New Thermodynamics: Rethinking the Science of Climate Change

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Abstract—Statistical analysis shows that climate change is due to human activities. The accepted reason being the greenhouse effect, which is based on the erroneous assumption that homonuclear gases are opaque to thermal energy. The reality is that all polyatomic gases absorb and then radially radiate thermal energy, as proven by their heat capacities. The greenhouse effect, then becomes secondary. Thermal energy generated by human activities is part of Earth’s anthroposphere which is where climate change is measured. Such human-generated thermal energy is absorbed by all our atmosphere’s polyatomic gases, which is then radially radiated by those very gases. Therefore, our whole atmosphere forms Earth’s thermal blanket, and human’s activities becomes the root cause of climate change. Our Sun’s influx starts outside of Earth’s thermal blanket, with much of its visible light reaching Earth’s surface. However, the majority of the Sun’s insolation is at thermal wavelengths, which are readily absorbed by Earth’s atmosphere, and whose energy are then radially radiated by its polyatomic gases. Global warming models need to change.

Index Terms—Global Warming, Climate Change, Anthroposphere, Greenhouse Effect

I. INTRODUCTION

In 2019 a BBC produced show on the application of statistical analysis to climate change titled, “Climate Change by the Numbers” discussed that statistical analysis has shown with over 95% certainty, that since 1880 Earth has experienced a 0.85 degrees °C temperature increase. This was statistically shown to be due to human activities. They also accepted that the greenhouse effect [1]-[3] is to blame.

Jean Fourier (1768-1839, Fourier series) in the 1820’s believed that Earth’s temperature was too high to be explained by solar radiation. He postulated that the Sun’s “luminous heat” (term for visible light) was able to pass through our atmosphere reaching Earth’s surface. This energy was then transformed into “non-luminous heat” (term for infrared), which could not readily pass back through the atmosphere into outer space. Accordingly, Fourier was thinking in terms of our whole atmosphere acting as a thermal blanket.

In 1896, Svante Arrhenius claimed that fossil fuels may enhance global warming, which he blamed on water vapor and carbon dioxide. Arguably, the science behind greenhouse gases started with John Tyndall’s use of spectrometry to study the physical properties of gases, in the mid and late 19th century. This was followed by John S. Shaw’s work in the 1940’s, on greenhouse gases. Based upon infrared spectrometry, it is now generally accepted that greenhouse gases are the gases that cause radiative-forcing, i.e., absorb and then radially radiate infrared radiation (thermal energy). This is the so-called greenhouse effect which is believed to cause any heat emanating from Earth’s surface to follow a rather circuitous path on its way back into outer space. Such circuitous paths take time.

Infrared frequencies, are those that are most often associated with thermal energy (heat). Using a rather simple apparatus filled with various gases and exposed to our Sun’s infrared radiation, Allmendenger [4] has clearly shown that atmospheric gases including homonuclear N₂ and O₂ do absorb thermal energy. This is in direct agreement with their heat capacities that are remarkably similar to that of other diatomic gases [5]-[9]. Note, that our atmosphere is predominately nitrogen (78%) and oxygen (21%).

Strangely, based upon their infrared spectrums, homonuclear diatomic gases such as nitrogen (N₂) and oxygen (O₂) are believed to be opaque to the infrared. It is as if our atmospheric gases do not absorb thermal energy when in thermal equilibrium inside of an infrared spectrometer, but when heated they clearly do. The conundrum of both heat capacities and other heating processes clearly proving that homonuclear gases do absorb thermal energy, has led this author to conclude that this is due to the calibration of infrared spectrometers [5], [6]. Namely, prior to measuring an infrared spectrum spectroscopy, one must calibrate the spectrometer:

- So that it matches known spectral lines; and
- Run a blank, i.e., measure and then subtract any background blackbody radiation (Stefan-Boltzmann).

What would happen if the contents of the spectrometer also absorbed and then radiated the same blackbody radiation [5], [6]? Accepting and investigating.

In thermal equilibrium, gases equally absorb and radiate thermal radiation, i.e., the influx and efflux of thermal energy are equal. That being the case, then subtracting any radiation that adheres to the Stefan-Boltzmann law, could also be the subtraction of a gas’ thermal signature [5], [6]. If true, then this certainly would explain why it is believed that homonuclear gases do not absorb in the infrared, although their heat capacities tell us otherwise.

One of the reasons for the above postulated mistake is that the traditional criteria for blackbody radiation is that it exists in cavities within crystalline solids. Moreover, the crystalline solid limitation is a mathematical assertion [6], [10], [11], rather than a logic-based observation.

Consider our Sun, or even white-hot molten metal coming out of a blast furnace. It is accepted that their radiation spectra adhere to the Stefan-Boltzmann law, yet neither is crystalline, nor do they reside in a cavity [6], [11].
Something is amiss because neither meets the accepted criteria for blackbody radiation.

Furthermore, liquids and amorphous solids both adhere to heat capacities that are remarkably similar to that associated with crystalline solids. Obviously, the mathematical limitation of blackbody radiation to cavities within crystalline matter is a misguided assertion. If so, then the application of Stefan-Boltzmann’s law to both our Sun and molten metal can be explained by their radiation densities being so much higher than that associated with the surrounding atmosphere [6], [11].

The above also explains why blackbody radiation was limited to cavities. The reason being that our atmosphere’s thermal radiation is shielded from inside the cavity by its surrounding matter. Therefore, all one witnesses inside of the cavity is the emanating blackbody radiation from the surrounding matter [11].

This author has discussed that kinetic theory needs to be rewritten in terms of inelastic collisions [8], [9], [12], rather than the traditional illusion of elastic collisions [12]. Furthermore, a plausible explanation for blackbody radiation is that it is the radiation associated inelastic intermolecular collisions [6], [11]. Moreover, many statistical ensembles are based upon the illusion of elastic collisions [11], rather than the reality of inelastic collisions.

The question then becomes, what exactly are the spectrums as depicted by the currently accepted infrared spectrometry? As measured inside of an infrared spectrometer, it is the excess infrared spectrum that is not defined by the Stefan-Boltzmann law. For example, it is the spectrum that is not necessarily part of the gas’ normal thermal signature [5], [6], [11]. For example, the spectrum associated with a molecule’s dipole moments. This means that the infrared spectrums often associated with the so-called greenhouse gases, are nothing more than the parts of their spectrum’s that may not necessarily be part of their normal thermal signature. Knowing that all polyatomic gases absorb thermal energy means that one must question the science behind the greenhouse effect.

The above is not to say that on a per molecule basis that so-called greenhouse gases do not absorb more infrared energy than nitrogen, or oxygen. Certainly, the more atoms that a molecule has, the more thermal energy that that particular molecule can absorb, as part of its vibrational energy [8], [9], [12]. Therefore, on a per molecule basis, the so-called green-house gases will generally absorb more thermal energy. However, due to the vast quantities of homonuclear gas molecules in our atmosphere, their contribution to our atmosphere acting as a thermal blanket, must be significant [5], i.e., the vast majority of our atmosphere’s gases are involved in radiative-forcing, the exception being monatomic gases such as argon.

The understanding that the whole atmosphere acts as Earth’s thermal blanket is not just limited to Fourier, and this author. Based upon traditional thermodynamics and the existing “flimsy” science of global warming, Dengler [13] has similarly concluded that our whole atmosphere acts as Earth’s thermal blanket.

This paper becomes an elaboration of this author’s previous paper on global warming [5].

II. OUR SUN’S INSOLATION

A sketch of our Sun’s irradiance is shown in Fig 1. It is generally accepted that our Solar radiation is approximately, 5% ultraviolet (300-370 nm), 43% Visible (370-740 nm), and 52% infrared [14], as illustrated in Fig 2. Note that the infrared is divided into the near infrared (740-3,000 nm), thermal infrared (3,000 nm - 8,000 nm) and long infrared (8,000 nm - 100,000 nm).

Furthermore, looking at Fig. 1 one might conclude that the Sun’s irradiance stops at 2,000 nm but this is not the case. The near infrared actually extends to 3,000 nm which is part of the calculation of its 52%. The reality is that the Sun’s insolation (irradiance) extends asymptotically through the longer wavelengths thermal and far infrared and into the microwave (λ > 100,000 nm) spectrum.

The implication of our Sun’s insolation extending through the infrared into the microwave means that our Sun actually radiates more thermal (mid) infrared energy and long (far) infrared energy than it emits at shorter wavelengths, e.g., visible light. This also raises the question, Is the visible (near) infrared spectrum more like visible light, or more like thermal energy [6], [11]?

If our Sun’s irradiance is considered an asymptote starting in the thermal infrared (3,000 nm) and ending at the microwave (100,000 nm), then the area under the spectrum’s curve could be approximated by a straight line parallel to the wavelength axis with a spectral irradiance approximated by 0.075 (W/m²/μm), as illustrated in Fig. 2.

Therefore, the thermal infrared energy density could approximately be:

\[(0.075)(8,000-3,000) = 375 \text{ W/m}^3\]

And the far infrared energy density by:

\[(0.075)(100,000-8,000) = 6,900 \text{ W/m}^3\]

The total energy density for the thermal through the long infrared spectrums then could be roughly approximated by:

\[(0.075)(100,000-3,000) = 7,275 \text{ W/m}^3\]

Based upon the above rough calculations, one would conclude that our Sun’s energy associated with both the thermal and far infrared may be several times the energy that is associated with the near infrared into the visible light part of the spectrum.
If we now calculate the energy density for our Sun’s spectrum from UV through to the long infrared spectrum, one obtains the data in Table I, showing rough approximations for the energy per unit volume for the various parts of our Sun’s spectrum.

Just as ozone in the upper atmosphere protects us from our Sun’s UV rays, greenhouse gases in the upper atmosphere absorb and then radially radiate our Sun’s thermal energy, hence directing a significant percentage of our Sun’s thermal energy back into outer space. This helps to explain the high temperatures in our thermosphere. Importantly, it also raises the question, Do the greenhouse gases located in the upper atmosphere actually cool, or heat our atmosphere [6]? The “greenhouse effect” climate change model has just been turned on its head. There is no argument that as first visualized by Fourier two hundred years ago that, much of our Sun’s visible radiation is absorbed by Earth’s surfaces and then transformed into longer wavelength radiation, e.g., thermal. Certainly, acceptance that our whole atmosphere acts as a thermal blanket changes any modeling [5]. What needs to be asked, Is the greenhouse effect now a secondary effect?

The above is not due to human activities with the exception of where humans have changed Earth’s albedo, e.g., black asphalt, black shingles, cement, cities etc.

### III. MAN’S ACTIVITIES

When rewriting thermodynamics, this author realized that all expanding systems here on Earth add energy into Earth’s atmosphere in the form of lost work [5], [15]-[19]. It must be understood that most useful systems are expanding systems. By useful systems, one means systems that are used to power man and/or his machines.

For expanding systems, the work term signifies an energy increase of our atmosphere’s energy, as defined with clarity by, \( W_{\text{in}}=(PdV)_{\text{atm}} \). It should be noted that the currently accepted explanation for inefficiencies is the second law of thermodynamics, i.e., isothermal entropy increases within isolated systems. Certainly, any system that does work onto its surrounding atmosphere cannot be deemed an isolated system. Therefore, the second law falters when applied to most useful systems here on Earth [5],[15]-[19]. This includes the internal combustion engine whose inefficiency has been reexplained by this author [18], as well as this author’s challenges to entropy at its most fundamental level [19]. Importantly, most all inefficiencies result in the heating of Earth’s atmosphere [5], and this fact lacks lucidity in traditional thermodynamics.

It should be emphasized that the above atmospheric energy increase can manifest itself as an isobaric volume increase (a potential energy increase), or as a localized pressure increase resulting in thermal energy increase, that may eventually result in an isobaric volume increase. Either way it is defined by \( (PdV)_{\text{atm}} \).

For contracting systems, there is no lost work. Think of the shrinking/contracting system as a subsystem inside of the larger atmosphere as a system. Contraction is as if part of the atmosphere shifts downwards, towards Earth’s surface resulting in a transformation of atmospheric potential energy into kinetic energy that being a form of thermal energy [17]-[20]. The point now becomes that both expanding and contracting systems alter our atmosphere’s energetics.

Any disturbance of our atmosphere may increase the generation of inelastic molecule collision induced photons (thermal?). Certainly, the majority of our activities must alter our atmosphere’s dynamics [5], resulting in atmospheric heating. This applies to most energy use and power generation whether one uses coal, gas, nuclear or electric. Even electric vehicles’ motions have drag which is a molecular level frictional heating of our atmosphere. This is not to say that some fuels are not cleaner than others it is just to say that there is no such thing as true clean energy usage.

The high-pressure exhaust coming out of a jet engine can be thought of as atmospheric heating. From kinetic theory it is known that the kinematics of gas molecules are all forms of thermal energy [8], [9]. Accordingly, all the momentum bestowed upon a jet plane by its engine is the direct heating of our atmosphere. This applies to all planes including both jet fuel and electric driven one.

Even a human running heats the atmosphere. It is just that Earth can handle tens of thousands of moving mammals without experiencing any dire effects. The same cannot be said of millions of cars in motion, nor of thousands of planes in flight.

All is not lost. Devices that use the atmosphere’s kinetic energy to propel or generate energy must be extracting kinetic energy, and therefore transform thermal energy from...
our atmospheric molecules. Examples are devices like sailboats and wind turbines.

Inelastic collisions also explain why pressure increases result in temperature increases, i.e., witnessed $P$-$T$ relationship. Specifically, as one increases a system’s pressure, the rate of intermolecular collisions increases, and/or the forces with which the molecules collide increases. Either way, a pressure increase, results in a temperature increase [12], [17]-[20]. This $P$-$T$ relationship can’t be properly explained using traditional thermodynamics [5].

Others have realized that for planets with gaseous atmospheres, some $P$-$T$ relationship contributes to the planet’s temperature. Some have argued that this proves that the greenhouse effect, hence man’s contribution to global warming is minimal [21, 22]. This author agrees that the greenhouse gas effect is not the primary effect, rather a secondary one. Furthermore, this author disagrees with Nikolov’s and Zellers [21] analysis because they use Earth’s data over Titan’s due to the abundance of measurements made on Earth. However, to determine if Earth’s temperature increase is due to human activity, then Titan must be used as the comparative data point.

Moreover, our atmosphere’s temperature is likely dominated by our Sun’s insolation, rather than our atmosphere’s $P$-$T$ relationship [6], [11]. This being the case care must be taken when comparing planets with atmospheres based upon $P$-$T$ analysis. Although this author’s new thermodynamics explains the existence of the $P$-$T$ relationship. There is still a need for further analysis of these relationships.

Carbon dioxide and other greenhouse gases are secondary causes to global warming because as a polyatomic gas they absorb and then radially radiate thermal energy, as proven by their heat capacities. This has little to do with a gas’ dipole moments, or whatever else their infrared spectrometry findings imply. Furthermore, as a secondary cause to global warming, one can also understand the findings determined by Harries et al [17], where Earth’s outbound infrared (thermal) spectrums were measured by satellites between 1970 and 1997. This was incorrectly taken to be direct proof for the greenhouse effect [5].

Accepting that all polyatomic gases contribute to our atmosphere acting as a planetary thermal blanket, the facts that differentiate the various polyatomic gases’ actual influence on Earth’s thermal blanket should include:

- Their concentrations in our atmosphere.
- Their relative heat capacities.
- Their scattering cross-section.
- Their locations in our atmosphere.

It is also known that clouds at night elevate our atmosphere’s local temperature. Water vapors and their associated droplets within a cloud, will absorb and then radially re-radiate significant amounts of the infrared energy emanating from Earth’s surface. They will also undergo intermolecular collisions with other atmospheric gas molecules, exchanging translational plus rotational energies, as well as vibrational energies.

It should be noted that although the whole atmosphere acts as a thermal blanket, on a per molecule basis water molecules will contribute significantly more to the thermal blanket effect when compared to homonuclear $N_2$ and/or $O_2$ gases. Moreover, any associated water droplets and/or ice crystal within that cloud should also significantly increase any thermal blanket effects.

It must be emphasized that the above happens at night when Earth’s surface radiates more thermal energy than it absorbs! In the daytime, clouds will have the reverse effect, i.e., cooling, as they reflect much of our Sun’s insolation back towards outer space. Herein, thermal energy includes both radiation and molecular energies (both inter and intra).

Contrails from jet airplanes behave similar to clouds in their behavior [24]. Perhaps contrails in the daytime will reduce global warming but this of course has to be weighed against the jet plane’s immense negative effects, i.e., their engine’s expulsion of thermal energy.

Man’s use of energy in every form must now be considered. Remember that human activity is located close to Earth’s surface, and this is where global warming is witnessed, i.e., since the whole atmosphere is our thermal blanket, thermal energy created by human activity must be a component of the global warming issue.

Tsao, Lewis and Crabtree [25] have stated that our Sun’s insolation is such that in 1.5 hrs our Sun shines as much energy onto Earth, as we humans consume in the year 2001 [26]. This certainly causes one to pause when considering man’s direct contribution to global warming. Keep in mind that global warming concerns 0.85 °C of unexplained temperature rise since 1880. Earth’s average temperature is 288 K, therefore we are roughly talking 0.85 degrees/288 degrees K vs (1.5 hrs/24 hr)/365 days/yr. Such rough math gives 0.00295 vs 0.00017, which roughly approximates 1 vs 17.

The above rough approximation assumes that thermal energy density approximates a linear function of temperature for all temperature regimes, which is not the case. Moreover, the likelihood is that the thermal energy density does not decrease linearly with decreasing temperature, i.e., as $T \rightarrow 0$. [6], [11]. Hence, perhaps 1/20 may be a more realistic guess. Note that based upon a 2 degrees temperature change this author has previously incorrectly speculated that the ratio was 1/40, [5].

Whatever the true ratio between what man generates and our Sun’s input, the fact remains that human activity and our Sun’s radiation are located on opposite sides of our thermal blanket, i.e., our atmosphere. Therefore, the two are not directly comparable.

Obviously, our current global warming models require a rethink, with the possible exception being that man’s activities have caused a 0.85 degree temperature increase since 1880. Moreover, if man’s energy use correlates with both population and economic growth, we all must pause and reflect.

IV. RENEWABLE ENERGY

Accepting that all man’s activities contribute to global warming implies no hope. Hope still resides in renewable energy sources, e.g., wind turbines extracting kinetic energy from our atmosphere.

Similar principles apply to solar arrays. Specifically, energy from our Sun is converted into electricity instead of
being absorbed and radiated back into our atmospheric as heat.

Therefore, when solar and wind generated electricity are consumed by man, they may approach being a zero-sum phenomenon, at least in terms of the heating our atmosphere, i.e., approach being thermally neutral.

The above concept of approximating true clean energy does not apply to all sources of electricity. Even nuclear energy is not clean beyond its nuclear waste. Specifically, the production of the steam required to turn its turbines is the production of lost work \([PdV]_{\text{sun}}\), which ultimately results in the heating of our atmosphere.

V. Conclusion

Statistical analysis has clearly shown that global warming is due to human activity.

Fourier got it right 200 years ago, in stating that our whole atmosphere acts a thermal blanket. One must accept that much of our Sun’s visible light passes through the atmosphere and is then absorbed by Earth’s surface. The absorbed energy is radiated as longer wavelength thermal radiation that is more readily absorbed, and is then radially re-radiated by all of Earth’s atmospheric polyatomic gases. Therefore, the concept of radiative-forcing being limited to so-called greenhouse gases is incorrect. Instead our atmosphere as a whole is Earth’s thermal blanket. The noted exception being our atmosphere’s monatomic gases, e.g., argon. Furthermore, green-house gas formation becomes a secondary effect in global warming.

With the exception of humans altering Earth’s albedo, the amount of visible light that is transformed into thermal radiation fundamentally remains a fairly neutral natural phenomenon.

Furthermore, our rudimentary analysis of extending our Sun’s irradiance into the microwave spectrum clearly shows that infrared energy from our Sun is actually greater than its visible light’s energy. This is because our Sun’s irradiance curves tend to be drawn on a scale that emphasizes both visible light and visible (near) infrared frequencies, while completely ignoring the thermal (mid) and long (far) infrared spectrums.

The fact that our Sun’s radiation is actually infrared dominated will change how our atmosphere’s thermal budget is modeled. However, contemporary problematic global warming models are not limited to misunderstandings concerning our Sun’s spectrum.

In so far as various gases are concerned, their contributions to global warming should be based upon their heat capacities, rather than the currently accepted science, which is based solely on infrared spectrometry. This has led to the erroneous conclusion that homonuclear gases are opaque to infrared wavelength. This in turn has led to the misunderstandings concerning the greenhouse effect. Accordingly, the so-called greenhouse gases’ contribution to radiative-forcing is most likely a secondary effect, when compared to our atmosphere as a whole.

In part, the infrared spectrometry’s grandiose mistake is based upon the incorrect 19th century assertion that limits blackbody radiation to cavities inside of crystalline matter. This mistake should have been obvious because of the fact that both the radiation from our Sun, as well as that from hot molten metal, are both blackbody. Certainly, neither molten metal nor our Sun is crystalline, and neither are located within a cavity.

All of the above does not alter the fact that global warming as witnessed is close to Earth’s surface and is due to human activity. Certainly, most of human activity will directly or indirectly result in the heating of our atmosphere. This heating by man started with the industrial revolution and will continue to increase, as long as man’s use of energy increases.

Since our whole atmosphere acts as a thermal blanket, one must bear in mind that our Sun’s insolation, and human activity, occur on opposite sides of Earth’s thermal blanket. This, as much as anything, means that we must completely rethink our global warming models. In other words, most atmospheric gases are responsible for radiative-forcing, hence the long circuitous path required for heat emanating from our Earth’s surface to reach outer space is due the whole atmosphere and not just the so-called greenhouse gases.

The above applies to the heat generated by all forms of man’s energy use, i.e., whether the energy source be electric, nuclear, coal, or fossil fuel. This does not mean that one form of energy is not cleaner than another. Certain renewable sources such as solar and wind power, will have a positive impact on the reduction of global warming, and may even be considered as approaching thermally neutral, i.e., close to true clean energy.

Increases in man’s energy use are strongly related to both our population, and economic, growth. This clearly coincides with Earth’s climate changes, as has been witnessed since the start of the industrial age.

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REFERENCES

[1] Darkwah, W., Odum B., Addae, M., Koomson, A., Kwakye, D., Ewurabena, A., Asenso, Buanya, B., “Greenhouse effect: Greenhouse gases and their Impact on Global warming” J. Sci. Res. and Rep. 17(6), (2017) pg 1-9
[2] Mitchell, John F. B. (1989). “The "Greenhouse" effect and Climate Change"; Rev.ofGeophy. 27 (1):115-139.
[3] Claussen, E.; Cochran, V.A.; Davis, D.P., eds. (2001). "Global Climate Data"; Climate Change: Science, Strategies, & Solutions. University of Michigan
[4] Allmendinger, T. “Thermal Behaviour of Gases Under the Influence of Infrared Radiation” Int. J. of Phys. Sci. Vol 11 (15) pg 183- 205 2016
[5] Mayhew K.W., “New Thermodynamics: Global Warming and Man’s Activities”, EJERS, Vol. 4, 7. (2019), pg 58-62
[6] Mayhew K.W., “New Thermodynamics: New Thermodynamics: Temperature, Sun’s Insolation, Thermal, and Blackbody Radiation” EJERS, Vol. 5, 3(2020) pg 264-270
[7] Rolle, Kurt, C., “Thermodynamics and Heat Power”, Maxwell Macmillan Canada, 1993
[8] Mayhew, K.W., “A New Perspective for Kinetic Theory and Heat Capacity”, Prog. in Phys., Vol. 13 (4) 2017 pg 166-173
[9] Mayhew, K.W. “Kinetic Theory: Flattening of Polyatomic Gases”, Prog. in Phys., Vol. 14 (2) 2018 pg 75-79
[10] Eisberg, R., Resnick, R., “Quantum Physics”, John Wiley & Sons Toronto 1974
[11] Mayhew, K.W., “New Thermodynamics: Understanding Temperature’s Limitations” E-J Phys. Vol 2 (2) 2020 pg1-6

[12] Mayhew K.W., “New thermodynamics: Illusions of Elastic Collisions in the Sciences”, EJERS, Vol. 5, 1, (2020), pg 87-90

[13] Dengler, J., “Physics of the Green House Effect” http://klimafaktener.net/?page_id=1245&unapproved=345&moderation-hash=1f603c25efb89516b71ac57a1d809d8&clang=en#comment-345

[14] Sohail, A., “Handbook of Research on Solar Energy Systems and Technologies”, IGI Global, Hersey, 2012 pg 165

[15] Mayhew K.W., “Second law and lost work”, Phys. Essays, 28, 1 (2015) pp 152-155

[16] Mayhew K.W., “Entropy an Ill-conceived Mathematical Contrivance” Phys. Essays, 28, 3 (2015) 352-357

[17] Mayhew, K.W., “Resolving Problematic Thermodynamics” Hadronic Journal, vol 41, 2018 pg 257-272

[18] Mayhew K.W., “New Thermodynamics: Inefficiency of a Piston-cylinder”, EJERS, Vol. 5, 2, (2020), pg 187-191

[19] Mayhew, K.W., “New Thermodynamics: Reversibility and Free Energy”, Hadronic Journal, Vol 43, 1, 2020 pg. 51-60

[20] Mayhew. K. W., “New Thermodynamics: Reversibility, Entropy and Adiabatic Processes”, E-J Phys. Vol 2 (3) 2020 pg1-6

[21] Nikolov and Zeller Nikolov, Ned and Zeller, Karl, “New Insights on the Physical Nature of the Atmospheric Greenhouse Effect Deduced from an Empirical Temperature Model” Environ Pollutt Climate Change 2017 1.

[22] Harries, John Edward, Brindley, H.E. Sagoo, Pretty, Bantges Richard “Increases in greenhouse forcing inferred from the outgoing longwave radiation spectra of the Earth in 1970 and 1997” Lett to Nature vol 410 pg 355-357, 2001

[23] Holmes, R., I., “Molar Mass Version of Ideal Gas Law Points to Very Low Climate Sensitivity” Ear. Sci. Vol 6. 6, (2017) pg 157-163

[24] Burkhardt, U. and Karcher B., “Global Radiative Forcing from Contrail Cirrus” Nature Clim. Ch. 1 54-58 (2011)

[25] Tsao,J., Lewis, N. and Crabtree, G., “Solar Facts” U.S. Dept of Energy.

[26] Lewis Nathan “Basic Research Needs in Solar Energy Utilization” Workshop Caltech (2005).