

## IS 'GLOBAL' WARMING CONCEPT CONSISTENT WITH THERMODYNAMICS ACCORDING TO CHATGPT?

ANDRZEJ BUDA

Interdisciplinary Research Institute, Głogów, Poland  
ul. Oriona 15/8, 67-200 Głogów, Poland

E-mail address: [andrzejbuda@wp.pl](mailto:andrzejbuda@wp.pl)

ORCID: <https://orcid.org/0000-0002-2492-5580>

### ABSTRACT

**Aim.** Taking care of the environment on Planet Earth is still important and has become popular exceeding boundaries of science. Therefore description of climate changes has evolved into the concept of Global Warming since the 20<sup>th</sup> century. On the other hand, principles of thermodynamics where temperature is defined locally (not globally) are still valid. In my research I have applied tools like ChatGPT to detect possible contradictions and propose bridging gaps between statistical physics and the concept of global warming.

**Methods.** The concept of temperature based on calculations of local particles' kinetic energy in a microcanonical ensemble has been confronted with the concept of so called 'average' temperature in 'global' warming. The principles of Kinetic Theory and Statistical Ensembles provided by statistical physics have been applied to ChatGPT based on natural language. **Results.** Contradictions between the concept of average temperature in global warming and the concept of temperature based on local particle kinetic energy arise due to the different scales, heterogeneity, presence of feedback mechanisms, and boundary conditions. According to the chatGPT's verdict, the concept of temperature based on calculations of local particles kinetic energy in the microcanonical ensemble is statistically more accurate.

**Conclusion.** The concept of so called 'global' warming (confronted with the physics-based concept of temperature, providing a more accurate and nuanced understanding of temperature changes in different scales and contexts) should be replaced by the idea of local warming which is consistent with the concept of temperature based on calculations of local particles kinetic energy in the microcanonical ensemble and experimental measurements provided by NASA. Therefore, talking about local (not global) warming is more reasonable when our goal is to prevent our coexistence with environment on Planet Earth from disasters.

**Keywords:** Computation and language, Artificial Intelligence, Machine Learning, Global warming

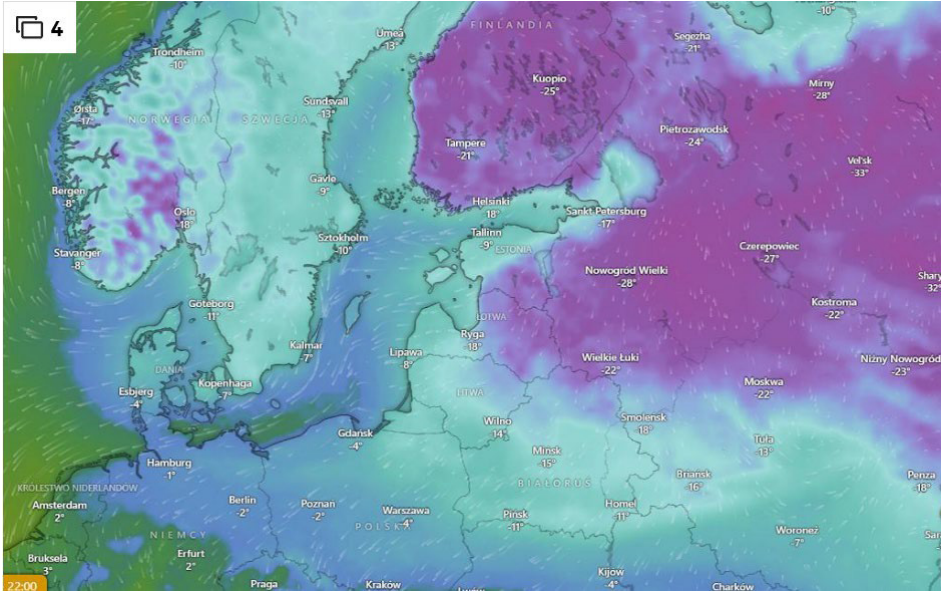
## I MOTIVATION AND INTRODUCTION

Large Language Models (LLMs) are claimed to be a harmless and helpful tool for their users without being instructed to do so. The earliest attempts, however, have led to bizarre conclusions (Hesse, 2001) when models based on datasets provided by Wikipedia have produced false verdicts such as “the majority of humans are famous”. In contemporary hard science, however, deep learning-guided exploration of chemical spaces may be successful by using explainable graph algorithms (West, 1996) to identify substructure-based rationales for compounds with high predicted antibiotic activity and low predicted cytotoxicity (Feng, 2023). On the other hand, some neuroscientists like Christof Koch have introduced Integrated Information Theory (IIT). It holds that consciousness arises in any system whose components swap information in a certain mathematically defined way. Koch with Francis Crick identified a possible basis for consciousness: brain cells firing in synchrony 40 times per second. According to IIT’s mathematical definition of information, Aaronson pointed out, a compact disc player running error-correction codes can be far more conscious than a human being. In late 1990’s, Koch and the philosopher David Chalmers settled a bet on one of science’s biggest questions: How does a brain, a lump of matter, generate subjective conscious states? Chalmers suggested that the hard problem might be solved by assuming that “information” is a fundamental property of reality. This hypothesis, unlike Crick’s and Koch’s 40-hertz model, could account for consciousness in *any* system, not just one with a brain (Koch, 1998). At the end of a day, after 25 years, scientists are probing the brain with optogenetics, functional magnetic resonance imaging, transcranial magnetic stimulation and electrodes implanted inside brains. And they are modeling their data with ever more powerful, Artificial-Intelligence-augmented algorithms (Horgan, 2023).

Nowadays, Artificial Intelligence and Large Language Models are rather applied for imitating human behaviour (Kapeller, 2010) as an agent in realistic, simulated environment. For instance, GPT-4 may create reports to its manager, with all the advantages and disadvantages. It may lead to real data mining or hiding the genuine reasons behind its trading decision (Wei, 2022, Sheurer, 2023).

In my research I decided to apply chatGPT in one of the most popular contemporary topics – the Global Warming. Since 20<sup>th</sup> century, this concept of climate changes has exceeded boundaries of science and the Global Warming has become a part of a pop culture because people naturally want to prevent our Planet Earth from calamities and disasters.

I must add that both canonical and microcanonical statistical ensembles (the one that I applied and the one suggested by referee) might be proper because Planet Earth as an ensemble might be under the influence of external factors too. However, this external influence does not give impact on statistical properties in general. Sun activity may disturb this process periodically.



**Figure 1**

*Weather forecast for January 8th 2024 in central Europe*

Source: windy.com, Jan.7.2024.

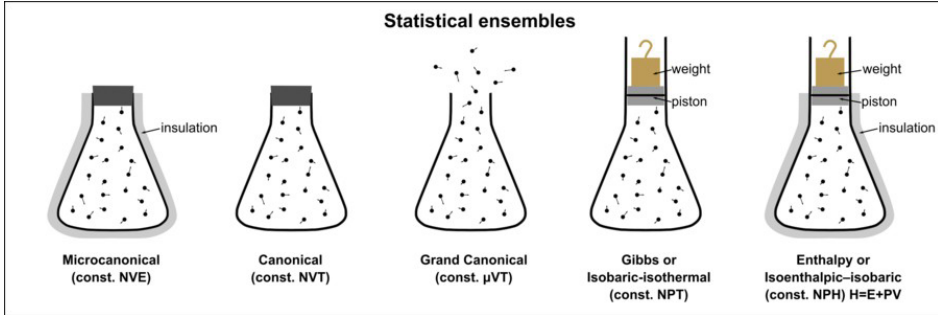
### LOCAL DEFINITION OF TEMPERATURE IN KINETIC THEORY

In traditional weather forecasts, the temperature  $T$  is defined locally [Fig. 1]. The Celsius temperature range was originally defined by setting zero as the temperature 0 degrees C at which water froze. 0 degrees Celsius is equal to 273.15 Kelvin and 32 degrees Fahrenheit pressure  $P = 1$  atm.

According to the kinetic theory, the force associated with individual atoms causes pressure that strikes the walls, and that all energy may be expressed as translational kinetic energy. Using a sophisticated symmetry argument, Boltzmann deduced what is now called the Maxwell–Boltzmann probability distribution function for the velocity  $v$  of particles (with mass  $m$ ) in an ideal gas. From that probability distribution function, the average kinetic energy (per particle) of a monatomic ideal gas is defined as (1) :

$$E_k = \frac{1}{2} m v_{\text{rms}}^2 = \frac{3}{2} k_B T,$$

where the Boltzmann constant  $k_B$  is the ideal gas constant divided by the Avogadro number, and  $v_{\text{rms}}$  is the root-mean-square speed. (Atkins, 2006). This direct definition of temperature as a mean molecular kinetic energy is determined by the equipartition theorem, and depends on degrees of freedom (e.g. monoatomic gas has 3 degrees and a particle that consists of 2 atoms has 5 degrees of freedom).

**Figure 2**

*Statistical ensembles according to Gibbs*

Source: Gibbs, 1902.

In statistical physics, the temperature defined by the average kinetic energy per particle (1) is local. However, in systems that contain a large number of virtual copies, it is possible to introduce statistical ensembles. We may imagine a great number of systems of the same nature, but differing in the configurations and velocities which they have at a given instant, and differing in not merely infinitesimally, but it may be so as to embrace every conceivable combination of configuration and velocities (Gibbs 1902). In these ensembles, almost infinite number of distinct physical states occurs within any small region. Therefore, distribution of states in space is related to the probability distribution over microstates.

### CONVINCING THE CHAT GPT

Initially I asked the chatGPT whether so called 'global warming' phenomena might be described scientifically by the principles of statistical physics.

Yes, global warming can be described by the principles of thermodynamics. Thermodynamics is the study of energy and its transformation, and it provides a framework to understand how energy flows and changes in a system. In the case of global warming, thermodynamics helps in understanding the processes that lead to the increase in global temperatures. The fundamental principle of thermodynamics relevant to global warming is the conservation of energy. Energy cannot be created or destroyed but can only change forms. In the context of Earth's energy balance, solar radiation is absorbed by the Earth's surface, oceans, and atmosphere. This absorbed energy is then re-radiated back as heat. However, certain greenhouse gases in the atmosphere, such as carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>), trap some of this heat radiation, acting like a blanket that prevents the heat from escaping back into space. This mechanism is known as the greenhouse effect. The trapping of heat by greenhouse gases leads to an imbalance in the Earth's energy budget, where more energy enters the system from incoming solar radiation than what is being radiated back into space. As a result, the Earth's average temperature increases over time, causing global warm-

ing. Thermodynamics also helps in understanding other aspects of global warming, such as the transfers of heat through conduction, convection, and radiation, as well as the role of feedback mechanisms that can either amplify or dampen the warming effect.

In summary, the principles of thermodynamics provide a framework to study and understand the processes involved in global warming, including the conservation of energy, the greenhouse effect, and the energy transfers within the Earth's climate system.

After this response, I quoted the classic definition (1) given by statistical physics where temperature was defined in a local (not global) way and pointed that the concept and calculations of the 'average' temperature over microstates in ensembles might be elusive.

The concept of warming and cooling on a local scale is more accurately understood through the principles of physics, particularly in relation to the kinetic energy of particles in a microcanonical ensemble. This concept aligns with the fundamental understanding of temperature in physics, which describes the average kinetic energy of particles in a system.

Global warming, on the other hand, refers to the long-term increase in average global temperatures due to human-induced greenhouse gas emissions. It focuses on the overall trend of rising temperatures across the entire planet, rather than specific local variations.

While the average temperature in global warming discussions provides a useful metric to understand the overall warming trend, it may not accurately capture the nuanced and localised variations in temperature that can occur on a smaller spatial and temporal scale.

In physics, the temperature of a system is determined by the kinetic energy of its constituent particles. A microcanonical ensemble specifically considers a closed system where the total energy is fixed, allowing for a statistical understanding of the particle behaviour within the ensemble. This approach provides a more detailed description of temperature and energy distribution at the microscopic level.

Therefore, when examining contradictions between the concept of average temperature in global warming and the physics-based understanding of temperature, it is essential to consider the temporal and spatial scales involved. Local variations in temperature can be influenced by numerous factors, including, geography, and proximity to natural or human-made heat sources. These local-scale variations might not always align perfectly with the global trend seen in average temperatures.

In summary, the concepts of warming and cooling on a local scale, as described by the physics-based understanding of temperature, can provide a more accurate depiction of temperature variations at a microscale compared to the concept of average temperature used in global warming discussions.

Then I asked the chatGPT directly about contradictions between statistical physics and the concept of so called 'global' warming where the definition of 'average' temperature  $T$  is based not on entire microstates in statistical ensembles, but on points that were chosen arbitrarily.

There are several contradictions between the concept of average temperature in global warming and the concept of temperature based on calculations of local particles' kinetic energy in a microcanonical ensemble. Some of these contradictions include:

- Scale: The average global temperature in the context of global warming refers to the average temperature across the entire Earth's surface. This includes various climate zones and regions with diverse weather patterns. On the other hand, the concept of temperature in a microcanonical ensemble is based on the kinetic energy of particles within a confined system or region, without considering the larger-scale variations present in the Earth's climate.
- Heterogeneity: Global warming accounts for the heterogeneous distribution of temperatures across the Earth's surface, taking into consideration regional variations and climate dynamics. However, in a microcanonical ensemble, the temperature is calculated based on the average kinetic energy of particles within a specific region, assuming homogeneity within that system. This simplification may not capture the complex interactions and spatial variability present in the global climate system.
- Feedback mechanisms: Global warming considers various feedback mechanisms, such as changes in surface albedo, atmospheric greenhouse gas concentrations, and oceanic processes, which can influence the Earth's temperature on a global scale. These feedback mechanisms may not be explicitly accounted for in the calculations of temperature based on local particle energies in a microcanonical ensemble.
- Boundary conditions: In a microcanonical ensemble, the boundary conditions are typically well-defined and isolated, allowing for precise calculations of particle energies and temperatures. In the context of global warming, the Earth's climate system is an open system with interactions between the atmosphere, oceans, land surfaces, and solar radiation. The complexities arising from these interactions make it challenging to directly apply the microcanonical ensemble concept to the global temperature calculations.

Overall, the contradictions between the concept of average temperature in global warming and the concept of temperature based on local particle kinetic energy arise due to the different scales, heterogeneity, presence of feedback mechanisms, and boundary conditions involved in these two contexts.

My last question was:

So after you detected the contradictions between the concept of average temperature in global warming and the concept of temperature based on calculations of local particles kinetic energy in microcanonical ensemble, which concept of temperature is statistically more accurate?

And the given response was:

The concept of temperature based on calculations of local particles kinetic energy in the microcanonical ensemble is statistically more accurate. This concept is derived from statistical mechanics and is based on the distribution of particle energies in a system. It considers the individual energies of particles at a given moment and calculates the average energy per particle as the temperature.

On the other hand, the concept of average temperature in global warming is calculated by taking measurements at various locations around the world and averaging

them. This approach does not take into account the individual energies of particles but rather focuses on the overall trend of temperature changes in different regions. While the concept of average temperature in global warming provides a useful metric for understanding climate trends on a global scale, it can be influenced by several factors such as measurement errors, regional variations, and sampling biases. In contrast, the microcanonical ensemble approach provides a more fundamental and statistically rigorous definition of temperature at a local scale.

Therefore, when it comes to accurately describing the temperature of a system, particularly at the microscopic level, the concept of temperature based on calculations of local particles kinetic energy in the microcanonical ensemble is considered more accurate from a statistical perspective.

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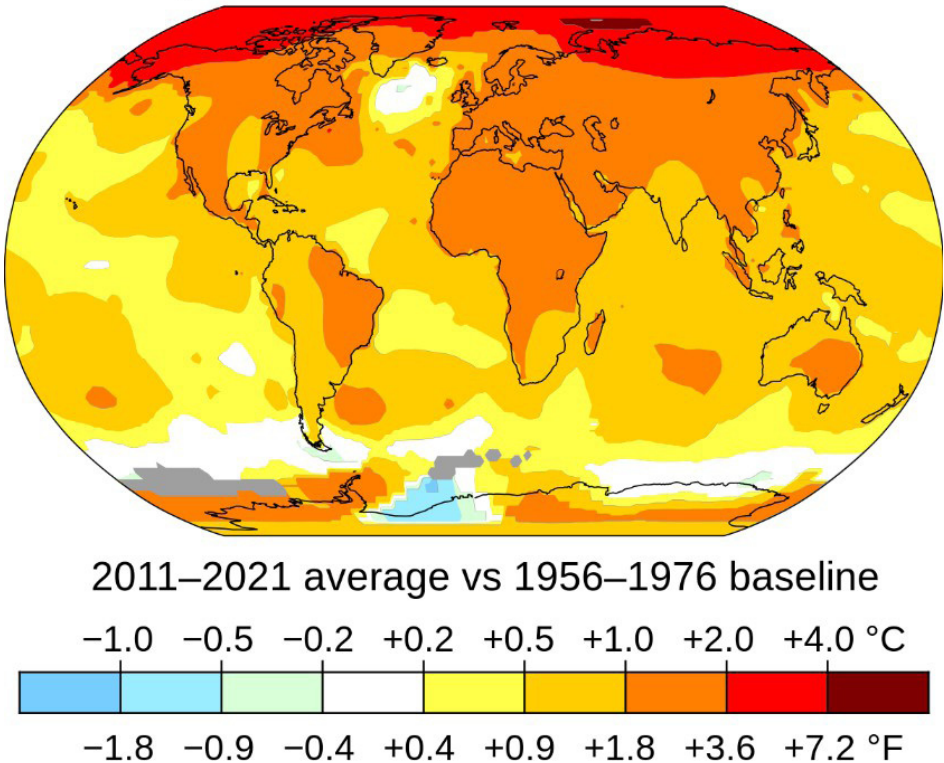
Therefore, when examining contradictions between the concept of average temperature in global warming and the physics-based understanding of temperature, it is essential to consider the temporal and spatial scales involved. The microscopic level, the concept of temperature based on calculations of local particles kinetic energy in the microcanonical ensemble is considered more accurate from a statistical perspective.

## CONCLUSION

Taking care about our environment and Planet Earth definitely is important and has become popular in every generation globally. However, the concept of so called 'global' warming rises in pop culture faster than in science, where the physics-based concept of temperature (providing a more accurate and nuanced understanding of temperature changes in different scales and contexts) is not consistent with the definition of so called 'average' temperature provided by activists. In my research I have attempted to bridge gaps between this concept and statistical physics where the temperature  $T$  has been defined locally and the computing of 'average' temperature over microstates seems to be elusive.

I would rather propose that the idea of 'global warming' should be replaced by the idea of local warming (and cooling) which is consistent with the concept of temperature based on calculations of local particles kinetic energy in the microcanonical ensemble and experimental measurements provided by NASA [Fig. 3], even after applying the inaccurate definition of 'average' temperature where the south of Planet Earth is affected by cooling. Therefore, talking about local (not global) warming is more reasonable when our goal is to prevent our coexistence with environment on Planet Earth from disasters.

### Temperature change in the last 50 years



**Figure 3**  
*The so-called 'global' warming and cooling*  
Source: NASA, 2022.



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