Anthropogenic Heat, a More Credible Threat to the Earth's Climate than Carbon Dioxide

Michel Vert[1]

[1]UMR CNRS 5247, IBMM, University of Montpellier

November 14, 2023

Anthropogenic Heat, a More Credible Threat to the Earth's Climate than Carbon Dioxide

Michel Vert

IBMM, UMR CNRS 5247, University of Montpellier, France

Corresponding author: Michel Vert, michel.vert@umontpellier.fr

Abstract: Unlike the radiative forcing linked to CO_2 and its cumulative storage in oceans since the start of the industrial era around two centuries ago, the Sun has heated the Earth for billions of years without accumulation and dramatic temperature drift. To overcome this obviously illogical difference in evolution, we first analyze several reasons showing that the current universally adopted relationship between carbon dioxide and global warming does not respect the fundamentals of Chemistry, Physics, and Thermodynamics. A recently proposed alternative mechanism, based on these hard sciences, is briefly recalled. In this new mechanism, heat on Earth is managed by water and its solid-liquid and liquid-vapor interphases equilibria before radiative elimination in space. Today, anthropogenic heat is increasingly seen as a complement to the solar heating although it is neglected in the universally adopted consensus. Anthropogenic heat releases are generally estimated from global energy consumption. A broader list of sources is established that includes the capture of solar thermal infrared radiations by artificial installations, including those acting as greenhouses. Three qualitative scenarios are proposed in which climate change depends on whether the ratio of anthropogenic heat releases relative to solar thermal contributions remains negligible, is acceptable or becomes so large that it could shorten the time until the next ice age. Currently, global temperature and ocean level are still very low compared to those in distant past. On the other hand, ice disappearance is indisputable, particularly at the levels of glaciers, floating ice, and permafrost. These features fit the scenario in which temperature continued to fluctuate as it did during the last 8,000 years of the current Holocene interglacial plateau while local rains, winds, floodings, droughts, etc., worsen in magnitude and frequency to help ice melt and evaporation manage excess heat. Policymakers should not wait to discover that decreasing atmospheric carbon dioxide has little effect on the worsening of climate events to begin mitigating of anthropogenic heat with the help of hard sciences scientists to work on quantification.

Key points

- Carbon dioxide-based radiative forcing as source of global warming does not resist to critical analysis based on fundamentals of chemistry, physics and thermodynamics
- Thermal properties of water, water interphase exchanges, formation of clouds and radiative elimination to space control heat supplies and climate changes since water is present on Earth
- Anthropogenic heat releases should not affect much temperature and ocean levels provided they remain negligible relative to solar heat supplies, but heat-dispersing local climatic vents should increase in strength and frequency

I. Introduction

Today, Earth would be subject to abnormal warming due to a surplus of atmospheric CO_2 generated by humans and at the origin of dramatic climate predictions for decades to come. However, these predictions only come from hypothesis and models in the absence of experimental support [1]. The greenhouse effect caused by some atmospheric gas referred to as greenhouse gas (GHG) and the resulting radiative forcing involve 19th century physics. They were adopted consensually as soon as 1990 by an international organization, the Intergovernmental Panel on Climate Change (IPCC) specially created in 1988. The goal of this organization was to assess and exploit scientific publications to issue reports and recommendations to politicians. Content and updates were selected by consensus only. Nevertheless, they are now adopted almost universally and serve as uncontestable truth opposing any criticism systematically classified as climate skeptic. Today, there are many scientific reasons to call into question the foundations of the consensus and make the role given to CO_2 as a greenhouse gas inconsistent. These reasons concern in particular atmospheric CO_2 concentration, solar irradiance, greenhouse effect, greenhouse gases, radiative forcing, heat accumulation in oceans and radiative elimination to space. Let us consider these factors step by step:

1) the averaged global atmospheric concentration in CO_2 is said having grown from c.a. 300 to 420 ppmv since the beginning of the industrial era in the second half of the 19^{th} century. This concentration is assessed from data collected at 3,400 meters on the slope of the Hawaiian volcano Mauna Loa after adaptations of the data, including elimination of humidity. The annual global CO_2 concentration thus obtained increases quite regularly year after year with seasonal zig-zags [2]. This concentration is generally considered uniformly distributed throughout the atmosphere and thus similar in the stratosphere and troposphere. In reality, CO_2 is not distributed uniformly as shown in a visualization proposed by NASA's Center for Climate Simulation [3]. This visualization consists in a combination of OCO-2 satellite and GEOS model data that gave the first 3D dynamic picture of carbon dioxide throughout the Earth's atmosphere between November-2014 and August-2015. According to this 3D video, carbon dioxide is mainly present in the Northern hemisphere with a high concentration in Winter and Spring, low in Summer and Autumn, and dependent on latitude, longitude and altitude. Therefore, averaging radiative forcing over the whole world lacks sense. Furthermore, the Mauna Loa volcano is located in the middle of the Pacific Ocean in a zone where high winds often blow directly or indirectly from the West after passage over China which is today the main producer of CO_2 in the world. The rather regular increase of the Hawaiian averaged concentration parallels the growth of Chinese CO_2 releases in the atmosphere [4], a trend that call into question the consistency of data on global CO_2 concentration.

2) it is common strategy to apply the black body theory to the Sun's surface at about 5800 K that emits a 1370 W/m^2 irradiance composed of all electromagnetic waves from high energy γ-rays to low energy radio-waves with large dominance of visible radiations situated in the 0.38-0.75 µm range [5]. The whole flux is corrected to 340 W/m^2 to take into account the pseudo-sphericity of the planet and further reduces to take into account the Raleigh scattering of very short waves by atmosphere molecules, the scattering by water droplets in clouds and particles of aerosols governed by Mie's law, and the reflection by the surface. In general, most of the diffracted energy is dispersed but transmitted, the rest being sent back. Despite these corrections, solar irradiance as thermal energy source should not be considered in its

entirety. Only the so-called thermal infrared waves (tIR) located in the range 3 to 20 µm (Fig. 1) counting for about 10% of the total irradiance is a source of atmosphere warming [6-8]. Most UV light heats the stratosphere because of absorption by ozone but the process is chemically controlled and only a small part of the UVs reaches the surface and contributes to sun burns or tanning. Visible light reaches almost completely the surface since the atmosphere is transparent for visible electromagnetic waves. Therefore, visible light cannot be a source of heating in absence of absorbers among atmospheric gas. In terms of atmosphere and environment warming, the solar irradiance must be reduced to thermal infrared waves (tIR). The reduction of the radiative energy carried by tIR due to absorption by some atmospheric gas during the transit though the stratosphere and the troposphere is not taken into account specifically in the consensus in which only surface irradiance is considered.

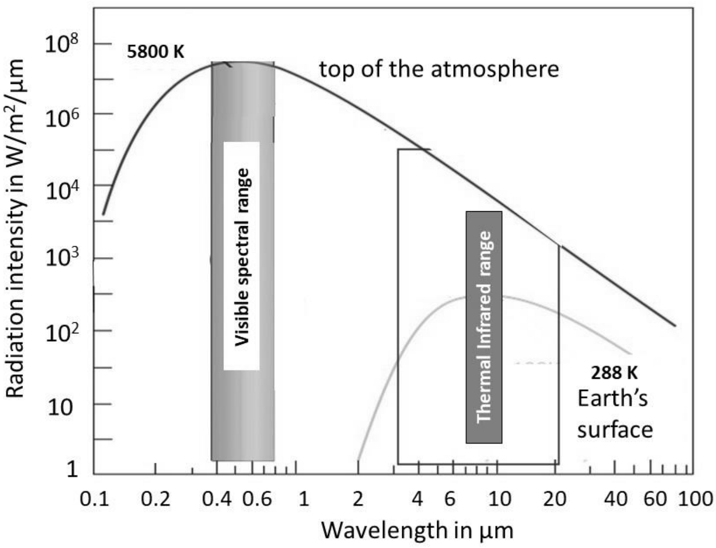

Figure 1: Schematic comparison between radiation intensities of tIR waves from the Sun and from Earth's surface according to the black body theory.

.

3) the concept of greenhouse gas is specific to the consensus. It is applied primarily to carbon dioxide considered to be the main source of global warming. Earth's surface warmed during the day emits, according to the black body theory, radiations in the 3 to 20 µm range where tIR radiations are. In the case of CO_2, the emitted 15 µm specific wave is absorbed and reemitted in all directions with half oriented to the surface that after absorption emits de novo the same but halved CO_2-specific radiation, this repeatedly to cause a temperature gain referred to as radiative forcing. This mechanism is simplistic and ignores that any transit of a surface emitted tIR through absorbing gas, liquid and solid matters, even if in the latter cases the penetration can be very small, is associated with reduction of the initial radiation energy, heat generation and cooling of the emitting surface, theoretically up to intermediate equilibrium of the environmental temperature. In physics terms, so-called greenhouse gases are, in reality, atmospheric gas that are capable of absorbing specific thermal IR waves through the excitation of discrete levels of interatomic vibrational energy in energetic harmony, this during entrance and exit. The thus excited molecules very quickly reemit the absorbed radiation with transfer of the radiative energy into kinetic energy that increases the movement of surrounding atmospheric molecules including these of oxygen and nitrogen that are not GHG. It is the gain in movement of all molecules in the air that generates an increase in environmental temperature, independently of the solar or surface origin of tIR. The decrease in initial energy upon absorption of an electromagnetic wave is governed by a

physical law named Beer's law [9]. This law says that, for a wave of a given energy, the distance to total absorption halves when the concentration in absorbent doubles but the amount of energy absorbed is the same, i.e., that of the initial wave. So, increasing the CO_2 concentration cannot be the source of a temperature rise. Only a heat supply, meaning positive difference of temperature can do this. Once IR radiations are converted to heat, the physics of heat and thermodynamics are the sciences that apply. Energy and energetic exchanges must be expressed in Joules (J).

4) the concept of greenhouse is also inconsistent in terms of physics. A greenhouse is a close space with a window that absorbs, or let thermal infrared radiations cross it and warmed the matters inside, including gases. The captured heat is then stored until it can escape as it is the case in a car left in an open parking lot. In this case, the interior temperature can rise up to 70°C in a sunny day. In the atmosphere, there is no such window and no enclosed space. There is therefore no real greenhouse. The heating of the atmosphere and the heating of surface materials depend solely on the absorption of thermal infrared radiations. Despite of the large irradiance from the Sun, only a small part (about 10%) of tIR waves is transmitted through the atmosphere and can warm it, except the transparence gap between 5 and 8 µm [11].

5) the radiative forcing poses a question too. It is said resulting from the so-called atmospheric greenhouse gases that include fluorocarbons, ozone, carbon dioxide, methane and water vapor as well, although water vapor is currently neglected in IPCC's recent reports despite a much greater tIR absorbing and heat producing activity than CO_2 [1,10]. Radiative forcing is said accumulated in the oceans since the start of the industrial era. However, during the current Holocene interglacial plateau established about 8,000 years ago, Earth's average temperature fluctuated with ups and downs within a 2°C range without heat accumulation [12] despite a much more intense solar tIR radiation than that of Earth's surface. This duality of fate is impossible in physics because heat is a unique phenomenon whose management is independent of the source.

6) as for the radiative elimination of heat to space, water vapor constitutes, much more than CO2 and other GHGs, a major obstacle to the transit of specific tIR waves through the atmosphere. When they penetrate from space as when they are emitted from the surface, thermal IR waves are absorbed, some in totality, by the local active gases (ozone in the stratosphere, CO2 in the stratosphere and the troposphere and water vapor only in the lower troposphere. Indeed, the temperature in the upper troposphere is too low (c.a. -50°C) for humidity to be present significantly. Therefore, radiative removal of heat is more efficient when the atmosphere is dry like in the Sahara Desert where a high temperature during the day can become negative overnight. If humidity is high, the radiative elimination is mitigated by the absorption by water vapor molecules, or because of masking by clouds if a dew point has been reached.

In summary, all these reasons lead to the conclusion that, on the one hand, the consensus mechanism based on greenhouse effect and radiative forcing does not respect many fundamentals of hard sciences, and, on the other hand, heat on Earth must be managed by a unique mechanism in which water, including humidity, must play an important role because of its exceptional thermal and physical properties. Last but not least, the size of the planet and the presence of wind and water streams are unfavorable for homogenization, a feature that justify data generally derived from averages of averages.

II. An alternative mechanism respecting hard sciences

An alternative mechanism based on heat was imagined to replace that based on greenhouse effect and radiative forcing [13]. According to this mechanism, any heat input into the environment, regardless of its origin, is managed by water and by its interphase equilibria (ice melting and evaporation) recognized as very efficient heat absorbers and transmitters. Unlike CO_2 that is only gaseous, water exists in solid, liquid and vapor phases in the atmosphere and the environment. Ice contributes to control the temperature of oceans like an ice cube does in a glass of water [14]. On the other hand, evaporation helps absorb local heat from previously warmed ocean and land surfaces to form warm water vapor that rises and transfers local heat from the surface to a cooler atmospheric zone where it occasionally condenses as liquid droplets and ice particles in clouds. In the meantime, the heat transferred from the surface is released in a zone where humidity no longer constitutes an obstacle to radiative elimination through a spectral zone of transparency between 5 and 8 µm called the water window. To some extent, in the proposed mechanism, water behaves like the refrigerant that transfers heat from the interior to the exterior of a refrigerator [15]. Environmental events like winds, hurricanes, tornadoes, air and oceanic streams are the means by which Nature diffuses and try to average local temperature differences. Their efficiency depends on the amount of heat and the rates of water interphases exchanges. The larger the heat to be moved, the stronger and the more frequent the climatic events must be. The entire mechanism schematized in Fig. 2 was detailed in a recent publication and validated [16] by the possibility to extend it to the large temperature (10°C) and sea level (120m) variations reported by paleoclimatologists during the glaciation-deglaciation periods that occurred in the distant past [17-18]. The current estimates respectively of 1.2 °C and 23 cm of the global temperature and ocean rises relative to 1880, are still very small and within the limits of the variations reported for the last 8,000 years of the Holocene [10]. In contrast, the acceleration of the disappearance of ices is incontestable [19].

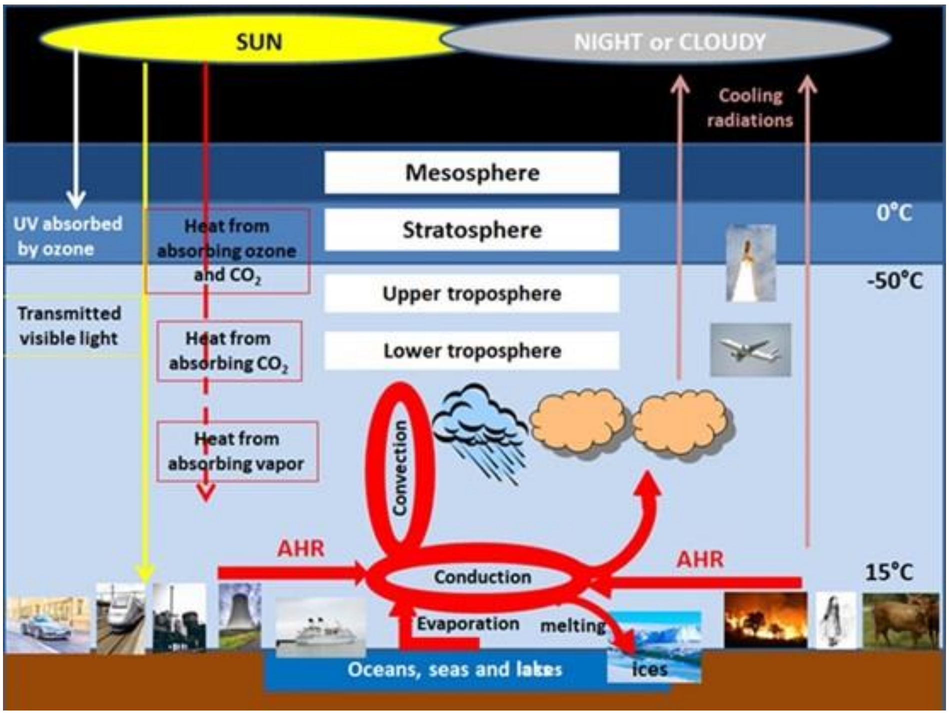

Figure 2: Schematic representation of the mechanism that manages solar and anthropogenic heat inputs to Earth [16]

In the previous section, we emphasized the illogic duality of fate between solar heat input and the radiative forcing with respect to accumulation in oceans. This was mostly a matter of time scale. The heat management based on water physical phases shows that the successive Holocene-like interglacial plateaus correspond to slow accumulation of heat in the environment over 10,000 to 30,000 years periods during which the transfer of surface heat to thickening clouds ends by the start of a new ice age once the Sun is efficiently masked [16]. Therefore, at the end of an interglacial plateau, the temperature should increase well above average since a thickening cloud layer also prevents radiative elimination. Unfortunately, temperature profiles of interglacial plateaus are not detailed enough to support this deduction [17,18]. Nevertheless, the role and the management of heat on Earth appear at least as credible as that assigned to CO_2 in glacial [21-22].

III. Heat on Earth

The Earth was formed approximately 4.5 billion years ago, followed by appearance of atmosphere and water allowing life to appear 3.5 billion years ago and to evolute since then. During this long period, Earth was supplied with heat by sequential solar heating and occasional heat releases by volcanoes and natural forest fires with radiative discharge into space. It therefore remained under the domination of Nature until Homo Sapiens learned to master the fire and began to modify his environment, a process which has accelerated over the last millennia in various parts of the world, paving the way for Chemistry, Physics, and Thermodynamics that have flourished over the last two centuries alongside the development of industrial activities. Gradually, wood combustion was complemented by the combustion of fossil compounds industrially extracted from the ground (oil, charcoal, peat, and natural gas). Late in the 19th century, the discovery of electricity quickly led to industrial production from thermal power plants, then nuclear power plants, and, more recently, from renewable resources to minimize CO_2 production and try to mitigate the dramatic consequences predicted by the IPCC for the decades to come [1]. Therefore, since the beginning of the industrial age, more and more heat due to humanity was injected in the environment in addition to heat provided naturally [23].

Today, the anthropogenic heat comprises:

1) the heat injected directly into the atmosphere from gas flaring, arsons, breeding of domestic warm-blooded animals, and humans as well.

2) the waste heat released during the extractions of energy precursors (oil, coal, natural gas, radioactive minerals),

3) the waste heat released during the transformation of these precursors into sources of energy (oil distillation, natural gas compression or liquefaction, processing of radioactive minerals to bars, etc.),

4) the heat produced and the waste heat released during the transport and the exploitation of these sources of energy (hot steam from machines, thermal plants and nuclear reactors cooling, thermic and electric cars, trains, trucks, planes, telephones, computers, data centers, electric wires, missiles, rockets, bombs, etc.). All these machines, plants, and equipment, use energy to provide comfort, work or services with yields far from 100%,

5) the heat formed during the treatment of urban wastes by combustion, etc.

In the past, Earth was largely covered by forests that absorb primarily solar visible light for photosynthesis. The absorption of tIR by plants is rather low and compensated by evapotranspiration similar to the perspiration that helps control human body temperature. Deforestation has opened up large spaces filled gradually by urban areas (about 3% of emerged lands) with roofs, paved surfaces, buildings, bituminous routes and concrete highways, airports, etc., whose materials are heated by absorption of solar tIR as everybody knows or can feels it. In addition, many human creations behave as true greenhouses which capture and temporarily store solar heat because of a lack of exit and convection inside. Examples of such greenhouses are cars, trains, houses and buildings with large windows, etc. The more recent appliances that behave as greenhouses are photovoltaic and thermal panels, roof water-heaters and some underroof spaces. Sooner or later, the supplement of capture of solar radiation is released into the environment directly or using cooling devices. The corresponding released energy coming from the Sun is likely to be much more important than that from inside the environment like waste heat, but data lack.

Quantification of anthropogenic heat releases has been proposed in the literature but estimates were limited to urban areas or do not involve evaporation mainly because of a lack of data and of the number of factors involved [24-26]. Unlike sequential natural heat sources (day not night, in summer more than in winter, in Northern and Southern hemispheres alternatively), many of the anthropogenic heat sources listed above are active almost permanently, a fundamental unfavorable difference in terms of the dynamic of management and elimination of heat. Indeed, periods of low activity of natural warming favor radiative elimination while permanent AHR reduced the efficiency of the elimination process and feed global warming when natural sources do not.

III. Why anthropogenic heat can alter the climate

Between 1900 and today, humanity and human activities changed very much. The evolution is well reflected by the growth of the main sources of anthropogenic heat:

1) the global human population has grown from 1.2 billion to 8 billion, with in part, a large increase of standard of living and a growth to 2 billion of warm-blooded domestic animals,

2) the surface of land converted into urban areas has increased very much, particularly in countries with large populations. Today, the surface is estimated at around 3 % with increasingly tall buildings,

3) the number of vehicles has grown from almost 0 to 1.48 billion,

4) the number of photovoltaic panels has grown from 0 to a rough estimate of 3 billion;

6) the number of nuclear plants in the world has grown from 0 to 410, with 59 under construction and 100 planned, etc..

To summarize, Earth is heated today directly by atmospheric and surface tIR absorbers, and indirectly by waste heat and by the capture of solar thermal IR by surface matters and by man-made greenhouses, all in growth.

The water-based mechanism of heat management suggests three scenarios for the future:

1) according to the first, AHR remain negligible with respect to solar inputs and the climate continues to fluctuate as it has in Holocene. The temperature continues to fluctuate within a range of 2°C and climatic events remain effective enough to eliminate efficiently the heat in space.

2) in the second, AHR are no longer negligible but the control of climate changes and the elimination of heat remain effective at the cost of worsened climatic events with, in particular, enhanced ice imbalance, more intense and more frequent local winds, hurricanes, tornadoes, more rains with floodings, more droughts and more clouds due to evaporation, etc...
3) in the last scenario, AHR reach a level such that, sooner or later, the melting of ice, evaporation, and heat diffusion by climatic events are no longer fast enough to avoid dramatic drifts compared to the thermal fluctuations in Holocene. The stock of ice is enormous but local climate anomalies are likely to worsened very much up to becoming dramatic. Based on distant past glaciation-deglaciation cycles, the consequence could be a shortening of the time frame until the end of Holocene and the start of the next glaciation period. According to paleoclimatologists, past plateaus lasted between about 10,000 to 30,000 years [17].

The challenge is to situate the current period in relation to one of these scenarios. The drifts of global temperature and ocean level are still very mall. In contrast, ice imbalance is significant and increases year after year. These observations suggest that the second scenario is under way. However, the lack of consistent data on the evolution of anthropogenic heat releases, the kinetic of ice disappearance, the rate of evaporation, the changing humidity, and the interferences between these, hampers significant quantification and thus excludes consistent long-term predictions, especially at the local level.

IV. Conclusions

Like the human body, the Earth can be considered a living system that tends to react to any disturbance. Meteorology is like Medicine. It diagnoses and justifies a climate disturbance based on short term observations. In contrast, predicting the climate in decades or more in advance through models and calculations or from past data is like willing to guess when a human being will have a stroke, a heart attack or a broken leg. Politicians are therefore like medical doctors. They are condemned to deal with climate disturbances from short term observations and not forecasts. If the whole world continues to neglect the role of AHR, the awakening could be dramatic in terms of climate worsening as well as politically and economically. Indeed, the risk is to see, in decades to come, climatic events worsen with local disasters despite the fighting against carbon-based sources of energy and the enormous sums of efforts and money involved in an inappropriate energy transition. There are solutions to mitigate the AHR. Thermal films on windows, limiting the power of cars, replacing paving stones and bitumen by earth or grass, favoring white surfaces, covering roofs with grass or thatch, favoring woody houses and wooden cladding, improving yields in work and using waste heat as secondary source of energy, etc., are examples of medications against AHR. However, in terms of AHR and justification of an energy transition, the gains brought by these solutions require the quantification from the cradle to the grave as is done for life cycle assessments [26], this for electricity and carbon energies comparatively.

As early as 1972 when the depletion of fossil resources was a prospect, Sicco Manshfolt, a former vice-president for agriculture of the European Commission underlined in “Letter Manshfolt 1972”: “it is evident that the society of tomorrow cannot be based on growth” [28]. Such an affirmation is applicable today in the context of climate change dependent on growing anthropogenic heat releases that inexorably threaten the planet.

Acknowledgements

The retired author is indebted to the University of Montpellier for providing an access to peer-reviewed and on-line free archives literatures and blogs.

Remark

Failing to respect the consensus on CO_2 radiative forcing, seminal papers were rejected by journals specialized in Climatology and were finally made available in free access archives or published in journals specializing in energy. Therefore, the present work has again been placed as preprint in open archives and is left to appreciation and fair exploitation by readers with citation.

References

1) IPCC, (2023), Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34 https://www.ipcc.ch/assessment-report/ar6/
2) Lindsey, R., (2022) Climate Change: Atmospheric Carbon Dioxide, NOAA. https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide
3) NASA Center for Climate Simulation, (2017) Carbone dioxide in 3D, https://svs.gsfc.nasa.gov/12445
4) Richie, H., (2019) Who emits the most CO_2 today? *Our World of Data*, https://ourworldindata.org/annual-co2-emissions
5) Sliney, D., (2016) What is light? The visible spectrum and beyond, *Eye*, 30:222–229. https://doi.org/10.1038/eye.2015.252
6) Gueymard, CA., (2004) The Sun's total and spectral irradiance for solar energy applications and solar radiation models, Solar Energy 76(4):423-453. Doi: 10.1016/j.solener.2003.08.039
7) Pierrehumbert, R.T., (2011) Infrared radiation and planetary temperature, *Physics Today*, 64, 33–38. https://doi.org/10.1063/1.3541943
8) Monteith, J.L. and Unsworth, M.H., (1990) Principles of Environmental Physics, 3nd edition, Academic Press. https://www.goodreads.com/book/show/1896902.Principles_of_Environmental_Physics%0d
9) Swinehart, D.F., (1962) The Beer-Lambert law, *J. Chem. Educ.* 39:333-335. https://doi.org/10.1021/ed039p333
10) Climate Physics, (2022) book on line with free access. https://laphysiqueduclimat.fr/wp-content/uploads/2022/12/Physique-du-climat_G1_en.pdf
11) Kääb, Andreas; Bolch, Tobias; Casey, Kimberly A; Heid, Torborg; Kargel, Jeffrey S; Leonard, Gregory J; Paul, Frank; Raup, Bruce H (2014). Glacier mapping and monitoring using multispectral data. In: Kargel, J.S., Leonard, G., Bishop, J., Kääb, M.P., Raup, B.H. Global Land Ice Measurements from Space. Heidelberg: Springer, pp. 75-112. (Fig. 4.2). DOI: 10.5167/uzh-102068
12) Vinther, B., Buchardt, S., Clausen, H., et al., (2019) Holocene thinning of the Greenland ice sheet, *Nature* 461:385–388. https://doi.org/10.1038/nature08355://laphysiqueduclimat.fr/wp-content/uploads/2022/12/Physique-du-climat_G1_en.pdf
13) Vert, M, (2022) A Different Vision of the Global Warming Based on Chemistry, physics and thermodynamics, *Intern. J. of Energy and Environ. Sci*., 7:74-79. https://article.sciencepublishinggroup.com/pdf/10.11648.j.ijees.20220705.11.pdf

14) M. Vert. (2019) Earth's ices melting: and if the greenhouse effect of anthropogenic CO_2 is not the (only) cause? *HAL CNRS*, https://hal.science/hal-02418659v1
15) M. Vert, (2021) Refrigerator as Model of How Earth's Water Manages Solar and Anthropogenic Heats and Controls Global Warming, *ESSOAr, published on line*. Doi: 10.1002/essoar.10507521.3
16) Vert, M., (2023) Electricity in the context of a new vision of global warming in which anthropogenic heat and not CO_2 is determinant, *Intern. J. Plasma Environ. Sci. and Technol.*, 17: (2) e02003 (9pp). https://doi.org/10.34343/ijpest.2023.17.e02003
17) J.R. Petit, J. Jouzel, D. Raynaud, N.I. Barkov, J.M. Barnola, I. Basile, I., et al., (1999) Climate and Atmospheric History of the Past 420,000 Years from the Vostok Ice Core, Antarctica, *Nature*, 399:429-436. http://dx.doi.org/10.1038/20859
18) Waelbroeck, C., Labeyrie, L., Michel, E., Duplessy, J.C., Mc Manusc, J.F., Lambeck, K., Balbon, Labracherie,E.M., (2002) Sea-level and deepwater temperature changes derived from benthic foraminifera isotopic records, *Quaternary Science Reviews*, 21:295-305. https://doi.org/10.1016/S0277-3791(01)00101-9
19) T. Slater, I.R. Lawrence, I.N. Otosaka, A. Shepherd, N. Gourmelen, L. Jakob, P. Tepes, L. Gilbert, P. Nienow, P., (2021) Review article: Earth's ice imbalance. *The Cryosphere*, 15:233–241. https://tc.copernicus.org/articles/15/233/2021/
20) Wilcox, P.S., Honiat, C., Trüssel, M. et al. (2020) Exceptional warmth and climate instability occurred in the European Alps during the Last Interglacial period. *Commun Earth Environ* 1:57. https://doi.org/10.1038/s43247-020-00063-w
21) Bauska, T.K., Marcott, S.A., Brook, E.J., (2021) Abrupt changes in the global carbon cycle during the last glacial period. *Nat. Geosci.* 14:91–96. https://doi.org/10.1038/s41561-020-00680-2
22) Herring, D., Lindsey, R., (2020) Hasn't Earth warmed and cooled naturally throughout history? *NOAA Climate.gov.*, and references therein. https://www.climate.gov/news-features/climate-qa/hasnt-earth-warmed-and-cooled-naturally-throughout-history
23) Vert, M., Global Anthropogenic Heat as Source of Ices Disappearance; Consequences for the Future of Earth and Humanity. *ESS Open Archive*, May 02, 2021. DOI: 10.1002/essoar.10506943.1
24) Chen.n B. Dong, L., Liu, X., Shi, G.Y., Chen, L., Nakajima, T., Habib, A., (2016) Exploring the possible effect of anthropogenic heat release due to global energy consumption upon global climate: a climate model study, *Int. J. Climatol*., 36:4790–4796. https://doi.org/10.1002/joc.4669
25) Bian, Q., (2019) The Nature of Climate Change- equivalent Climate Change Model's Application in Decoding the Root Cause of Global Warming. *Intern. J. of Environ. and Clim. Change*, 9:801–822. https://doi.org/10.9734/ijecc/2019/v9i1230160
26) Bian, Q.H., (2022) Global Warming Thermodynamics. *Open Access Library Journal*, 9: e8945. https://doi.org/10.4236/oalib.1108945
27) Finnveden, G., Hauschild, M.Z., Ekvall, T., Guinée, J., Heijungs, R., Hellweg, S., Koehler, A., Pennington, D., Suh, S., (2009) Recent developments in Life Cycle Assessment, *J. Environ. Manag.*, 91:1-21. https://doi.org/10.1016/j.jenvman.2009.06.018
28) Mansholt, S.C., Mansholt Letter 1972, Internationaal Instituut voor Sociale Geschiedenis, Amsterdam. (1945-1995). Teksten van lezingen van J. Linthorst Homan. In manuscript en gedrukt. 1951-1953, p. 528. https://nieuweinstituut.nl/en/projects/the-mansholt-letter/de-brief