Scientific Research Publishing

Atmospheric and Climate Sciences, 2026, 16(2), 424-446
https://www.scirp.org/journal/acs
ISSN Online: 2160-0422
ISSN Print: 2160-0414

A Hemispheric View on the Solar Induced Temperature of the Earth

Ulrich O. Weber

Independent Researcher, Co-Operation with the European Institute for Climate and Energy, Jena, Germany
Email: u.weber.geosci(at)t-online.de

How to cite this paper: Weber, U.O. (2026) A Hemispheric View on the Solar Induced Temperature of the Earth. *Atmospheric and Climate Sciences*, **16**, 424-446.
https://doi.org/10.4236/acs.2026.162023

Received: February 4, 2026
Accepted: April 25, 2026
Published: April 28, 2026

Abstract

From the first computer-based climate models to the latest general circulation models, hardware and software development have made incredible strides. However, the underlying physical principles of solar irradiation still date back to the analog era, and the initial simplifications of the underlying physical knowledge have not been sufficiently refined. The sun's role is still reduced to its global average value over day and night, and furthermore, the geographical differences between the tropics and the poles continue to be neglected. Modern computer systems no longer require such simplifications. From the perspective of applied physics, it would be advantageous to begin climate calculations for the Earth today directly with the incident solar radiation on its dayside. This work demonstrates that a hemispherical consideration of incident solar irradiation, incorporating time of day, individual geographic location, and season, could significantly improve the scientific view on the role of the Sun more effective than miniaturizing the computational cells in digital climate models further.

Keywords

Computer-Based Climate Models, Earth's Natural Temperature, Inversion of the Stefan and Boltzmann Law, Terrestrial Day and Night Cycle, Solar Induced Temperature, Pirani Curve, Hemispheric Convection Model

1. Introduction

The Intergovernmental Panel on Climate Change (IPCC), an organisation founded by WMO and UN in 1988, evaluates and regularly reports the scientific basis and the current state of global warming, which shall be caused by an enhanced greenhouse effect (GHE) due to carbon dioxide (CO_2) from the anthropogenic use of fossil fuels. Consequently, from 1988 onwards, the functioning of the so-called natural atmospheric GHE itself should be scientifically absolutely clear and verifiable. However, the enhanced GHE does not yet appear to be fully understood, as the IPCC [1] repeats in its Sixth Assessment Report (Working Group 1, Annex 1.A. 2021) a statement from the First Assessment Report (SPM of the FAR, 1990): "*The unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more*". This quote demonstrates that the problem of the enhanced GHE, which is said to cause anthropogenic global warming (AGW), was already described as unresolved in the FAR report (1990) and remained unresolved for the following three decades until the AR6-SPM declaration (2021). This lack of general scientific knowledge does not provide a confidence-building perspective on the scientific climate models that incorporate AGW into future projections of the GHE model. Since the enhanced GHE shall occur on the same physical basis as the natural atmospheric GHE, the question arises consequently, whether the natural GHE itself has been scientifically fully understood.

The constant cycle of day and night had once led climate sciences to use a single global average value for solar irradiance that shall represent both phases in future climate models, as, for example, IPCC models use to do to date. The outline of the paper follows the natural atmospheric greenhouse effect being derived as a "factor 4" from a quarter of the Solar constant and describes the spread of this factor 4 in climate sciences. Section 4 restarts the physical perspective on temperature generation from the Earth's dayside on, where solar shortwave irradiation firstly hits terrestrial matter. The next section proves this hemispheric perspective to already include a natural variety of seasonal climate variations over geographic latitudes, being followed by open questions about energy transport within the Earth's atmosphere. This analysis ends up with the natural atmospheric energy decay following the plain barometric formula without any additional energy generation needed within the atmosphere.

2. Analysis of the So-Called Natural Atmospheric Greenhouse Effect

Although it is argued by Cook *et al.* [2] that 97% of scientists do agree to anthropogenic global warming (AGW), the natural atmospheric GHE has not been clearly and physically comprehensibly defined to date. Even today there exists no undisputed general schoolbook-model of the GHE in scientific literature but a great variety of different GHE models. All these uncountable GHE models are based on the difference of 33 Kelvin between a "natural" temperature (NTE) of the Earth at minus 18 degrees Celsius, calculated from the globally averaged power of the incoming short wave insolation on Earth over 24 hours by an inversion of the Stefan Boltzmann law (S-B inversion), and the globally averaged measured near surface temperature (NST) of 15 degrees Celsius. This S-B inversion could be simplified further by using a quarter of the solar constant with the same result. The so called radiation altitude of the Earth is then declared to be that special part of the atmosphere with a local temperature of minus18 degrees Celsius equal to the Earth's "natural" temperature. From the barometric formula this part of the atmosphere with a temperature of minus 18 degrees Celsius can be identified at an altitude of about 5.000 meter.

A nowadays mainly well accepted model of the GHE in climate sciences originates from Trenberth *et al.* [3] who are starting their global description from 341 Watt per square meter for the incoming solar short wave (SW) irradiation. In fact, the ratio between the circle area of the incoming short wave insolation and the areal extent of the whole Earth is 1:4, referred to below as "factor 4". The distribution of the solar constant at 1.361 Watt per square meter across the entire surface of the Earth is therefore one quarter, or 341 Watt per square meter. Taking into account the Earth's mean albedo of about 30% and following this factor 4-approach, the net temperature-effective incoming solar irradiation on Earth results in 239 Watt per square meter and cannot explain for the measured NST of about 15 degrees Celsius. Additional longwave back radiation from greenhouse gases in the atmosphere with an additional longwave (LW) net radiation flow of 159 Watt per square meter towards the Earth's surface shall then meet the need of the measured NST at 398 Watt per square meter and allegedly ensure an outgoing longwave radiation of 239 Watt per square meter from the top of the atmosphere (TOA) to outer space. This article will follow these integer values from Trenberth *et al.* [3] in argumentation. The factor 4, used in an S-B inversion to determine a "natural" Earth temperature of minus 18 degrees Celsius, inevitably leads to a difference of 33 Kelvin compared to the globally averaged measured near-surface temperature (NST) of 15 degrees Celsius and is known as the natural atmospheric GHE, as shown in **Figure 1**:

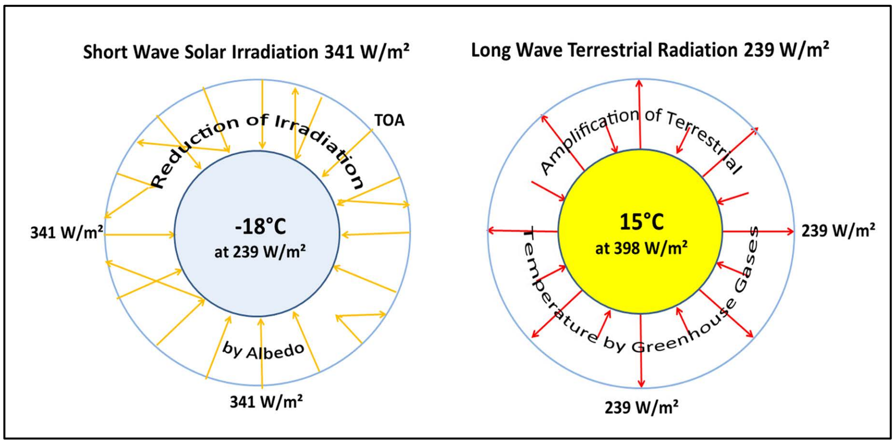

Figure 1. The incoming solar short wave (SW) irradiation (left) and the outgoing terrestrial long wave (LW) radiation (right) from the principle of the natural atmospheric GHE following the values from Trenberth *et al.* [3].

Aside from the fact that a global average temperature should be better additionally specified with its minimum and maximum values, for example, NST = 15 degrees Celsius (−92˚C/58˚C), calculating an average "natural" black body temperature for the Earth from a quarter of the solar constant leads to physically questionable results. Already on a first sight one could find a series of contradictions against the secured laws of physics within this principle of the natural atmospheric GHE:

- The Earth's so called natural temperature of minus 18 degrees Celsius is derived by an S-B inversion with a global averaged net value of solar irradiation. The law of Stefan and Boltzmann (S-B law), however, describes strictly a just-in-time relation between temperature and specific radiation power of a black body. Being a fourth-power relation this physical law is not valid for any arithmetic averaged value of temperature and this limitation is also valid for any scalar value of specific radiation power in a physical inversion of this law.
- The averaged incoming specific net solar irradiance power of 239 Watt per square meter from the factor 4-division of the solar constant equals the mean terrestrial longwave radiation of 239 Watt per square meter and ignores the continuous change between day and night on Earth.
- The radial vector directions of the incoming solar SW irradiation in the common GHE model do not comply with the parallel nature of the factual solar irradiation on Earth. Being one fourth of the solar constant the incoming SW must rather keep its original vector direction or becomes even a scalar if it would be derived from the averaged 24 h solar energy amount at the Earth's surface as being argued in various GHE models.
- The distance between the observation planes for a quarter of the solar incoming irradiance at the top of the atmosphere (TOA) and the measured global mean near-surface temperature is the whole atmosphere of the Earth. The difference between two averaged temperatures, the calculated NTE and the measured NST, is then attributed to the so called GHE caused by a long wave back radiation out of the atmosphere in between. However, there is no evidence that the two observation planes are physically equivalent. Rather, the temperature in the troposphere follows the barometric formula.
- The laws of Thermodynamics state clearly that a body could not be further heated up by its own radiation.

All these arguments could not be healed within the frame of the existing knowledge in physical sciences. Gerlich und Tscheuschner [4] alone have explicitly disproved 14 different definitions of the GHE, but the GHE approach with a quarter of the solar constant is still standard in climate sciences.

3. The Spread of the Factor 4 Approach in Climate Science

In climate science, the so-called GHE from the factor 4 approach for the incoming solar irradiation serves as a global constant to reconcile measured temperatures with theoretical data. There are ongoing scientific efforts to quantify the atmospheric impact of CO_2 and water vapour more exactly by a combination of the idealized radiative-convective equilibrium (RCE) and quantitatively reasonable models for their temperature forcing. And already the basic planetary energy balance of such a RCE starts with a quarter of the solar constant, as described, for example, by Jeevanjee [5]. Furthermore, Wild [6] has analysed the solar radiation budgets from 20 general circulation models (GCMs) participating in the second phase of the Atmospheric Model Intercomparison Project (AMIPII). The multimodel mean average of the 20 GCMs accounts 162 Watt per square meter for the solar SW portion absorbed at surface and 74 Watt per square meter for the solar SW portion absorbed in the atmosphere which sum up to 236 Watt per square meter of the solar SW irradiation being absorbed on Earth between TOA and surface. This mean average from 20 GCMs proves that even in general circulation models the factor 4 derivative of the solar constant, as it is defined by the GHE paradigm, is used in the calculation of climate models and needs the atmospheric GHE to account for the difference between calculated temperatures and the measured NST.

Already the very starting point of the GHE paradigm, which assumes that a globally averaged quarter of the incoming solar shortwave irradiation with parallel vector direction can represent the radial terrestrial longwave radiation, ignores the natural sequence of day and night on Earth. And the derivation of a temperature from a 24 h average of solar irradiation by an S-B inversion leaves the frame of physics and becomes a pure mathematical result. From this global mathematical average there exists no interconnection back to the real existing physics at individual locations at all. Furthermore, nowhere in literature could be found a global distribution chart for the GHE, not the contrast between day and night, nor a global geographic distribution, and neither its development through the seasonal succession of the year.

The Earth's axis of rotation is not directed parallel to the normal vector of the ecliptic of the solar system. Consequently, there are strong local fluctuations in solar irradiation on Earth throughout the year—the so-called changing of the seasons. Daily local solar irradiation at the Earth's surface varies thus in power and energy with latitude and seasons. During the year, the maximum solar power migrates along with the vertical projection of the sun between the tropics. However, due to the different day lengths between summer and winter, the maximum solar energy for a 24 hour-day falls on the polar day of the respective summer hemisphere, with its absolute maximum in the southern polar region because of the Earth's elliptical orbit. This meridional distribution of incoming solar energy within 24 hours is illustrated, for example, in a figure by Kramm and Mölders [7] for an entire year and all latitudes between 90˚ South and 90˚ North. This figure shows clearly that the zonal solar energy, relative to a 24 h-day, increases towards the polar day, reaches its maximum at the summer solstice, and drops to zero in the polar night around the winter solstice.

Therefore, the GHE should also vary meridional through the geographic latitudes, as it allegedly depends on the local surface temperature, which itself is caused by incoming solar HF-irradiation. Despite enormous local temperature differences throughout the year in latitudes outside the tropics, no global distribution of the so-called natural atmospheric GHE could be found in the scientific literature. Information on its local and annual fluctuations or its interaction with solar-induced local temperatures is also lacking.

The greenhouse effect of 33 Kelvin, originally presented as the difference between two globally averaged temperatures—the theoretical blackbody temperature NTE of minus 18 degrees Celsius and the measured terrestrial NST of 15 degrees Celsius, is consequently not quantified with its timely and geographic variations. But there is a clear statement from von Storch *et al.* [8] about the need to simulate the GHE by a sole factor Tau (τ) in parameterized computer models, (quote in translation),

> "If one wants to reproduce the actual globally averaged annual mean temperature of approximately 288 K, one must prevent the infrared radiation emanating from the Earth's surface from leaving the system completely. One adds a factor τ to equation (4.4), which parameterizes the effect of atmospheric substances (radiatively active gases such as CO_2 or cloud water) on the transmission of radiation. The factor T implies a reduction in the effective atmospheric transmissivity, *i.e.*, transmittance, for long-wave radiation."

The atmospheric GHE appears to be merely a theoretical artefact from a comparison of two different globally averaged mean temperatures, and seems not to be based on local physical measurements or calculations. An explaining argument about the nature of atmospheric forcing could be found at Schwartz [9], quote,

> "Because of the importance of forcing by GHGs as a driver of climate change, and because forcing cannot be directly measured (SN5) but can be determined only by radiative transfer calculations, such calculations assume considerable significance."

A purely theoretically defined phenomenon that has not yet been experimentally verified leaves much room for error and speculation. In the simplified solution of the radiative transfer equation presented by Kämpfe [10] solar irradiation and terrestrial radiation are equated following the S-B law. The S-B law describes a real-time relation for the radiation power of a black body with its temperature T at:

$$P = \sigma \cdot A \cdot T^4 \quad (1)$$

where P is the radiation power in Watt, A is the surface area of the black body in m^2 and σ is the Stefan-Boltzmann constant being at $5.67 \cdot 10^{-8}$ W/(m^2K^4). With the specific power density $S = P/A$ in Watt per square meter we then receive for the S-B law:

$$S = \sigma \cdot T^4 \quad (2)$$

This physical law describes a temporally exact relationship between T^4 and S of a body with uniform temperature and its radiation in the direction of the normal vector of its surface. In opposite, an S-B inversion gives a calculative temperature equivalent for the incoming radiation component that incident on a body in the direction of the normal vector of its surface. Consequently, no temperature T could be generated physically in real-time without incoming insolation at all:

$$T = \sqrt[4]{S/\sigma} \tag{3}$$

Williams *et al.* [11] explicitly support such an S-B inversion for the day side of the Moon, quote:

> "The lunar regolith is highly insulating due to its low density and thermal conductivity (Linsky, 1966, Cremers and Birkebak, 1971, Keihm and Langseth, 1973) and therefore heat flow into the subsurface during the day is small compared to the incident solar flux (Vasavada *et al.*, 1999, 2012). Daytime temperatures can therefore be approximated from the balance of incoming solar flux and outgoing thermal emission:
>
> $$T(\theta) = \left[S(1-A)\cos(\theta)/\varepsilon\sigma\right]^{1/4}$$
>
> [Formula (1) at Williams *et al.* corresponding here to (5)]
> where S is the solar constant, A is albedo, ε is emissivity, and σ the Stefan-Boltzmann constant [with θ = latitude]."

Kämpfe [10] equates the incoming radiation flux of the Sun hitting the Earth (Φ_{Sun}) and the outgoing radiation flux of the Earth (Φ_{Earth}). This equation is correct for the total amount of energy. But from the circular area of the incident shortwave solar irradiation (πR^2) and the spherical surface of the Earth ($4\pi R^2$) as well as the solar constant S_0, the Earth's albedo and its radius R, Kämpfe [10] calculates then the equilibrium temperature T_{eq} of the Earth with an S-B inversion to be 255 Kelvin (−18˚C) over day and night. The Earth's "natural" temperature NTE thus corresponds herein to the temperature of a self-luminous star with a uniform surface temperature of 255 Kelvin and does not represent the calculative average from the temperature distribution of a hemispherical illuminated planet with day and night, nor the distribution of temperature through its geographic latitudes. Due to the simplified solution of the radiative transfer equation, the area ratio of incoming to outgoing fluxes by a factor of 4 inevitably found its way into scientific practice and led to the GHE paradigm. This solution ignores the natural radiation succession of day and night on Earth and directly compares the incoming solar shortwave radiation with the outgoing terrestrial longwave radiation without considering the natural solar temperature generation being restricted to the dayside of the Earth, where insolation exclusively hits matter.

The so called "natural atmospheric greenhouse effect" has not yet been detected, is theoretically bound to the fourth part of the solar constant, and is represented by a factor T in climate computer models. These findings could explain why no temporal and geographic distribution of the GHE can be found in the scientific literature. Furthermore, an extensive analysis by Kramm and Dlugi [12] challenges the whole physical base of the so called GHE, quote,

> "Based on our findings, we conclude that 1) the so called atmospheric green-

house effect cannot be proved by the statistical description of fortuitous weather events that took place in past climate periods, 2) the description by AMS and WMO has to be discarded because of physical reasons, 3) energy-flux budgets for the Earth atmosphere system do not provide tangible evidence that the atmospheric greenhouse effect does exist."

After all these physical insights and arguments, it may be helpful to start the consideration of terrestrial temperature genesis from the ground up again.

4. An Alternative Perspective for the Terrestrial Temperature Genesis

The permanent terrestrial change between day and night must not be neglected in climate sciences. The solar azimuth angle represents the local solar time of the day. And already the old Greeks knew the function of the solar zenith angle on terrestrial climate and called it in ancient Greek "κλίμα" (climate). With solar zenith and solar azimuth angles the S-B inversion could estimate an instantaneous theoretical local "solar temperature" for every individual location on the day side of the Earth at any time. There is a huge difference in the result of an S-B inversion if the incoming solar irradiation is either divided by four in a joint global day and night average or physically correct distributed over the dayside hemisphere.

The S-B law describes the relation between the temperature of a black body, usually a sphere, and its radiance in the direction perpendicular to its surface. Consequently, in an S-B inversion the incident radiation must be a directed vector, which is considered only with its component perpendicular to the receiving surface and could never be a scalar. Therefore, the scalar factor 4 from the GHE paradigm cannot represent the vector direction of solar irradiation on Earth. Focusing solely on the Earth's dayside, where the SW insolation strikes matter, the result is not a factor of 4 but rather the full solar beam striking the curved day side of the Earth according to Figure 2.

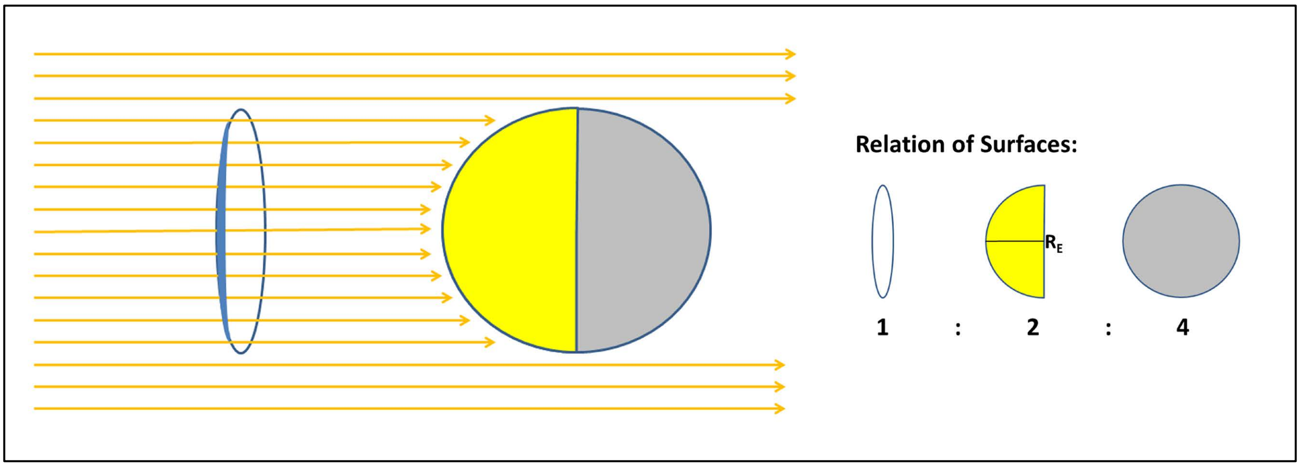

Figure 2. The factual geometry of solar insolation on Earth for a day in equinox and the relation between the involved areas with R_E being the radius of the Earth.

Figure 2 represents the daytime hemispheric solar temperature derived from an inversion of the SW solar radiation power. A parallel bundle of solar insolation in a circle with the Earth's radius hits the day side of the Earth. The specific power of that insolation depends on the local solar zenith and azimuth angles. It becomes immediately clear that the curved shape of the Earth's day side hemisphere does not allow for a uniform temperature from the S-B inversion of the incident solar SW irradiation, nor may the solar radiation power be averaged over the dayside hemisphere before the S-B inversion. In addition, because of the day side's curved surface, no areal average of the incoming specific solar power can be used to calculate temperatures from an S-B inversion for the whole hemisphere. Following the Stefan and Boltzmann approach for the solar temperature on Earth, the local solar temperature (LST_L), representing the S-B temperature equivalent of a local S-B inversion of the incoming solar irradiation, is in general only depending on the solar constant, the Earth's albedo, the factual solar angles ς_L, and θ_L or, alternatively, the local coordinates λ_L and φ_L, the day of the year (D_y) and the local solar time (H_{sL}):

$$LST_L = F\left(S_0, \alpha, \varsigma_L, \theta_L\right) \tag{4}$$

where S_0 is the solar constant, α the Earth's albedo, ς_L and θ_L are the local solar zenith and azimuth angles respectively, both depending on the local geographic coordinates λ_L and φ_L as well as (D_y) and (H_{sL}). Following the author's approximation scheme, the calculation scheme for the average temperature on the Earth's day side hemisphere can be represented by a sequence of mantle rings with constant specific solar power as shown in Figure 3.

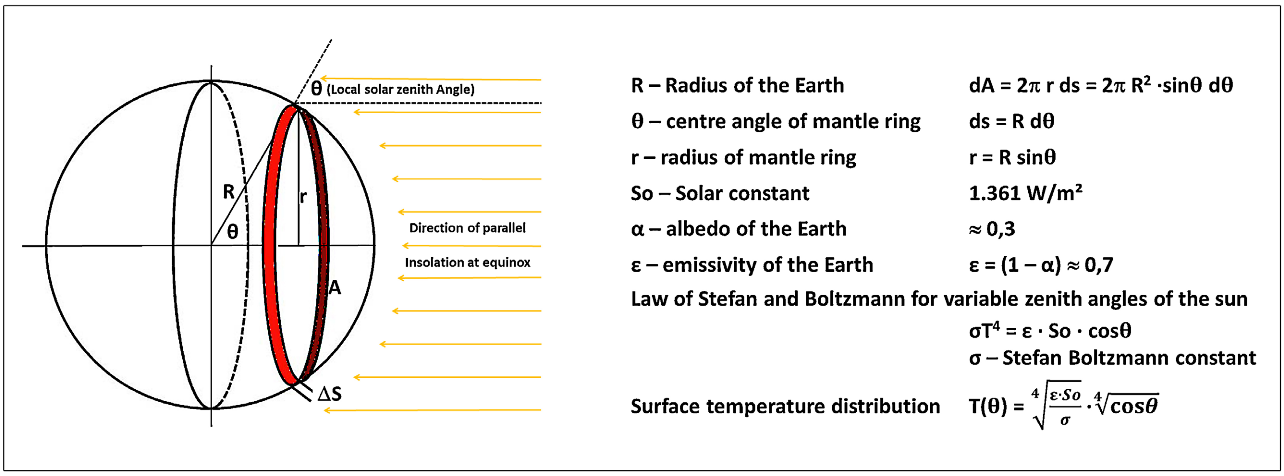

Figure 3. The integration scheme for the Earth's day side average temperature at solar equinox with spherical mantle rings (after Markus Ott [13])—assumptions and calculation framework included

The area-averaged mean temperature of the dayside hemisphere, T_{hem}, becomes calculated by Markus Ott [13] from a base temperature of 0 Kelvin. The dayside's areal integral solution of the surface temperature distribution $T(\theta)$ gets then divided by the areal extent of the whole hemisphere:

$$T_{hem} = \frac{1}{2\pi R^2} \int_{\text{Day Side}} T(\theta)\,\mathrm{d}A \quad (5)$$

$$T_{hem} = \frac{1}{2\pi R^2} \int_0^{\pi/2} \sqrt[4]{\frac{\varepsilon \cdot So}{\sigma}} \cdot \sqrt[4]{\cos\theta} \cdot 2\pi R^2 \cdot \sin\theta\,\mathrm{d}\theta \quad (6)$$

$$T_{hem} = \sqrt[4]{\frac{\varepsilon \cdot So}{\sigma}} \cdot \int_0^{\pi/2} \sqrt[4]{\cos\theta} \cdot \sin\theta\,\mathrm{d}\theta \quad (7)$$

$$T_{hem} = \sqrt[4]{\frac{\varepsilon \cdot So}{\sigma}} \left| -\frac{4(\cos\theta)^{5/4}}{5} + C \right|_0^{\pi/2} = \sqrt[4]{\frac{\varepsilon \cdot So}{\sigma}} \cdot \frac{4}{5} \quad (8)$$

$$T_{hem} = \sqrt[4]{\frac{0.7 \cdot 1.361 \frac{\mathrm{W}}{\mathrm{m}^2}}{5.67 \times 10^{-8} \frac{\mathrm{W}}{\mathrm{m}^2 \cdot \mathrm{K}^4}}} \cdot \frac{4}{5} \approx 288\ \mathrm{K} \approx 15^\circ\mathrm{C} \quad (9)$$

The integral solution from Markus Ott [13] of approximately 15 degrees Celsius (min. = 0 K at 90˚lat./max. = 351 K at 0˚lat.) follows the author's numerical approach for an S-B inversion at solar equinox. Please note that such S-B inversion estimates the local temperature stepwise from segments of constant radiation power as presented in **Figure 3**. Only then, in a final step, these calculated temperatures become averaged over their day side areal contribution. This calculated average temperature is confirmed by the calculations of Milanković [14] for the whole Earth with 15.2 degrees Celsius being the calculated mean annual solar temperature with a resting atmosphere and a uniform land cover. The above hemispheric calculation determines the maximum possible solar temperature on Earth from a basal temperature of 0 Kelvin. In reality, the night side's average temperature, except the polar region of the winter hemisphere, can barely fall far below 0 degrees Celsius because the temperature on our 71% water planet is supported by the mean temperature of the oceans. This global average sea surface temperature (SST) is given for the world (60˚S-60˚N, 0-360˚E) by the Climate Change Institute from the University of Maine [15] at about 20 degrees Celsius for the years 1981 to 2025. Since this global mean SST, being the average over day and night, summer and winter, spring and autumn, northern and southern hemisphere, it proves that the Earth's oceans between 60˚ South and 60˚ Nord have a temperature about 5 degrees higher than the NST at 15 degrees Celsius; however, the polar calottes beyond 60˚S and N have not been taken into account here. Being a steady-state system, the atmospheric and oceanic heat storages of the Earth are already been filled up to their possible equilibrium, according to the solar constant and the Earth's albedo. In a rough and reserved approach of the author with a temperature of only 0 degrees Celsius for the whole amount of water in the Earth's oceans the result comes with a minimum energy content of $1.53 \cdot 10^{27}$ Joule (S. Appendix). Thus, the energy stored within the terrestrial oceans alone, without the energy content of the atmosphere, represents at least the energy of 400 years permanent solar irradiation on Earth.

5. The Hemispheric Solar Temperature of the Earth

Solar temperatures can only be generated where sunlight hits matter, and this occurs exclusively at the day side of the Earth. By inverting the Stefan-Boltzmann law (3), the solar constant of 1.361 Watt per square meter results in a temperature equivalent of about 120 degrees Celsius. But the Earth is not a black body. Approximately 30% of the incoming solar SW irradiation gets reflected, diffracted or bended away and does not contribute to the Earth's temperature. All the visual impressions of mankind, besides artificial illumination, are bound to this 30% fraction of sunlight. Consequently, for a "gray" planet with an albedo, like for example the Earth, the S-B law must be altered to:

$$S_0 \cdot (1-\alpha) = \sigma \cdot T^4 \qquad (10)$$

with α being the albedo at approximately 30%. The maximum temperature-effective solar radiation gets then reduced to 953 Watt per square meter resulting in a maximum Stefan-Boltzmann temperature equivalent of 87 degrees Celsius. Contrary to the globally uniformly distributed factor 4 result, the true local maximum solar temperature depends on the local solar noon and the true local solar zenith angle for each day of the year. From an S-B inversion one can estimate the maximum S-B temperature equivalent (solar temperature) for the incoming solar SW irradiation. The next Figure 4 shows such estimate for the temperature generating part of the maximum solar insolation ($S_0 \cdot \varepsilon \cdot \cos\varsigma$) with ($\varepsilon = 1 - \alpha$) and ς being the local solar zenith angle at local solar noon over all days of the year for various geographic latitudes.

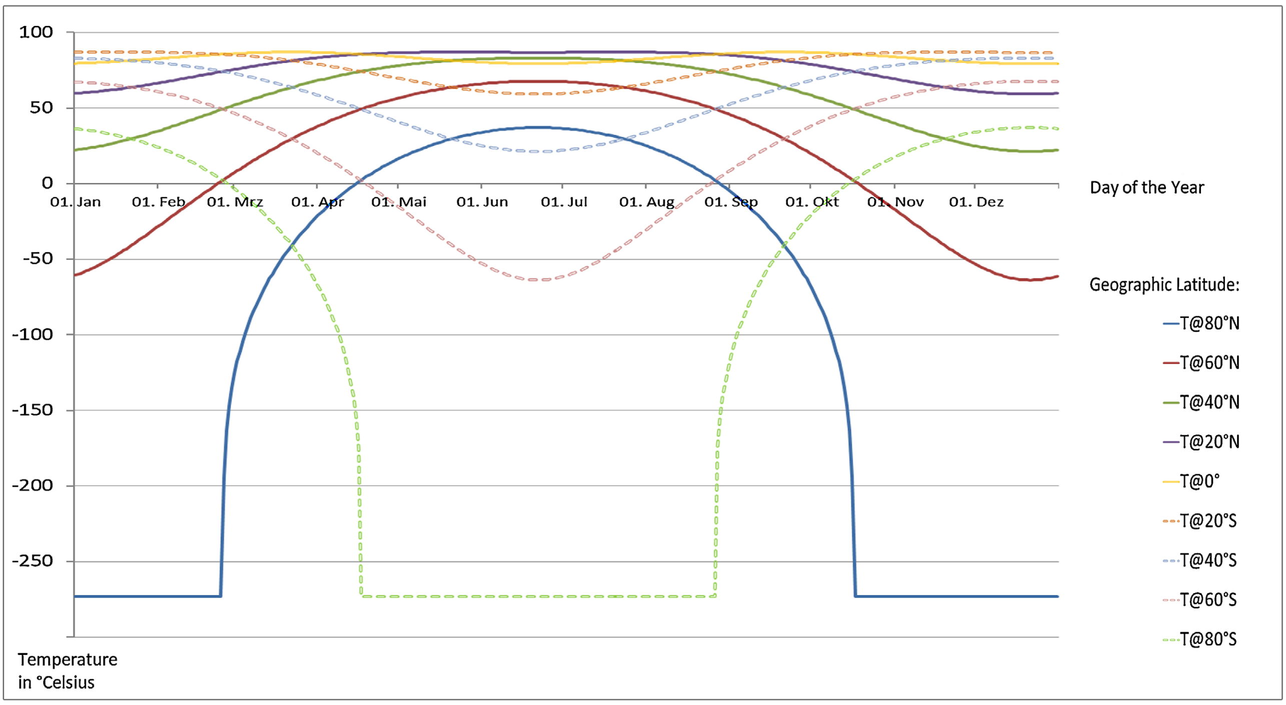

Figure 4. The maximum solar temperature from an S-B inversion at local solar noon for the incoming net solar SW irradiation ($S_0 \cdot \varepsilon \cdot \cos\varsigma$) with ($S_0$ = 1.361 W/m^2 and $\varepsilon = 1 - \alpha$) over the whole year for various geographic latitudes.

The displayed maximum solar temperature is not reached anywhere on earth. Starting with sunrise and heating of the surface, energy is moved away from the specific location by convection and evaporation. This energy remains then in the global circulations for minutes, hours, days, years, decades or even centuries until its released again through advection and condensation. However, the Earth's atmosphere and oceans form a stationary system; therefore, a comparable amount of energy is simultaneously available elsewhere through advection and condensation, which has been transported there by global circulations over minutes, hours, days, years, decades or even centuries.

For any individual location "L" the specific Stefan-Boltzmann power equivalent S_L for the maximal and minimal local temperature, for example within a 24 h-day, can be defined as:

$$S_{L\max} = \sigma \cdot T_{L\max}^4 \quad \text{and} \quad S_{L\min} = \sigma \cdot T_{L\min}^4 \tag{11}$$

We receive then for the difference of the specific power from the two extreme temperatures at location "L":

$$S_{L\max} - S_{L\min} = \Delta S_L = \sigma \cdot \left(T_{L\max}^4 - T_{L\min}^4 \right) \tag{12}$$

where ΔS_L being the local portion of the solar SW irradiation to increase the local minimum night temperature to the local maximum day temperature. The calculation according to Equations (5) to (9) is based on an initial terrestrial temperature of 0 Kelvin and yields the maximum possible average temperature of the day side. In reality, the local terrestrial temperature reaches its minimum value early at first sunrise and its maximum value in the afternoon, with both values being significantly above 0 Kelvin. Consequently, only the overnight energy loss between the local minimum and maximum temperature needs to be replaced by the incoming solar SW radiation on a daily base, so that enough SW insolation remains to maintain the energy content of the global circulations. This argument is even stronger for the ocean temperature which supports the night side near surface temperature, because through the night time the ocean temperature drops, different to the land surface temperature, only by a few degrees Celsius. For an individual location "L" the incoming hemispheric solar SW irradiation S_{0L} could then be estimated to be split into:

$$S_{0L}\left(\text{day} = S_0\left(\alpha, \varsigma_L, \theta_L \right), \text{night} = 0 \right) = \Delta S_L + S_{LCA} + S_{LCO} + S_{LE} \tag{13}$$

where S_{0L} is the portion of the solar constant depending on albedo, local solar azimuth and zenith following Equation (4), ΔS_L being the insolation power to increase the temperature of the local matter between $T_{\min}$ and $T_{\max}$, S_{LCA} and S_{LCO} are the portions of insolation transported away as energy by convection through atmosphere and oceans respectively while S_{LE} being the portion for local evaporation. The individual local contribution to the global LW radiation of the Earth is then:

$$S_{LLW} = S_{LTM} + S_{LAA} + S_{LAO} + S_{LC} \tag{14}$$

where S_{LLW} is the local contribution to the LW radiation power that leaves the

Earth to outer space and S_{LTM} is the contribution of the local matter. S_{LAA} and S_{LAO} are the local incoming portions from advection through atmosphere and oceans respectively while S_{LC} is the local portion from condensation. **Figure 5** shows the principle of the meridional energy transport as a function of geographical latitude.

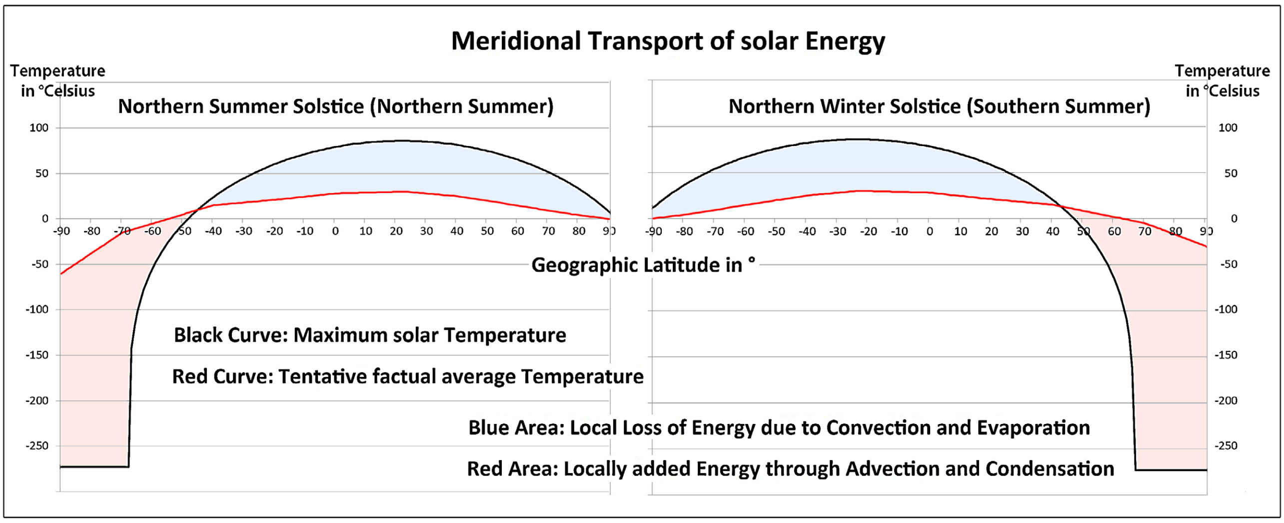

Figure 5. Estimate of the author for the meridional terrestrial transport of solar energy at the solstices as a function of latitude, based on calculated solar temperatures according to **Figure 4** and estimated latitudinal temperature means.

This figure shows that the amount of solar energy, which is locally lost in the tropics and in the summer season of the moderate latitudes through convection and evaporation (blue areas) gets finally transported to the polar zones where it increases the local temperature (red areas). Häckel [16] argues with a common global average for the annual meridional transport where all other energetic processes are assumed to have zero mean value and gives a formula for the horizontal exchange of energy, being:

$$Q + L_l + L_w + V = 0 \tag{15}$$

where Q is the radiation balance, which already includes the so called atmospheric LW back radiation, L_l is the energy transport through air and L_w through water, and V is the latent energy. Häckel's [16] formula (15) represents the annually averaged meridional energy transport, while the instantaneous hemispheric Equations (13) and (14) describe the specific radiant power for the same processes in an individual moment of the year at an individual geographic location. The latent energy V in equation (15) would correspond to the instant sum of $(-S_{LE} + S_{LC})$ in Equations (13) and (14) respectively. The radiation balance Q has no direct hemispheric equivalent, because Equation (13) describes the general local situation at the Earth from a hemispheric view while Equation (15) describes the average annual meridional exchange of energy for the entire surface of the Earth on a factor 4 basis.

According to the hemispheric model, represented by **Figure 4** and **Figure 5** respectively, three geographic zones of latitude can be distinguished, which divide the Earth in principle: the tropical zone as a continuous source of energy between the tropics at 23˚26′05″N and S with barely distinct seasons, the polar calottes between 66˚33′55″N and S around the respective pole being characterized by a semi-annual alternation between polar day and polar night, and in between the temperate zone with poleward increasing differences between summer and winter time from the respective tropic on. To maintain such global measured average temperature of constant 15 degrees Celsius, the solar irradiation over 24 h must substitute the Earth's energy loss over 24 h. With the solar constant S_0 at 1.361 Watt per square meter and an albedo of 30% the incoming net solar energy on Earth from a circular area of πR^2 accounts in 24 hours:

$$\left(S_0 \times 0.7\right) \mathrm{W/m^2} \times 86.400\ \mathrm{s} \times 1.6677 \times 10^{14}\ \mathrm{m^2} = 1.05 \times 10^{22}\ \text{Joule} \tag{16}$$

And the outgoing terrestrial energy content from the Earth being a spherical surface of $4\pi R^2$ accounts in 24 hours to:

$$\left(S_0 \times 0.7/4\right) \mathrm{W/m^2} \times 86.400\ \mathrm{s} \times 5.0671 \times 10^{14}\ \mathrm{m^2} = 1.05 \times 10^{22}\ \text{Joule} \tag{17}$$

As the NST is being globally averaged at the same time over day and night, summer and winter, spring and autumn, as well as northern and southern hemisphere, there may not be an exact match between incoming solar shortwave (SW) and outgoing terrestrial longwave (LW) radiation at any specific time on a daily basis, but rather in the sense of the WMO's 30-year climate definition [17]. Following the S-B law, there is a significant contradiction in this comparison: Although the criterion of equality between the 24 h energy amount of the incoming net solar SW radiation and the outgoing terrestrial LW radiation is met, a NST at 15 degrees Celsius corresponds to an average specific radiation of 398 watts per square meter rather to 239 W/m^2.

But the measured globally averaged NST of the Earth at 15 degrees Celsius has remained stable over more than a whole century being reported by Arrhenius [18] in 1906 at 15 degrees Celsius, Milanković [14] in 1941 at about 15 degrees Celsius and NASA [19] in 2022 at 15 degrees Celsius. Kramm *et al.* [20] even report averaged global temperatures out of the 19th century from Schoch (1856) at 15.0 degrees Celsius, Ferrel (1877) at 15.7 degrees Celsius, and Spitaler (1885) at 15.1 degrees Celsius.

So far, the incoming SW insolation and the emergence of temperatures on the Earth's dayside, supported by the oceans' energy content, have been observed from a hemispherical view. Now, the terrestrial LW radiation must be analyzed to solve the stated contradiction between the specific radiation power at 398 Watt per square meter from the Earth's surface and 239 W/m^2 at the so called radiation altitude.

6. Some Unsolved Questions about the Transport of Energy within the Earth's Atmosphere

In scientific discussions convection and longwave (LW) radiation are used in parallel for energy transport in the Earth's atmosphere. From the view of physics there do exist only three possibilities then. Either there is solely radiation or solely convection or there is a combination from both, with all three possibilities representing the same amount of transported energy. This chapter digs for pure physical arguments beyond the established factor 4 mainstream knowledge, again.

6.1. Measured infrared Spectra from Satellites

The reduced infrared spectra of infrared active gases like CO_2, H_2O, O_3, and CH_4 as being measured by satellites are considered as evidence for the GHE of the Earth. It is undisputed that the radiation of IR-active gases occurs randomly and in all directions. Let us imagine a surface at the so called atmospheric radiation altitude with its normal vector being the radial direction away from the Earth. In a rough approximation it is assumed that only the LW radiation of the IR-active gases which is radiated away from this surface to outer space leaves the Earth's atmosphere. Already this simplified perspective spans a solid angle of $2\pi_{sr}$ for the outgoing LW radiation of the Earth. The manual for the surface based AERI instrument (Atmospherically Emitted Radiance Interferometer) from ABB [21], however, states that the spatial field of view of the AERI is 45 mrad full angle. Furthermore, it does not come out clearly from the "AERI Handbook" [21], weather data are measured, calculated, or combined from both, quote with emphasis from "7.1.3 Specifications",

> "Resolution of instrument is one wavenumber (1/cm). Range of wavelengths is 520 to 3300 wavenumbers or 400 to 3300 wavenumbers in the ER polar detector. **Data are collected only in the atmospheric windows.** Maximum range is top of atmosphere on a clear-sky day. Measurements are taken every 8 minutes in standard mode and every minute in rapid sampling mode. The instrument views straight up into the atmosphere with a 1.3-degree field-of-view."

Calibration using two internal blackbodies thus establishes a computational plane for radiance as a function of wavenumber. Measurements are only taken in the wavenumber range of approximately 700 to 1250 (atmospheric window), while results between wavenumbers 520 and 3300 are output with a spectral accuracy of one wavenumber. Assuming that the aperture determines the spatial resolution of a radiance Interferometer, satellite instruments should be constructed quite similar to the AERI instrument. Taylor *et al.* [22] give the resolution of the airborne Scanning High-resolution Interferometer Sounder (S-HIS) at 100 mrad angular field of view. Paige *et al.* [23] give in their description of the Diviner Lunar Radiometer Experiment a Detector Geometric IFOV at 3.4 mrad cross track and 6.7 mrad in-track for the field of view. Hence, there is a great difference between the aperture of the terrestrial LW radiation at a solid angle of $2\pi_{sr}$, and the capability of spectrometers with a full angle of about 100 mrad or less, because such instrument could only measure the portion of nearly radial outgoing rays. Consequently, the reduced amplitude spectrum of the Earth's LW radiation could be an artefact of the instrument construction rather than a proof for the GHE.

6.2. About Energy Transport within the Earth's Atmosphere

Physics clearly state that the overall amount of energy transported must not exceed or fall below its factual existing amount. A Pirani curve may help to understand the mechanism of the terrestrial energy transport to outer space. The Pirani instrument is a glass cylinder that can be evacuated and contains a filament. Over the range of measurements at different pressures the temperature of the filament is held constant and the electrical energy to maintain its temperature is recorded. A typical Pirani curve shows three nearly straight parts that are connected by two bended mixed zones to each other. **Figure 6** is adopted from Jousten [24] who shows Pirani curves for different types of gas over pressures at seven powers of ten. The adopted curve gives a generalized impression of the kind of energy transport for mixed air in different pressure regimes.

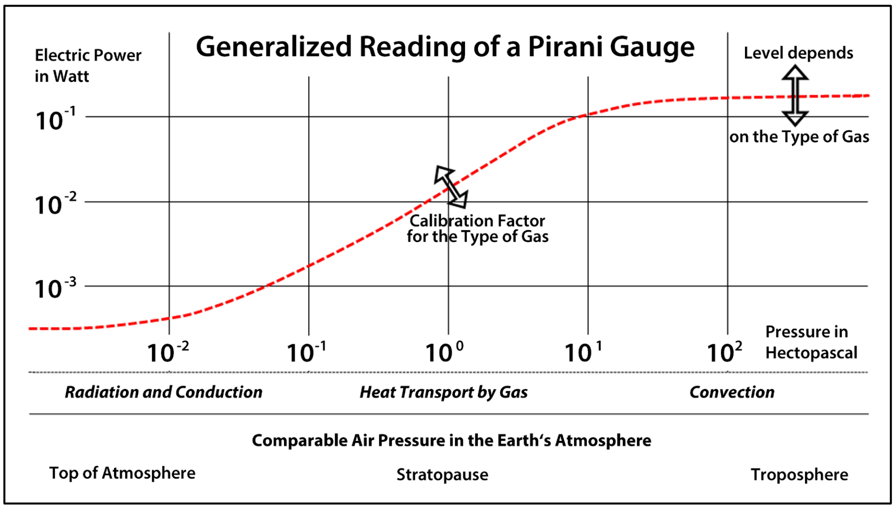

Figure 6. The basic course of a Pirani curve according to Jousten [24], adopted by the author to its principles and applied to the Earth's atmosphere.

Pirani gauges are typically set to nitrogen or pure air. The manufacturer Pfeiffer Vacuum [25] gives calibration factors for other types of gas for pressures below 1 Hectopascal in the manual of his instrument TPR 270, for example 0,9 for carbon dioxide (CO_2), and mentions "*In the pressure range* < 1 *hPa the display is linear*" (translation to English by the author). The manufacturer's calibration factor for CO_2 proves that infrared-active gases do not behave basically different from IR-passive gasses in a low pressure atmosphere. At very low pressure around 1 Pascal there is only energy transport by radiation as **Figure 6** shows. The term "conduction" there may be neglected because it stands for the energy loss through the electric connectors of the filament. And as the temperature of the filament is held constant throughout the measurement, this energy loss will also be constant. At an air pressure of 1 Hectopascal (about 50 km altitude) there is only energy transport by gas, while at higher pressures above 10 Hectopascal there is only energy transport by convection. 10 Hectopascal air pressure is equivalent to an altitude of about 30 km in the standard atmosphere and 100 Hectopascal represent about 20 km as shown in Figure 7.

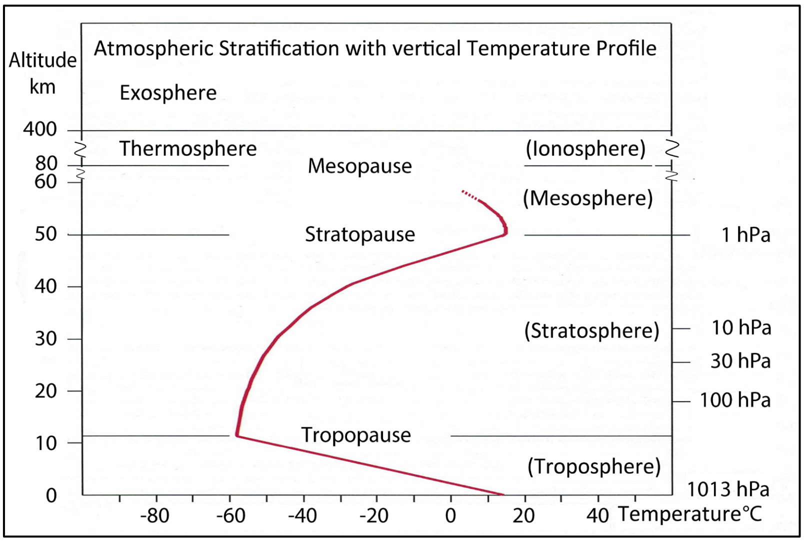

Figure 7. The standard atmosphere with temperature and air pressure from different sources [26] [27].

Figure 7 confirms the above findings. According to the Pirani curve displayed in Figure 6 any energy transport by radiation is very unlikely within the troposphere and that seems also be true for the claimed radiation elevation of the GHE paradigm at about 5.000 meters altitude. This result strengthens the argument in favor of the barometric formula that the main part of the energy is transported away from the Earth's surface by convection. Furthermore, the adopted Pirani curve confirms the finding from the barometric formula that no radiation transport of energy takes place within the troposphere. The existence of a back radiation following the GHE paradigm as an additional source of energy for the temperature genesis on Earth is therefore very unlikely.

6.3. About the Origin of Atmospheric Back Radiation

The so called atmospheric back radiation accounts in total to 333 Watt per square meter and is supposed to heat up the Earth's surface with a net portion of 159 Watt per square meter from minus 18 degrees Celsius to 15 degrees Celsius in average. Consequently, the natural atmospheric GHE must be located between the Earth's surface at sea level and 5.000 meter altitude in the atmosphere. In this part of the GHE model there is again a series of physical contradictions:

- A specific portion of energy from the Earth's surface can only be transported once to the so called radiation altitude, either by atmospheric convection or by LW radiation. If a reasonable amount of energy gets transported from the surface to the origin of atmospheric back radiation below 5.000 meter altitude by LW radiation, then this portion is missing for the transport by convection.

- And, in addition, this GHE-derived radiation altitude cannot exceed the elevation of the globally distributed more than 5.000 meter high mountains by a considerable margin. But such physical border should then have been clearly identified in the past. However, not a single report could be found in literature describing that such a measured physical boundary between convection and radiation has been discovered anywhere about 5.000 m elevation.
- The atmosphere between the Earth's surface and the so called radiation altitude strictly obeys the barometric formula, with pressure and temperature decreasing continuously with increasing altitude up to the tropopause. Consequently, except the LW radiation leaving through the atmospheric window directly, there can be no additional energy transport by longwave radiation from the Earth's surface feeding the assumed origin of atmospheric back radiation between the sea level and the so called radiation altitude.

In addition, it would be an incredible physical coincidence if the altitude of 5.000 meters, calculated from the NST of 15 degrees Celsius at sea level using the barometric formula, were to correspond exactly to the Stefan-Boltzmann temperature of the radiation emanating from the Earth at 5.000 meters with 239 Watt per square meter, according to the GHE paradigm.

7. The Outgoing Longwave Radiation of the Earth

The last important task is to solve the stated contradiction and to align the different levels of observation in the GHE paradigm. Trenberth *et al.* [3] show in their global annual mean Earth's energy budget that the outgoing terrestrial longwave radiation from the Earth to outer space accounts to 239 Watt per square meter with a Stefan-Boltzmann temperature equivalent of minus 18 degrees Celsius. The GHE-paradigm defines this radiation altitude of the Earth at about 5.000 meters while the outgoing LW radiation from the surface accounts to 398 Watt per square meter.

The barometric formula depends on the Earth's gravity and the air mass, which is essentially determined by water vapor. A compilation from NOAA [26] dated from 1976 proves that the temperatures from the U.S. standard atmosphere are well known in atmosphere physics since more than half a century. The pressure of the air declines with altitude and so does the density and the temperature of a specific air volume. Rising in the atmosphere, such a specific air volume expands its size through falling air pressure with altitude, but due to the adiabatic nature of convection the energy content of the extended volume remains constant. The average lapse rate in the standard atmosphere accounts for 6.5 Kelvin per 1.000 Meter rise and the barometric formula connects both observation levels of the GHE in a physically correct manner, the Earth's surface at sea level and the so called radiation altitude in the atmosphere as shown here by NASA [28]:

$$T = 15.04 - 0.00649 * h \quad (18)$$

where the temperature T is given in Celsius degrees, and h is the altitude in meters. At a negative gradient of 6.5 Kelvin per 1.000 meter altitude a temperature drop of 33 Kelvin occurs from sea level at a temperature of 15 degrees Celsius to the so called radiation altitude of about 5.000 m and thereby the Earth's longwave radiation temperature of minus 18 degrees Celsius is reached without involving any additional atmospheric effect—solely through gravitational volume change. The validity of the barometric formula itself proves that no radiation transport of energy is taking place in the lower atmosphere between the Earth's surface at sea level and the GHE radiation altitude. Consequently, the barometric formula sufficiently explains the decay of the specific radiation power at 398 watts per square meter from the Earth's surface to 239 W/m² at the so called radiation altitude of about 5.000 meter.

8. Discussion

The conventional estimate of a global natural temperature for the Earth has been challenged, because it depends on a geometrical factor 4 for the solar constant at TOA and results in a "natural" temperature of minus 18 degrees Celsius for the Earth. The resulting atmospheric GHE of 33 Kelvin from this factor 4-approach for the solar constant, which is needed to account for the measured global averaged near surface temperature of 15 degrees Celsius, does not comply with the trusted rules of physics. The whole GHE logic is arbitrary and does not follow the actual physical knowledge nor the S-B law or its inversion correctly. The GHE theory neglects the difference between day and night, and therefore the author [29] had once decided to focus on the temperature genesis of the Earth from a hemispheric day side perspective as being presented in this paper.

The main arguments against the factor 4 GHE paradigm are the wrong implementation of the S-B inversion with a global average of solar irradiation, and the missing of the alteration between daytime with solar temperature generation and night time without, as well as the lack of consideration of the stored energy amount in oceans and atmosphere of the Earth which support the night-time temperatures. These shortcomings lead to a global uniform "natural" temperature of minus 18 degrees Celsius for the Earth, where the individual measured near surface temperature is assumed to depend strongly on an atmospheric GHE. But there exists no individual qualified dependence between the atmospheric GHE and local geographic coordinates nor solar time but a global constant 33 K difference between this "natural" temperature of the Earth and the measured mean near surface temperature. The hemispheric view, in contrary, assumes that the terrestrial temperature is caused solely by the factual solar irradiation on the day side of the Earth and ends up with the correctly measured global average temperature of about 15 degrees Celsius for the day side. The temperature of the night side is then determined by the energy content of the oceans, as proven by the averaged measured sea surface temperatures and its energy content. Consequently, the hemispheric view on the terrestrial temperature genesis does explain the measured temperatures on Earth strictly on the path of secured physical knowledge. This hemispheric convection model leaves no room for an atmospheric GHE, nor for an atmospheric back radiation. The temperature on Earth is determined exclusively by the sun, the Earth's albedo, the energy content of the oceans, and the global circulations.

9. Summary and Conclusions

The hemispheric convection model starts with the solar temperature at the Earth's day side. Through the daytime the factual local temperature is governed in reality by the local loss of energy (= power x time) into the global circulations in oceans and atmosphere. Figure 5 gives a graphic estimate for the principle of the meridional energy transport on Earth from warm to cold zones, *i.e.* energy is transported meridional from the tropic zone and the moderate zone of the summer hemisphere into the moderate and the polar zone of the winter hemisphere by the global circulations. Generally, solar energy is constantly transported from warm to cold regions of the Earth by global circulation patterns. This hemispheric view mirrors a strict accordance with the physical basis resulting in the factual global temperature distribution that needs no explanation through a natural atmospheric greenhouse effect, nor an atmospheric back radiation.

And, finally, even the so called radiation altitude for the Earth's LW radiation from the GHE paradigm at about 5.000 meter should be reconsidered. There is a strong contradiction between this radiation altitude and a Pirani estimate for atmospheric energy transport. Following these findings, the radiation altitude of the Earth may likely to be localized at an altitude far above the atmosphere's tropopause. And, according to the arguments from the Pirani estimate, direct radiation through the atmospheric window to outer space should also be reassessed.

Notes

In this article, averaged values are used in argumentation. It has to be emphasized here clearly that averaged values do not meet the T^4-function between temperature and the specific radiation power of a black body correctly, according to the S-B law. But the correct argumentation, depending on a calculation with the local solar zenith and azimuth angles, would hamper the understanding of the given arguments heavily.

Acknowledgements

I thank the European Institute for Climate and Energy and its Vice President Michael Limburg for the opportunity to present the intermediate steps of my hemispheric convection model on its public platform for discussion. Markus Ott has transferred my numeric hemispherical approximation into an integral solution. And Karsten Schütz kindly proofread the manuscript and has sharpened my arguments in English, making this article better understandable for the interested reader. The flaws arose from subsequent text changes by the author.

Declaration

No AI tools except internet translators have been used in the creation of this paper.

Funding

This research received no funding and was conducted by pure scientific curiosity.

Data Availability Statement

This work uses neither new data nor new physical insights. Rather, the article bridges the gap between the established physical GHE-description in climate science and the actual origin of terrestrial temperature genesis.

Conflicts of Interest

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

References

[1] IPCC (2023) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157896

[2] Cook, J., Nuccitelli, D., Green, S.A., Richardson, M., Winkler, B., Painting, R., *et al.* (2013) Quantifying the Consensus on Anthropogenic Global Warming in the Scientific Literature. *Environmental Research Letters*, **8**, Article 024024. https://doi.org/10.1088/1748-9326/8/2/024024

[3] Trenberth, K.E., Fasullo, J.T. and Kiehl, J. (2009) Earth's Global Energy Budget. *Bulletin of the American Meteorological Society*, **90**, 311-324. https://doi.org/10.1175/2008bams2634.1

[4] Gerlich, G. and Tscheuschner, R.D. (2009) Falsification of the Atmospheric CO_2 Greenhouse EFFECTS within the FRAME of Physics. *International Journal of Modern Physics B*, **23**, 275-364. https://doi.org/10.1142/s021797920904984x

[5] Jeevanjee, N. (2023) Climate Sensitivity from Radiative-Convective Equilibrium: A Chalkboard Approach. *American Journal of Physics*, **91**, 731-745. https://doi.org/10.1119/5.0135727

[6] Wild, M. (2005) Solar Radiation Budgets in Atmospheric Model Intercomparisons from a Surface Perspective. *Geophysical Research Letters*, **32**, L07704. https://doi.org/10.1029/2005gl022421

[7] Kramm, G. and Mölders, N. (2025) On the Insolation at the Top of the Earth's Atmosphere and Its Variation under Smooth Changes of Astronomical Elements during the Past Four Centuries. *Natural Science*, **17**, 72-123. https://doi.org/10.4236/ns.2025.176009

[8] von Storch, H., Güss, S. and Heimann, M. (1999) Das Klimasystem und seine Modellierung - eine Einführung. Springer-Verlag Berlin Heidelberg New York, p. 83.

[9] Schwartz, S.E. (2018) The Greenhouse Effect and Climate Change. ESS Open Archive. https://doi.org/10.1002/essoar.81ea1b43594141c6.558e238c20a84445.1

[10] Niklaus, K. (2026) Physik der Atmosphäre vom Herbstsemester 2007 am Institute of Applied Physics (IAP) der Uni Bern. https://www.yumpu.com/de/document/read/6234709/physik-der-atmosphare-iap-microwave-physics

[11] Williams, J.P., Paige, D.A., Greenhagen, B.T. and Sefton-Nash, E. (2017) The Global Surface Temperatures of the Moon as Measured by the Diviner Lunar Radiometer

Experiment. *Icarus*, **283**, 300-325. https://doi.org/10.1016/j.icarus.2016.08.012

[12] Kramm, G. and Dlugi, R. (2011) Scrutinizing the Atmospheric Greenhouse Effect and Its Climatic Impact. *Natural Science*, **3**, 971-998. https://doi.org/10.4236/ns.2011.312124

[13] Ott, M. (2021) Dismantling the CO_2-Hoax. pp. 51-52. https://tomn.substack.com/p/dismantling-the-co2-hoax

[14] Milanković, M. (1941) Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitenproblem. Éditions Speciales, Académie Royale Serbe, p. 436.

[15] Climate Change Institute at the University of Maine (2025) Daily Sea Surface Temperature 1981-2025 from NOAA Optimum Interpolation SST (OISST) Internet. https://climatereanalyzer.org/clim/sst_daily/?dm_id=world2

[16] Häckel, H. (1993) Meteorologie. Verlag Eugen Ulmer UTB.

[17] World Meteorological Organization and WMO Climatological Normals (2015) Averages of Climatological Data Computed for the Following Consecutive Periods of 30 years, Internet. https://community.wmo.int/en/activity-areas/climate-services/climate-products-and-initiatives/wmo-climatological-normals

[18] Arrhenius, S. (1906) Die vermutliche Ursache der Klimaschwankungen. Nobelinstitut Band I, No. 2, p. 4.

[19] NASA (2022) NASA Planetary Fact Sheet. https://assets.science.nasa.gov/content/dam/science/psd/solar/2023/09/s/Solar_System_Thermometer-02152022-1.jpg

[20] Kramm, G., Dlugi, R., Berger, M. and Mölders, N. (2020) Meridional Distributions of Historical Zonal Averages and Their Use to Quantify the Global and Spheroidal Mean Near-Surface Temperature of the Terrestrial Atmosphere. *Natural Science*, **12**, 80-124. https://doi.org/10.4236/ns.2020.123012

[21] ABB Analytical Measurement (Manufacturer) (2013) Installation and User Guide (AERI and E-AERI Systems). Document Number: AA004389-01 Rev D.

[22] Taylor, J.K., Revercomb, H., Fred Best, P., *et al.* (2025) The Scanning High-Resolution Interferometer Sounder (S-HIS), A White Paper Submitted to the ARM Aerial Instrumentation Workshop White Paper Call. https://www.ssec.wisc.edu/~dennyh/uw_ssec_anl_cels_workshop/WhitePaper-AAF_2020_SHIS_submitted.pdf

[23] Paige, D.A., Foote, M.C., Greenhagen, B.T., Schofield, J.T., Calcutt, S., Vasavada, A.R., *et al.* (2009) The Lunar Reconnaissance Orbiter Diviner Lunar Radiometer Experiment. In: *Lunar Reconnaissance Orbiter Mission*, Springer, 125-160. https://doi.org/10.1007/978-1-4419-6391-8_7

[24] Jousten, K. (2017) Physikalisch-Technische Bundesanstalt (Nationales Deutsches Metrologieinstitut), Presentation "Vacuum Gauges I" at the CERN Accelerator School June 6-15, 2017. https://indico.cern.ch/event/565314/contributions/2285744/attachments/1470253/2283712/CAS_Gauges_1_Jousten_v2.pdf

[25] Pfeiffer Vacuum (2025) (Manufacturer) Betriebsanleitung (Manual) for the Compact Pirani Gauge TPR 270. Document PT0567BDE, pp. 21-22.

[26] NOAA (1976) U.S. Standard Atmosphere, Item NOAA-S/T 76-1562, US Government Printing Office, Stock No. 003-017-00323-0: p. 25. https://ntrs.nasa.gov/api/citations/19770009539/downloads/19770009539.pdf

[27] Agerius, A. (2021) Kritische Analyse zur globalen Klimatheorie. Tredition, p. 123.

[28] NASA (2021) Earth Atmosphere Model.
https://www.grc.nasa.gov/www/k-12/airplane/atmosmet.html

[29] Weber, U. (2016) A Short Note about the Natural Greenhouse Effect, Mitteilungen der Deutschen Geophysikalischen Gesellschaft (ISSN 0934-6554) 3/2016: 19-22.
https://dgg-online.de/WordPress_01/wp-content/uploads/2016/12/DGG-3-16web1.pdf

[30] Water Science School (2019) U.S. Geological Survey: How Much Water is There on Earth?
https://www.usgs.gov/water-science-school/science/how-much-water-there-earth?qt-science_center_objects=0#qt-science_center_objects

Appendix: Estimate for the Minimum Heat Content of the Global Oceans

Radius R of the Earth	6371	km	6.371.000	m
Circle of incoming insolation	(*PI R*²)		1.27516E+14	m^2
Solar constant	1361	W/m^2		
Solar constant minus the Earth's albedo of 30%	953	W/m^2		
Temperature-effective solar irradiation in 24 h	86400	Seconds	1.04963E+22	Joule
Water in Oceans, Seas, & Bays [30]	1.338E+9	km^3	1.338E+21	kg
Specific heat capacity of water	4.186	J/kg/K		
Heat content of the oceans at 0˚C			1.52904E+27	Joule
Ocean's heat content/24 h temp.-eff. insolation	145.674	Days of 24 h	399	Years