sufficed, because the fly-directions (momenta) of the incoming photon, of the fly away Photon and of the molecule must lie in a plane. Perpendicular to this plane all momentum are zero.

In the resting coordinate system, only the incoming photon has a energy ($= h \cdot \nu$) and a momentum ($= \dfrac{h \cdot \nu}{c}$). The excited molecule with the mass M emits a photon before it collide with other molecules. Energy and momentum must be retained as sum of photon and molecule (with the flight off speed v). Usually the incoming photon and the outcoming photon have a different frequency ($\nu' = \nu - \Delta$). Also the »flight directions« from outcoming photon and molecule differ from the direction of the incoming photon by the angle φ and ϑ. So it results in the following three equations for momentum and energy:

$$
\begin{aligned}
h \cdot \nu &= h \cdot \nu' + \frac{M}{2} v^2 && \text{Energy} \\
\frac{h \cdot \nu}{c} &= \frac{h \cdot \nu'}{c} \cos\varphi + M \cdot v \cos\vartheta && \text{Momentum in the direction of approach} \\
0 &= \frac{h \cdot \nu'}{c} \sin\varphi + M \cdot v \sin\vartheta && \text{Momentum perpendicular to the direction of approach}
\end{aligned}
\tag{k-144-43}
$$

If M is large enough (this is in the infrared range is always the case: $M c^2 \gg h \nu$) the system of equations can be solved for any angle φ. A limitation for allowable angle does not exist. (Note: In the resting system of the excited molecule, all directions are equally distributed.) There are any possible emission directions (including backwards: $\varphi > \pi/2$). Each angle $\varphi \neq 0$ is linked with a frequency decrease in the resting system of the affected molecules, neverthless in the resting system of the atmosphere could be a frequency increase of the emitted photon due to the Doppler effect, if for example, the affected molecule »flew« quickly enough against to the incoming photon.

The solution of the system of equations reads:

$$
\begin{aligned}
\frac{\Delta}{\nu} &= \frac{M c^2}{h \nu} - 1 + \cos\varphi - \sqrt{\left(\frac{M c^2}{h \nu} - 1 + \cos\varphi\right)^2 - 2\,(1 - \cos\varphi)} \\
\sin\vartheta &= \sqrt{\frac{h \nu \cdot \nu}{2 M c^2 \cdot \Delta}} \left(1 - \frac{\Delta}{\nu}\right) \sin\varphi
\end{aligned}
\tag{k-144-44}
$$

5 Physicist's Summary

A thorough discussion of the planetary heat transfer problem in the framework of theoretical physics and engineering thermodynamics leads to the following results:

1. There are no common physical laws between the warming phenomenon in glass houses and the fictitious atmospheric greenhouse effect, which explains the relevant physical phenomena. The terms „greenhouse effect“ and „greenhouse gases“

are deliberate misnomers. Because of the transparency to radiation of the covering (glass surface or atmosphere), incoming radiation acts like a heating source; without this heating source, the inside of the glasshouse as well as the atmosphere cool down to the surrounding temperatures. In addition, the surrounding temperatures are very different: with the glasshouse the temperature of the atmosphere, with the greenhouse effect the temperature of space (not quite, because the earth's surface is also heated by the earth's core).

2. There are no calculations to determinate an average surface temperature of a planet Indeed, when - as appropriate - it is assumed that as a consequence of convective heat transport, the deviations of the average surface temperature are small in contrast with the surface temperature (see after Equation (88 on page 70))
   - with or without atmosphere,
   - with or without rotation,
   - with or without infrared light absorbing gases.

   The frequently mentioned difference of 33°C for the fictitious greenhouse effect of the atmosphere is therefore a meaningless number. No.
3. Any radiation balance for the average radiant flux is completely irrelevant for the determination of the ground level air temperatures and thus for the average value as well. It is not a question of the ground level, but of the end level.
4. Average temperature values cannot be identified with the fourth root of average values of the absolute temperature's fourth power. This applies essentially only to large deviations from the median value; under Earth conditions the deviations are small enough (see after Equation (88 on page 70))
5. Radiation and heat flows do not determine the temperature distributions and their average values. Indeed they do!
6. Re-emission is not reflection and can in no way heat up the ground-level air against the actual heat flow without mechanical work. Re-emission is indeed not reflection and initially plays no role, because emission from all layers - even from the greenhouse gases - is the normal condition in a warm place. Heating occurs because of the additional solar heating.
7. The temperature rises in the climate model computations are made plausible by a perpetuum mobile of the second kind. This is possible by setting the thermal conductivity in the atmospheric models to zero, an unphysical assumption. It would be no longer a perpetuum mobile of the second kind, if the „average" fictitious radiation balance, which has no physical justification anyway, was given up. No. The emission from all layers - even from the greenhouse gases - is the normal condition in a warm place. The heating occurs because of the additional solar heating.
8. After Schack 1972 water vapor is responsible for most of the absorption of the infrared radiation in the Earth's atmosphere. The wavelength of the part of radiation, which is absorbed by carbon dioxide is only a small part of the full infrared spectrum and does not change considerably by raising its partial pressure. This absorption is almost irrelevant for the greenhouse effect.
9. Infrared absorption does not imply „backwarming". Rather it may lead to a drop

of the temperature of the illuminated surface. Indeed, not absorption, but emission - the latter leads to conservation of atmospheric temperature. The average temperature is less or more according to the absorption length because the layer which is transparent to space is not sharply defined.

10. In radiation transport models with the assumption of local thermal equilibrium, it is assumed that the absorbed radiation is transformed into the thermal movement of all gas molecules. There is no increased selective re- emission of infrared radiation at the low temperatures of the Earth's atmosphere. This is correct, but the shortening of the absorption length results in a higher back-radiation to the Earth"s surface (see section 4.4.4 on page 110).
11. In climate models, planetary or astrophysical mechanisms are not accounted for properly. The time dependency of the gravity acceleration by the Moon and the Sun (high tide and low tide) and the local geographic situation, which is important for the local climate, cannot be taken into account.
12. Detection and attribution studies, predictions from computer models in chaotic systems, and the concept of scenario analysis lie outside the framework of exact sciences, in particular theoretical physics. But the increase of the back-radiation on account of the shortening of the absorption length lies within the bounds of physics.
13. The choice of an appropriate discretization method and the definition of appropriate dynamical constraints (flux control) having become a part of computer modelling is nothing but another form of data curve fitting. The mathematical physicist v. Neumann once said to his young collaborators: „If you allow me four free parameters I can build a mathematical model that describes exactly everything that an elephant can do. If you allow me a fifth free parameter, the model I build will forecast that the elephant will y." (cf. Ref. [219].)
14. Higher derivative operators (e.g. the Laplacian) can never be represented on grids with wide meshes. Therefore a description of heat conduction in global computer models is impossible. The heat conduction equation is not and cannot properly be represented on grids with wide meshes. Heat transport through heat conductance with high wind speeds in the atmosphere in contrast with convective heat transport through winds is negligible. The non-consideration of a negligible magnitude causes a deviation that can also be neglected.
15. Computer models of higher dimensional chaotic systems, best described by non-linear partial differential equations (i.e. Navier-Stokes equations), fundamental differ from calculations where perturbation theory is applicable and successive improvements of the predictions - by raising the computing power - are possible. At best, these computer models may be regarded as a heuristic game.
16. Climatology misinterprets unpredictability of chaos known as butter y phenomenon as another threat to the health of the Earth.
17. Back-radiation exists, and it increases with the shortening of the absorption length. Because of this - independent of weather caprioles - the back-radiation, because of the shortening of the absorption length, is always higher than without the shortening of the absorption length (see section 4.4.4 on page 110).

In other words: Already the natural greenhouse effect is a myth albeit any physical reality [65]. The CO_2-greenhouse effect, however is a „mirage“ [199]. No, because it can be exactly explained physically with the Einstein equation [79]. See section 4.1 on page 94 The horror visions of a risen sea level, melting pole caps and developing deserts in North America and in Europe are fictitious consequences of fictitious physical mechanisms as they cannot be seen even in the climate model computations. The emergence of hurricanes and tornado s cannot be predicted by climate models, because all of these deviations are ruled out. The main strategy of modern CO_2-greenhouse gas defenders seems to hide themselves behind more and more pseudoexplanations, which are not part of the academic education or even of the physics training. A good example are the radiation transport calculations, which are probably not known by many. Another example are the so-called feedback mechanisms, which are introduced to amplify an effect which is not marginal but does not exist at all. Evidently, the defenders of the CO_2-greenhouse thesis refuse to accept any reproducible calculation as an explanation and have resorted to unreproducible ones. A theoretical physicist must complain about a lack of transparency here, and he also has to complain about the style of the scientific discussion, where advocators of the greenhouse thesis claim that the discussion is closed, and others are discrediting justified arguments as a discussion of „questions of yesterday and the day before yesterday“[66]. In exact sciences, in particular in theoretical physics, the discussion is never closed and is to be continued ad infinitum, even if there are proofs of theorems available. Regardless of the specific field of studies a minimal basic rule should be fulfilled in natural science, though, even if the scientific fields are methodically as far apart as physics and meteorology: At least among experts, the results and conclusions should be understandable or reproducible. And it should be strictly distinguished between a theory and a model on the one hand, and between a model and a scenario on the other hand, as clarified in the philosophy of science.

That means that if conclusions out of computer simulations are to be more than simple speculations, then in addition to the examination of the numerical stability and the estimation of the effects of the many vague input parameters, at least the simplifications of the physical original equations should be critically exposed. Not the critics have to estimate the effects of the approximation, but the scientists who do the computer simulation. This is indeed done, by indicating the range of the predictions. Without feedback effects, the dependence of the climate system upon concentration changes are clearly indicated; which concentration changes will occur is politically dependent and feasible policies are quantified through scenarios. Uncertainty arises through the feedback effects which are not yet understood in all details.

In addition we have a chaotic system unlike any other chaotic system. There are chaotic systems with one or more fixed points and chaotic systems without fixed points. The atmosphere seems to belong to a chaotic system with a fixed point, analogous to the chaos of particle motion in a gas volume.

---

65) If the natural greenhouse effect is a physical reality, it must be physically explainable and cannot be a myth. An atmosphere without natural greenhouse effect is the antithesis of reality (see comment p. 72 in section 3.7.4 on page 68).

66) a phrase used by von Storch in Ref. [166]

„Global warming is good . . . The net effect of a modest global warming is positive.“ (Singer). [67] In any case, it is extremely interesting to understand the dynamics and causes of the long-term fluctuations of the climates. However, it was not the purpose of this paper to get into all aspects of the climate variability debate. However, it is laymen, incapable of reading between the lines, who deny the greenhouse effect on principle.

The point discussed here was to answer the question, whether the supposed atmospheric effect has a physical basis. This is not the case. Yet the commentaries establish the physical basis. In summary, there is no atmospheric greenhouse effect, in particular CO_2-greenhouse effect, in theoretical physics and engineering thermodynamics. Thus it is illegitimate to deduce predictions which provide a consulting solution for economics and intergovernmental policy.

Acknowledgement

This work is dedicated (a) to the late Professor S. Chandrasekhar, whom R.D.T. met in Chicago in 1991, (b) to the late Professor C. F. v. Weizsäcker, a respected discussion partner of both authors, and (c) the late investigative science journalist H. Heuseler, whom G.G. owes valuable information on the topic.

Both authors would like to thank many people for discussions, email exchanges, and support at various stages of this work, in particular StD Dipl.-Biol. Ernst- Georg Beck, H. J. Labohm, Professor B. Peiser, H. Thieme, Dr. phil. Wolfgang Thüne, and Professor A. Zichichi for sending them the manuscript of his talk presented at the Vatican conference. Mrs. S. Feldhusen's first translation of Ref. [92] is greatly appreciated.

Gerhard Gerlich would like to express his gratitude to all those who contributed to this study either directly or indirectly: Students, Staff Members, Research and Teaching Assistants, even collegues, who listened to his lectures and talks, who read his texts critically, who did some successful literature search. In particular, he is indebted to the Diploma Physicists (Diplomphysiker) Dr. V. Blahnik, Dr. T. Dietert, Dr. M. Guthmann, Dr. G. Linke, Dr. K. Pahlke, Dr. U. Schomäcker, H. Bade, M. Behrens, C. Bollmann, R. Flögel, StR D. Harms, J. Hauschildt, F. Homann, C. Mangelsdorf, D. Osten, M. Schmelzer, A. Söhn, and G. Törö, the architects P. Bossart and Dipl.-Ing. K. Fischer. Gerhard Gerlich extends his special gratitude to Dr. G.-R. Weber for very early bringing his attention to the outstanding DOE 1985 report [5] to which almost no German author contributed. Finally, he is pleased about the interest of the many scientific laymen who enjoyed his talks, his letters, and his comments.

Ralf D. Tscheuschner thanks all his students who formulated and collected a bunch of questions about climate physics, in particular Elvir Donlíc. He also thanks Professor A. Bunde for email correspondence. Finally he is indebted to Dr. M. Dinter, C. Kloeß, M. Köck, R. Schulz for interesting discussions, and Professor H. Grassl for an enlightening discussion after his talk on Feb. 2, 2007 at Planetarium Hamburg. A critical reading by M. Mross and Dr. M. Dinter and a translation of Fourier's 1824 paper in part by M. Willer's team and by Dr. M. Dinter are especially acknowledged.

The authors express their hope that in the schools around the world the fundamentals of physics will be taught correctly and not by using award-winning „Al Gore“ movies

67) cf. Singer's summary at the Stockholm 2006 conference [166].

shocking every straight physicist by confusing absorption/emission with reflection, by confusing the tropopause with the ionosphere, and by confusing microwaves with short-waves.

5.1 Comments on these people

The mentioned architects, Paul Bossert and Konrad Fischer, really form a trio, joined by Professor Claus Meier, who deny certain physical knowledge. Paul Bossert initiated an investigation of the physics of outer walls at the Swiss Material Testing Establishment (EMPA), in which he participated himself [85]. Since the investigation confirmed the physics, he now labels the investigation as falsified. With Konrad Fischer and Professor Meier, a discussion over several years took place in the journal ≫Bauen im Bestand≪, in which, after refutation of all ≫technical≪ arguments, Professor Meier tried to rescue his ≫science≪ with a papal citation. [78].

6 Contents

List of figures

List of tables

Index

Content

[1] Gerlich, Gerhard ; Tscheuschner, Ralf D.: *Falsification Of The Atmospheric CO2 Greenhouse Effects Within The Frame Of Physics.* Internet. http://www.arxiv.org/PS_cache/arxiv/pdf/0707/0707.1161v2.pdf. Version: 2007

[2] P. Murdin (Ed.): *Encyclopaedia of Astronomy and Astrophysics.* New York : Nature Publishing Group, 2001

[3] . . . : Radar in Meteorology. In: D. Atlas (Hrsg.): *AMS Battan Memorial Volume*, American Meteorological Society, 1990

[4] . . . ; J. Gribbin (Hrsg.): *Climatic Change.* Cambridge : University Press, 1978

[5] . . . ; MacCracken, M. C. (Hrsg.) ; Luther, F. M. (Hrsg.): *Projecting the Climatic Effects of Increasing Carbon Dioxide.* United States Department of Energy, DOE/ER 0237, 1985

[6] . . . ; Craig, E. (Hrsg.): *Routledge Encyclopedia of Philosophy.* New York : Routledge/Taylor & Francis, 2007 http://www.rep.routledge.com

[7] . . . : *Pontifical Council for Justice and Peace, Climate Change and Development. International Conference.* The Vatican. http://www.justpax.it/eng/home_eng.html. Version: 26. - 27. April 2007

[8] . . . : *Absorption TiNOX.* Version: 2000. http://www.solar4ever.de/Tinox.htm

[9] *Journal of Irreproducible Results* http://www.jir.com/

[10] . . . : *Emissionsfaktoren.* http://www.omega.de/pdf/ir-book/ti1008.pdf

[11] A. Emmerich, H. K. G. Gerlich G. G. Gerlich: Particle motion in stochastic force fields. In: *Physica* 92A (1978), S. 262 – 378

[12] AAAS: *AAAS Board Statement on Climate Change.* http://www.aaas.org/climate

[13] Ahrens, C.D.: Essentials of Meteorology. In: *Invitation to the Atmosphere. 3rd Edition.* Belmont, CA : Thomson Books / Cole, 2001

[14] Albert, H.: *Treatise on Critical Reason.* Princeton : Princeton University Press, 1985

[15] Albrecht, F.: Strahlungsumsatz in Wolken [Turnover radiation in clouds]. In: *Meteorologische Zeitschrift* 50 (1988), S. 478–486

[16] Albrecht, F.: Intensität und Spektralverteilung der Globalstrahlung bei klarem Himmel [Intensity and spectral distribution of solar radiation in clear sky]. In: *Archiv für Meteorologie, Geophysik und Bioklima* B3 (1951), S. 220–243

[17] Albrecht, F.: Untersuchungen über die spektrale Verteilung der Himmelsstrahlung und die Strahlungsbilanz der Atmosphäre [Studies on the spectral distribution of sky radiation and radiation balance of the atmosphere]. In: *Meteorologische Zeitschrift* 52 (1935), S. 454–452

[18] Alley, R. u. a.: *Climate Change 2007: The Physical Science Basis - Summary for Policymakers Intergovernmental Panel of Climate Change 2007).* http://www.ipcc.ch/SPM2feb07.pdf

[19] Anonymous: *Meyer's Enzyklopädisches Lexikon Bd. 10 [Meyer's Encyclopaedic Dictionary Vol 10].* Mannheim : Bibliographisches Institut, 1974

[20] Anonymous: *Efficient Windows Collaborative - Your Gateway to Information on How to choose Energy-Efficient Windows.* http://www.efficientwindows.org

[21] Anonymous: *The Greenhouse Effect.* http://www.britannica.com/eb/article-9037976/greenhouse-effect

[22] Anonymous: *Mojib Latif.* http://www.mopo.de/info/suche/web/index.html?keyword=Mojib%20Latif

[23] Anonymous: *SysML - Open Source Specification Project.* http://www.sysml.org/

[24] Anonymous: *The great global warming swindle.* Channel4, UK, Channel 4, Thursday 8 March, 9pm 2007

[25] Anonymous: *Science.* http://en.wikipedia.org/wiki/Science

[26] Anonymous: *Demarcation Problem.* http://en.wikipedia.org/wiki/Demarcation_problem

[27] Anonymous: *The greenhouse conspiracy.* SBS Television Australia [also shown in Channel4, GB], 1990

[28] Anonymous: *Stellungnahme der Deutschen Meteorologischen Gesellschaft zu den Grundlagen des Treibhauseffektes [Opinion of the German Meteorological Society on the basics of the greenhouse effect].* http://www.dmg-ev.de/gesellschaft/aktivitaeten/pdf/treibhauseffekt.pdf

[29] Anonymous: *Der Treibhauseffekt [The greenhouse effect].* http://de.wikipedia.org/wiki/Treibhauseffekt, Abruf: 23.03.2007

[30] Anonymous: *The Engineering Toolbox.* http://www.engineeringtoolbox.com/air-properties-d_156.html

[31] ANONYMOUS: *Climate Change Experiment Results.* http://www.bbc.co.uk/sn/climateexperiment/

[32] ARRHENIUS, S.: Die vermutliche Ursache der Klimaschwankungen [The presumed cause of climate variability]. In: *Meddelanden fran K. Vetenskapsakademiens Nobelinstitut* 1 (1906), Nr. 2

[33] ARRHENIUS, S.: Über die Wärmeabsorption durch Kohlensäure und ihren Einfluss auf die Temperatur der Erdoberfläche [About the heat absorption by carbon dioxide and its influence on the temperature of the earth's surface]. In: *Förhandlingar Svenska Vetenskapsakademiens* 58 (1901), S. 25 – 58

[34] ARRHENIUS, S.: On the Influence of Carbonic Acid in the Air Upon the Temperature of the Ground. In: *Philosophical Magazine* 41 (1896), S. 237–276

[35] AVERY, D. T. ; SINGER, S. F.: *Unstoppable Global Warming - Every 1500 Years.* Lanham MD : Rowman & Littlefield Publishers, Inc., 2006

[36] BAKAN, S. ; RASCHKE, E.: Der natürliche Treibhauseffekt [The natural greenhouse effect]. In: *Promet (Deutscher Wetterdienst)* 28 (2002), Nr. 3/4, 85-94. http://dmg-ev.de/gesellschaft/publikationen/pdf/promet/pdf_gross/promet_28_34.pdf

[37] BALACHANDRAN, A. P. ; ERCOLESSI, E.: Statistics on Networks. In: *Int. J. Mod. Phys.* A7 (1992), S. 4633 – 4654

[38] BARKER, E.F. ; ADEL, A.: Resolution of the Two Difference Bands of CO_2 Near 10 μm. In: *Phys. Rev.* 44 (1933), S. 185 – 187

[39] BARRON, W. R.: *Grundlagen der Infrarot-Temperaturmessung [Fundamentals of infrared temperature measurement].* http://www.omega.de/pdf/ir-book/ti1002.pdf

[40] BAUER, H.: *Wahrscheinlichkeitstheorie und Grundzüge der Maßtheorie [Measure and Integration Theory].* Berlin : Walter De Gruyter, 1964

[41] BAUER, H. ; BUCKEL, R. B.: *Measure and Integration Theory.* Berlin : Walter De Gruyter, 2002 (Studies in Mathematics 26)

[42] BAUR, F. ; PHILIPS, H.: Der Wärmehaushalt der Lufthülle der Nordhalbkugel im Januar und Juli und zur Zeit der Äquinoktien und Solstitien. 1. Mitteilung: Die Einstrahlung bei normaler Solarkonstante [The heat budget of the atmosphere of the Northern Hemisphere in January and July and at the time of the equinoxes and solstices. 1. Communication: The radiation at normal solar constant]. In: *(Gerlands) Beiträge zur Geophysik* 42 (1934), S. 159–207

[43] Baur, F. ; Philips, H.: *Der Wärmehaushalt der Lufthülle der Nordhalbkugel im Januar und Juli und zur Zeit der Äquinoktien und Solstitien. 2. Mitteilung: Ausstrahlung, Gegenstrahlung und meridonaler Wärmetransport bei normaler Solarkonstante [The heat budget of the atmosphere of the Northern Hemisphere in January and July and at the time of the equinoxes and solstices. 2. Communication: Broadcast, meridonaler radiation and heat transfer during normal solar constant].* (Gerlands) Beiträge zur Geophysik 45, 81-132 (1935),

[44] Beck, E.-G.: 180 Years of atmospheric CO_2 Gas Analysis by Chemical Methods. In: *Energy & Environment* 18 (2007), S. 259 – 282

[45] Beck, E.-G.: *180 Years of atmospheric CO_2 Gas Analysis by Chemical Methods, Erratum.* http://www.biokurs.de/treibhaus/180CO2/erratum.doc

[46] Beckenbach, E. F. ; Bellman, R.: *Inequalities.* Berlin : Springer, 1983

[47] Berry, E. X.: Comment on 'greenhouse' effect. In: *J. Appl. Meteor.* 13 (1974), S. 603 – 604

[48] Blasing, T. J. ; Smith, K.: *Recent Greenhouse Gas Concentrations.* http://cdiac.esd.ornl.gov/pns/current_ghg.html

[49] Boltzmann, L.: Ableitung des Stefan'schen Gesetzes, betreffend die Abhängigkeit der Wärmestrahlung von der Temperatur aus der electromagnetischen Lichttheorie [Stefan'schen derivation of the law, concerning the dependence of the thermal radiation of temperature from the electromagnetic theory of light]. In: *Annalen der Physik und Chemie* 22 (1884), S. 291 – 294

[50] Born, M. ; Wolf, E.: *Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light.* Bd. 6th Edition. Cambridge, UK : Cambridge University Press, 1997

[51] Bouali, H.: Combined radiative and convective heat transfer in a divided channel. In: *Int. J. Numerical Methods Heat & Fluid Flow* 16 (2006), S. 84–106

[52] Bray, D. ; Storch, H. von: *Climate Scientists: Perceptions of Climate Change Science.* http://coast.gkss.de/staff/storch/pdf/070511.bray.GKSS.pdf. Version: 2007

[53] Budden, K. G.: *Radio Waves in the Ionosphere.* Cambridge University Press, 1966

[54] Businger, J. A.: The glasshouse (greenhouse) climate. In: Wijk, W. R. V. (Hrsg.): *Physics of Plant Environment.* Amsterdam : North Holland Publishing Co., 1963

[55] C. Essex, B. A. R. McKitrick M. R. McKitrick: Does a Global Temperature Exist? In: *J. Non- Equil. Thermod.* 32 (2007), S. 1 – 27

[56] Callen, H. B.: *Thermodynamics and an Introduction to Thermostatics. Second edition*. New York : John Wiley & Sons, 1985

[57] Callendar, G. S.: Temperature Fluctuations and Trends over the Earth. In: *Quarterly J. Royal Meteorological Society* 87 (1961), S. 1 – 12

[58] Callendar, G. S.: On the Amount of Carbon Dioxide in the Atmosphere. In: *Tellus* 10 (1958), S. 243 – 248

[59] Callendar, G. S.: Can Carbon Dioxide Influence Climate? In: *Weather* 4 (1949), S. 310 – 314

[60] Callendar, G. S.: Infra-Red Absorption by Carbon Dioxide, with Special Reference to Atmospheric Radiation. In: *Quarterly J. Royal Meteorological Society* 67 (1941), S. 263–275

[61] Callendar, G. S.: Variations in the Amount of Carbon Dioxide in Different Air Currents. In: *Quarterly J. Royal Meteorological Society* 66 (1940), S. 395–400

[62] Callendar, G. S.: The Composition of the Atmosphere through the Ages. In: *Meteorological Magazine* 74 (1939), S. 33–39

[63] Callendar, G. S.: The Articial Production of Carbon Dioxide and Its Influence on Climate. In: *Quarterly J. Royal Meteorological Society* 64 (1938), S. 223–240

[64] Cess, R. D.: Intercomparison and Interpretation of Climate Feedback Processes in 19 Atmospheric General Circulation Models. In: *J. Geophysical Research* 95 (1990), S. 16601 – 16615

[65] Chandrasekhar, S.: *Radiative Transfer*. New York : Dover Publications, Inc., 1960

[66] Chang, J.-H.: *Climate and Agriculture*. Chicago : Aldine Puhl, 1968

[67] Clausius, R.: *Die Mechanische Wärmetheorie [The Mechanical Theory of Heat]*. Bd. 3. Auflage. Vieweg, 1887

[68] Clausius, R.: *Mechanical Theory of Heat*. `http://www.humanthermodynamics.com/Clausius.html`. Version: 1887

[69] Cole, F.-W.: *Introduction to Meteorology*. New York : Wiley, 1970

[70] Connolley, W. M.: *Science (related to climate change)*. `http://www.wmconnolley.org.uk/sci/wood_rw.1909.html`

[71] Cracken, M. C. M.: Carbon Dioxide and Climate Change: Background and Overview. In: Energy, DOE/ER 0. o. (Hrsg.): *Projecting the Climatic Effects of Increasing Carbon Dioxide*, 1985, S. 25 – 55

[72] CRC PRESSE(DRUCK), 2001 Boca R. Boca Raton: *D. Basu, Dictionary of Geophysics, Astrophysics, and Astronomy.* Boca Raton : CRC Press, 2001

[73] CURTIS, A.R. ; GOODY, R.M.: Thermal Radiation in the upper atmosphere. In: *Proc. Roy. Soc. London* A236 (1956), S. 193 – 206

[74] DAVIDSON, P. A.: *An Introduction to Magnetohydrodynamics.* Cambridge University Press, 2003

[75] DRAPER, N. R. ; SMITH, H.: *Applied Regression Analysis.* New Jersey : Wiley, Hoboken, 1998

[76] DYSON, F.: *University of Michigan 2005: Winter Commencement Address.* `http://www.umich.edu/news/index.html?DysonWinCom05`. Version: 2005

[77] BARY, E. de ; BULLRICH, K. ; MÖLLER, F.: Beiträge zur Erklärung von Himmelsfarbe und Helligkeit [Contributions to the explanation of sky color and brightness]. In: *Zeitschrift für Meteorologie* 8 (1954), S. 303 – 309

[78] EBEL, J.: Strahlungsheizung [Radiant heating]. In: *B+B (Bauen im Bestand)* (2006), Nr. 5

[79] EINSTEIN, Albert: Zur Quantentheorie der Strahlung [For the quantum theory of radiation]. In: *Physikalische Zeitschrift bzw. Physikalische Gesellschaft Zürich - Mitteilungen* 18 (1916 bzw. 1917), S. 47 – 62 bzw. 121 – 128

[80] ELSAESSER, H. W.: The Climate Effect of CO_2: A Different View. In: *Atmos. Env.* 18 (1984), S. 431 – 434

[81] EVANS, E. V. ; KENNEY, C. N.: A Flow Method for Determining the Thermal Conductivity of Gas Mixtures. In: *Nature* 203 (1964), S. 184 – 185

[82] F. KREITH, R. F. B. u. a.: Heat and Mass Transfer. In: KREITH, Frank (Hrsg.): *Mechanical Engineering Handbook.* Boca Raton : CRC Press LLC, 1999

[83] FLEAGLE, R. G. ; BUSINGER, J. A.: *An Introduction to Atmospheric Physics.* New York : Academic Press, 1963

[84] FOURIER, J.: Remarques générales sur les températures du globe terrestre et des espaces planétaires [General remarks on the temperatures on the Earth and the planetary spaces]. In: *Annales de Chemie et de Physique* 27 (1824), S. 136–167

[85] FOURIER, J.: Mémoire sur les températures du globe terrestre et des espaces planétaires. In: *Mémoires de l'Academie Royale des Sciences* 7 (1824), S. 569 – 604

[86] FRANK, T. ; BOSSERT, Paul u. a. ; 788, Untersuchunsbericht Nr. 1. (Hrsg.): *Energiebilanz von Außenwänden unter realen Randbedingungen [Energy performance of external walls under real boundary conditions].* Dübendorf, Schweiz : Eidgenössische Materialprüfungs- und Forschungsanstalt (EMPA), 1994

[87] FULLEKRUG, M.: Atmospheric electromagnetics and climate change. In: (ED.), C. B. (Hrsg.): *From Regional Climate Modelling to the Exploration of Venus* Bd. ERCA 7. Grenoble, France, 2. November 2006, S. 157 – 166157

[88] GERLICH, G.: Über die Physik und Mathematik globaler Klimamodelle [About the physics and mathematics of global climate models]. In: GESPRÄCH (Hrsg.): *Kolloquium der Deutschen Chemischen Gesellschaft.* Münster, 21. 05. 2007

[89] GERLICH, G.: Klima, Energie und Katastrophen [Climate, energy and disaster]. Erkrath : MIT Mittelstandsund Wirtschaftsvereinigung der CDU, Stadtverband Erkrath, 19. 10. 2005

[90] GERLICH, G.: Physikalische und mathematische Gesetze in der globalen Klimatologie [Physical and mathematical laws in the global climatology]. In: GESPRÄCH (Hrsg.): *Klimawandel - menschlich bedingt oder aufgebauscht? [Climate change - human-caused or aufgebauscht?].* Göttingen : Friedrich Naumann Stiftung und Rudolf von Bennigsen Stiftung, 15. 5. 2004

[91] GERLICH, G.: On the physics and mathematics of global climate models. In: *Gespräch, Kyoto - Klimaprognosen - Aussagekraft der Modelle und Handlungsstrategien [Conversation, Kyoto - Climate Forecasts - expressiveness of the models and strategies for action].* Theodor-Heuss-Akademie, Gummersbach, 20. 2. 2005

[92] GERLICH, G.: Physical foundations of the greenhouse effect and fictitious greenhouse effects. In: *Gespräch auf dem Herbstkongress der Europäischen Akademie für Umweltfragen: Die Treibhaus-Kontroverse, 1995 [Discussion on the Fall Congress of the European Academy for the Environment: The global warming controversy, 1995].* Leipzig, 9. - 10. 11. 1995

[93] GERLICH, G.: Eine Verallgemeinerung des Stratonovich-Verfahrens für Anwendungen in der statistischen Mechanik [A generalization of the Stratonovich procedure for applications in statistical mechanics]. In: *Physica* 82A (1976), S. 477 – 499

[94] GERLICH, G. ; WULBRAND, W.: Kinetische Gleichungen für Systeme mit unendlich vielen Freiheitsgraden [Kinetic equations for systems with infinitely many degrees of freedom]. In: *Abhandlungen der Braunschweigischen Wissenschaftlichen Gesellschaft* Bd. XXIX, 1978, S. 97 – 105

[95] GERLICH, G.: *Tensorpotentiale in der Magnetohydrodynamik und das Dynamoproblem, Thesen [Tensorpotentiale in magnetohydrodynamics and the dynamo problem, theses].* TU Braunschweig, 1970

[96] Gerlich, G. ; Kagermann, H.: Herleitung kinetischer Gleichungen mit dem verallgemeinerten Stratonovich-Verfahren [Derivation of kinetic equations with the generalized Stratonovich method]. In: *Physica* 88A (1977), S. 283 – 304

[97] Gold, E.: The Isothermal Layer of the Atmosphere and Atmospheric Radiation. In: *Proc. Roy. Soc. London* A82 (1909), S. 43–70

[98] Gore, Al: *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It*. New York : Melcher Media/Rodale Publishing, 2006

[99] Grassl, H.: Zwischen Eiszeit und globaler Erderwärmung [Between Ice Age and global warming]. In: *Gespräch*. Planetarium Hamburg, 02. Feb. 2007

[100] Grassl, H.: 'Treibhausgase' haben deutlichen Einfluss ['Greenhouse gases' have significant influence]. In: *Handelsblatt* 3.1. (1996)

[101] Grigull, Ulrich ; Sandner, Heinrich: *Wärmeleitung [thermal conduction]*. Berlin Heidelberg New York : Springer-Verlag, 1979

[102] Guggenheim, D.: *An Inconvenient Truth*. `http://www.climatecrisis.net`

[103] Hansen, J. u. a.: Efficient Three-Dimensional Global Models for Climate Studies: Models I and II. In: *Monthly Weather Review* 111 (1983), S. 609 – 662

[104] Hardy, G. H. ; Littlewood, J. E. ; Polya, G.: *Inequalities*. Cambridge, UK : Cambridge University Press, 1934

[105] Hardy, J. P.: *Climate Change. Causes, Effects, and Solutions*. West Sussex, England : John Wiley & Sons Ltd., 2003

[106] Heiss, K. P.: *Globale Erwärmung - Globaler Winter: was sagen die Daten? [Global Warming - Global Winter: what the data say?]*. – mailto: Klaus-p-heiss@msn.com

[107] Heuseler, W.: *Private Communication*. 1996

[108] Hofmann, G.: Zur Darstellung der spektralen Verteilung der Strahlungsenergie [To display the spectral distribution of radiation energy]. In: *Archiv für Meteorologie, Geophysik und Bioklima* B6 (1955), S. 274 – 279

[109] Houghton, J.T. u. a.: *Climate Change 2001: The Scientific Basis - Contribution of Working Group I to the Third Assessment Report*. Cambridge : University Press, 2001

[110] Houghton, J.T. u. a.: *Climate Change 1995: The Science of Climate Change - Contribution of Working Group I to the Second Assessment Report*. Cambridge : University Press, 1996

[111] Houghton, J.T. u. a.: Radiative Forcing of Climate Change: Summary for Policymakers. WHO, IPCC, UNEP : Report of the Scientific Assessment Working Group of IPCC, 1994

[112] Houghton, J.T. u. a.: *Climate Change 1992: The Supplementary Report to the IPPC Scientic Assessment - Report Prepared for IPCC by Working Group I.* Cambridge : University Press, 1992

[113] Houghton, J.T. u. a.: *Scientific Assessment of Climate Change - The Policymakers' Summary of the Report of Working Group I of the Intergovernmental Panel of Climate Change.* WHO, IPCC, UNEP, 1990

[114] Houghton, J.T. u. a.: *Climate Change 1994: Radiative Forcing of Climate Change and An Evaluation of the IS92 Emission Scenarios.* Report of Working Groups I and III of the IPCC. Cambridge : University Press, 1990

[115] Houghton, J.T. u. a.: *Climate Change 1990: The IPPC Scientific Assessment - Report Prepared for IPCC by Working Group I.* Cambridge : University Press, 1990

[116] Huang, K.: *Statistical Mechanics.* New York : John Wiley & Sons, 1987

[117] Hug, H.: *Die Angsttrompeter [The Anxiety trumpeters].* München : Signum Verlag, 2006

[118] Hölder, O.: Über einen Mittelwertsatz [Over a mean rate]. In: *Nachr. Ges. Wiss. Göttingen* (1889), S. 38 – 47

[119] Itzykson, C. ; Zuber, J.-B.: *Quantum Field Theory.* New York : McGraw-Hill Education, 1980

[120] Jackson, J. D.: *Classical Electrodynamics.* New York : John Wiley & Sons, 1962

[121] Jaworowski, Z.: CO_2: The Greatest Scientific Scandal of Our Time. In: *EIR Science* March 16 (2007), S. 38 – 53

[122] Jones, M. D. H. ; Henderson-Sellers, A.: History of the greenhouse effect. In: *Progress in physical geography* 14 (1) (1990), S. 1 – 18

[123] Kassner, K.: *Theoretische Physik IV, Vorlesungsskript zur Statistik [Theoretical Physics IV, lecture script on statistics].* http://wase.urz.uni-magdeburg.de/kassner/itp2/thermoscript_orig.pdf

[124] Keeling, C. D.: The Influence of Mauna Loa Observatory on the Development of Atmospheric CO_2 Research. In: Miller, John (Hrsg.): *In Mauna Loa Observatory. A 20th Anniversary Report.* NOAA Environmental Research Laboratories, Boulder, CO : National Oceanic and Atmospheric Administration Special Report, September 1978, S. 36 – 54

[125] KEELING, C. D.: The Carbon Dioxide Cycle: Reservoir Models to Depict the Exchange of Atmospheric Carbon Dioxide with the Ocean and Land Plants. In: *Chemistry of the Lower Atmosphere* (1973), S. 251 – 329

[126] KEELING, C. D.: Rewards and Penalties of Monitoring the Earth. In: *Annual Review of Energy and the Environment* 23 (1998), S. 25 – 8225

[127] KEELING, C. D.: The Concentration and Isotopic Abundances of Carbon Dioxide in the Atmosphere. In: *Tellus* 12 (1960), S. 200 – 2003

[128] KEELING, C. D. u. a.: A Three-Dimensional Model of Atmospheric CO_2 Transport Based on Observed Winds. In: PETERSON, David H. (Hrsg.): *Aspects of Climate Variability in the Pacific and the Western Americas.* American Geophysical Union, Washington DC : AGU Monograph 55, 1989, S. 165 – 363

[129] KEELING, C. D. u. a.: Increased Activity of Northern Vegetation Inferred from Atmospheric CO_2 Measurements. In: *Nature* 382 (1996), S. 146 – 149

[130] KEELING, C. D. u. a.: Atmospheric Carbon Dioxide Variations at Mauna Loa Observatory. In: *Tellus* 28 (1976), S. 538 – 551

[131] KHILYUK, L. F. ; CHILINGAR, G. V.: On global forces of nature driving the Earths climate. Are humans involved? In: *Environ. Geol. 50* 50 (2006), S. 899 – 910

[132] KITTEL, C.: *Thermal Physics.* Bd. 21st Printing. New York, 1980 : W.H. Freeman and Company, 2000

[133] KNEER, R.: *FEUERUNGSTECHNIK [combustion technology].* Lehrstuhl für Wärme- und Stoffübertragung. Rheinisch-Westfälische Technische Hochschule Aachen. `http://www.wsa.rwth-aachen.de/uploads/tx_lnetfiles/skript_ft_komplett_20-11-06.pdf`. Version: 2006

[134] KUPTSOV, L.P.: Hölder inequality. In: *Encyclopaedia of Mathematics (SpringerLink)*, 2001

[135] LEE, B.: Effects of tent-type enclosures on the microclimate and vaporization of plant cover. In: *Oecologica Plantarum* 1 (1966), S. 301 – 326

[136] LEE, R.: The 'greenhouse' effect. In: *J. Appl. Meteor.* 12 (1973), S. 556 – 557

[137] LEWIS, M.: *A Skeptic's Guide to An Inconvenient Truth.* Washington : Competitive Enterprise Institute, 2006 `http://www.cei.org/pages/ait_response.cfm`

[138] LIDE, D. R.: *CRC Handbook of Chemistry and Physics.* Bd. 83th Edition. Boca Raton : CRC Press LLC, 2002

[139] LORENZ, E. N.: Deterministic Nonperiodic Flow. In: *J. Atmospheric Sciences* 20 (1963), S. 130 – 141

[140] Luther, F. M. ; Ellingson, R. G.: Carbon Dioxide and the Radiation Budget. In: *Projecting the Climatic Effects of Increasing Carbon Dioxide*, United States Department of Energy, DOE/ER 0237, Dec. 1985, S. 25 – 55

[141] Manabe, S.: Climate and the Ocean Circulation: I. The Atmospheric Circulation and the Hydrology of the Earth's Surface. In: *Monthly Weather Review* 97 (1969), S. 739 – 774

[142] Manabe, S.: Climate and the Ocean Circulation: II. The Atmospheric Circulation and the Effect of Heat Transfer by Ocean Currents. In: *Monthly Weather Review* 97 (1969), S. 775 – 805

[143] Manabe, S. ; Strickler, R.F.: Thermal Equilibrium of the Atmosphere with Convective Adjustment. In: *J. Atmosph. Sciences* 21 (1964), S. 361 – 385

[144] Manabe, S. ; Wetherald, R.T.: On the Distribution of Climate Change Resulting from an Increase in CO_2 Content of the Atmosphere. In: *J. Atmosph. Sciences* 37 (1980), S. 99 – 118

[145] Manabe, S. ; Wetherald, R.T.: Thermal Equilibrium of the Atmosphere with a Given Distribution of Relative Humidity. In: *J. Atmosph. Sciences* 24 (1967), S. 241 – 259

[146] Mann, M. E. ; Jones, P. D.: Global surface temperatures over the past two millenia. In: *Geophysical Research Letters* 30 (2003), S. 5–1 – 5–4

[147] Marcuvitz, N.: *Waveguide Handbook*. London : Peter Peregrinus Ltd., 1986

[148] Martin, P.E. ; Barker, E.F.: The Infrared Absorption Spectrum of Carbon Dioxide. In: *Phys. Rev.* 37 (1932), S. 291 – 303

[149] McGuffie, K. ; Henderson-Sellers, A.: *A Climate Modelling Primer*. West Sussex, England : John Wiley & Sons, 2006

[150] Mecke, R.: Über Zerstreuung und Beugung des Lichtes durch Nebel und Wolken [About scattering and diffraction of light through fog and clouds]. In: *Ann. d. Physik* 65 (1921), S. 257 – 273

[151] Miller, A.: *Meteorology*. Ohio, Columbus : Merrill Books, 1966

[152] Mitchell, J.: *Climate Change Myths*. `http://www.metoffice.gov.uk/corporate/pressoffice/myths/index.html`

[153] Montgomery, C. G. ; Dicke, R. H. ; Purcell, E. M.: *Principles of Microwave Engineering*. New York : McGraw-Hill, 1948

[154] Munn, R. E.: *Descriptive Micrometeorology*. New York : Academic Press, 1966

[155] Möller, F.: *Einführung in die Meteorologie: Physik der Atmosphäre II [Introduction to Meteorology: Atmospheric Physics II].* Mannheim : Bibliographisches Institut, 1973

[156] Möller, F.: *Einführung in die Meteorologie: Physik der Atmosphäre I [Introduction to Meteorology: Atmospheric Physics I].* Mannheim : Bibliographisches Institut, 1973

[157] Möller, F.: Strahlung der unteren Atmosphäre [Radiation of the lower atmosphere]. In: *Handbuch der Physik* 48 (1959), S. 155 – 253

[158] Möller, F.: Ein Kurzverfahren zur Bestimmung der langwelligen Ausstrahlung dicker Atmosphärenschichten [A short procedure for determining the longwave broadcasting thicker layers of atmosphere]. In: *Archiv für Meteorologie, Geophysik und Bioklima* A7 (1954), S. 158 – 169

[159] Möller, F.: Labilisierung von Schichtwolken durch Strahlung [Labilisierung layer of clouds by radiation]. In: *Meteorologische Zeitschrift* 60 (1948), S. 212 – 213

[160] Möller, F.: Zur Erklärung der Stratosphärentemperatur [To explain the stratospheric temperature]. In: *Die Naturwissenschaften* 31 (1943)

[161] Möller, F. ; Mannabe, S.: Über das Strahlungsgleichgewicht der Atmosphäre [About the radiation balance of the atmosphere]. In: *Z. f. Meteorologie* 15 (1961), S. 3 – 8

[162] Möller, F. ; Mügge, R.: Gesamte und zonale nächtliche Gegenstrahlung als Mittel zur Gewinnung aerologischer Aufschlüsse [Total and zonal nocturnal radiation as a means of extracting aerological breakdowns]. In: *Beiträge zur Physik der (freien) Atmosphäre* 20 (1933), S. 220 – 233

[163] Mügge, R. ; Möller, F.: Zur Berechnung von Strahlungsströmen und Temperaturänderungen in Atmosphären von beliebigem Aufbau [For the calculation of radiation currents and temperature changes in the atmospheres of arbitrary structure]. In: *Zeitschrift für Geophysik* 8 (1932), S. 53 – 64

[164] Nakićenović, N. u. a.: *Emission Scenarios - A Special Report of Working Group III of the IPCC.* Cambridge : University Press, 2000

[165] Oeschger, H.: Treibhauseffekt durch Kohlensäure - Ja oder Nein? [Greenhouse effect by carbon dioxide - Yes or No?]. In: *Neue Züricher Zeitung* 28 (1976), Nr. 9.11.

[166] P. Stilbs, Organizing chairman [.: Global Warming - Scientific Controversies in Climate Variability. In: *International seminar meeting at The Royal Institute of Technology (KTH).* Stockholm, Schweden, 11. - 12. September 2006

[167] Paul, C R.: *Fundamentals of Electric Circuit Analysis.* Mississauga, Ontario : John Wiley & Sons Canada Ltd., 2001

[168] Pettersen, S.: *Introduction to Meteorology.* New York : McGraw-Hill, 1958

[169] Planck, M.: Über das Gesetz der Energieverteilung im Normalspectrum [About the Law of the Power Spectrum in the Normal]. In: *Annalen der Physik* 4 (1901), S. 553 – 563

[170] Planck, M.: Über das Gesetz der Energieverteilung im Normalspectrum [About the Law of the Power Spectrum in the Normal]. In: *Verhandlungen Deutsche Physikalische Gesellschaft* 2 (1900), S. 202 – 204 and 237 – 239

[171] Prévost, Pierre: *Du Calorique rayonnant [Of radiant caloric].* Paris : J.J. Paschoud, 1809

[172] Tscheuschner, R. D. ; Hoch, S. ; Leschinsky, E. ; Meier, C. ; Theis, S. ; Wieck, A. D.: Robustness of the quantum Hall effect, sample size versus sample topology, and quality control management of III-V molecular beam epitaxy. In: *Int. J. Mod. Phys.* B12 (1998), S. 1147 – 1170

[173] Rahmstorf, S.: *Antworten auf Leserbriefe.* `http://www.pik-potsdam.de/~stefan/leser_antworten.html`, Abruf: 23.03.2007

[174] Rothman, L. S. u. a.: The HITRAN molecular spectroscopic database and HAWKS. In: *Journal of Quantitative Spectroscopy and Radiative Transfer* 60 (1998), 665 - 710. `http://cfa-www.harvard.edu/hitran/Download/HITRAN96.pdf`

[175] Rudzinski, K.: Kein Treibhauseffekt durch Kohlensäure [No greenhouse effect caused by carbonated]. In: *Frankfurter Allgemeine Zeitung* (1976), Nr. 15.09.

[176] Rybicki, G.B. ; Lightman, A. P.: *Radiative Processes in Astrophysics.* New York : John Wiley & Sons, 1979

[177] Safran, S. A.: *Statistical Thermodynamics of Surfaces, Interfaces, and Membranes.* Reading, Massachusetts : Addison-Wesley, 1994

[178] Scaife, A. ; Folland, C. ; Mitchell, J.: A model approach to climate change. In: *Physics World* 2 (2007). `http://physicsweb.org/articles/world/20/2/3/1`

[179] Schack, A.: *Der industrielle Wärmeübergang [Industrial Heat Transfer].* Bd. 1. Auflage 1929, 8. Auflage. Düsseldorf : Verlag Stahleisen m.b.H., 1983

[180] Schack, A.: Der Einfluß des Kohlendioxid-Gehaltes der Luft auf das Klima der Welt [The influence of the carbon dioxide content of air on the climate of the world]. In: *Physikalische Blätter* 28 (1972), S. 26 – 28

[181] SCHAEFER, C. ; PHILIPPS, B.: Das Absorptionsspektrum der Kohlensäure und die Gestalt der CO_2-Molekel [The absorption spectrum of carbon dioxide and the shape of the CO_2-Molekel]. In: *Z. für Physik* 36 (1926), S. 641 – 656

[182] SCHLOERER, J.: *Climate change: some basics*. http://www.faqs.org/faqs/sci/climate-change/basics/

[183] SCHNEIDER, S.H.: On the Carbon Dioxide Climate Confusion. In: *J. Atmospheric Sciences* 32 (1975), S. 2060 – 2066

[184] SCHUMANN, W. O.: Über die strahlungslosen Eigenschwingungen einer leitenden Kugel, die von einer Luftschicht und einer Ionosphärenhülle umgeben ist [About the radiation-free self-oscillations of a conducting sphere, by an air layer and a envelope of the Ionosphere surrounded covered]. In: *Zeitschrift und Naturforschung* 7a (1952), S. 149 – 154

[185] SCHUSTER, Norbert ; KOLOBRODOV, Valentin G.: *Infrarotthermographie [infrared thermography]*. Weilheim [u.a.] : Wiley - VCH, 2000

[186] SCHÖNWIESE, C.-D. ; DIEKMANN, B.: *Der Treibhauseffekt [The greenhouse effect]*. Stuttgart : Deutsche Verlags-Anstalt, 1987

[187] SELLERS, W. D.: *Physical Climatology*. Chicago : The University of Chicago Press, 1965

[188] SHU, F. H.: *The Physics of Astrophysics. Volume II: Gas Dynamics*. Mill Valley, California : University Science Books, 1992

[189] SHU, F. H.: *The Physics of Astrophysics. Volume I: Radiation*. Mill Valley, California : University Science Books, 1991

[190] SOON, W. ; BALIUNAS, S.: *Lessons & Limits of Climate History: Was the 20th Century Climate Unusual?* Washington D.C. : The George C. Marshall Institute, 2003

[191] CHORIN, A. J. ; MARSDEN, J. E.: *A Mathematical Introduction to Fluid Mechanics*. Bd. Third Edition. New York : Springer, 1993

[192] SPROTT, J. C.: *Chaos and Time-Series Analysis*. Oxford University Press, 2003

[193] STAINFORTH, D.A. u. a.: Uncertainty in predictions of the climate responses to rising levels of greenhouse gases. In: *Nature* 433 (2005), S. 403 – 406

[194] STEFAN, J.: Über die Beziehung zwischen der Wärmestrahlung und der Temperatur [About the relationship between the thermal radiation and the temperature]. In: *Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften* 79 (1879), S. 391 – 428. – Facsimile on http://www.ing-buero-ebel.de/strahlung/Original/Stefan1879.pdf

[195] Stichel, P.C.: *Leserbrief an das Westfahlenblatt (unveröffentlicht) [Letter to the Westfahlenblatt (a newspaper) (unpublished)].* 1995

[196] Storch, H. von: Die Diskretisierung ist das Modell [The discretization is the model]. In: H. Hagedorn, H. Röck (. K.-E. Rehfues R. K.-E. Rehfues (Hrsg.): *Klimawandel im 20. und 21. Jahrhundert: Welche Rolle spielen Kohlendioxid Wasser und Treibhausgase wirklich? [Global Warming in the 20th and 21 Century: What is the role of greenhouse gases carbon dioxide and water really?]* Bd. 28. München : Verlag Dr. Friedrich Pfeil, 2005 (Rundgespräche der Kommission für Ökologie)

[197] Svensmark, H. ; Friis-Christensen, E.: Variation of Cosmic Ray Flux and Global Cloud Coverage: A Missing Link in Solar-Climate Relationships. In: *Journal of Atmospheric and Solar-Terrestrial Physics* 59 (1997), S. 1225 – 1232

[198] Svozil, Karl: Feyerabend and physics. In: *International Symposium Paul Feyerabend 1924-1994. A philosopher from Vienna*, University of Vienna, June 18-19 2004

[199] Thieme, H.: *On the Phenomenon of Atmospheric Backradiation.* `http://www.geocities.com/atmosco2/backrad.htm`

[200] Thüne, W.: *Freispruch für CO_2 [Acquittal for CO_2].* Saarbrücken : Edition Steinherz, Discovery Press, 2002

[201] Thüne, W.: *Der Treibhaus-Schwindel [The greenhouse-dizziness].* Saarbrücken : Edition Steinherz, Discovery Press, 1998

[202] Tyndall, J.: *Contributions to Molecular Physics in the Domain of Radiant Heat.* New York : Appleton, 1873

[203] Tyndall, J.: Further Researches on the Absorption and Radiation of Heat by Gaseous Matter (1862). In: *Contributions to Molecular Physics in the Domain of Radiant Heat.* Appleton, New York, 1873, S. 69 – 121

[204] Tyndall, J.: On Radiation through the Earth's Atmosphere. In: *Philosophical Magazine* 25 (1863), S. 200 – 206

[205] Tyndall, J.: On the Relation of Radiant Heat to Aqueous Vapor. In: *Philosophical Magazine* 26 (1863), S. 30 – 54

[206] Tyndall, J.: On the Absorption and Radiation of Heat by Gases and Vapours . . . . In: *Philosophical Magazine* 22 (1861), S. 169 – 194

[207] Cubasch, U. ; Sauter, B.D. ; Hegel, G.C.: Klimamodelle - Wo stehen wir? [Climate Models - Where do we stand?]. In: *Phys. Blätter* 4 (1995), S. 269 – 276

[208] Unsöld, A.: *Physik der Sternenatmosphären [Physics of stellar atmospheres].* Berlin - Göttingen - Heidelberg : Springer-Verlag, 1955

[209] VIRGO, S. E.: Loschmidt's Number. In: *Science Progress* 27 (1933), S. 634 – 649

[210] ROEDEL, Walter: *Physik in unserer Umwelt: die Atmosphäre [Physics in our environment: the atmosphere]*. Berlin - Heidelberg - New York : Springer-Verlag, 2000. – ISBN 3–540–67180–3

[211] WEART, S. R.: *The Discovery of Global Warming*. Cambridge, Massachusetts : Harvard University Press, 2004 http://www.aip.org/history/climate/

[212] WEGMAN, E. J. u. a.: Ad Hoc Committee Report on the 'Hockey Stick' Gobal Climate Reonstruction. (1996). http://republicans.energycommerce.house.gov/108/home/07142006_Wegman_Report.pdf

[213] WEISE, K.: *Differentialgleichungen [differential equations]*. Göttingen : Vandenhoeck & Ruprecht, 1966

[214] WEIZEL, W.: *Lehrbuch der Theoretischen Physik [Textbook of Theoretical Physics]*. Berlin : Springer, 1963

[215] WIEDEMANN, Uwe: *experimentum crucis (on-line-Lexikon der Philosophie) [(on-line Encyclopaedia of Philosophy)]*. http://www.phillex.de/expcruc.htm

[216] WIMMER, M.: Über die Beeinflussung der ultraroten Kohlensäureabsorptionsbande bei 4,27 μm durch fremde Gase und ihre Anwendung zur Gasanalyse [About the influence of the ultra-red carbon dioxide absorption band at 4.27 μm by foreign gases and their application to gas analysis]. In: *Annalen der Physik* 81 (1926), S. 1091 – 1112

[217] WOOD, R. W.: Note on the Theory of the Greenhouse. In: *Philosophical magazine* 17 (1909), S. 319 – 320

[218] ZDUNKOWSKI, Z. ; BOTT, A.: *Dynamics of the Atmosphere: A course in theoretical Meteorology*. Cambridge University Press, 2003

[219] ZICHICHI, A.: Meteorology and Climate: Problems and Expectations, Pointifical Council for Justice and Peace. In: *Climate Change and Development. International Conference*, The Vatican, 26. - 27. April 2007

[220] ZMARSLY, Ewald ; KUTTLER, Wilhelm ; PETHE, Hermann: *Meteorologisch-klimatisches Grundwissen [Meteorological climatic basic knowledge]*. Ulmer, 2007 (Uni-Taschenbücher M). http://www.utb.de/katalog_suchen_detailseite.jsp?buchid=949. – ISBN 978–3–8252–2281–9

[221] STEFAN, J.: Über die Beziehung zwischen der Wärmestrahlung und der Temperatur [About the relationship between the thermal radiation and temperature]. In: *Sitzungsberichte der mathematisch-naturwissenschaftlichen Classe der kaiserlichen Akademie der Wissenschaften* 79 (1879), S. 391 – 428. – facsimile by http://www.ing-buero-ebel.de/strahlung/Original/Stefan1879.pdf

[222] C. E. Baukal, Jr.: *Heat Transfer in Industrial Combustion.* Boca Raton : CRC Press LLC, 1999

[223] Statistisches Bundesamt: *Bevölkerung Deutschlands bis 2050. 11. koordinierte Bevölkerungs-Vorausberechnung [Germany's population by 2050. 11. coordinated population forecast].* Wiesbaden. `https://www-ec.destatis.de/csp/shop/sfg/bpm.html.cms.cBroker.cls?cmspath=struktur,vollanzeige.csp&ID=1019439`. Version: 2007

[224] *DIN EN ISO 6946: 2003-10; Wärmedurchlasswiderstand und Wärmedurchgangskoeffizient [DIN EN ISO 6946: 2003-10; thermal resistance and heat transfer coefficient].* Beuth-Verlag Berlin, Oktober 2003

[225] Gerlich, Gerhard: *Betreff: Re: Leserbrief [Subject: Re: Letter to the editor].* E-mail to author E-mail and large round, 2008. – 18. Feb 2008 22:58

[226] Tscheuschner, Ralf D.: *Betreff: Ebelsche Perpetuierung [Subject: Ebelsche perpetuation].* E-mail to author E-mail and large round, 2008. – 21. Mär 2008 22:47