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# A Different Vision of the Global Warming Based on Chemistry, Physics and Thermodynamics

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**Abstract:** A direct relationship between abnormally rapid global warming and the CO<sub>2</sub> produced by the exploitation and human uses of fossil fuels (coal, oil, natural gas, peat) is the basis of the recommendations made by the Intergovernmental Panel of Experts on Climate Change (the IPCC group) to fight against a worrying climatic drift in the next few decades. The IPCC mechanism of global warming is mostly based on radiative forcing and does not take into account ice melting and water evaporation as temperature controlling physical phenomena. Although, more and more scientists argue against the consensual IPCC's vision, what is missing is opposition of another mechanism. The aim of the article is to propose an alternative mechanism derived from the analysis of facts and factors that contribute to warm the Earth. Starting from the fact that the Sun has been heating the planet for billions of years without dramatic drift other than fluctuations, it is shown that the environment is heated from natural sources (Sun, volcanoes) and by anthropogenic heat release. Anthropogenic heat is mostly composed of residual or waste heat coming from the production and the uses of energy necessary to satisfy human needs in work. To avoid the complexity of phenomena occurring in the atmosphere, the discussion was mostly based on examples taken from the current life to make the involved sciences clearer. Two major facts are emphasized. First, if there are natural and anthropogenic sources of heat energy on Earth, heat is a unique physical phenomenon. Second, heating by natural sources is sequential (day and night, summer and winter) whereas anthropogenic heating is almost permanent. This new vision leads to a new mechanism based on the physical and thermal properties of water and of solid-liquid-gas interphase equilibria involving exchanges of matter and heat. According to this mechanism, the temperature and ocean level rises should be smaller than predicted by the IPCC group but climatic events (winds, storms, hurricanes, tornadoes, streams, etc.) that are involved in the averaging of opposite local climates (dry and wet, droughts and floods, cold and hot, etc.) should increase in strength and frequency. It is concluded that minimizing anthropogenic heat release should be more efficient than fighting the sole CO<sub>2</sub> to keep the drift of climatic events within acceptable limits.

**Keywords:** Global Warming, Anthropogenic Heat Release (AHR), Water Interphase Exchanges, Radiative Heat Elimination, Water as Climate Control Agent, Thermal Infrared Radiations

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## 1. Introduction

A direct relationship between abnormally rapid global warming and the CO<sub>2</sub> produced by the exploitation and human uses of fossil fuels (coal, oil, natural gas, peat) is the basis of the recommendations of the Intergovernmental Panel on Climate Change (the IPCC group) to fight against a worrying climatic drift in the next few decades [1, 2]. The IPCC forecasts are based on an abundant literature of models, on the notions of greenhouse effect applied to CO<sub>2</sub>, and on radiative forcing that provide a surplus of heat on Earth compared to the beginning of the industrial era.

The greenhouse effect was introduced at the end of the 19th century to justify an excess in the average temperature on Earth relative to Earth without atmosphere. At that time, the physics of radiations did not include its quantic complement yet. The initial greenhouse effect is nowadays adapted to anthropogenic CO<sub>2</sub> to justify a climate change perceived as abnormally rapid, mainly in terms of disappearance of ices (polar, floating, glaciers, permafrost). Indeed, the average global temperature and the level of seas and oceans should become dramatic, but only in a future estimated at several decades [1, 2].

The Sun has been heating the Earth for billions of years by the thermal infrared part of emitted electromagnetic radiations

that is absorbed by the matters that make up Earth's environment, in particular some of the gases present in the air known as greenhouse gas. Although much less intense, it is this type of radiations that heats the atmosphere and the people when an infrared heater is used to warm a room.

Since the atmosphere was formed, the energy brought by the Sun returned to space by reflection or by emission of thermal radiations, otherwise the heat would have accumulated, thus preventing life from appearing and persist.

According to the IPCC group, the Earth's surface emits infrared waves directed towards space. Some of them are absorbed specifically by CO<sub>2</sub> molecules present in the air and re-emitted in all directions. The re-emitted waves directed towards space continue their way while those directed towards the surface are retained and heat the environment whose temperature rises. This is the so-called greenhouse effect [1-3]. About 90% of the surplus of heat due to anthropogenic CO<sub>2</sub>, presently referred to as radiative forcing, is said stored in oceans that warm and expand [2, 4]. The rest heats Earth's environment. The storage of radiative forcing over the years since the beginning of the industrial era is the cause of global warming. Dilatation and water from the melting of disappeared ices are the main reasons invoked to predict the submersion of coastlines and islands.

Confirmation by experiment of the greenhouse effect and its consequences being impossible due to the gigantism of the planet and the complexity of the phenomena involved, the forecasts established by the IPCC group are only consensual. Over successive United Nations Climate Changes Conferences (COPs) and IPCC reports, the consensus has become universal with increasingly worrying forecasts justifying advice to politicians to replace fossil fuels with sources of energy, in particular renewable ones, which do not generate CO<sub>2</sub> [1, 2]. The basis of IPCC's predictions have long and increasingly been challenged by some non-climate scientists who had, with rare exceptions, only open access archives, internet blogs and popular journals to be heard [5]. For these opponents, often qualified as climate-skeptics [6], the greenhouse effect has no scientific basis and the radiative forcing is doubtful, even non-existent for some, because it does not respect the physics of electromagnetic radiations and the thermodynamics of the exchanges of heat by conduction and convection. However, the criticisms remain without echo because they are not accompanied by an alternative mechanism to greenhouse effect. It is this deficiency that we propose to fill without going into too specialized scientific considerations at the present stage.

## 2. A Different Vision

For billions of years, the Sun has been heating the Earth with ups and downs (day and night, summer and winter, northern and southern hemispheres, etc.). Whatever the phenomena involved when solar radiations pass through the atmosphere (transmission, absorption by certain gases which generates heat, diffusion by particles and aerosols, reflection on clouds, etc.), the main observation is that after billions of years, there is no

dramatic accumulation of heat even if significant fluctuations have taken place such as alternation of glacial periods preceded by a period of overheating. Fossil bones of cold blood reptiles have been detected in Greenland, for example.

The Sun is not the only natural source that intermittently heats the lower atmosphere. The heat input through the Earth's insulating crust is negligible, but volcanic eruptions transfer heat to the environment from the central magma, occasionally. Natural forest fires contribute also occasionally.

With the transition to the industrial era and the accelerated development of humanity, other sources of heat have appeared in the environment. Let us mention the combustion of carbonaceous fossil compounds which produces not only CO<sub>2</sub>, but also heat. Importantly, the combustion of fossil hydrocarbons produces CO<sub>2</sub> and heat, but also water in the form of vapor. This water is released from a chemical stock formed millions of years ago during fossilization. The hot CO<sub>2</sub> and water gases resulting from these combustions transmit their heat to the environment by conduction and convection as they cool. Independently, nuclear power plants produce electricity but also residual waste heat evacuated in the form of clouds by cooling towers in which liquid water is also heated. Wind turbines and solar panels produce electricity which is also accompanied by waste heat. Once produced, electricity, regardless of its origin, is used to provide work always accompanied by residual heat released into the environment. Electric trains, electric cars, electric heating and cooling systems, computers and data stocking centers, mobile phones, and any other electric machine bring heat into the atmosphere as do agricultural fires (Amazon), arsons, rockets, etc.. Last but not least, the environment is also heated by the growing populations of human beings and of warm-blooded domestic animals whose metabolism produces CO<sub>2</sub>, water and heat. It is the whole of the global waste heat due to humanity and its activities that we will call anthropogenic heat release (AHR).

Heat normally has no identity. Solar or anthropogenic, it circulates on Earth by contact between hot and cold matter until the transfer results in equilibrium at intermediate temperature. In practice, the Earth is very large and global thermal equilibrium is far from being reached. The imbalances leave areas of extremes (hot and cold; droughts and floods; land and lakes, etc.). The balancing trend depends on atmospheric and oceanic phenomena of diffusion and convection. However, the solar contribution to environment heating is discontinuous. When it is absent at night, or diminished by cloud screening or in winter, the almost continuous and more or less localized anthropogenic contributions persist and tend to maintain, if not worsen, the differences between local climate extremes due to the Sun.

The heat that is exchanged between materials within the environment can only be eliminated by emission of radiations towards space because the materials that constitute Earth are trapped by gravity. The emission of thermal radiations by a material depends on its temperature. In a vacuum as in interstellar space, radiations pass through without alteration. This is no longer the case when radiations have to pass

through the atmosphere, whether entering or leaving. The absorption of radiations by an absorbent material results in attenuation of the initial energy. This is how sunglasses or sunscreen protects against visible light and ultraviolet radiations, respectively. For a given initial energy, the loss of intensity depends on the absorptivity of the absorbing medium, on the optical path, and on the concentration in the case of mixtures with a transparent medium (solvent or gas) as reflected in Beer-Lambert law [7].

According to physicists of radiations, CO<sub>2</sub> is not a greenhouse gas [8]. Nevertheless, it is an absorbent gas that converts radiative energy into heat and thus warms the atmosphere. The same is true of ozone and water vapor, the latter being not taken into account by the IPCC group for its forecasts despite its recognition as the most efficient gas among greenhouse gas.

Ozone is a radiation absorbent gas formed from oxygen in the stratosphere zone above the troposphere. Ozone absorbs in the ultraviolet part of the solar radiation spectrum and protects living systems in the lower troposphere. It also absorbs in the thermal infrared zone. At the top of the stratosphere, the temperature can reach 0°C while, below, the upper troposphere is at -50°C.

CO<sub>2</sub> is chemically stable at any altitude. Its concentration in volume is almost constant in the stratosphere and in the troposphere but its molar concentration in mole/m<sup>3</sup> on which its absorbent power depends, increases with atmospheric pressure when the altitude decreases, even if in the end there is homogenization.

Water is a radiation absorbent that should only be in gas form like CO<sub>2</sub>. Actually, the three physical forms (solid, liquid, gas) coexist in the environment, a fact extremely important for climate control and for heat management. From the chemistry and physics viewpoints, many of the properties of ice and liquid water depend on the presence of reversible hydrogen bonds formed between O and H atoms of molecules in a kind of crosslinking in which bonds between atoms are stabilized relative to independent water molecules. Therefore, specific radiative energies required to cause vibrations of the stabilized bonds are located in the zone of more energetic infrared radiations which are not sources of heat. Only the vapor form, whose molecules are independent, absorbs thermal infrared radiation. In the upper troposphere at -50°C, there is no gaseous form of water. Only traces of liquid water in undercooling and solid ice particles may be present. Therefore, the conversion of radiative energy into heat takes place mainly in the lower troposphere where climate and climatic phenomena occur and where heat exchanges take place between hot and cold areas of the environment. However, water vapor presents a window of transparency (Figure 1) which opens access to space to compatible radiations originating from space or from Earth's surface [8].

These few elements presented in a simplified way hide the great complexity of the phenomena involved and especially their variability. Many data concerning Earth's radiations and heat budgets are expressed in terms of flux/m<sup>2</sup> [1-2]. Most result from averages and often averages of averages. Indeed,

in terms of absorption and emission, the square meters are very different from one place to the other. One thing is certain, solar heat has been managed for billions of years with all the complexity that implies. Anthropogenic heat is individualized as a supplement to solar heat but not as a physical phenomenon to be managed specifically. It is a unique mechanism that manages the whole.

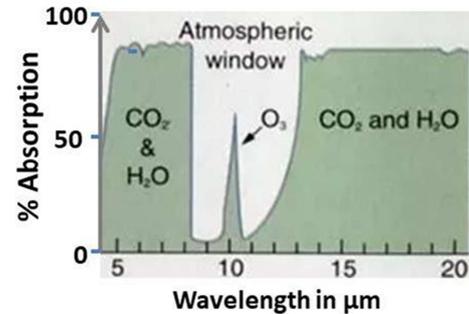


Figure 1. Spectrum of solar radiations in the thermal infrared region and the water window of transparency.

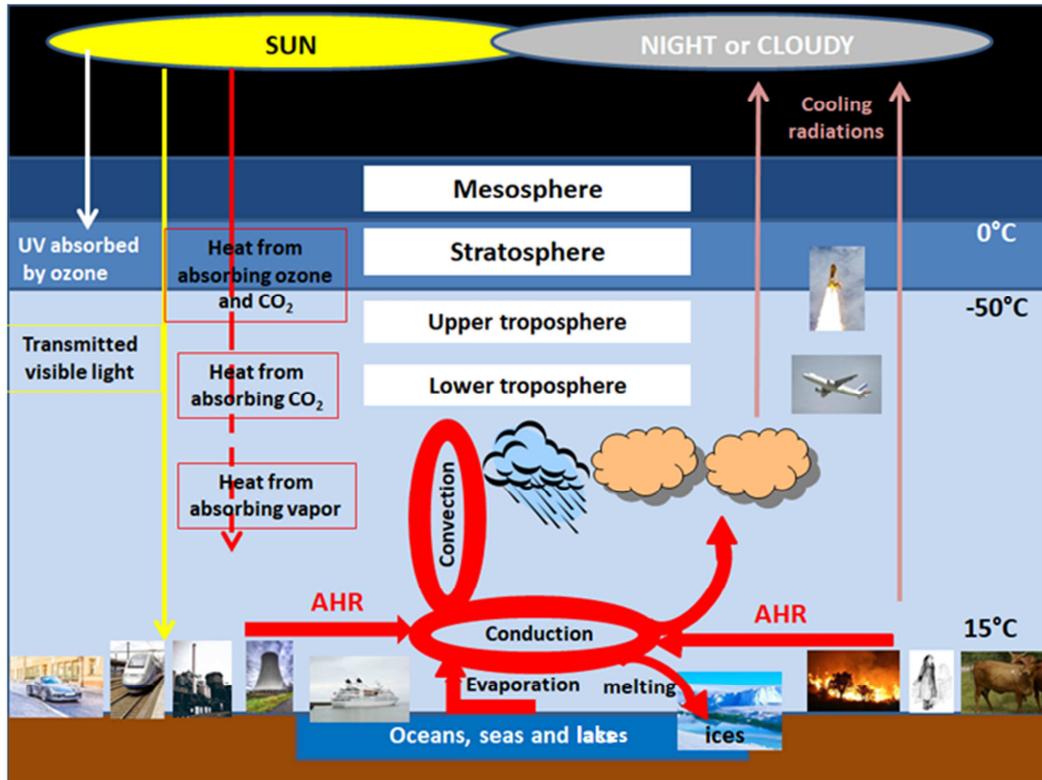
### 3. A Climate Regulation Mechanism Based on Water

An alternative mechanism is proposed to replace the greenhouse effect. It aims to manage heat inputs to the lower troposphere, regardless of their origins, without accumulation. If the estimates of the rises in the average terrestrial temperature and the average level of the seas and oceans are still within the ranges of uncertainty, the disappearance of ices is indisputable. British researchers have estimated the mass of ices (polar, floating, glaciers, permafrost) that disappeared between 1994 and 2017 at 28,000 billion tonnes [9]. At the same time, it has been shown that the residual heat resulting from the production and exploitation of the various energy sources during the same period [10] and the heat necessary to melt this mass of ice are of the same order of magnitude [11]. Earth's ices are therefore part of the means of compensation for a local heat input, like an ice cube in a glass of water. This compensation includes several steps: heating of ices from a negative temperature to 0°C, then fusion from solid to liquid at a constant temperature of 0°C and finally passage of the released water from 0°C to 15°C, the global mean environment temperature. Clearly, the Sun has been heating the Earth for billions of years to a level well above that due to mankind. Therefore, ices should have disappeared a long time ago. This is clearly not the case.

So, the then solar heat was managed by another means that complemented ice melting. This means is well known in physics. It is evaporation. If the heat input persists in an overheated zone, liquid → gas phase transfer, or evaporation, occurs to absorb the surplus of heat. This transition absorbs a lot of heat because it has again to break hydrogen bonds. The warm water vapor formed being less dense than the cold and/or dry air, it rises up to the altitude where the temperature corresponds to the dew point at which the vapor condenses

into clouds with the formation of water droplets, sometimes ice particles, according to condensation, the reverse process of evaporation. The heat stored on the surface is thus transferred to the level of clouds with some loss on the way by conduction towards the cooler ambient air. At the level of clouds, the heat released by condensation is absorbed by local materials (gas

molecules, water droplets and, where applicable, ice particles). Coalesced water droplets return to the surface as rains and occasionally snowfalls while the local materials hotter than the ambient emit radiations according to their temperature and thus contribute to the elimination of calorific energy towards space (Figure 2).



**Figure 2.** Schematic representation of solar and anthropogenic sources of heat, heat transfer and heat elimination according to the proposed mechanism.

Cloud formation by condensation of rising warm vapor occurs in zones where the local atmospheric pressure is lower than on the surface. Furthermore, the rising water being condensed, the concentration of absorbent water molecules (humidity) is lower above the clouds than close to the surface. The elimination of thermal energy by radiations is thus facilitated and bypasses the absorptive and diffusive screening that the lower atmosphere and the clouds constitute for radiations from the surface. The role of water as a heat transfer medium from Earth's surface to the upper troposphere from which the heat is evacuated to space is comparable, in principle, to the role the refrigerant plays in a refrigerator [12] or to the role of sweat which regulates the temperature of our body by evaporation. In terms of thermodynamics, ice melting and evaporation are phase transition phenomena. As they depend on latent specific heats of fusion and evaporation respectively, they are able to absorb much more heat energy than the storage in oceans which depends on the water heat capacity only [13].

Year 2018 was taken as model to estimate heat energy absorption and transfer involved in ices disappearance, surface and ocean water evaporation, and interphase equilibria that fix local temperature, at least basically [12]. Precise information was lacking to quantify the different pathways and stages of energy

elimination by emission, and the transfer of cooling radiations to space. Quantification of heat supplies and heat transfers is possible provided that the criterion of equilibrium is respected, something possible in a laboratory and, maybe, in small geographic zones, but not at the level of a planet whose size and surface are enormous relative to the thickness of the atmosphere. At the Earth level, global effects result from the summation and the averaging of local effects under the mixing action of more or less random and chaotic movements within the atmosphere (winds, storms, hurricanes, jet streams) and the oceans (hot and cold streams). Since melting ice and evaporation are temperature-regulating phenomena, the global temperature should not change, at least in principle. In reality, global increase of the average temperature is possible, but not as much as predicted by the IPCC group. Similarly, the level of seas and oceans should rise due to the melting of ices but less than predicted because of less dilatation and because of the intervention of evaporation that both limit the quantity of liquid water generated by the melting of lost ices. In contrast, the local climate phenomena (winds, rains, storms, hurricanes, floods, droughts, etc.), which provide the energy necessary to average local zones with opposite effects, must worsen. Indeed, they will have to distribute a continuous and increasing input of anthropogenic heat concentrated on areas with high activity and

high population in addition to the sequential heating and cooling periods due to solar and volcanic natural supplies of heat. The IPCC group has not yet taken into account the phenomena of evaporation and condensation from a thermodynamic point of view [14]. The AR5 report mentions the term “evaporation” approximately 200 times but not in connection with climate regulation [1]. The AR6 report is limited to stating “*it is virtually certain that evaporation will increase over the oceans*” [2]. However, the capture of heat by the ocean adopted by the IPCC group is a much less effective than evaporation to combat an increase in temperature [12]. A simple example showing the efficiency of evaporation is that of air fresheners that cool the atmosphere of a room by dispersing nebulized mini droplets of water.

#### 4. Conclusion

Replacing anthropogenic CO<sub>2</sub>-based greenhouse effect and resulting radiative forcing by fundamentals of chemistry, physics and thermodynamics led to a new mechanism of climate control based on water chemical, physical and thermal properties. The anthropogenic heating assigned to the CO<sub>2</sub> radiative forcing is replaced by the waste heat energy released in the environment from the global energy produced and exploited by humans to satisfy their needs in comfort and activities. It is newly emphasized that anthropogenic heat supply is almost active permanently whereas natural solar and volcanic heat supplies are sequential with variable lengths of on-off periods. Ongoing radiations that heat the environment and outgoing ones that eliminate heat are kept in the new mechanism. Ice melting and water evaporation-condensation interphase transitions are means to transfer heat from the surface to the level of clouds from which radiative elimination is favored. This mechanism has two major consequences.

First, there is a risk of thermal runaway if the heat of anthropogenic origin continues to grow. Sooner or later, ices will disappear and evaporation will remain the only available means to absorb heat. In the meantime, the formation of an increasingly extended and thick layer of clouds will be formed which, by masking more and more the incoming solar radiations, will lead to a reformation of ices on the surface as it was in the very distant past during the alternations of glacial periods preceded by very hot periods. Fortunately, at the current rate, the disappearance of ices is a matter of centuries because the stock is still in considerable amounts. Unlike most ices which are geographically localized, evaporation is active in oceans, seas and lakes as well as in land. The consequences are floods, droughts, and heat waves. Such climatic events will increase in frequency and amplitude if more AHR is to be distributed and managed.

Secondly, the recommended strategy to control climate drift that is based on decreasing the production of anthropogenic CO<sub>2</sub> is not appropriate. It is the fight against AHR that must be organized. This implies the promotion of energy saving and demographic control to hope containing the worsening of the extremes of climatic disturbances that some think are already manifest.

The proposed heat management mechanism is new and thus still mostly qualitative, although some claims are already supported by quantitative results collected from available data as shown for year 2018 [12]. The size of the planet, the complexity of the phenomena involved, and the fluctuations in accessible data are going to be major hurdles to further quantification. Advances will obviously require multidisciplinary collaborations.

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