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Re: Information Quality Act Reconsideration Request Regarding Dissemination of Flawed Information Concerning the Terms "Greenhouse Effect" or "Greenhouse Gas"

This letter is a request for reconsideration (RFR) of your response to RFC #21001 dated 24-February-2021. In that response you offer four specific reasons for denial of the RFC:

A. A lack of peer review of the basis on which the RFC was formed.
B. The assumption that the non-linear nature of the Stefan-Boltzmann equation eliminates the applicability of the superposition principle.
C. The assumption that a *288K* ground surface temperature when subjected to Stefan-Boltzmann analysis would necessarily yield a flux of *390 W/m²* –exceeding the combined solar and geothermal flux of *240.065 W/m²* absorbed in violation of the first law of thermodynamics.
D. A hypothesis of extension that the techniques described in RFC #21001, when applied to other heat sources (e.g., fossil fuel combustion), would markedly increase the Earth's surface temperature above what has been empirically determined.

You also note, parenthetically, that climate models are not limited to one-dimensional blackbody analysis that is questioned in the RFC. The implication being that a one-dimensional model is insufficient to draw a conclusion on the existence of the greenhouse effect.

Let me begin this RFR by stating my appreciation for your measured and studious response to the RFC.

A. Peer-Review

On the question of peer-review, I have not offered anything new in the way of science or mathematics in the RFC. The topics of heat equation, Stefan-Boltzmann radiative cooling, and the superposition principle are well-known and universally accepted. Your response is testament to the prevalent reliance researchers have on these basic tools. I believe that

universal acceptance renders peer review of these tools unnecessary. My RFC was limited to informing you that, in the Agency's analysis of the accuracy of published information, those tools have been misapplied. As a result, the quality of related information disseminated by the Agency has been compromised and should be dealt with.

You stress in your response that you rely on USGCRP, IPCC, and NAS for guidance in assessing the accuracy of the information in question. However, I am certain that the Agency does not relinquish its responsibility for making the final determination as instructed by the Information Quality Act. RFC #21001 and this RFR serve as additional resources on which to make your determination. If the other concerns on which your decision was made are proven invalid herein, then I expect the Agency will reconsider the decision irrespective of what organizations share those invalidated concerns.

B. Applicability of the Superposition Principle.

On the question of the non-linearity of the Stefan-Boltzmann equation, I suggest that the Agency has neglected to consider that the system analyzed to deduce a *33K* deficit in surface temperature is one of time-averaged data. That is, *240 W/m²* and *288K* are time-averages of the empirical data. So, too, is the *0.065 W/m²* provided in the RFC.

Once the time average is applied, the system of interest is, by definition, one of steady state. With reference to the following diagram,

the system we are discussing is a column of "dirt" with albedo-reduced incoming solar flux, Q_S, incident on its upper boundary. Geothermal heat, Q_G, incident on its lower boundary, and radiant heat, Q_R, emitted into space.

There is no other requirement necessary for determining the applicability of the superposition principle. All fluxes are time averaged values and, therefore, treated as constant. This is consistent with the analysis that concludes a *33K* temperature deficit exists. Because it is in steady state, the outgoing flux is a known parameter due to conservation of energy.

These fluxes represent fixed Neumann boundary conditions on a temperature field, *T(y),* that obeys the linear heat equation. The superposition principle is always applicable for a linear system with Neumann boundary conditions. Note that the Stefan-Boltzmann equation has no role yet. We simply have a conservation of energy-flux problem due to the steady-state condition.

In truth, the heat equation is excessive in that we are dealing with a steady state system. It is sufficient to simply use the Fourier law of heat conduction to determine the temperature field within the column.

The temperature field is the unknown in the problem, and to solve it we employ the superposition principle to split the problem into two parts. One isolating the solar flux and the associated cooling response that maintains steady state. The other similarly isolating the geothermal heat flux and its cooling response. The cooling responses are trivially equal in magnitude to the source fluxes due to energy conservation.

Once the two sub-problems are so defined, we will assume radiant cooling and apply the Stefan-Boltzmann equation to the top surface of each of these sub-problems to determine their independent temperatures. Finally, consistent with the superposition principle, we can sum the solutions to arrive at the top surface temperature for the combined system of interest.

Up to the point of defining the technique of cooling, Stefan-Boltzmann has no role. If the top surface of the region of interest is cooled by convection or conduction, then other analyses would be required. However, the application of the superposition principle would proceed in the same manner no matter the technique of cooling. This is true since the system is defined to be in steady state by the analysis that is being refuted. That is, the analysis that incorrectly finds a *33K* deficit in temperature.

Using the prescription above, the temperature field is trivially determined and can simply be written down:

$$T(y) = 64.8 \cdot (\Phi^{0.25} + \varphi^{0.25}) + \frac{\varphi}{\lambda} \cdot y, \qquad\qquad \textbf{1}$$

where Φ is the incident flux on the top boundary and φ is the flux incident on the bottom boundary. The sum in parentheses is due to the superposition principle and λ is the Fourier thermal conductivity of our "dirt". The *64.8* factor and the *0.25* exponents are dictated by Stefan-Boltzmann. Note that *y* increases with depth.

The non-linearity of Stefan-Boltzmann is only germane when solving the dynamic problem. That is, when the outgoing flux at the boundaries is an unknown function of time. By assuming steady state, as is done in the ubiquitous analysis that finds a *33K* deficit, the outgoing flux is known, and the dynamics are moot.

One can gain further intuition by assuming a Fourier transform in the time coordinate of the dynamic solution, whatever that may be. The zeroth-order term of that transform is the averaged problem at hand. The comprehensive solution will be the sum of the zeroth-order term and the time-dependent terms. It is only the time-dependent terms that are affected by the non-linearity of Stefan-Boltzmann.

In this view, it is readily seen that the time dependent solution simply oscillates about the zeroth order transform solution. It is important to note that the zeroth order solution is unaffected by the dynamics of the problem. It will always remain the solution to the averaged problem we are faced with.

So, declaring the outgoing flux as simply the sum of the incident fluxes at each boundary ignores the prescription required by the superposition principle. And the superposition principle is required by the knowledge that the system is linear, and the boundary conditions are known, fixed Neumann conditions. They are known because the system is defined to be in steady state with time-averaged parameters.

C. Anomalous Radiant Cooling Flux

The conclusion of the Agency that the *288K* surface temperature will yield a *390 W/m²* flux is due to the same mistake outlined above. That is, in the figure above, Q_R is the unknown and the upper boundary temperature is known. In this case, the observer has two Neumann and one Dirichlet boundary conditions. The superposition principle is always applicable to a linear system with any combination of Dirichlet and Neumann boundary conditions.

In this problem, the unknown is the total radiant flux. Once again, the problem is properly divided into two systems identified with the incident fluxes. The outgoing fluxes of each sub-problem is trivially determined from conservation of energy. Those being a flux of *240 W/m²* for one subsystem and *0.065 W/m²* for the other yielding a total outgoing radiant flux of *240.065 W/m²*. The Dirichlet condition (*288K* surface temperature) is unnecessary in finding the solution, but it is necessary to legitimize the use of the superposition principle.

Therefore, the 390 W/m² postulated by the Agency is shown to be in error due to the failure to properly solve the thermodynamics problem at hand using the manifestly applicable superposition principle.

D. Additional Heat Sources

The question of additional sources and their effect on the surface temperature is a good one, although trivial to deal with. To maintain the one-dimensional nature of the system of interest in the diagram above, we will focus on the heat fluxes, Φ and φ in Eqn. 1 above.

Conservation of energy allows us to view either of these as the sum of any number of constituents. For example, the geothermal heat, φ, comprises both nuclear decay and

primordial components. Similarly, solar flux, Φ, can be viewed as the sum of that provided from the left and right hemispheres of the sun (or any other convenient division).

Therefore, including another source is trivially accomplished by simple addition of the new source magnitude to Φ or φ, based on which surface the new source flux is directed. It is the boundary condition that is modified, not the method of solution. So, if we place a fossil-fuel burning "engine" such that its waste heat is incident on the upper boundary of the system of interest, the incident boundary flux is increased by *2.8mW/m²* to 240.028 *W/m²*. But the lower boundary remains at 0.065 W/m². This leads to a surface temperature estimate of

$$
\begin{aligned}
\mathrm{T} &= 64.8 \cdot (\Phi^{0.25} + \varphi^{0.25}) \\
&= 64.8 \cdot (240.028^{0.25} + 0.065^{0.25}) \\
&= 64.8 \cdot 4.441 \\
&= 287.8K.
\end{aligned}
\qquad \textbf{2}
$$

In this calculation the entire *2.8mW/m²* is assumed to be waste heat. That is probably not the case since the engine will also perform work that will have no immediate thermodynamic effect on the environment.

If, instead, the "engine" is positioned below the region of interest such that it increases the lower boundary incident flux, then the steady-state surface temperature would be estimated as

$$
\begin{aligned}
\mathrm{T} &= 64.8 \cdot (\Phi^{0.25} + \varphi^{0.25}) \\
&= 64.8 \cdot (240^{0.25} + 0.093^{0.25}) \\
&= 64.8 \cdot 4.488 \\
&= 290.8K.
\end{aligned}
\qquad \textbf{3}
$$

In no case would multiple heat fluxes incident on the *same boundary* be treated separately.

Therefore, the Agency's concern that use of the superposition principle would anomalously increase Earth's surface temperature is shown to be the result of visualizing the application of Stefan-Boltzmann to each source as opposed to each boundary condition. That visualization is contrary to the proper analysis of the system of interest and would violate conservation of energy.

E. Complex Finite Element Climate Models

In reference to the more rigorous finite element modeling you mention, all such models attempt to reproduce the postulated greenhouse effect-driven climate forcings. The magnitude of such forcing is based on the postulated *33K* temperature deficit that RFC #21001 and this RFR discuss. That *33K* temperature deficit has been shown in the RFC and, in a more detailed manner, in this RFR as being an artifact of improperly combining solar and geothermal flux contrary to standard, accepted mathematical techniques. In failing to properly apply the

superposition principle in analyzing the one-dimensional climate model, researchers are now attempting to reproduce, in the more robust models, a metric that does not exist.

However, this takes us outside of the original request which deals only with the determined accuracy of the documents and publications that the Agency is responsible for.

Summary

In summary, your reasons for denial of RFC 21001 have been dealt with, in detail, using known physical laws and standard mathematical techniques. It has been shown that the Agency's analysis of the applicability of the superposition principle is inconsistent with the steady-state character of the system for which the *33K* deficit was postulated. Consequently, the Agency's analysis directly violates conservation of energy as evidenced by the solution being inconsistent with the superposition principle which is required by the Neumann boundary conditions and the linear system involved.

It is further shown that the Agency's hypothesis of approximately 390 W/m^2 from the measured 288K surface temperature is also the result of not employing the superposition principle in the system of interest and properly solving for the unknown outgoing flux. Consistent and proper use of the Principle and rigorous analysis of the system at hand yields accurate surface temperature estimates and associated fluxes.

The Agency has contended that substantially increased surface temperatures would result if other sources such as fossil fuel combustion were treated similarly. This has been shown to be an artifact of treating each source as a boundary condition as opposed to determining boundary conditions consistent with the sources first then solving the heat equation subject to those boundary conditions. If the problem is generated in this consistent manner, the solution using the superposition principle is accurate and reliable.

The organizations that the Agency relies on for technical guidance share the concerns that led to the RFC denial. In the above, each of those concerns have been shown to violate physical laws and standard mathematical practice. The Federal Register, Volume 67, Number 36, Friday, February 22, 2002/Notices Page 8459 charges the Agency with ensuring that it accurately reports existing information in a clear, complete, and unbiased manner. And that the Agency verifies that the information itself is accurate. This RFR has detailed how the publications in question are in violation of physical laws and standard mathematical practice. I am confident that the Agency can put aside the relationship it has with the USGCRP, IPCC, and NAS in reconsidering its denial of RFC #21001 in an unbiased manner.

In closing, I formally request that the Agency reconsider its decision to deny RFC #21001. The reasons for denial have each been addressed and shown to violate well-known physical laws and standard mathematical techniques. In this, no new science or mathematics have been offered or needed. As such, it appears that the Agency has unintentionally misapplied concepts and procedures inappropriate to the problems at hand. In so doing, the Agency has published

and certified documents with inaccurate content, contrary to the mandates of the Information Quality Act.

Thank you for your attention and consideration.

Sincerely,

Frank A Tinker, Ph.D.