Neue Studie: Ein „Denkmodell“, das von einem „natürlichen Treibhauseffekt“ von 33 K ausgeht, ist eine „wertlose“ Behauptung

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Die Vorstellung von einer 33 K wärmeren Erde aufgrund des Vorhandenseins von Wasserdampf und CO_2 (Treibhausgase) in der Atmosphäre beruht vollständig auf unbeobachteten und unbekannten Faktoren oder auf Annahmen darüber, wie eine imaginäre Welt ohne Atmosphäre aussehen würde.

Es wird weithin angenommen, dass wir die effektive Strahlungstemperatur, eine einheitliche globale Temperatur, die weltweit einheitliche Albedo … eines Gesteinsplaneten bestimmen können, indem wir einfach Gedankenexperimente darüber anstellen, wie eine erfundene Welt ohne Atmosphäre aussehen würde (z. B. kein N_2, O_2, atmosphärischer Druck, Wolken, Wasserdampf …).

Dieses „Gedankenmodell“ wurde in einer neuen, von vier Atmosphären-Physikern veröffentlichte Studie einer kritischen Analyse unterzogen.

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On the Solar Climate of the Moon and the Resulting Surface Temperature Distribution

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The solar climate of our Moon is analyzed using the results of numerical simulations and the recently released data of the Diviner Lunar Radiometer Experiment (DLRE) to assess (a) the resulting distribution of the surface temperature, (b) the related global mean surface temperature $\langle T_s \rangle$, and (c) the effective radiation temperature T_e often considered as a proxy for $\langle T_s \rangle$ of rocky planets and/or their natural satellites, where T_e is based on the global radiation budget of the well-known "thought model" of the Earth in the absence of its atmosphere. Because the Moon consists of similar rocky material like the Earth, it comes close to this thought model.

The effective radiation temperature of the Earth either with or without an atmosphere is only a synonym for the global average of the infrared radiation emitted to space. It is a measure of the intensity of the radiation emanating from the Earth and, therefore, says nothing about the existing temperature distribution [35]. It was considered, for instance, by Defant and Obst [36], Lenard [37], Möller [38], and later adopted by many others like Hansen *et al.* [24] to quantify the so-called greenhouse effect. However, in the case of the Earth in the absence of its atmosphere, T_e would only correspond to a globally averaged surface temperature if the surface temperature were uniformly distributed, which is, by far, not the case. A uniform distribution of the surface temperature would only exist in the trivial case that the solar constant for the planet or natural satellite would be zero. As illustrated in **Figures 1-3**, the distribution of the surface temperature on a planet or a natural satellite (like Earth's Moon or Jupiter's Galilean moon Io) in the absence of an atmosphere is non-uniform.

The formula for the effective radiation temperature, T_e, either of the Earth (with or without an atmosphere) or the Moon (or any other planet and natural satellites),

$$T_e = \left(\frac{(1-\alpha_G)S}{4\varepsilon_G \sigma} \right)^{\frac{1}{4}} \tag{1.1}$$

is crudely based on the solar climate. This formula is based on a global radiative equilibrium which means that the infrared radiation emanating from this conceptual Earth, $\varepsilon_G \sigma T_e^4$, is equal to the globally averaged absorbed solar radiation, $(1-\alpha_G)S/4$ [10]. Here, α_G is the global (or planetary) albedo in the solar range, S is the solar constant, ε_G is the global emissivity, and $\sigma = 5.67 \times 10^{-8}\,\mathrm{W \cdot m^{-2} \cdot K^{-4}}$ is Stefan's constant. Note that the power law of Stefan [11] and Boltzmann [12] is only valid on a local scale. Applying it on a global scale notably disagrees with the prerequisites and assumptions on which the derivation of this power law is based. In the case of the Earth, the solar constant is about $S = 1361\,\mathrm{W \cdot m^{-2}}$ [13-16]. With the usual assumptions of $\alpha_G = 0.30$ and $\varepsilon_G = 1.0$, one obtains $T_e \approx 255\,\mathrm{K} = -18^{\circ}\mathrm{C}$. Thus, the so-called natural atmospheric greenhouse effect is usually quantified by $\Delta T = \langle T_m \rangle - T_e \approx 33\,\mathrm{K}$, where $\langle T_m \rangle \approx 288\,\mathrm{K}$ (e.g., [2, 17-26]) is the globally averaged near-surface air temperature. Here, the angle brackets, $\langle \ldots \rangle$, define the global average (e.g., [19, 27-29])

$$\langle \psi \rangle = \frac{1}{4\pi} \int_0^{2\pi} \int_0^{\pi} \psi(\theta,\varphi) \sin\theta \, \mathrm{d}\theta \mathrm{d}\varphi = \frac{1}{2} \int_0^{\pi} \bar{\psi}(\theta) \sin\theta \, \mathrm{d}\theta \tag{1.2}$$

with the zonal average (e.g., [28-32]),

$$\bar{\psi}(\theta) = \frac{1}{2\pi} \int_0^{2\pi} \psi(\theta,\varphi) \mathrm{d}\varphi \tag{1.3}$$

where $\psi(\theta,\varphi)$ is a field quantity like the solar insolation, $F_S(\theta,\varphi)$, the absorbed solar irradiance, $Q(\theta,\varphi)$, the infrared irradiance, $F_{IR}(\theta,\varphi)$, and the surface temperature, $T_s(\theta,\varphi)$.

The assumption of a global albedo of about $\alpha_G = 0.30$, however, is far from reality because this value is related to the entire Earth-atmosphere system. For $\alpha_G = 0.30$, the infrared radiation emitted to space would be that at the top of the atmosphere (TOA) of about $\langle F_{IR} \rangle \cong 238.2\,\mathrm{W \cdot m^{-2}}$. The cloud cover primarily contributes to this value of the global albedo, but a cloud cover cannot exist in the thought model of the Earth in the absence of its atmosphere. Furthermore, the global emissivity of such a conceptual Earth is unknown. Both quantities might be related to those of the Earth's Moon, as done by Kramm *et al.* [29].

Since, however, the thought model of an Earth in the absence of an atmosphere eludes observation, there are some assumptions that can be combined at will. Inserting, for instance, $\varepsilon_G = 0.8$ as assumed by Schack [33], and $\alpha_G = 0.07$ as suggested by Budyko [34] for the Earth in the absence of its atmosphere into Equation (1.1) would provide $T_e = 289\,\mathrm{K}$. Thus, we would obtain $\Delta T = \langle T_m \rangle - T_e \approx -1\,\mathrm{K}$.

Based on the globally averaged emitted infrared radiation of $\langle F_{IR} \rangle = 290.5\,\mathrm{W \cdot m^{-2}} \pm 3.0\,\mathrm{W \cdot m^{-2}}$ derived from these 24 datasets (see **Figure 22**), the effective radiative temperature for the Moon would be $T_{e,M} = \langle T_{bol}^4 \rangle^{1/4} = 271.0\,\mathrm{K} \pm 0.7\,\mathrm{K}$. **Figure 22** also shows the emission of infrared radiation calculated by applying the Stefan-Boltzmann power law to the globally averaged bolometric temperatures illustrated in **Figure 20**, *i.e.*,

$$\varepsilon\sigma \langle T_{bol} \rangle^4 < \langle \varepsilon\sigma T_{bol}^4 \rangle \tag{6.1}$$

Apparently, this kind of calculation is meritless. Therefore, it is time to acknowledge that the Stefan-Boltzmann power law must not be applied to globally averaged temperatures.

The DLRE data provide observational evidence that the concept of the effective radiation temperature must be discarded for planets and their natural satellites. In the case of stars, for which the concept of the effective radiation temperature was derived, the condition of a uniformly distributed emittance may be crudely fulfilled, and the stars' emission spectra may be approximated by Planck's blackbody radiation function related to their effective radiation temperatures, as illustrated in **Figure 23** for our Sun. The condition of a uniform distribution of the emittance, however is, by far, not fulfilled in the case of planets and their natural satellites. In addition, their emission spectra vary with latitude and time. This fact is the reason why radiometers use different channels as illustrated by **Figure 15** and **Figure 16** to cover the wide range of surface temperatures. Since the maximum of the intensity of Planck's blackbody radiation function is proportional to the fifth power of the temperature [8, 86, 108, 109], averaging over the Planck functions for different temperatures is physically and mathematically awkward.

Based on the observations performed at the landing site of the Apollo 15 mission, we showed that the occurrence of the two lunar eclipses has only a negligible effect on the zonal averages of the surface temperature if twelve lunations are considered.

The global averages of the bolometric temperature, $\langle T_{bol} \rangle$ for all 24 DLRE datasets related to the subsolar longitude ϕ_{ss} amount to $\langle T_{bol} \rangle = 201.1\,\mathrm{K} \pm 0.6\,\mathrm{K}$. Based on the globally averaged emitted infrared radiation of $\langle F_{IR} \rangle = 290.5\,\mathrm{W \cdot m^{-2}} \pm 3.0\,\mathrm{W \cdot m^{-2}}$ derived from these 24 DLRE datasets, the effective radiative temperature of the Moon is $T_{e,M} = \langle T_{bol}^4 \rangle^{1/4} = 271.0\,\mathrm{K} \pm 0.7\,\mathrm{K}$ so that $\langle T_{bol} \rangle \cong 0.742 T_{e,M}$. This means that in the case of the Moon, the effective radiation temperature is about 60 K higher than the globally averaged surface temperature.

Furthermore, our results obtained by means of the DLRE observations confirm Kramm *et al.* [29] who obtained for the Moon $\langle T_{slab} \rangle \cong 197.9\,\mathrm{K}$ and $T_{e,M} = \langle T_{slab}^4(\theta,\varphi) \rangle^{1/4} \cong 266.4\,\mathrm{K}$ resulting in $\langle T_{slab} \rangle \cong 0.743 T_{e,M}$. Our results also empirically confirm the temperature inequality (1.17) of Gerlich and Tscheuschner [53], *i.e.*, $\langle T_{bol} \rangle < \langle T_{bol}^4 \rangle^{1/4} = T_{e,M}$.

Obviously, the relationship between the global average of the surface temperature and the effective radiative temperature of a rocky celestial body differs by a factor that depends on the astronomical parameters, especially on the angular velocity of rotation. Kramm *et al.* [29], for instance, found for the solar climate of the 27.4 times faster rotating Earth $\langle T_{slab} \rangle \cong 0.828 T_{e,E}$. Consequently, the DLRE observations provide empirical evidence that in the case of rocky planets and their natural satellites, the globally averaged surface temperature is notably lower than their effective radiation temperature. Finally, based on the 24 DLRE datasets our study showed that applying the Stefan-Boltzmann power law to the globally averaged bolometric temperatures provides meritless results for rocky celestial bodies.

Quelle: Kramm et al., 2022

Die Autoren verwenden Beobachtungsmessungen aus 24 Datensätzen für den Mond – der in der realen Welt einem Gesteinsplaneten ohne Atmosphäre am nächsten kommt – als Testobjekt. Sie kommen zu dem Schluss, dass die global gemittelte Temperatur notwendigerweise „etwa 60 K“ niedriger ist als die effektive Strahlungstemperatur, was die Annahmen des „Denkmodells“ über einen Unterschied von 33 K „Treibhauseffekt“ für die effektive Strahlungstemperatur gegenüber der globalen Durchschnittstemperatur (255 vs. 288 K) „wertlos“ macht.

Andere Beispiele für einen disqualifizierenden Kontrast zwischen Beobachtungen und modellierten Annahmen sind:

„Im Falle der Erde ohne ihre Atmosphäre würde [die effektive Strahlungstemperatur] nur dann einer global gemittelten temperatur entsprechen, wenn diese gleichmäßig verteilt wäre [d.h. die Temperatur an den Polen wäre die gleiche wie in den Tropen], was bei weitem nicht der Fall ist.“

„Das Potenzgesetz von Stefan und Boltzmann ist nur auf einer lokalen Skala gültig. Seine Anwendung auf globaler Ebene widerspricht den Voraussetzungen und Annahmen, auf denen die Ableitung dieses Gesetzes

beruht.“

„Die DLRE-Daten [Mond] liefern Beobachtungsdaten, die belegen, dass die effektive Strahlungstemperatur für Planeten und ihre natürlichen Satelliten verworfen werden muss.“

„Die Annahme einer globalen Albedo von etwa 0,30 ist jedoch weit von der Realität entfernt, da sich dieser Wert auf das gesamte System Erde-Atmosphäre bezieht. Die Wolkendecke trägt in erster Linie zu diesem Wert der globalen Albedo bei, aber eine Wolkendecke kann in dem Denkmodell der Erde ohne ihre Atmosphäre nicht existieren.“

Link:
https://notrickszone.com/2022/12/26/new-study-a-thought-model-saying-theres-a-33-k-natural-greenhouse-effect-is-meritless-assumption/

Übersetzt von Christian Freuer für das EIKE