

A Novel Perspective on the Greenhouse Effect

**What a Heat Loss Vacuum Gauge can Teach Us
about Energy Balance in the Lower Atmosphere**

A Bit About Tom Shula

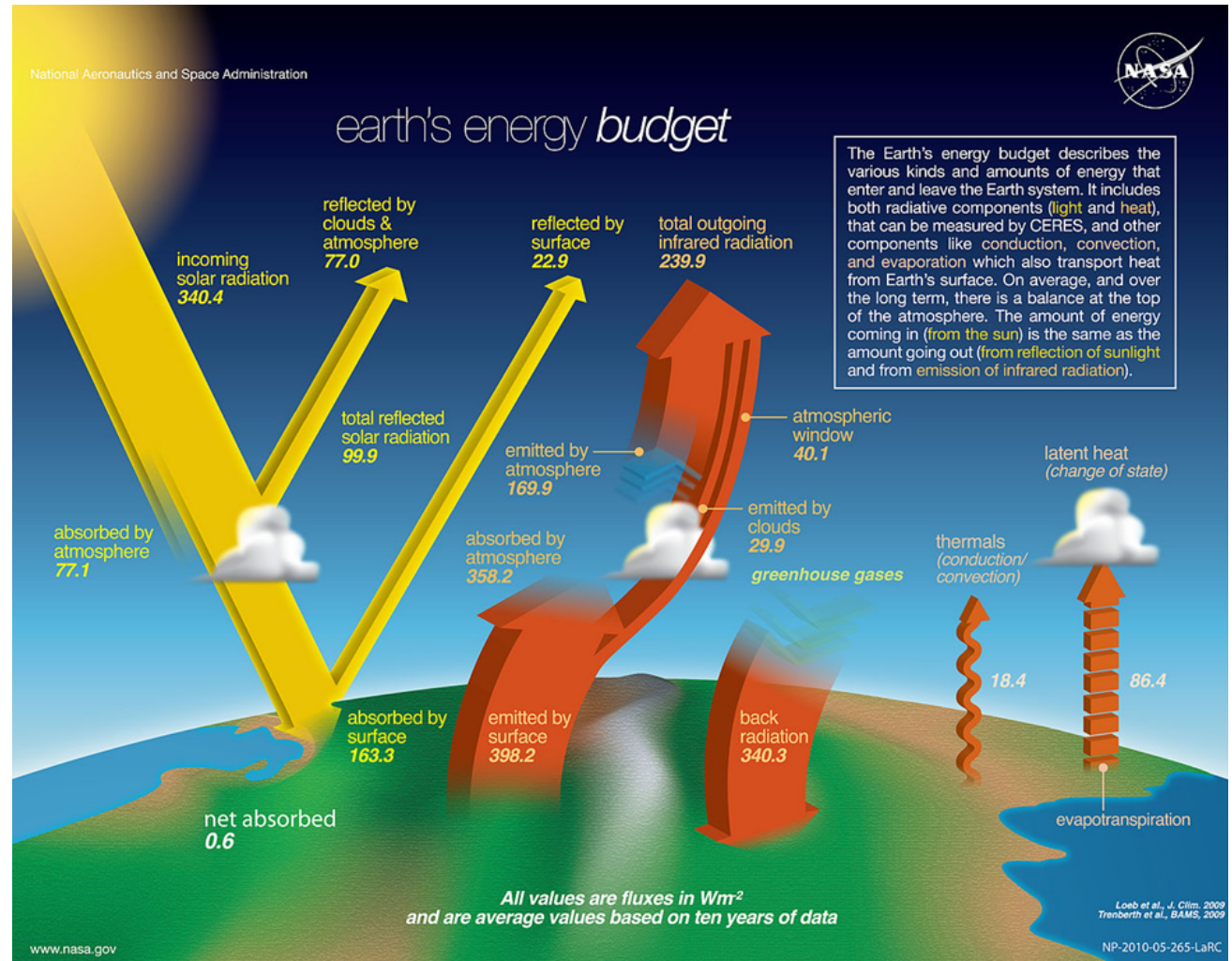
- Academic training in theoretical physics. Disillusioned with the community and left with a M.S. to work in tech industry.
- Primary work in semiconductor and disk drive component and system development and manufacturing.
- Brief diversions into other industries including steel mills, refining, food processing, and waste treatment.
- Exposed to a broad range of fluid dynamic systems with pressures ranging from kpsi to 10^{-12} Torr, and temperatures from 77K (liquid nitrogen) to $>1000\text{C}$
- I have been extremely curious from an early age, and was considered a top problem solver in my professional technical career
- I've been following the "climate change issue since the "global cooling" scare of the 1970s. More intently since 2009.

What's Different About My Approach

- As I have followed the climate change debate for many years, the focus on the climate realist side has been to incrementally debate the details of what the actual vs modeled results in the future might be
- While I respect all the work that has been done by the hundreds of professionals in the field, my approach has been very different
- Based on my professional experience, I have known that the fundamental underpinnings of the greenhouse effect were incorrect.
- My singular focus has been to find experimental proof that the greenhouse effect is a false concept. Recent insight after many years of accumulating information led to an insight several months ago. I present the solution which is both simple and powerful.

NASA model of Energy Balance in the Atmosphere

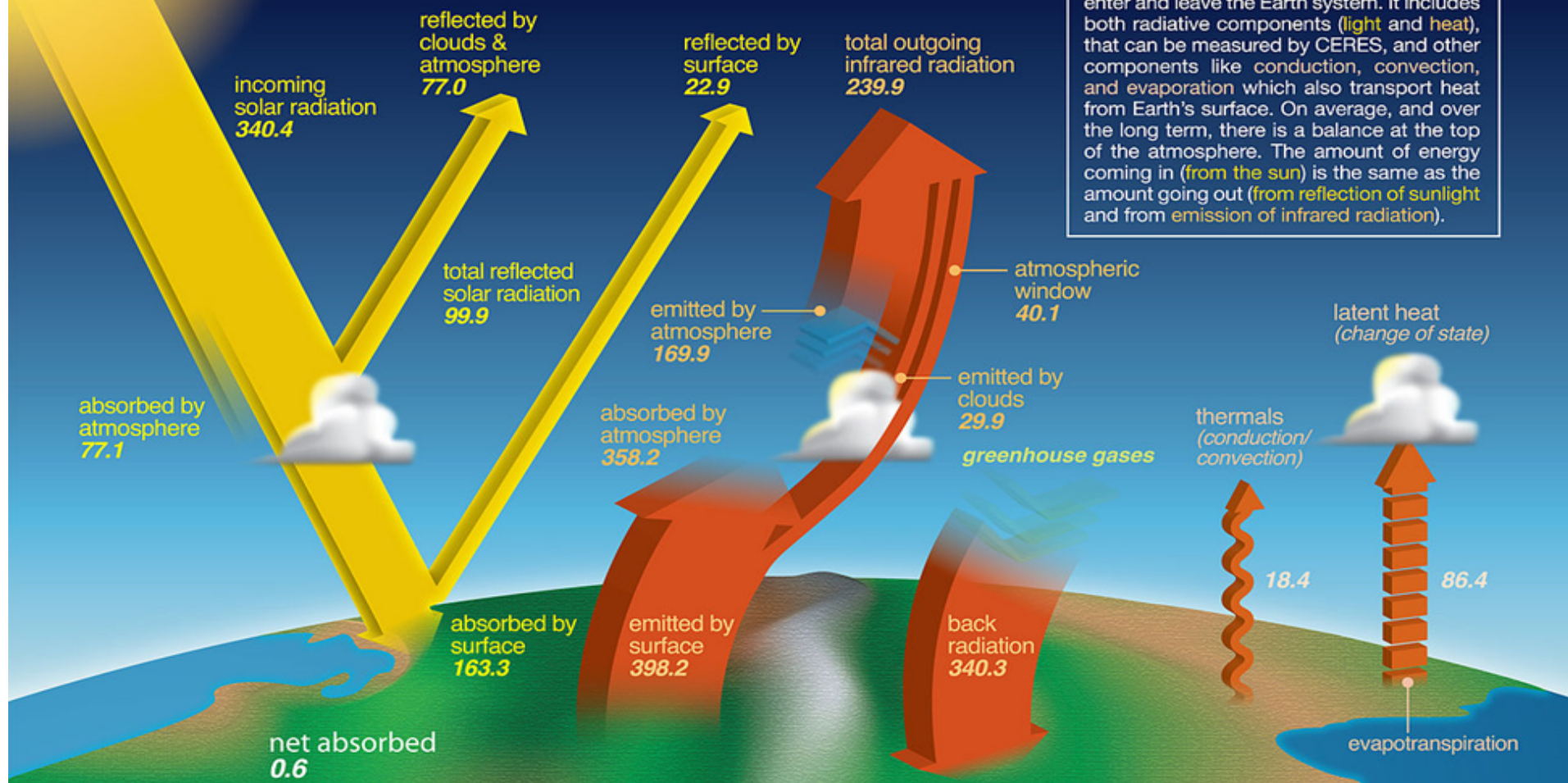
- Yellow Arrows indicate incoming Solar Radiation Energy
- Red Arrows indicate outgoing Longwave (infrared) Radiation Energy
- This is an example. Values may change slightly based on different model parameterization
- The model is limited as it is a “static” model. It assumes a flat, one-sided earth without diurnal variation. The energy flux numbers in the diagram are $\frac{1}{4}$ the actual solar energy flux peak values.





earth's energy *budget*

The Earth's energy budget describes the various kinds and amounts of energy that enter and leave the Earth system. It includes both radiative components (*light* and *heat*), that can be measured by CERES, and other components like conduction, convection, and evaporation which also transport heat from Earth's surface. On average, and over the long term, there is a balance at the top of the atmosphere. The amount of energy coming in (*from the sun*) is the same as the amount going out (*from reflection of sunlight* and from emission of infrared radiation).



All values are fluxes in Wm^{-2}
and are average values based on ten years of data

Loeb et al., J. Clim. 2009
Trenberth et al., BAMS, 2009

How does the Earth Lose Heat Energy?

- In physics, there are three mechanisms available to transport heat: Radiation, Conduction, Convection
- According to the model, there are three components of heat transport upward from the surface
- The Radiation component, indicated by the large red arrow pointing upward from the surface, is 398.2 Watts/m² in this example
- The Convection component in this example is 18.4 Watts/m²
- A third component, Latent Heat or evapotranspiration, constitutes 86.4 Watts/m².

Where do these parameters come from?

- The value of 398.2 Watts/m² come from treating the Earth as a blackbody and using the Stefan-Boltzmann Law to determine the power output.
- The values for Conduction/Convection and Latent Heat appear to be chosen to balance the incoming and outgoing energy
- The Back Radiation component (340.3 Watts/m²) is based on treating the atmosphere as a blackbody radiating downward to the surface

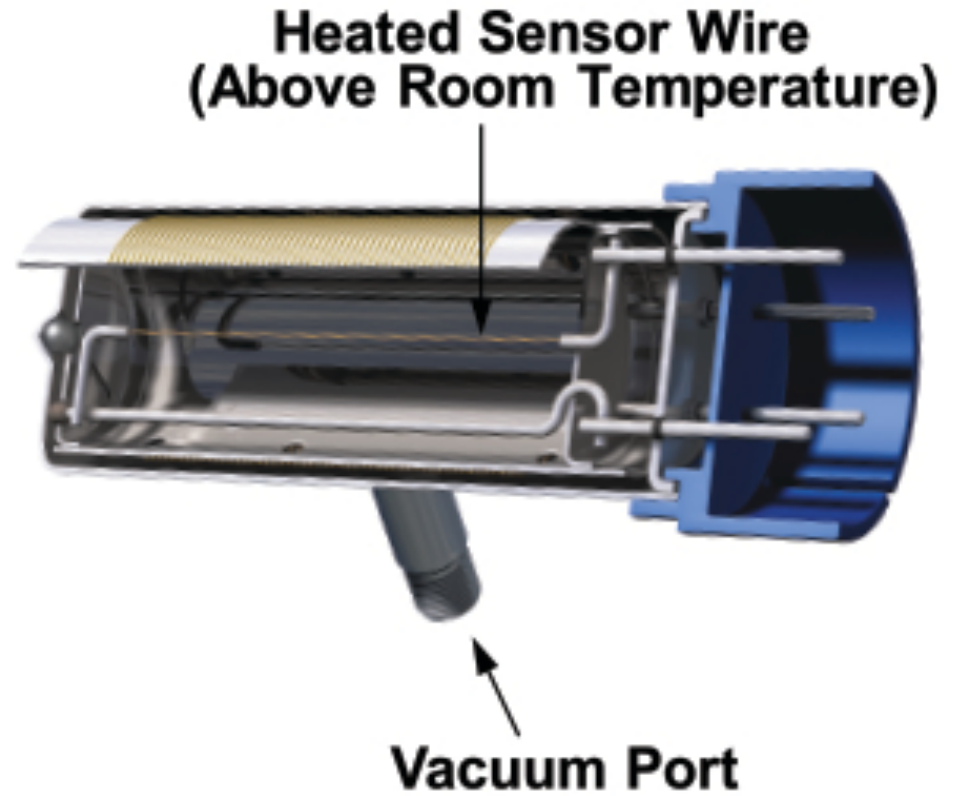
How can we Determine if these Assumptions are Reasonable?

- For purposes of this exposition, we will consider only the upwelling radiation from the surface of 398.2 Watts/m^2 and the Conduction/Convection of 18.4 Watts/m^2
- This does not mean that the Latent Heat component of 86.4 Watts/m^2 is unimportant. In fact, it is very important. This pertains to water vapor which is a major player in heat transport from the surface.
- According to the model, for the heat transport from the surface related to Radiation and Conduction/Convection, The Radiation component is 95.5% and the Conduction/Convection component is 4.5%

What do we want to Measure?

- It is apparent that in the climate models, it is assumed that Radiation is the primary mechanism of heat transport upward from the surface of the Earth
- We want to measure the ACTUAL relative contributions of Conduction/Convection vs Radiation to heat transport at the surface
- It so happens that there is an instrument designed to do precisely this that is been in widespread use in many industries for over 100 years.

The Pirani Gauge



This image was provided with permission by MKS Instruments, Inc. (Andover, MA)

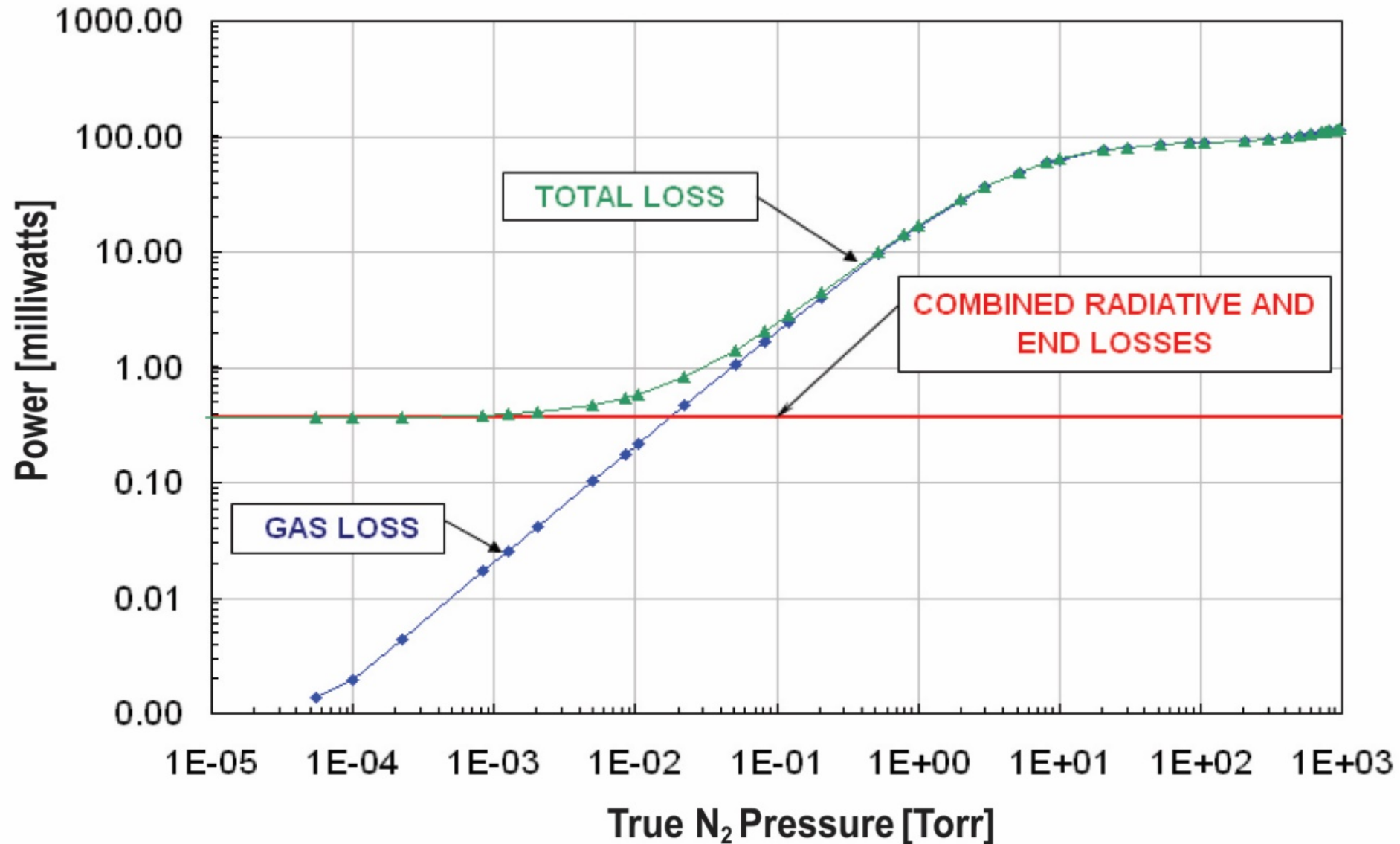
The Pirani Gauge

•The modern Pirani Gauge is used to measure vacuum in the range from 760 Torr to 10^{-4} Torr, though some are designed to measure higher pressures up to 1000 Torr. It was invented in 1906 by Marcello Pirani, a German physicist working for Siemens & Halske, and has been used in a myriad of applications for over 100 years. The operating principle of the gauge is simple. Inside the gauge body there is a filament that is heated and maintained at a constant temperature. The energy going into the filament is controlled via the current flowing through it. Energy can be dissipated from the filament in four ways:

- Gas Conduction
- Gas Convection
- Radiation
- End Losses (i.e., conduction of heat from the filament to its support structure.)

•The Radiation and End Losses are constant and can be measured by creating an adequate vacuum inside the gauge so that losses from conduction and convection are negligible. When gas is introduced to the enclosure, heat is removed from the filament via conduction and convection. The input power required to maintain the temperature of the filament will depend on how much energy is being removed via conduction and convection by the gas. In summary, the Pirani gauge tells us the relative contributions to heat transport by radiation versus conduction/convection as a function of gas pressure for an object (the filament in this case) held at a constant temperature. Referring to the paragraph preceding the above image, this is exactly the measurement we are looking for.

Power Accounting for a Heat-Loss Vacuum Gauge



This image was provided with permission by MKS Instruments, Inc. (Andover, MA)

Some Specific Relative Values from the Heat Loss Plot

	Radiation Contribution	Conduction/Convection Contribution
760 Torr/Sea Level	0.4%	99.6%
10 Torr/110,000 feet	0.7%	99.3%
.02 Torr/250,000 feet	50.0%	50.0%
Greenhouse Effect Model*	95.5%	4.5%

- The first three rows of values are from the Pirani Gauge heat loss curve on the previous page, with the approximate altitude equivalent of that pressure.
- The last row are the approximate values used in climate models
- Which is more likely to reflect reality?

How this relates to the Greenhouse Effect

- The filament in the Pirani Gauge is analogous to the surface of the Earth.
- As the pressure rises, more air molecules collide with the heated filament, giving the molecules more energy. (conduction)
- The hotter molecules rise, and cooler molecules then collide with the filament continuously. (convection)
- This process is perfectly demonstrated in the operation of the Pirani Gauge
- The author can only speculate regarding why this has not been given consideration earlier

Conclusions

- The Pirani Gauge provides a method to measure the relative contributions of radiation vs. conduction/convection in a gaseous environment.
- The performance of the Pirani Gauge indicates that at pressures relevant to the lower atmosphere (troposphere + stratosphere), radiation accounts for less than 1% of heat transport.
- The greenhouse effect, if it exists, is based on radiative heat transport in the lower atmosphere. Therefore, the greenhouse effect, if it exists, plays an insignificant role in heat transport in the lower atmosphere.
- Climate models generally are based on radiative transport as the primary driver of heat transport in the lower atmosphere. Since the Pirani Gauge demonstrates that this cannot be the case, these models are based on a false assumption and are therefore invalid.
- Because these models are based on the greenhouse effect and, by extension, imply Anthropogenic Global Warming, there is no scientific evidence for Anthropogenic Global Warming.

How do we explain the temperature of the Earth

- The only input of energy to the Earth is sunlight, which arrives at the speed of light.
- The Earth's surface loses heat via convection and evapotranspiration in the process we call weather.
- These processes transport energy much more slowly than the speed of light, so the cooling of the Earth's surface continues after the light of the sun is gone.
- Weather is the chaotic process by which the Earth loses its excess heat without ever reaching equilibrium. It is driven by convection.
- In the upper atmosphere the energy leaves via radiation as excited molecules transition to lower energy states

How did “Science” Get This So Wrong

- The Stefan-Boltzmann Law only holds strictly at 0K, i.e., a perfect vacuum. This is often ignored.
- Neither the surface of the Earth nor its atmosphere can be treated as blackbodies, but that is what modern climate models do.
- At the Earth’s surface there are about 100,000 colliding air molecules for each potential photon emitted based on the Stefan Boltzmann Law. This explains the much greater energy transfer by conduction/convection.
- This is described in more detail in the paper the author has made available

Closing Thoughts 1

- The concepts of “greenhouse effect” and “radiative forcing” as applied to climate only exist in models and the minds of those who believe in them. They do not represent the real dynamics of heat transfer in an atmosphere as is perfectly demonstrated by the operation of the Pirani Gauge
- The energy input from the Sun drives climate and weather on the Earth, and the Earth climate/weather system responds via evapotranspiration, conduction, and convection according to the laws of physics. This does not include an imagined “recycling” of infrared radiation in the atmosphere.

Closing Thoughts 2

- The author gives express permission to share this information freely
- The climate realist community needs to change the narrative. The debate needs to shift from an argument regarding the degree of “radiative forcing” / “greenhouse effect” to falsifying it as an invalid hypothesis.
- The concept of warming due to gases in the atmosphere was first proposed by Fourier in 1824, later by Tyndall in 1859, and still later around 1896 by Arrhenius. None of these proposals gained any traction. It was only in the modern era with the potential for massive government funding and the creation of a continuing “crisis” that it entered the “mainstream” sphere. The author has found no other “fact check” of the concept in almost 200 years save this one. It is past due.