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Review Article

On earth system dynamics' hypothetical "greenhouse effect"

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Abstract

We review an editorial article in the climate journal Earth Systems Dynamics (ESD 14, 241–242, 2023): the headline title of which makes two scientifically incorrect assertions: (i) that the greenhouse-gas hypothesis, i.e., cause of global warming by ~1K in 1950-2020, is an established scientific truth, and (ii) that heat emissions from global fuel combustion are, by comparison, negligible. Both statements are inconsistent with the laws of classical thermodynamics, with the limitations of the Earth's global energy budget multivariate computer models, and with the known absorption and emission spectroscopy of carbon dioxide (CO_2). The scientific method of establishing truth requires hypotheses to be tested against experimental results by circumspective scientific scrutiny. Scientific knowledge cannot be established by consensus politics. We question the wisdom of a policy of rejecting articles that may disparage the greenhouse gas hypothesis. By this criterion of science by consensus, the 1543-AD publication of Nicholas Copernicus's research article, which disputed the prevailing consensus of the Ptolemaic hypothesis of a static Earth system, would have been rejected by Copernicus Publications. The ESD editors cite, as an example, two recent articles, they say, that should have been rejected without peer review. Both articles, which contradict the greenhouse gas hypothesis, were peer-reviewed for sound science, and published by MDPI recently in Entropy. We find that Copernicus Publications' peer-review policy, and this ESD editorial article, in particular, are unethical. A policy of only publishing consensus science enhances an ascendancy of politically motivated subjective pseudoscience, causing a stagnation of our scientific understanding and description of Earth systems.

Introduction

In an extraordinary review article [1], the editors of Earth System Dynamics (ESD), Kleidon, et al. declare a policy of rejection, without peer review, of any research results that test the Greenhouse-Gas Hypothesis (GGH) of global warming against experimental observations. These editors have taken it upon themselves to openly criticize the publication of two peer-reviewed articles [2,3] in the thermodynamics journal Entropy. The ESD headline, moreover, is without scientific basis, and highly misleading to those uninitiated in the relevant sciences, *inter alia* government politicians, national and international funding bodies, news reporters, and social media.

For the purposes of this response, we revisit all nine references 4-13 cited by Kleidon, et al. [1] claiming that they establish the GGH is a scientific truth. We investigate what, if anything, these references can tell us about the greenhouse gas hypothesis. The short answer is nothing; at best, it remains unsubstantiated. Their editorial reveals an ignorance of the principles of thermodynamic equilibrium and the application of the laws of thermodynamics to climate science. The article does not address the scientific content of either of the two research articles that led to the conclusions that disparage the greenhouse gas hypothesis of global warming. In the Kleidon-ESD editorial citation list, there is no reference to any research by the five ESD editorial authors, not one single reference to any research, or experimental results in any other peer-reviewed scientific paper that establishes the greenhouse-gas hypothesis as scientific truth. Their reference list contains only four peer-reviewed research articles in climate journals to support their headline title. In the following sections, we reveal

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that all four articles report experimental results that disagree with the greenhouse gas hypothesis.

"Greenhouse effect"

The expression "greenhouse effect" in the editorial title [1] is misleading. That simply means heat loss, mainly by convection, is blocked by the window glass, hence the warming effect. There is no such greenhouse closed-window effect in the Earth's atmosphere. The GGH analogy has arisen from a theory that transducer gases, such as CO_2, that are known to convert photons into enthalpy, are responsible for air confined within a greenhouse is warmer than ambient air outside. In fact, the absorption of IR radiation by the mole fraction [CO_2] in air (= 0.0004) is completely negligible compared to conduction and convection from surfaces within the greenhouse irradiated by sunlight, and also compared to water mole fraction [H_2O], 20 times [CO_2], and a more powerful molecular transducer. Hence the term "greenhouse effect" is not relevant for the theory of global warming from 1950 - 2023. Therefore, the editorial headline, "*Global warming is due to an enhanced greenhouse effect*" [1] is deceptive.

What is "negligible": current global warming index GWI

The second headline statement "*anthropogenic heat emissions currently play a negligible role at the global scale*" can also be dismissed as untrue simply by applying the first law of thermodynamics to the total enthalpy output. *Quote* [1] "*A quick look at the global surface energy balance illustrates this clear picture; human primary energy consumption amounted to 595 EJ in 2021 (BP2022)*". This is an experimental result that we all agree with. The data from the BP report [4] is shown in Figure 1 on top left. A trivial application of the 1st law shows that 595 exa-joules emitted into the atmosphere every year do not "*play a negligible role*" [1] when we view it alongside the current Global Warming Index (GWI), also shown in Figure 1, 0.0175 K/ year (1970 - 2021). Indeed, anthropogenic heat production exceeds the enthalpy flux corresponding to GWI by ~ 7 times, as shown below.

Kleidon, et al. have converted the 595 EJ energy/year (2021) into a uniform concentric-mean heat flux by dividing over the area of the earth's surface and then converting it to Watts. They obtain a fuel energy total emission of 0.04 Wm^{-2}, which they describe as "minute" compared to solar radiation, and hence, they claim, (quote): "*play a negligible role in global warming*".

Figure 1 shows that before the beginning of the rise in the GWI around 1920, for many decades even before the industrial revolution from 1850 to 1920, the GWI was 0.00 ± 0.01 K, i.e. zero, by definition of "global warming" to within the accuracy that means air temperature can be measured at monitoring stations. Using the (ideal gas) heat capacity of the atmosphere, C_p = (7/2) nR = 5174.1 EJ/K, where R (= 8.31446 J/(K. mol) is the molar gas constant, and n (= 1778 × 10^{18} mol) is total atmosphere mass converted to moles, we obtain C_p = 5174.1 EJ/K independent of temperature (T) and pressure (p). We can calculate the mean concentric heat transfer emission rate corresponding to the current GWI, 0.0175 K/year. We obtain the result that GWI heat flux account is 0.0061 Wm^{-2}: i.e.,

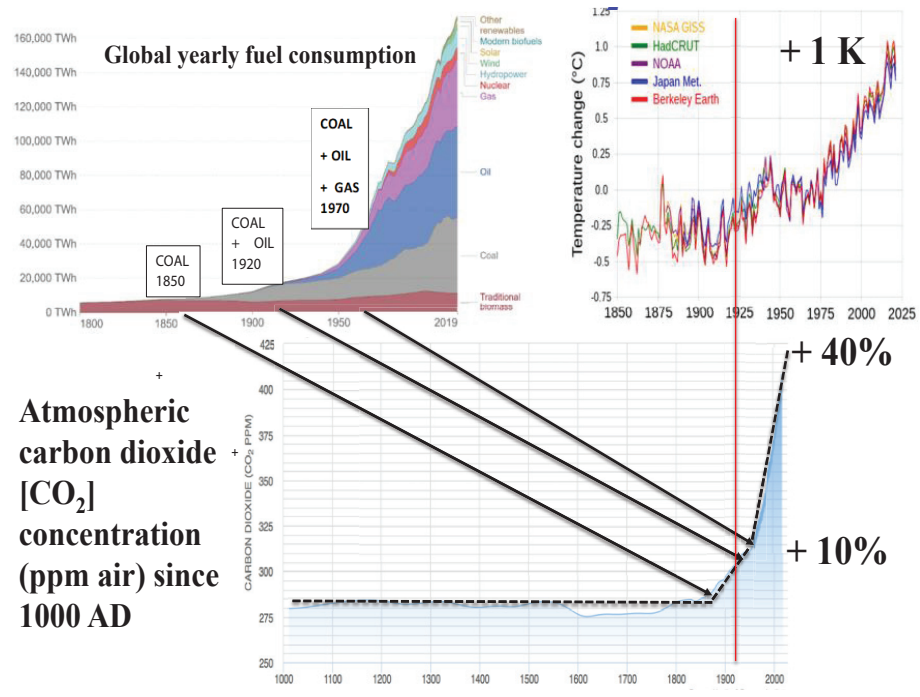

Figure 1: Time correlations between fossil fuel emissions of heat with GWI and CO_2 concentrations. Left: annual enthalpy output from all fuel sources from 1850 to 2019; **Right:** global warming index from 5 independent sources from 1850 to 2020: the present annual rate in increase of average temperature <DT> (GWI) per year is 0.0175 ± 0.0005 K. **Below:** average concentration of CO_2 in the Earth's atmosphere over last thousand years: until 1850 the beginning of the industrial revolution, coal and steam engines, the level remained constant below 2.85 ppm, then increasing by ~ 1 ppm/ annum for 120 years to 1970 and has been increasing by roughly 2 ppm /year since around 1970.

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approximately 7 times smaller than the anthropogenic heat production that Kleidon et al. [1] describe as "minute".

"Anthropogenic heat" references

The experimental rate of heat released is indeed confirmed in Kleidon et al.'s reference to Jin, et al. (2019), that this is equivalent to an average rate of fuel enthalpy output of 0.04 Wm^{-2}. There is nothing in reference [4] to support the greenhouse gas hypothesis, quite the opposite. Quote: (Jin, et al. [5]) *"The globally averaged terrestrial AHFs (anthropogenic heat fluxes) were estimated at 0.05, 0.13, and 0.16W m^2 in 1970, 2015, and 2050, respectively, but varied greatly among countries and regions".*

The warming distributions over predominantly populated land areas as reported by Jin et al., however, are inconsistent with the greenhouse-gas hypothesis. This article by Jin, et al. [5] actually confirms that the temperature increases contradict the greenhouse gas hypothesis since CO_2 increases would lead to uniformly distributed anthropogenic enthalpy emissions. Both the NY Times 2019 global warming map in reference [3] and the analysis of Jin et al. confirm that the greenhouse gas hypothesis of a fully dispersed excess [CO_2] disagrees with the geographically heterogeneous nature of the GWI global distribution.

The geographical distribution of 2K+ hotspots is irrefutable direct experimental evidence that a substantial fraction of the global warming index (1950 - 2020) of ~ 1 K may be accounted for by enthalpy emissions from fracking operations in the shale gas industry as shown here in Figure 2.

The other three references that Kleidon, et al. [1] cite as evidence for the greenhouse gas hypothesis as established science [6-8] also confirm just the opposite. Block, et al. in 2004 [6], focussed research into enthalpy increases in some industrial regions of Europe. 20 years ago, they concluded (from computer models!) Quote [6] *"The direct effect discussed in this paper is smaller than the expected warming causes by increasing greenhouse gas concentrations [*sic: predicted by computer modelling*] (Houghton 2001, Keuler, et al. 2003) But anthropogenic heat will become more important in the future, because of the steady increase in world energy consumption and the growth of population in urban areas".*

Kleidon, et al. also cite Mark Flanner (2009) [7] to support their claims that anthropogenic heat is negligible. This is what Flanner reported in the opening paragraph of his summary. Quote:*" Nearly all energy used for human purposes is dissipated within the Earth's land-atmosphere system. Thermal energy released from non-renewable sources is therefore a climate forcing term. Averaged globally, this forcing is only + 0.028 Wm^{-2}, but over the continental United States and Western Europe, it is + 0.39 and + 0.68 W/m^{-2} respectively".* Nowhere in Flanner's paper is there any suggestion that anthropogenic heat emissions could be "negligible", even considering 0.04 Wm^{-2}, the present experimental global average forcing from fossil fuel.

Joule-Mayer 1st law of irreversible thermodynamics

In support of their "anthropogenic heat is negligible" claim, Kleidon, et al. [1] also cite the 2012 article by Stephens, et al. [8] that addresses just the global radiation balance, whence the entire Earth is treated as an isolated thermodynamic system, open to radiation transfer. Computer models of all these processes are based only upon the Joule-Mayer 1st law of irreversible thermodynamics [14]. The abstract of this reference to global energy balancing states the following.

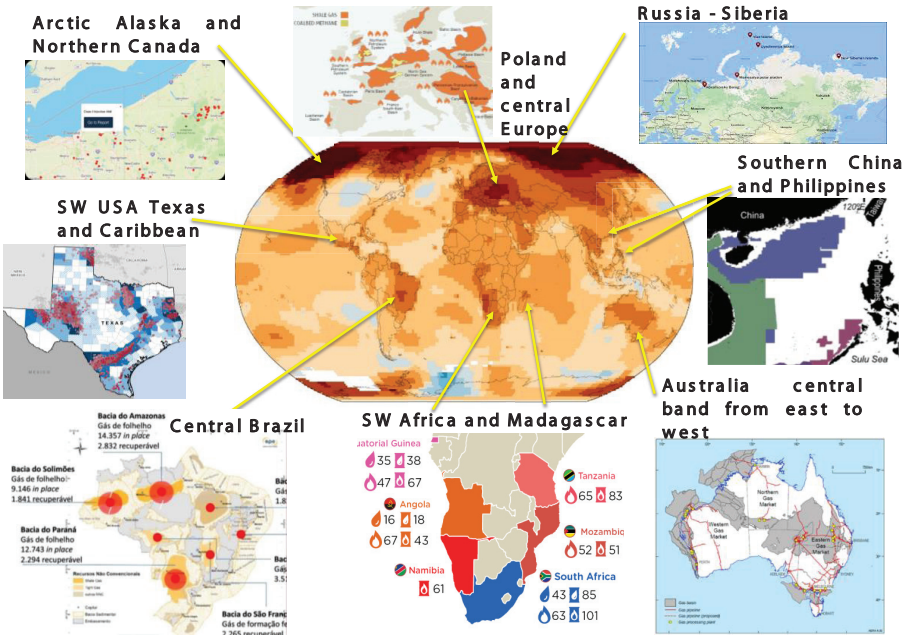

Figure 2: New York Times global warming map of the GWI average (2019) : https://www.nytimes.com/interactive/2020/01/15/climate/hottest-year-2019.html: distribution of temperature increases since 1950: the dark brown (2K+) 'hotspots' coincide with regions in countries of the most intensive shale gas exploration and recovery by fracking industries; the original figures and web references to the national shale gas exploration maps cited above are individually detailed and referenced in [3].

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We quote (Stephens, et al.) [8]: *"The global balance of energy fluxes within the atmosphere or at the Earth's surface cannot be derived directly from measured fluxes and is therefore uncertain. This lack of knowledge of surface energy fluxes profoundly affects our ability to understand how Earth's climate responds to increasing concentrations of greenhouse gases."*

In other words, computer modelling of all the contributions to the concentric mean energy budget at the Earth's biosphere surfaces cannot tell us anything about the reason for the biosphere GWI of 0.0061 ± 0.0001 Wm^{-2} from the radiation balance at the Earth's surface where the biosphere GWI is recorded, Stephens et al. report a net Earth's surface radiation balance of 0.6 ± 17 Wm^{-2}, with a level of uncertainty far exceeding the calculated imbalance by orders of magnitude. Far from supporting the GGH, their result Figure 3, with data from Stephens et al. confirms the absurdity of the UN-IPCC climate modelling conclusion from multivariate computer modelling. In the IPCC computer models, the entire Earth is a closed system that can exchange heat only by radiation to and from space. The total energy-flux balance includes many sources and exceedingly complex unknown terms, and also with uncertainties from fossil fuel emissions admitted by the energy industries [9].

One of the smallest of terms of the Earth's energy budget is the greenhouse-gas (CO_2) hypothesis energy flux term. We can define this quantity as the (hypothetical) excess energy flux arising from a 40% increase in [CO_2]:

$$\Delta E_{ggh} = E[CO_2: 400\ ppm] - E[CO_2: 285\ ppm]$$

Then, we can collect all the terms in an energy balance equation to be solved for ΔE_{ggh} in any Joule-Mayer energy conservation multivariate computer model. There are no less than 20 resolved terms in the incoming and outgoing radiation balance (E_{sun} - E_{earth}) listed in the review of Stephens, et al. [8] (Figure 2). A GGH 'master equation' can thus be summarized (see Wikipedia: "Earths Energy Budget" for a list of some of the terms with self-evident subscripts):

$$\Delta E_{ggh} = (E_{sun} - E_{earth}) + E_{gg} + E_{elec} + E_{ff} - E_{alb} - E_{ref} + E_{insol} + ...\pm E_n.... = 0.0061\ Wm^{-2} \quad (1)$$

(n = unknown number of all non-negligible E_{flux} source terms in the equation: a full list is unlimited!)

Using conservation of all energy sources, in conjunction with the radiation balance for the total energy flux, as derived by the IPCC climate modelling community [10-13], Kleidon, et al. [1] claim that a multivariate computer model, based upon this global energy balance of known energy flux sources, can lead to the confirmation of current GWI surface flux is ΔE_{ggh} = 0.0061 W/m^{-2}, as an established science truth. The uncertainty in just the biosphere surface radiation balance is ± 17 Wm^{-2} [5] some ~3000 times greater than the GWI experimental result for ΔE_{ggh}.

This ESD editorial statement by Kleidon et al. is merely a restatement of the IPCC greenhouse gas hypothesis. We quote [1]: *"the greenhouse gas forcing can then explain very well the increase in mean global surface temperature of over 1 °C since preindustrial times."* In fact, the statement is misleading. Figure 1 shows that the [CO_2] increase above 285 ppm began with the use of coal at the start of the Industrial Revolution around 1850, whereas the global warming index from 1850 to 1920 was zero, i.e., in disagreement with the GGH. The absence of climate-change events before 1950 may be explained by coal combustion, unlike hydrocarbon fuels, coal does not emit H_2O into the atmosphere (Table 1).

Gibbs 1st and 2nd laws: H and S are state functions

The beauty of Gibbs' classical thermodynamics is that for all reversible processes, however many, however complex, whatever may be our ignorance of mechanisms and time scales, reversible heat (Q_{rev}) defines the state functions [14], enthalpy (1st law Hess) $\Delta H = Q_{rev}$, and entropy (2nd law, Carnot) entropy $\Delta S = Q_{rev}/T$. No matter what the reversible path complexity of the cycle of intermediate processes, no matter how great our ignorance of kinetic mechanisms of these processes, at a

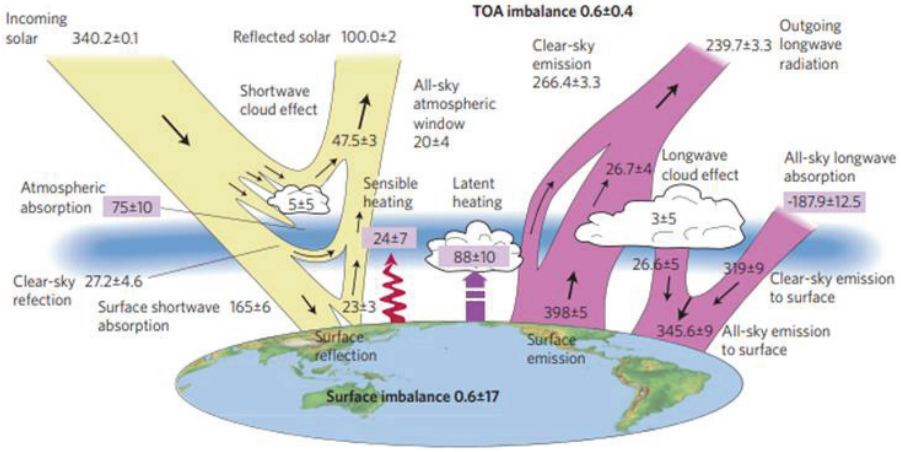

Figure 3: Radiation balance terms in the GGH master equation (1) shown by Stephens, et al. [6]: all values of the energy fluxes quoted with estimated uncertainties are in Wm-2. Stephens et al. modified the original of this Figure which is open access in an IPCC report [12]: also https://judithcurry.com/2012/11/05/uncertainty-in-observations-of-the-earths-energy-balance/

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Table 1: Fossil fuel emission reactions (i) carbon from coal (~1850 - 2020), (ii) octane from crude oil (~1920 - 2070), and (iii) methane from shale gas reservoirs (~1970 - 2020) as shown in Figure 1. Heats of combustion from https://docbrown.info/page07/delta1Hd.htm

Reaction n°	carbon	oxygen		carbon dioxide	water	enthalpy (= ΔH)
i	C	+ O_2	→	CO_2	none	+ 394 kJ/mol
ii	(1/8) C_8H_{18}	+ (25/16) O_2	→	CO_2 +	(9/8) H_2O	+ 683 kJ/mol
iii	CH_4	+ 2 O_2	→	CO_2 +	H_2O	+ 890 kJ/mol

constant thermodynamic equilibrium state of air, at a fixed recording station, at constant composition, is defined only by its Temperature (T) and Pressure (p). Then, with T and p fixed, the heat change Q_{rev} = ΔH = TΔS = 0 for all cyclic processes if the GWI is zero, as seen in Figure 1 from 1850 to 1920.

To apply this basic tenet of thermodynamics to a non-zero GWI, we don't need to know any of the details of mechanisms or sources of heat transfer. In order to discover possible reasons for global warming, we only need to look at what has changed since the Earth was at steady-state equilibrium in the pre-industrial global warming era. Notwithstanding the plethora of complex heat transfer processes and mechanisms involved, many of which are inextricably combined, and some unknown, the Earth reaches a steady state whence the net radiation balance at the top of the atmosphere is exactly zero, if the GWI <DT> atmosphere is zero.

Far from *"being clearly attributed to increase greenhouse gases"* as stated by Kleidon, et al. [1] this, 0.6 ± 0.4 Wm^{-2} at the top of the atmosphere, is just a small fraction of the sum of the uncertainties in Figure 3, as calculated from satellite data by Stephens, et al. [6] that they estimate to be of the order ± 17 Wm^{-2} at the Earth's surface. For comparison, the heat forcing of GWI by GGH at the Earth's surface is presently estimated at 0.0061 ± 0.001 Wm^{-2}.

Modern monitoring stations define and measure air temperatures to an accuracy well within ± 0.01K [15]. From Figure 1, given the C_p atmosphere, we calculate that between 1850 and 1920 the mean GWI/ decade is 0.000 ± 0.001 Wm^{-2}. That is the margin of error. Since enthalpy is a state function, if ΔT changes, what are the possible reasons for the corresponding enthalpy flux change? The greenhouse-gas hypothesis and computer models that can parameterise it, neglect the experimental result: fossil fuel combustion discharges an amount of heat, globally, that is several times greater, than is assumed in the greenhouse-gas hypothesis, to explain the present GWI [3]. This result begs the question, not 'What causes global warming (1950 - 2023)?', but 'What counteracting effects cause global cooling of the anthropogenic heating that presently prevails?'

Likewise, we can apply the 2nd law of equilibrium thermodynamics (entropy, hence also Gibbs energy are state functions) to the question: can a change in GWI of 1 K over 70 years change the climate? The Earth's climates are principally determined by atmospheric pressure fluctuations leading to cloud formation that occurs when moist air cools below the saturation pressure (p_s). When the climate change is zero, there is no change in either of the state functions enthalpy or entropy, hence also Gibbs energies that determine the cloud condensation equilibria. The Clapeyron equation, derived from Gibbs's 2nd law, relates the change in p_s that would occur due to global warming, i.e. DT > 0:

$$\Delta(p_s) = p_s S_{vap} \Delta T/ (RT) \quad (2)$$

If T is ~ 280 K, and ΔT = 1K i.e. GWI, S_{vap} ~ 150 J/(mol.K), R is the molar gas constant, we obtain a change in Δp_s of 0.0005 atm, if p_s is 0.01 atm. A more accurate estimate will be reduced by the entropy of cloud formation. This simple result tells us that the main property that determines climates has changed by only a small amount as a consequence of a GWI rise of 1K over a 70-year period. This may not be of significant consequences compared to much larger natural geographical and seasonal fluctuations around <T> (z) and <p_s>(T) that determine the Earth's climates.

Spectroscopy of CO_2

The greenhouse gas hypothesis is based upon conjectures regarding the molecular spectroscopic properties of the CO_2 molecule that may have never been validated. Here, we summarise some essential experimental facts regarding the molecular physics of CO_2 spectroscopy.

The rate of emission of the photonic energy from the Earth's surface as black body radiation by Stefan-Boltzmann law in the absorption bands of CO_2 is limited compared to the [CO_2] concentration capacity to absorb it [16,17]. In the IR spectra of CO_2, the lines in the rotational structure of CO_2 vibrational bands efficiently absorb about 10% of all IR in the specific IR bands where these lines appear, letting through the remaining 90%, and evidently absorbing absolutely nothing at all other IR wavelengths. Therefore, CO_2 can affect no more than 10% of the surface-emitted IR radiation, and this absorption is already strongly saturated, as the absorption length does not exceed 300 meters for the relevant lines considered, whereas the troposphere, which determines climates, is 10 km thick.

In this, alternative hypothesis, we should expect only very small effects due to increased atmospheric CO_2. Indeed, doubling atmospheric CO_2 would reduce the absorption length to 150 meters, which results in less than 1K at the surface assuming a 6.5 K/ km lapse rate - if everything is contained at this relatively weak line with a long absorption length. The absorption length of the dominant line, however, is ~3 meters, so 1.5 meters would be equivalent to 0.015 K at the surface. This effect would not even be measurable.

We should emphasize that these analyses [16,17], however, are based upon the literature data that the shortest wavelength a CO_2 gas molecule can temporarily absorb and emit is at wavenumber 2349 cm^{-1}. That is a near-IR wavelength. For shorter wavelengths, CO_2 is said to be transparent. That is a central GGH assumption i.e. based upon the spectroscopic properties of the CO_2 molecule. An isolated CO_2 molecule does not absorb in UV- VIS range, because the first excited electronic state is too high: and absorbs mainly in a single band

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in IR. These spectroscopic data, however, are obtained in high vacuum labs for isolated molecules of a rarified gas of pure CO_2 in an otherwise empty bottle.

We do know, however, that this GGH assumption neglects the clusters of H_2O and CO_2 in air and clouds. The monomer fraction density of both H_2O and CO_2 in ambient air, and lower temperatures at elevations, could be as low as 10% and it will decrease with T at height. The radiation absorption and emission properties of atmospheric CO_2, which could be more than 50% H_2CO_3, will have different molecular orbital energy levels, weaker bonds with lower excited states, and different vibrational-rotational absorption spectra. The relevant spectroscopic data of various CO_2-H_2O complexes will be completely different from those of a rarified gas of isolated CO_2 molecules. For a review section on recent research on the cluster physics of molecular gases: see Sedunov (2012) [18].

Recent satellite measurements [19], moreover, show that a reduction of IR emissions in CO_2 bands at some latitudes and heights is partially compensated by increased emissions in CO_2 and H_2O bands at other latitudes and heights. The topmost "single-unit-absorbance" layer where IR radiation disconnects from the atmosphere and goes directly out, is a height that varies with different absorption wavelengths. For water, it can hardly exceed 10 km as water condenses to cloud in the tropopause. For CO_2 it is higher, as CO_2 is homogeneous even at higher altitudes. This atmospheric heat redistribution maintains global temperatures more tightly than local temperatures that experience larger deviations.

We should at least consider scientifically sound alternatives to GGH. One such hypothesis, proposed recently by physicists Lightfoot and Orvil [20], is based upon the interacting radiation physics of both CO_2 and H_2O. They reach the following conclusion: quote "*It appears the gas laws as applied in this paper are not included in climate models. If they were included the models could not project continually increasing atmospheric temperature with increasing concentration of CO_2. Whether or not the models can be restructured for improved performance is beyond the scope of this study.*" This recent, and valued, 2018 contribution to the scientific debate on climate change would have been rejected by Copernicus Publications' ESD journal.

Climate-change hypotheses

Implicit in the Kleidon, et al. editorial article [1] is an *ad hoc* incorrect assumption by the four references to IPCC reports they cite [7-9,12], that equates the greenhouse-gas hypothesis to their climate-change hypothesis. GGH and CCH are certainly not synonymous, and probably not even related as a corollary, as the world's media have been misled to believe by the IPCC reports. They create a wide media consensus that "climate change" and "global warming" are inextricably related and imply that both these hypotheses are established scientific truth. They are not the same conceptually, however. Global warming is not a hypothesis: the current GWI of 0.0175 K/year since 1970 is an experimental result of independent verifiable sources. Now, "Could this slight warming effect cause significant changes in the Earth's land climates equivalent to CCH?" is a different question.

The Earth's climates, or weather patterns, nevertheless, have been changing for countless different known and unknown reasons, including galactic and insolation events, and lithosphere geothermal activity since its surface solidified 4,000,000,000 years ago. Eventually, water began to collect in, and evaporate from its basin bottoms. It is still changing, over the surface spatially, and on all time scales. It is possible that the climate changes we have witnessed in recent decades (e.g., more floods) are related to the GWI index, but that is another hypothesis, while the (IPCC) climate-change hypothesis (CCH) still remains to be tested against experimental results by the scientific method. The IPCC- CCH can be summarised: "the increase in GWI from zero in 1950 to ~ 1K in 2020 is the cause of changes in the Earth's land climates, as evidenced by record temperatures (since records began only 200 years ago) and increased flood frequency on the land surfaces since around 1980". The IPCC climate-change hypothesis assumes the increase in land surface flooding is caused by enhanced evaporation rate from sea surface, and an increase in water in the troposphere, caused by the increase in GWI (~1 K since 1920: Figure 1).

Therefore, whilst the IPCC-CCH remains an unsubstantiated and unlikely hypothesis, the atmospheric research community should consider alternative hypotheses provided they are based upon sound science. The Earth's various weather patterns that determine the climates are mainly determined by the pressure fluctuations depicted as contours of isobars (Figure 4 shows monthly averages for example) that we see daily on TV weather forecasts. A corollary of the greenhouse gas CO_2 hypothesis of global warming is that if the GWI index returned to a sustainable zero GWI = 0 e.g., by eliminating further emissions of CO_2, (C-net zero IPCC policy), then the Earth's climates would stop changing. Is this hypothesis now a scientific truth, we ask?

Whereas a heat enthalpy output corresponding to 0.85 K over 70 years, in a typical land surface climate, with seasonal fluctuations in temperatures varying by an average of ± 50 K between winter and summer, seems an unlikely cause of fundamental changes other than extending summer by a day, and or shortening winter by a day, perhaps? The global weather patterns are determined, not by fluctuations in temperatures at the Earth's surface, but by fluctuations in pressure around the global mean annual surface air pressure of 1013.5 mb at sea level. Typical average monthly pressures for the extreme seasons are shown in Figure 4. By contrast with the wide fluctuations in temperature between the extremes of winter and summer, weather patterns, such as rainfall statistics, and extreme events, such as flooding, are determined by extremely small fluctuations between high-pressure clear skies (> 1020 mb) and low-pressure cloudy skies (< 1005 mb). It is the cloud formation that causes the surface temperature extremes from winter to summer. The pressure variations in Figure 4 are determined by the amount of water in the atmosphere that can be regarded as a 2-phase equilibrium, between condensed cloud colloid, and steam at a partial pressure (humidity) of the order 0.01-atmosphere pressure.

The Earth's climate is principally determined by atmospheric pressure fluctuations that depend on the equilibrium constant

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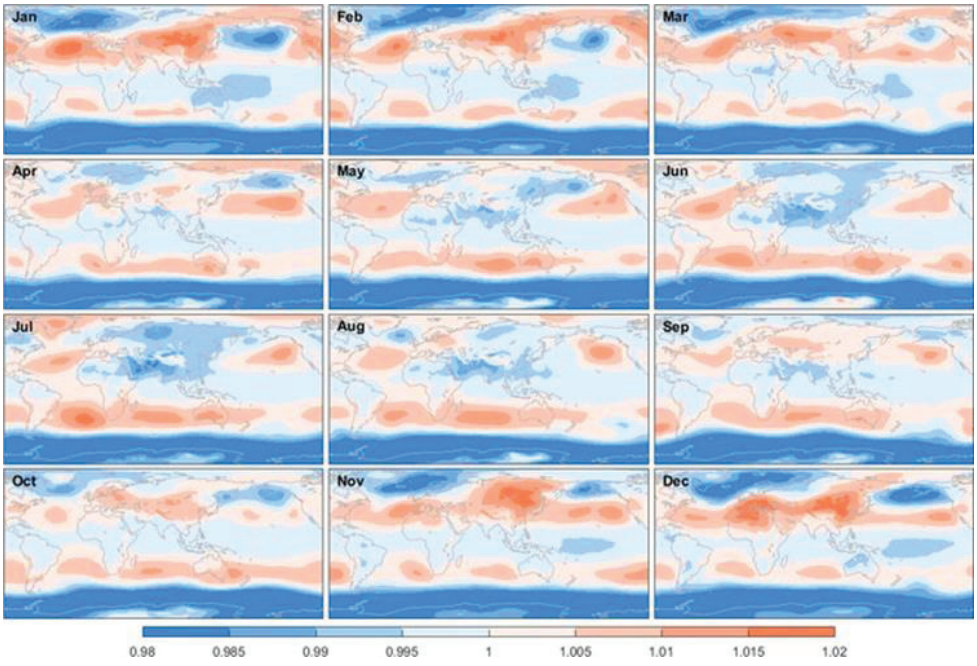

Figure 4: Global atmospheric pressure isobaric contours that determine weather patterns and Earths climates (units 1 atmosphere = 1.013 mb): are mid-winter month averages (January 2022) and midsummer month averages (July 2022) There are very large average temperature differences between winter and summer months but all monthly pressure patterns look much the same; temperatures do not affect the climate so much as small seasonal variations in pressure, up ± 0.01b (1% of $<p_0>$) cause seasonal climate changes depending on water concentration $[H_2O]$, or humidity, that could more than explain a GWI increase of 0.85 K in 70 years since 1950. (Obtained from ECMWF: https://www.ecmwf.int/)

for water mole fraction in air $[H_2O]_{air}$. The Van't Hoff equation derived from Gibbs 2nd law (entropy is a state function) tells us roughly what the annual increase in the equilibrium constant concentration $[H_2O]_{air}$ if the temperature of the air increase (ΔT) is present GWI 0.0175 K/year (Figure 1). H_{vap} is the latent heat of the evaporation of water in a cloud. Assuming Dalton's ideal gas law, then:

$$\Delta \log_e \{[H_2O]_{air}\} = H_{vap}\, \Delta T / RT^2 \sim 0.001 \quad (3)$$

The equilibrium additional state variable water concentration $[H_2O]_{air}$ that determines weather patterns, and also the climate rate processes, is changing, on average, only by a small degree due to GWI compared to natural geographical and seasonal fluctuations around <T> (z) and <p>(z) that determine the Earth's climates. The total change in the mean concentration $<\Delta[H_2O]_{air}>$ however, caused by the output from the fossil fuel industry, may not be negligible, by comparison.

Besides CO_2, and enthalpy (ΔH) the fossil fuel industry emits large quantities of water into the atmosphere; just as with the DH effect, the effect of water emission in fuel combustion is generally considered negligible in computer modelling, and IPCC-GGH reports [7-9,12] compared to total pre-climate-change $[H_2O]$ effects in the Earth's energy budget. But is it negligible, we ask?

The water emissions shown for example in Table 1 may not support GGH, and yet they are neglected in references [10-13] and in computer models of the global energy-budget equation (1). We note that the steep increase in replacement of coal by natural gas, that besides a 25% higher enthalpy output per mole of CO_2, burning natural gas results in twice as much water emission per mole of CO_2 than hydrocarbons: this may not be a negligible contribution to a global effect of reducing the mean barometric pressures that could then cause 'climate change' by global wetting, rather than global warming.

This response to Kleidon, et al. ESD editorial [1] is not the platform for details of an alternative CCH to IPCC hypotheses GGH ≡ CCH. We should at least note a literature of plausible alternative hypotheses that are being ignored. For example, we note that the present annual total water in the atmosphere [22] is approximately 700 × 10^{15} mol, increasing by 1.5% per decade, giving an annual rate of increase as 1.05 × 10^{15} mol/year. From the present 2022 output of H_2O from the oil and gas industries using the BP data [4], and mole balances in Table 1 we obtain a figure close to 1.0 × 10^{15} mol/year of anthropogenic water vapour. Is this a coincidence? The observation could perhaps help to explain the conclusion of physicists Lightfoot and Orvil [21] that water, and to a lesser extent CO_2, are the global coolants that counteract the anthropogenic enthalpy increase from fossil fuels in Figure 1 and Table 1.

Science by consensus

Finally, we would like to question the Kleidon et al. statement, that the greenhouse gas hypothesis must be true because the GGH ..., we quote: *"..... represents a wide scientific consensus reflected in a series of IPCC reports"* [1]. This disingenuous insinuation, that a "scientific consensus" preceded the IPCC reports, is contradicted by the US Senate Report published in 2007 [23]. In fact, it is the IPCC publicity machinations that have created a media and public consensus, that has never been

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shared by most of the disinterested leading world scientists in the area of atmospheric physics. The ridiculously large number of 'authors' and 'editors' in these references [10-13], 100+ names in 4 references by Kleidon, et al. is just another example of how an apparent "science by consensus" myth can be spread by illusions.

Year 2023 marks the 550th anniversary, of the birthday (24-05-1473), of Nicholas Copernicus, Polish scholar and founding father of Earth sciences, pictured in Figure 5. Before Copernicus, everybody in the world "knew" that the sun and planets go around the Earth as first hypothesized by Ptolemy 1500 years earlier. This was doctrinaire science by consensus. Copernicus spent much of his adult life observing the phenomena of Earth and the planet's partial eclipses, especially of the moon. In 1543, the year of his death, he was able to confirm and publish his epic discovery that the earth and planets orbit the sun [24].

The scientific truth, that Copernicus had discovered, was subsequently confirmed by Galileo's telescope technology advances, and Kepler's applied mathematics. Their research articles, that confirmed Copernicus's Earth's orbit hypothesis, would also have been rejected by Copernicus Publications.

Because of the "scientific truth by consensus" fallacy in XVI century AD, which we are now witnessing again in 2023 [1], it took more than 100 years after Copernicus's death for the dynamics of the solar system, as we now know it, to become accepted knowledge by contemporary authorities. If Nicholas Copernicus were alive today, what would he make of Copernicus Publications and ESD rejection policy we wonder? This journal and its parent company are a betrayal of his great scientific achievement. This is a publishing company founded on the blind and exclusive acceptance of the IPCC greenhouse gas and "global warming = climate-change" hypotheses. Copernicus Publications only publishes scientific papers that conform to established science by consensus: this, however, defines "pseudoscience" (see Wikipedia). For political and financial reasons, all submissions received by Copernicus Publications that focus on experimental results and observations that do not support either the greenhouse gas hypothesis of global warming or the IPCC climate-change hypothesis, have been rejected without peer review [1].

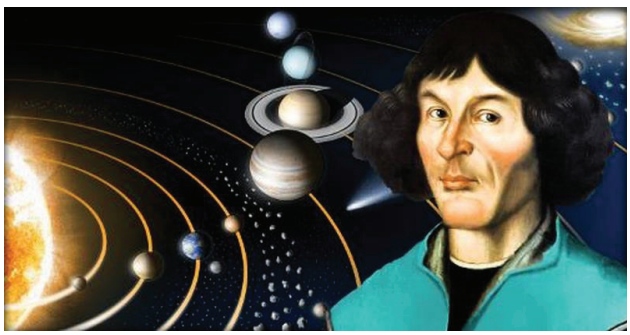

Figure 5: Nicholas Copernicus 1473 -1543: founding father of Earth sciences, and pioneer opponent of science by consensus: his breakthrough article that changed the whole world's perception of Earth [24] would have been rejected by Copernicus Publications. Picture courtesy of https://www.famousscientists.org/nicolaus-copernicus/

It has been found recently by statistical analysis [25] that the perpetuation of this peer-review policy actually creates the fictitious scientific "truth" by consensus. We are presently witnessing an insidious development with journals such as ESD, which, instead of publishing scientific research that tests the greenhouse gas and climate-change hypotheses, are rejecting all such publications without peer review. Such an unethical practice actually converts unsubstantiated hypotheses into a spurious 'science by consensus'.

Conclusion

From the foregoing sections of this response article, we conclude with a short list of statements that we believe to be established scientific knowledge. The "greenhouse effect" is real, but it is not relevant to the "Greenhouse Gas Hypothesis" (GGH). We can summarise GGH as GWI temperature between 1920 and 2022 (~ 1 K) is the result of a 40% increase in CO_2 that began at the beginning of the Industrial Revolution in 1850.

We know of no bone fide peer-reviewed scientific research that that establishes the greenhouse gas hypothesis as a scientific truth. Cited research articles we have reviewed, however, confirm the conclusion that enthalpy from fuel combustion is a major contributor to the non-zero GWI 1950-2020. The anthropogenic heat from the energy industry is several times greater than what is required to explain the GWI and hence cannot be construed as "negligible".

The two hypotheses, "Global warming" and "climate-change", are not synonymous, as IPCC reports and the Editors of Earth System Dynamics, and countless other environmental science journals wrongly presume. The GWI averages are experimental data that we all agreed upon. The Climate-Change Hypothesis (CCH), i.e., that the GWI increase of 0.85 K (1970 - 2020) has caused floods, and heat waves, increasingly witnessed, since ca. 1970, is quite a different hypothesis that could be unrelated to the GWI results.

Multivariate computer modelling of atmospheric energy balance processes cannot be used to confirm GGH as a scientific truth due to inherent unknown terms, and uncertainties in the many variables involved. Computer experiments on minimalist models, however, may be used to disparage hypotheses. Consequently, the cause of global warming is increased CO_2 is a hypothesis solely based upon limited knowledge of its spectroscopic and transducer properties in the atmosphere. We do not yet know enough about the spectroscopic properties of gaseous complexes of both CO_2 and H_2O *in situ* to deduce, validate, or invalidate, the GGH hypothesis at the molecular level.

The fact that the increase in CO_2 began with the industrial revolution in 1850, whereas the GWI only began to increase at first in 1920, and by its present rate in 1970, with a mid-period of cooling in 1940 - 1970, is an experimental observation that disagrees with the GGH. A uniform atmospheric increase in CO_2 cannot explain the geographical distribution of temperature-increase hotspots, whereas the compelling evidence of a causal relationship with geothermal heat from shale gas fracking operations is evident.

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The Earth's weather patterns are determined by fluctuations in pressure that depend, not so much upon small variations in mean temperatures, but concentrations of atmospheric water. The total amount of [H_2O] in the atmosphere is increasing by roughly the same rate that water is globally being emitted by the combustion of fossil fuels.

Finally, Earth System Dynamics' Editorial claim that GGH must be true because there is "wide scientific consensus" is meaningless without a definition of qualification. When the definition excludes all of its beneficiaries, such as the 100+ names in all IPCC reports and also the 5 "editors-in-chief" authors of the ESD editorial, there exists a silent (silenced?) majority of professional well-qualified scientists that do not accept the GGH as a scientific truth.

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