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Absorption of Thermal Radiation in the Atmosphere in the Presence of CO_2: A Photon Gas Model

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Abstract

The paradigmatic challenges of our time include the presence of greenhouse gases in the atmosphere, their influence on the Earth's climate, global warming, and the green transition. The assessment of these issues and their relative importance divides the scientific community. Some researchers deny the existence of a significant greenhouse effect and its influence on weather and climate, while others, in our view, tend to overemphasize it. In this paper, a Simple Model (SM) is presented to address this question. The use of General Circulation Models (GCMs) is considered unnecessary, as their complexity introduces substantial uncertainty in describing the role of greenhouse gases. It is difficult to understand why, despite the well-established principles of thermodynamics, energy transfer, and fluid mechanics, a definitive resolution of this issue has not yet been achieved, and no clear position has emerged regarding the role of CO_2. The approach relies exclusively on fundamental equations that are part of standard university curricula. Only well-known and verified relationships are used. These are further developed through mathematical analysis, and the resulting conclusions provide a clear interpretation of the magnitude of climate change, the need to reassess the green transition, and the justification for maintaining both nuclear and hydrocarbon-based energy systems.

Keywords: thermal radiation; gas model; greenhouse effect

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1. Introduction

In our previous papers [1,2], the increase in atmospheric CO_2 concentration from 1960 to the present was examined. The question was raised to what extent this increase can be considered anthropogenic and how large the contribution of natural inflow is. The problem was analyzed using a reservoir-type model. The result indicated that, contrary to the prevailing scientific view, approximately 95% of the CO_2 exchange between the Earth and the atmosphere is of natural origin, and only about 5% is anthropogenic.

In the present study, it is demonstrated that the greenhouse effect attributed to CO_2, and the associated atmospheric warming, has become negligible because the atmospheric CO_2 concentration had already reached a level by 1960 at which the relevant absorption bands (frequency ranges in the Planck distribution) were effectively saturated. Any further increase in CO_2 concentration beyond this level did not enhance the greenhouse effect and did not cause additional warming of the Earth's atmosphere.

This raises the further question of what has caused the global warming observed since then. In this paper, the fundamental equations related to the theory are formulated, and the relationship between the increase in CO_2 concentration and atmospheric warming is examined based on the available data from the period considered.

The fundamental equations describing the absorption of thermal radiation in the atmosphere by CO_2 molecules are standard university-level material. The photon absorption capability and emissivity of CO_2 can be analyzed using an inhomogeneous linear differential equation with constant coefficients. Surprisingly, this straightforward and fully adequate approach is not discussed in the literature, although it represents the only appropriate state model (SM).

A state equation has been established that expresses a logarithmic relationship between CO_2 concentration and emissivity. This relationship has not been previously explored or published in the literature. It is emphasized that the derivations and conclusions are based on conventional tools of mathematical analysis, without the use of prior assumptions or impermissible simplifications. The theory is fully consistent with the Stefan–Boltzmann law, Planck distribution, and the Beer–Lambert law.

2. Photon Theory of Thermal Radiation

In the following, the equations are presented that allow the emissivity in the atmosphere to be related to CO_2 concentration. Based on this relationship, the associated atmospheric temperature rise can be described, and a prognosis can be given regarding how temperature is expected to change if the CO_2 concentration is doubled or multiplied under a repeated "business as usual" scenario.

2.1 Physical model for the description of thermal radiation

The normal-direction thermal radiation intensity originating from 1 m^2 of the Earth's surface is considered. Thermal radiation is treated as a lossy photon flux, where the loss is caused by energy absorption by CO_2 molecules. The photon flux can be interpreted as a photon gas that propagates within a radiation tube, adopting terminology analogous to that used in fluid mechanics.

2.2 Fundamental Equations of Photon Flux

2.2.1 Radiation spectrum – Planck distribution

$$i_\lambda^{(0)}(\lambda, T) = \frac{\partial e^{(0)}}{\partial \lambda} = C_1 \frac{\lambda^{-5}}{e^{C_2/(\lambda T)} - 1}, \qquad (1)$$

where

$i_\lambda^{(0)}(\lambda, T)$ spectral radiation intensity of a black body.

λ wavelength,

T temperature,

C_1, C_2 constants,

e Euler's number,

$e^{(0)}$ total radiation of the black body

2.2.2 Stefan-Boltzmann law

$$e^{(0)}(T) = \sigma_0 T^4 \qquad (2)$$

where

σ_0 Stefan-Boltzmann constant.

$e^{(0)}$ total radiation intensity of the black body over the entire wavelength range.

2.2.3 Gas medium – Radiation intensity and Beer's law

$$\frac{i_{\lambda,\varphi}(\lambda,T_g)|_{x=X}-i_{\lambda,n}^{(0)}(\lambda,T_g)}{i_{\lambda,\varphi}|_{x=0}-i_{\lambda,n}^{(0)}(\lambda,T_g)} = e^{-k_{i,\lambda}p_i X} \tag{3}$$

where

$i_{\lambda,\varphi}$ the radiation intensity in the direction φ

$i_{\lambda,n}^{(0)}$ normal spectral intensity of a black body,

$k_{i,\lambda} \cong k$ spectral absorption (extinction) coefficient of the absorbing gas species,

p_i partial pressure of the absorbing gas species,

X coordinate along the radiation path.

2.2.4 Absorption–emission factor (degree of blackness) of a gas layer

$$\varepsilon = \frac{i_{\lambda,n}(x)}{i_{\lambda,n}^{(0)}} = \varepsilon_\lambda \equiv \alpha_\lambda = 1\text{- } e^{-k_i p_i x} \tag{4}$$

The product $px \equiv [bar][m]$ and can be combined into a single variable $py \equiv [bar][m]$

2.2.5 Transmissivity factor of the gas layer

$$\tau_\lambda = 1 - \varepsilon_\lambda. \tag{5}$$

3. Emission (Absorption) Factor. Analysis of the Intensity Absorbed by CO_2. The Problem of CO_2 "Doubling" (Lindzen's Statements [3])

3.1 Single CO_2 concentration

The limiting value of emissivity is

$$\lim \varepsilon_1 = \lim_{x\to\infty\ px\to\infty} \left(1 - e^{-kp_0 x}\right) = 1 \tag{6}$$

where po is the partial pressure corresponding to a single CO_2 concentration.

An infinitely extended gas body behaves as a black body. It cannot absorb or emit more radiation.

3.2 *Doubling of the CO_2 concentration, or doubling of (px)*

$$\varepsilon_1 = 1 - e^{-kp_0 x} = 1 - e^{-ky} \tag{7}$$

$$\varepsilon_2 = 1 - e^{-k2p_0 x} = 1 - e^{-k2y} \tag{8}$$

3.3 Relationships between ε_2 and ε_1

3.3.1 Logarithm of the transmissivity ratio

$$\gamma_1 = \ln\frac{1-\varepsilon_2}{1-\varepsilon_1} = \ln\frac{e^{-k2p_0x}}{e^{-kp_0x}} = \ln e^{-kp_0x} = -kp_0 x \tag{9}$$

The ratio γ_1 is a function of x. If x is constant, the ratio is also constant and independent of the doubling of CO_2 concentration.

$$\lim_{x\to\infty} \gamma_1 = 0$$

- Difference of emissivities

$$\varepsilon_2 = 1 - e^{-k2p_0x} \tag{10}$$

$$\varepsilon_1 = 1 - e^{-kp_0x} \tag{11}$$

$$\gamma_2 = \varepsilon_2 - \varepsilon_1 = \Delta\varepsilon = e^{-k2p_0x} + e^{-kp_0x} = e^{-kp_0x}\left(e^{-kp_0x} + 1\right) \tag{12}$$

$\lim_{x\to\infty} \gamma_2 = \Delta\varepsilon = 0$. The difference tends to zero.

- Ratio of transmissivities

$$\gamma_3 = \frac{1-\varepsilon_2}{1-\varepsilon_1} = \frac{e^{-k2p_0x}}{e^{-kp_0x}} = e^{-kp_0x} \tag{13}$$

$\lim_{x\to\infty} \gamma_3 = 0$ The ratio of transmissivities tends to zero.

- Ratio of logarithms of transmissivities

$$\gamma_4 = \frac{\ln(1-\varepsilon_2)}{\ln(1-\varepsilon_1)} = \frac{-k2p_0x}{-kp_0x} = 2 \tag{14}$$

The ratio of logarithms is constant and independent of the doubling. This may be the point misinterpreted by Lindzen [3]. From this,

$$\ln(1 - \varepsilon_2) = 2\ln(1 - \varepsilon_1) \tag{15}$$

$$1\text{-}\varepsilon_2 = (1 - \varepsilon_1)^2 \tag{16}$$

$$\varepsilon_2 = 1 - (1 - \varepsilon_1)^2 \tag{17}$$

if $\varepsilon_1 \to 0$, then $\varepsilon_2 \to 0$, if $\varepsilon_1 \to 1$, then $\varepsilon_2 \to 1$.

The emissivity corresponding to doubled CO_2 concentration can be calculated from the emissivity at single concentration.

- Limiting value of emissivity

$$\varepsilon = 1 - e^{-kpx} \tag{18}$$

$$\lim_{x\to\infty\; px\to\infty} \varepsilon = 1 \tag{19}$$

An infinitely extended gas body behaves as a black body, independently of the CO_2 concentration.

$$i_{\lambda,n} = i^0_{\lambda,n} \tag{20}$$

From the above, the validity of Lindzen's statements [3] is not confirmed. However, Lindzen's intention and effort toward climate scepticism [3] are viewed as favourable from our perspective.

4. Formulation of the General State Equation

Let an arbitrary multiplicity be introduced. In this case, Equation (17) can be written as

$$\varepsilon_n = 1 - (1 - \varepsilon_0)^n \tag{21}$$

where n is arbitrary and n > 0.

5. The Past, the present, and the Future

Between 1960 and 2020, the total anthropogenic heat input to the atmosphere was approximately 9000 EJ, which corresponds to 18,000 kJ/m² when averaged over the Earth's surface. During the same period, the atmospheric temperature increased by 0.5 °C. The associated increase in atmospheric enthalpy, calculated from this temperature rise, was 7,850 kJ/m². This indicates that the heat released from anthropogenic fuel use was more than sufficient to account for the observed increase in atmospheric enthalpy.

In 1960, the atmospheric CO_2 concentration was 315 ppm, and the absorption bands were already saturated. As a result, additional warming of the air due to the greenhouse effect of CO_2 was no longer possible. Between 1960 and 2020, the total increase of 100 ppm in CO_2 concentration consisted of approximately 20% anthropogenic origin, while the remaining portion was of natural origin.

At present, the anthropogenic CO_2 input has stabilized at approximately 5 ppm per year. The anthropogenic CO_2 fraction behaves as a self-adjusting system. Theoretically, over an infinite time horizon, this input would result in an increase of 20 ppm with a time constant of 4 years, and 50 ppm with a time constant of 10 years. If this trend were to continue in the future, and if a greenhouse effect and corresponding atmospheric temperature rise were hypothetically assigned to this process, the following theoretical—but practically unrealizable—temperature increases could be estimated.

Table 1: Self-adjusting effect of anthropogenic CO_2 inflow and the associated theoretical temperature increase for different time constants.

Time constant (e-time)	Anthropogenic CO_2 inflow	Self-adjustment time	Self-adjusted concentration increase	Concentration increases during e-time	Atmospheric temperature increases during e-time	Temperature increases over the full self-adjustment time (infinite time)
4 years	5 ppm/year	Infinite	20 ppm	12.6424 ppm	0.05495 °C	0.08694 °C
10 years	5 ppm/year	Infinite	50 ppm	31.606 ppm	0.13739 °C	0.21739 °C

A complete cessation of anthropogenic CO_2 emissions (full green transition) would, hypothetically and over an infinite time horizon, "avoid" only a 0.08614 °C temperature increase.

6. Validation of the State Equation and Visualization of the Calculations

The performed calculations show, in agreement with the results of Tibor Ónodi [4] and Csaba Huszár [5], that the absorption wavelengths associated with CO_2 concentration were already saturated by 1960. At that time, the emissivity of the CO_2 gas body had already reached a value of 0.99, which increased only to 0.996962 by 2020 despite the additional 100 ppm rise in concentration. Since an analytical continuous function cannot represent discontinuities, singularities, or breaks, and its limit tends toward unity, this is considered to confirm the validity of the saturation hypothesis.

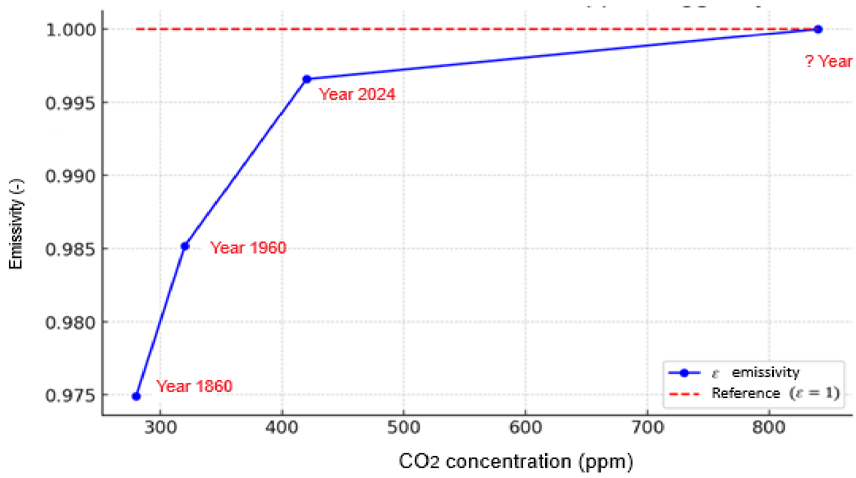

Figure 1: Emissivity as a Function of CO_2 Concentration

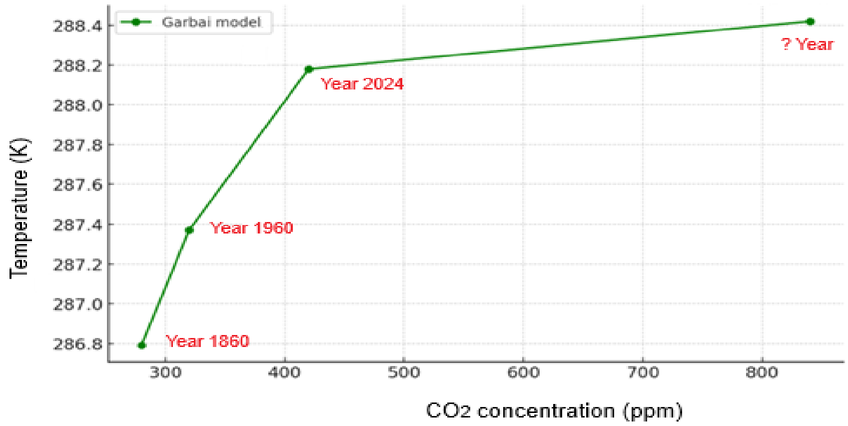

Figure 2: Temperature as a Function of CO_2 Concentration

7. Conclusions

On July 23, 2025, a report was published by a U.S. governmental department stating that efforts aimed at preventing climate change may be considered more harmful than preparing for its impacts. The report assessed the role of the greenhouse effect as negligible, regarded the electrification of the automotive industry as unnecessary, supported the continued production of gasoline-powered vehicles, and characterized the green transition as potentially detrimental. The authors of the present paper consider these positions to be consistent with the conclusions drawn from their earlier research and view their findings as supporting this perspective.

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References

1. Garbai László, Kontra Jenő, Sánta Róbert, Barna Lajos. A légköri CO2-koncentráció dinamikus egyensúlyának vizsgálata, Magyar Épületgépészet, LXXIV. évfolyam, 2025/4. szám
2. Sánta, R., Garbai, L. Investigation of the dynamic equilibrium of atmospheric CO2 concentrations. Air Qual Atmos Health (2025). https://doi.org/10.1007/s11869-025-01783-8

3. Lindzen, R. S., & Choi, Y.-S. (2011). *On the observational determination of climate sensitivity and its implications*. Asia-Pacific Journal of Atmospheric Sciences, 47: 377-390. DOI: 10.1007/s13143-011-0023-x
4. Ónodi Tibor, Kételyek az üvegházhatás mértékében, Kőolaj és Földgáz 36. (136.) évfolyam 10. szám, 2003.

Huszár Csaba, Gajáry Antal, Leválhat-e az emberiség a fosszilis energiaforrásokról? PBK konferencia 2024.12.9. Professzorok Batthyány Köre, Budapest.