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The Cloud Model for Climate Change

Michael Nelson, David B. Nelson

[1]Retired, Pleasanton, CA, USA
[2]Independent Researcher, Granite Bay, CA, USA
Email: mnelsonchemicalengineer@gmail.com

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Abstract

In 1995, the Intergovernmental Panel on Climate Change (IPCC) released a thermodynamic model based on the Greenhouse Effect, aiming to forecast global temperatures. This study delves into the intricacies of that model. Some interesting observations are revealed. The IPCC model equated average temperatures with average energy fluxes, which can cause significant errors. The model assumed that all energy fluxes remained constant, and the Earth emitted infrared radiation as if it were a blackbody. Neither of those conditions exists. The IPCC's definition of Climate Change only includes events caused by human actions, excluding most causes. Satellite data aimed at the tops of clouds may have inferred a high Greenhouse Gas absorption flux. The model showed more energy coming from the atmosphere than absorbed from the sun, which may have caused a violation of the First and Second Laws of Thermodynamics. There were unexpectedly large gaps in the satellite data that aligned with various absorption bands of Greenhouse Gases, possibly caused by photon scattering associated with re-emissions. Based on science, we developed a cloud-based climate model that complied with the Radiation Laws and the First and Second Laws of Thermodynamics. The Cloud Model showed that 81.3% of the outgoing reflected and infrared radiation was applicable to the clouds and water vapor. In comparison, the involvement of CO_2 was only 0.04%, making it too minuscule to measure reliably.

Keywords

Climate Change, Greenhouse Gas, CO_2, Clouds, Model, Thermodynamics

1. Introduction

The Intergovernmental Panel on Climate Change (IPCC), a joint enterprise with the United Nations, has produced extensive reports since 1990 exceeding ten thousand pages. To assist them in making Climate Change projections, they published a comprehensive thermodynamic model, which is set forth in more detail in Paragraph 3. This study examines the IPCCs model and the underlying publication that created it. Because this review involves radiation and thermodynamics, it is beneficial to review the history and fundamentals of the basic natural laws.

2. What Is Radiation?

2.1. Discovery That Light Had Different Wavelengths with Different Energies

Sir Frederick Herschel (1738-1822) conducted an experiment where he split sunlight into its colors using a prism. He shined each colored light onto several thermometers and noticed that the thermometers each registered a slightly different temperature. Johann Ritter (1801) took it a step further and conducted an experiment showing that sunlight had invisible radiation at a higher energy level. He discovered ultraviolet light. This opened the door to the discovery of invisible gamma rays and x-rays. Wilhelm Wein (1893) observed that light intensity was related to its temperature. Max Planck (1906) produced a formula connecting the energy of each photon to its frequency. The higher the frequency, the greater the energy and that it varied with the temperature to the fourth power. Stefan-Boltzmann produced the following equation that calculates the radiation energy flux.

$$E = e\sigma AT^4 \quad (1)$$

where:

E equals energy flux of the radiation,

e is the emissivity of the radiating object. This is equal to the absorptivity at equilibrium,

σ is the Stefan-Boltzmann constant, *i.e.* 5.670373×10^{-8} watts/m^2·K^4,

A is the area of the emitting source, and

T is temperature in the Kelvin scale.

In science and engineering, flux means a quantity passing through a surface area in a given amount of time. If it has a direction, then it is a vector. If it does not have a direction, then it is considered a scalar quantity. In thermodynamics, energy flux goes from a higher temperature to a lower temperature following a thermal gradient. This makes thermodynamic flux a vector quantity, *i.e.*, it has a direction and quantity.

2.2. Kirchhoff's Laws on Spectral Absorption and Emission

German scientist Gustav Kirchoff, in the mid-1800s, developed certain laws on the theory of spectrum analysis and laws of thermal radiation. He developed three laws [1].

- *First Law*: *A hot solid, liquid, or dense gas emits radiation at all wavelengths* (*a continuous spectrum of radiation*).
- *Second Law*: *A thin hot gas in front of a cooler background emits radiation at*

a discrete set of isolated wavelengths.

- *Third Law: A thin cool gas in front of a hotter solid, liquid, or dense-gas background removes the radiation from the background source at special wave lengths.*

The first law relates to emissions by solids (land) and liquids (ocean) over a wide range of wavelengths. The atmosphere is not a dense gas as referenced in the first law. The second law is that a gas **emits** radiation at discrete wavelengths known as its spectral profile. The third law is that an atmosphere above a warmer surface (land or ocean) **absorbs** radiation at its spectral wave lengths. Hence, atmospheric gases "emit and absorb" radiation at their peak wavelengths. This is a major difference between solids and liquids. The Sun emits radiation (photons) at all wavelengths, including gamma rays, visible light, infrared, etc. and the Earth's solid and liquid surfaces absorb most of it. All radiation, regardless of its internal energy, travels at the same speed.

2.3. Basic Radiation Terms and Definitions

Absorptivity is a measure of when photons are absorbed and transfers its energy into the material. When that happens, the energy can be turned into another form, such as thermal, mechanical, chemical, or electrical or it can be re-emitted. The absorptivity of a solid or liquid is equal to its emissivity at equilibrium. Hence, a perfect absorber has a value of 1 and a perfect emitter has a value of 1. Something that absorbs well, *i.e.* a black surface, also emits well. Conversely, something that reflects 100% absorbs nothing and emits nothing. Absorptivity can be higher or lower than the emissivity when equilibrium has not been achieved.

Albedo is the fraction of the incoming sunlight that is reflected away by the Earth. It is a complicated formula dealing with diffuse illumination and directional hemispherical and bi hemispherical reflectance.

Destructive Interference is where two or more waves traveling in different directions collide and their amplitudes partially combine. If they are the same size and going in opposite directions, they cancel each other out.

Electromagnetic radiation is another term for radiation and covers all spectrum, such as gamma rays, x-rays, ultraviolet light, infrared, microwave, and radio. No matter their origin or destination, all photons travel at the speed of light. This can be slightly slower when passing through a medium, like an atmosphere. In the absence of any medium, the empty space is referred to as a vacuum. The speed of light in a vacuum is 670 million miles per hour.

Emission is where a material generates and discharges its own radiation, *i.e.* photons. Almost all solids and liquids have the power to reflect. Gases behave in a more restrictive manner. Additionally, photons can be absorbed by solids and liquids across a wide range of wavelengths. Normally, gases restrict themselves to their absorption profile (see Kirchoff's third law).

Emissivity is similar to albedo but deals with its own emissions. It is the ratio of energy radiated when compared to a perfect emitter known as a blackbody

[2]. A number of 0 means that it emits no radiation and a number of 1 means it is a perfect emitter. Emissivity is controlled by the shape [3], roughness [4], color [5], direction [6], wavelength, and many other factors [7]. It can vary from less than 0.01 up to almost 1 [8]. For example, gravel is a poor emitter with an emissivity of 0.28. Green plants have an emissivity varying from 0.8 to 0.96.

Reflection is where electromagnetic radiation bounces off a boundary between materials. It depends on the wavelength of the incoming radiation and the material. A mirror is an example of reflection. Reflection is not absorption and re-emission.

2.4. Some General Limitations

Most of the radiation laws are based on the concept of a blackbody. A blackbody is an ideal object that absorbs all radiation. The name comes from the fact that since it absorbs all light, it will appear black. A blackbody is also a perfect emitter with an emissivity of one. That means it cannot reflect. A blackbody must be at thermal equilibrium. The Earth's thermal energy constantly changes since it is spinning and has an elliptical orbit. It prevents it from reaching thermal equilibrium. In addition, the Earth reflects about 30% of the incoming radiation and therefore cannot be a blackbody or have an emissivity of 1. Assigning a value of 1 will likely result in an overstatement of the emitted flux.

Evaluating the temperature of every place on earth is necessary to determine a truly accurate energy balance, and this is a limitation on all climate models. Given the constant temperature fluctuations, the calculations must be performed whenever the temperature changes.

2.5. Using an Average Temperature Does Not Translate into an Average Radiation Energy Flux

Using the world's average temperature to calculate the average radiation flux hitting the Earth is not accurate. That is because the Stefen Boltzmann Equation 1 is based on the temperature raised to the fourth power. As such, the average temperature may not reveal an average energy.

An example illustrates this issue. Assume the temperatures on a distant planet varied from 50˚K to 150˚K. This would yield an average temperature of 100˚K. Using the average temperature, the Stefan-Boltzmann Equation 1 calculates an energy flux to be 5.67 watts/m^2 (assuming a black body and an emissivity of 1). Compare that value (5.67) with the energies of the two temperatures and then averaging those energies. The energy at 50˚K results is 0.35 watts/m^2 and the energy at 150˚K is 28.7 watts/m^2. The average of those two energies is 14.5 watts/m^2. The disparity between them is considerable (5.67 verses 14.5) and creates an error exceeding 200%. The amount of error varies depending on the temperature ranges used in computing the average and the existence of non-linear peaks and valleys in the range.

When this analysis is done with the Earth using a surface temperature range inside the atmospheric infrared window, then the error is estimated to be approximately 12%.

3. Analysis of IPCC Climate Change Model

The IPCC adopted a thermodynamic model to assist them in projecting future Climate Change trends. NASA, NOAA, and numerous universities have adopted this particular IPCC climate model.

3.1. What Is Climate Change?

The typical definition of climate change as understood by most people, including scientists, as: "*a long-term change in the earth's climate, especially a change due to an increase in the average atmospheric temperature*" [9].

The IPCC modified this definition to limit Climate Changes to only **man-made activities** [10]. Whenever climate change is used in this article with capital letters, it refers to the IPCC's definition, and not the definition commonly understood. This "man-made" requirement has created a major misunderstanding of the expression used by the media. It is incredibly frustrating that "Climate Change" does not mean that "the climate changes".

The IPCC modification is reflected on page 56 of the 1995 Assessment report under "Climate Change Definitions", [10]: "*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*", emphasis added.

The US EPA also concurs with that definition and stated on page 11 of its planning documents [11]. "*Climate change refers to changes in global or regional climate patterns attributed largely to human-caused increased levels of atmospheric greenhouse gases*". Emphasis added.

In this study, climate change is defined broadly, not just as a result of human actions. It includes changes caused by all activities, events, and circumstances. An example illustrates this point. What if the sun stopped shining and the temperatures on Earth plummeted? Would that be considered a climate change? According to the IPCC or EPA, **it would not** since the sun's darkness was not caused by human activities.

Why did the IPCC re-define Climate Change? This was answered in the 2021 IPCC 6th Assessment Report [12]. They stated their views, which unequivocally indicates a particular mind set.

- "*Human activities have caused unprecedented changes in Earth's climate*".
- "*Human activities have already damaged our planet, including the frozen regions and the ocean*".
- "*Climate change is caused by humans*".
- "*It is unequivocal that humans are causing the warming*".

The history of climate change going back 500 million years has shown that climate change is a natural process and unrelated to CO_2 [13]. This was long before humans first appeared on the Earth about seven million years ago.

3.2. What Is a Climate Model?

A *climate model* is a representation of the Earth's climate system, designed to predict the behavior of components [14]. The climate model prepared by the IPCC is shown in **Figure 1** and involves the entire world and has been used to make projections up to 100 years in the future. Models are only accurate when all the known variables are considered. Ignoring a single major variable can doom a projection. A 3-day normal weather forecast is about 85% - 90% accurate. The weather forecasting accuracy drops to 70% - 85% for 5-day forecasts, 40% - 70% for a 7 day forecast, and 20% - 40% for a 10 day forecast. And it also depends on the distance from the projection site, usually within 50 to 150 miles [15].

3.3. What Type Is the IPCC Model?

There are many types of models. One type is based on an instantaneous glimpse in time and place. Another type is based on historical observations. Another is rooted in mathematics, and a fourth relies primarily on empirical measurements. However, most are combinations of those four types. The IPCC changed the model in 2023 by dividing it into two scenarios, one applicable to a clear sky and one with clouds [16]. However, the fundamental basis remained the same.

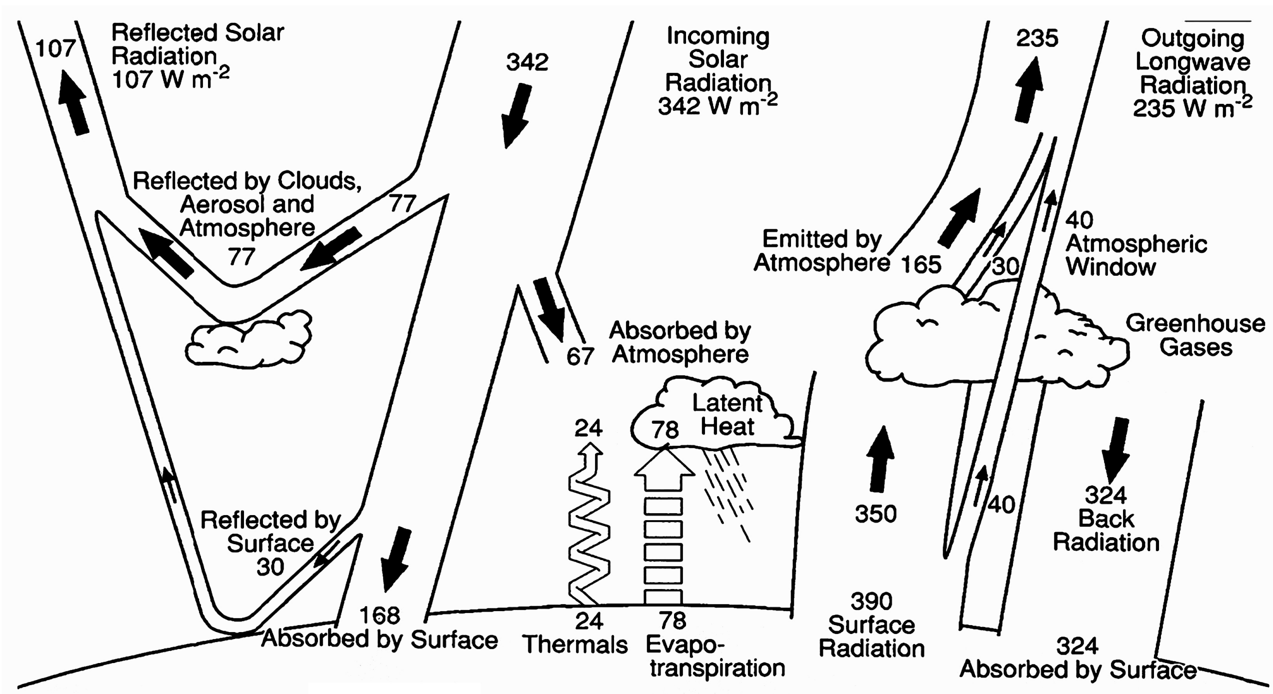

Figure 1. This is from the IPCC 1995 Assessment report on page 58 [10]. "The Earth's radiation and energy balance. The net incoming solar radiation of 342 W·m^{-2} is partially reflected by clouds and the atmosphere, or at the surface, but 49% is absorbed by the surface. Some of that heat is returned to the atmosphere as sensible heating and most as evapotranspiration that is realised as latent heat in precipitation. The rest is radiated as thermal infrared radiation and most of that is absorbed by the atmosphere which in turn emits radiation both up and down, producing a greenhouse effect, as the radiation lost to space comes from cloud tops and parts of the atmosphere much colder than the surface. The partitioning of the annual global mean energy budget and the accuracy of the values are given in Kiehl and Trenberth (1996)".

3.3.1. Based on a Glimpse Analysis

This type of model is commonly used in climate change, weather forecasting, astrophysical observations, epidemiological studies, and population studies.

The model shown in the IPCC Figure 1 states on page 56-57 that the amount of energy per second falling on a surface one square meter outside the atmosphere is 1370 watts/m^2 when facing the Sun. Because it limits the number to one specific amount (1370 watts/m^2) and a one square meter area, it implies a glimpse model. But the IPCC report further stated that it reduced the incoming flux from the sun by one-half because of the lack of sunlight at night. It reduced it by another one-half because of the spherical nature of the Earth. This appears to conflict with a specific point in time and place as needed for a glimpse model.

3.3.2. Based on Historical Records

Since the IPCC requires climate change must be associated with man-made activities, any historical records that predate humans would not fit within their stated parameters. There were no historical records referenced in the IPCC assessment report that described the model or in the designer's publication [17]. Therefore, the model does not appear to be based on historical records.

3.3.3. Based on Empirical Analysis

Empirical data is information derived from observations, devices, and machines. The IPCC does not show how the incoming flux from the sun was determined. However, a referenced study indicated that the value was based on a solar sphere with the Earth's radius. Therefore it was based, at least in part, on mathematics.

Regarding the model's reflected flux, it referenced a study by Kiehl and Trenberth [17], who stated that it was derived from satellite observations. Hence, this element includes empirical data.

Using both mathematical and empirical techniques is common. And they are consistent with the scientific method. Almost all models use assumptions in order to simplify the computations.

3.4. Assumptions Applicable to Climate Models

The IPCC climate model has many assumptions. Table 1 covers a few of them. Column 1 is the assumption number. Column 2 is a general description, and column 3 is comments relating to it.

3.5. Uncertainties Associated with the IPCC Model

The expression "uncertainty" means the degree to which a measurement, calculation, or forecast is not perfectly known or cannot be precisely determined. The IPCC used the word uncertainty 3350 times in the Climate Change assessment reports.

3.5.1. Different or Alternate Interpretations

The IPCC model was created using data from satellites aimed at the top of clouds. The clouds' location, height, temperature, and type of detector were not

Table 1. Model assumptions.

No.	The Assumption	Comments on the Assumption
		Incoming Radiation from the Sun
1.	There are no energy sources other than radiation from the sun.	There are many other energy sources, including nuclear reactions at the Earth's core, nuclear decay, primordial cooling, tidal effects from the moon, etc. [13].
2.	The incoming radiation (342 watts/m^2) remains constant.	The Earth spins and therefore cannot have a constant incoming sunlight flux. The sun's output changes daily and follows an 11-year sunspot cycle. Earth has an elliptical orbit which changes the incoming radiation flux. The Earth tilts each year, creating the four seasons, which change the location of the incoming flux and amount of reflective surfaces.
3.	The albedo (the amount of reflection from clouds, snow, sea ice, glaciers, and land) does not change.	The albedo is not constant. Clouds are constantly changing. Snow cover varies on the land between 35 to 60 degrees latitude for part of the year [18]. Forest fires and volcanoes produce particles that can stay in the atmosphere for years. These factors constantly change the albedo.
		Outgoing Infrared Radiation from the Earth
4.	A world average temperature is used to represent an average Infrared Radiation Energy Flux. (Figure 1 shows 390 watts/m^2 for surface radiation.)	Radiation energy varies with the temperatures to the fourth power. Averaging is an arithmetic calculation in the first power. This is discussed with examples in Paragraph 2.5. The infrared energy shown in the IPCC model emitted from the surface is 390 watts/m^2. It should be 12% higher, or 437 watts/m^2.
5.	The Earth is composed of a single material that emits radiation as if it were a blackbody with an emissivity of 1.	The Earth's surface is made up of millions of materials of different colors, shapes, roughness, phases (liquid/solid), etc., and can vary from 0.28 (gravel), 0.8 (snow), 0.9 (sand) to 0.95 (water) [19]. Clouds have an emissivity around 0.79% ± 6% [20].
		Factors Concerning the Heat Balance
6.	Earth does not have any heat modulating systems such as oceans.	Oceans modulate the temperature. The ocean contains 98.89% of the heat when compared to the atmosphere at 1.11% [21]. It stores energy when the temperature rises and releases it when the temperatures drop. If the atmosphere rose 100˚F, the oceans would only rise 1˚F. Water is the biggest reason Venus and Mars are not currently habitable [22].
7.	There is no volcanism, hurricanes, earthquakes, forest fires, or any other natural event.	These factors can affect the heat balance.
8.	There is no biology.	Biology consumes, releases, and stores vast amounts of energy. These energy stores are included in mountains of limestone, granite, hematite, coal, oil shale, etc., as well as massive reservoirs of crude oil and natural gas.

specified by either the IPCC or the model's designers. The designers reported (page 201) that the data "shows upward longwave spectral emissions from the earth's surface" [17]. Based on that statement, it appears that the designers believed the satellite was measuring the infrared flux coming from the ground as filtered through the clouds. In the designers' study, they calculated the energy flux that reached the top of the atmosphere (blue curve) and compared that flux to the observed surface data (red curve) detected by the satellite. They then subtracted the blue curve from the red curve to produce what they called a "radiation forcing" flux.

The term "radiation forcing" is an expression the IPCC used as a way of estimating the "global mean surface temperature".

3.5.2. Source of Infrared Radiation Selection

Because they aimed the satellite at the top of the clouds, it could have been measuring the radiation flux **emitted** by the clouds as opposed to the surface flux **filtering through** the clouds. The dips and gaps between the satellite data (red curve) and the calculated theoretical value (blue curve) may be caused by Greenhouse Gas absorption (O_3, H_2O, CO_2) and aerosols located in the stratosphere. Typically, satellites aimed at the tops of clouds only show cloud emissions **and not** the filtered emissions from the ground [23]. This is discussed in more detail in Section 4.

3.5.3. Using an Emissivity of 1, the Theoretical Maximum of a Blackbody

The IPCC model assumed that the SRF (surface radiation flux) had an emissivity of 1, *i.e.* a black body. Applying an appropriate emissivity reduces the longwave energy flux by up to 30%. This is discussed in more detail in Section 4.

3.5.4. Energy Flux Values Appear High

The IPCC model's designers subtracted the blue curve from the red curve on page 202 of their study [17]. They called this energy flux a radiative forcing. The designers integrated (the area under the curve) and showed a longwave radiative flux was 155 watts/m^2 (pg. 201). This is a very high absorption flux and only slightly less than the sun's radiation absorbed by the Earth (169 watts/m^2). But, as discussed later, the absorption does not mean the photon energy is turned into sensible heat. Sensible heat is the energy it takes to change the temperature of mass as it warms up or cools down without a phase change. Most of the photon absorptions are simply re-emitted. This re-emission process often takes place in less than 2 microseconds [24].

If one assumed that the satellites were measuring the emissions from the cloud and not from the ground, it results in a much lower Greenhouse Gas flux value, *i.e.* it goes down from 155 watts/m^2 to about 50 watts/m^2.

3.5.5. Ignoring Aerosols in the Stratosphere

The designers of the IPCC model stated on page 200 [17]: "*We also neglected the longwave effect of aerosols based on the work of Coakley et al.* (*1983*)". This was because they were investigating the surface flux coming from the Earth's surface in the troposphere. Coakley *et al.* [25] concentrated their work on aerosols in the **troposphere**. However, if the satellite data was related to the flux coming from the cloud tops, then the aerosols in the stratosphere may become important.

3.5.6. Infrared Flux Numbers

The IPCC model shows that it was perfectly balanced, with 235 watts/m^2 coming in from the sun and 235 watts/m^2 of infrared radiation emitted by the Earth. A balance of energy is expected in a stable environment. However, the heat balance on the Earth's surface creates a perplexing problem. It showed that 168 watts/m^2 of the incoming sunlight were absorbed by the Earth's surface. The heat leaving the Earth's surface was 24 watts/m^2 by wind, 78 watts/m^2 by evaporation, and 390 watts/m^2 by infrared radiation. This totals 492 watts/m^2 and not 168 watts/m^2. That would constitute an enormous cooling force.

To balance the Earth's surface energy budget, the IPCC adopted a back radiation flux of 324 watts/m^2. Plus, they have identified this flux as a vector quantity. We could not determine where this number came from. This justified the 492 watts/m^2 (168 + 324). But by adopting a back radiation vector flux, it appears to violate the First and Second Laws of Thermodynamics.

3.5.7. Model Shows More Radiation Energy Coming from the Atmosphere than Coming from the Sun and Absorbed by the Earth

The IPCC model shows that there were 324 watts/m^2 coming from the atmosphere that was absorbed by the earth. That's 37.8% more than all the absorbed energy coming from the sun. The atmosphere does not generate its own energy. There is no atmospheric chemical reactor like a coal or fossil fuel power plant in the sky. There is no nuclear reactor. The First Law of Thermodynamics prohibits free energy or perpetual motion systems.

3.6. First Law of Thermodynamics

The First law is a form of conservation of energy. Except for nuclear fission and fusion reactions where mass is converted, energy can neither be created nor destroyed. It can only be transferred or stored by various processes, such as mechanical or chemical methods. Neither of those processes is applicable here. The First Law of Thermodynamics is represented by the following equation.

$$E_2 - E_1 = Q - W \tag{2}$$

where:

E_2 is the total energy of the system after something is done,

E_1 is the initial energy of the system,

Q is the energy transferred into the system, and

W is the work done by the system.

In this case, E_1 is the energy of the Earth and its atmosphere before receiving the heat from the sun, and E_2 is the energy after receiving the sun's heat. The sun's absorbed radiation of 235 watts/m^2 is Q. There is no reference in the model about work being done by the system. Hence, E_2 minus E_1 must be equal to 235 watts/m$^{2.}$. The model also shows that 235 watts/m^2 left the Earth, returning it to its original state. That is consistent. But there is an extra 324 watts/m^2 that came from the atmosphere and was absorbed by the Earth. That part appears to be a violation of the First Law of Thermodynamics.

In 2013, the IPCC recognized the problem of energy unbalance and arbitrarily adjusted the downward flux (324 watts/m^2) to precisely match the incoming flux from the sun in 1995 (342 watts/m^2) [26]. They acknowledged the problems (pg. 182) such as "missing energy", "considerable uncertainty" in the absorbed radiation, "uncertainties" in precipitation regarding evaporation, "uncertainty" in the sensible heat, and "uncertainties in estimates of both radiative and non-radiative components of the surface energy budget". The 2013 assessment report failed to resolve the missing energy or solve the stated uncertainties. Furthermore, it appeared to disregard the essential principles outlined in the First and Second Laws of Thermodynamics.

3.7. Second Law of Thermodynamics

This law states that the net heat flows from hot to cold and is a vector quantity. The equation that applies is:

$$S_f = S_i + Q/T_h - Q/T_c \tag{3}$$

where:

S_f is the final entropy of the system,

S_i is the initial entropy of the system,

Q is the heat/energy transferred from hot to cold, a vector quantity,

T_h is the hot temperature, and

T_c is the cold temperature.

This equation is based on a fundamental law of nature called entropy, which is a measure of the randomness of a system. It forces things, like energy, to move in the direction of disorder, *i.e.* higher entropy. The Earth is about 288˚K (59˚F) and space has a temperature near 2.7˚K (minus 453˚F). Temperature is a measure of energy. Hence, energy will move from the higher temperature Earth to a lower temperature space. Under the IPCC model, it reported 324 watts/m^2 of back radiation traveled from the cooler atmosphere to the warmer Earth. This appears to be inconsistent with the Second Law of Thermodynamics.

Proponents that support a back radiation analysis contend that the Second Law only applies to thermal energy and not radiation. They argue that radiation travels in all directions and has a distribution pattern known as the Stefan-Boltzmann and Weins Displacement Laws. However, thermal energy can travel in any direction and also has a distribution pattern known as the Maxwell Boltzmann distribution.

The leading scientists did not voice an opinion that the thermodynamic laws did not apply to radiation. This included Grimaldi 1665, Huygens 1678, Sir Isaac Newton 1687, and Maxwell 1864. Albert Einstein (1979) went a step further. He stated that the law of thermodynamics was "*the only physical theory of universal content, which I am convinced, that, within the framework of the applicability of its basic concepts, it will never be overthrown*".

Tests were done with parallel plates of different temperatures and placed in a vacuum. They showed that the colder plate warmed, and the warmer plate cooled. With the test conducted in a vacuum, the only method of heat transfer was through radiation. Hence, the net energy **radiation** flux follows the fundamental laws of thermodynamics and will be in the direction of the cooler objects.

The Stefan-Boltzmann equation can be used to calculate radiation heat transfer consistent with the Second Law of Thermodynamics [27].

$$\Delta U = U_h - U_l = e\sigma A\left[T_h^4 - T_l^4\right] \quad (4)$$

where:

U_h is the energy flux having a higher energy state,

U_l is flux having a lower energy state,

T_h is the higher temperature object raised to the fourth power,

T_l is the lower temperature object raised to the fourth power,

e is the emissivity of the object,

σ is the Stefan-Boltzmann constant, and

A is the area.

3.7.1. The Second Law of Thermodynamics Applies to Net Flow

When calculating heat transfer, backflow transfers are excluded. The **net** flux is always from hot to cold and since it is a vector, it has a direction. This is true regardless of the existence or nonexistence of any alleged backflow. For example, putting more ice around a pot of water will never make the water warmer. There could be crisscrossing flows or internal heat eddies as long as the net flux vector is toward the cooler object.

This net flux analysis applies to more than thermodynamics. This is common in many areas of the natural world. For example, Ohm's law—electricity flows from a higher voltage to a lower voltage, Ficks Law—mass flows from a higher concentration to a lower concentration; Bernoulli's Principle and Stokes law—fluids flow from a higher pressure to a lower pressure, etc.. This principle applies to almost all the natural laws. It is basically how engineers calculate energy and mass transfers.

3.7.2. Does the IPCC Model Violate the Second Law of Thermodynamics?

The IPCC model set forth in **Figure 1** shows that 390 watts/m^2 of infrared radiation was emitted from the surface and 324 watts/m^2 came back and absorbed by the Earth as back radiation. That meant there were 66 watts/m^2 of net flux that was emitted by the warmer surface. Therefore, there is a net energy flux vector leaving Earth toward the cooler atmosphere and space, but only 66 watts/m^2. If the notation of 324 watts/m^2 vector from the atmosphere to Earth is removed, it would be consistent with the second law. But it would also have to be removed from the outgoing 390 watts/m^2, otherwise the radiation energy balances would be off. The model should only show a net upward flux vector of 66 watts/m^2 without reference to a backward flux vector, or a sideway flux vector, or a twisting flux vector, or any other directional vector that is not governed by the locations of the high and low temperatures.

In order to have a net downward vertical flux vector of 324 watts/m^2, according to the Stefan-Boltzmann equations, it would require an infrared radiation source in the troposphere directly above the emitting surface with an average temperature higher than 144˚F. That does not exist. The highest average atmospheric temperature over the last 500 million years was 94˚F [13]. Today, the average troposphere temperature ranges from 59˚F at the surface to a minus 60˚F at the tropopause. Consequently, the transfer of a downward vector energy flux from the atmosphere to the Earth appears to defy the principles of the Second Law of Thermodynamics.

3.8. IPCC Did Not Address Either the First or Second Law of Thermodynamics

A computer search of more than ten thousand pages of the IPCC's Climate Change Assessment Reports, using the word search string of "First Law of Thermodynamics, 1st Law of Thermodynamics, Second Law of Thermodynamics", or "2nd Law of Thermodynamics:" did not reveal those words being used. (Report dates searched 1990, 1994, 1995, 2001, 2007, 2013, 2014, 2021, 2022, and 2023.) It is not difficult for engineers to comply with these laws since it is routinely done every day. The Cloud Model shown in Section **5** illustrates how it is handled with radiation.

4. The IPCC Model as Based on the Greenhouse Theory

Figure 2 in this study modifies the Planck's Earth surface radiation flux (blue curve) and a satellite flux (red curve) that was presented in Figure 1 on page 201 by the IPCC's climate model designers [17]. It adds a Planck type curve (green) applicable to emissions from the tops of clouds.

4.1. Assumption That the Satellite Was Measuring the Cloud Emissions

The green curve shown in Figure 2 is based on the assumption that the satellite was measuring cloud emissions and not the Earth's surface emissions as filtered by the clouds. The difference between the green curve and the red curve is shown in Figure 3.

According to the IPCC, the difference between the curves represents the amount of absorption applicable to the Greenhouse Gases. The greater the flux, the greater the Greenhouse effect.

Figure 3 shows a flux of about 50 watts/m^2 and roughly 70% lower than the 155 watts/m^2 used in the IPCC model. The pink shaded area in Figure 3 coincides with the ozone absorbance band. Ozone has a concentration in the stratosphere of about 10 ppmv, which is about eight times higher than it is in the troposphere. The light green shaded area indicates an area that has an absorption band by water vapor. However, the amount of water vapor in the stratosphere is very low. The yellow shaded area has absorption bands associated with water vapor, CO_2 and hydroxyl ions.

The numbers shown in Figure 3 are from 0 to 8 watts/m^2 microns. This may seem small, but watts are on a per second basis for every one square meter of surface area. After one hour, the 50 watts/m^2 becomes 180,000 watt-hours/m^2 and after one day becomes 4.3 million watt-days/m^2.

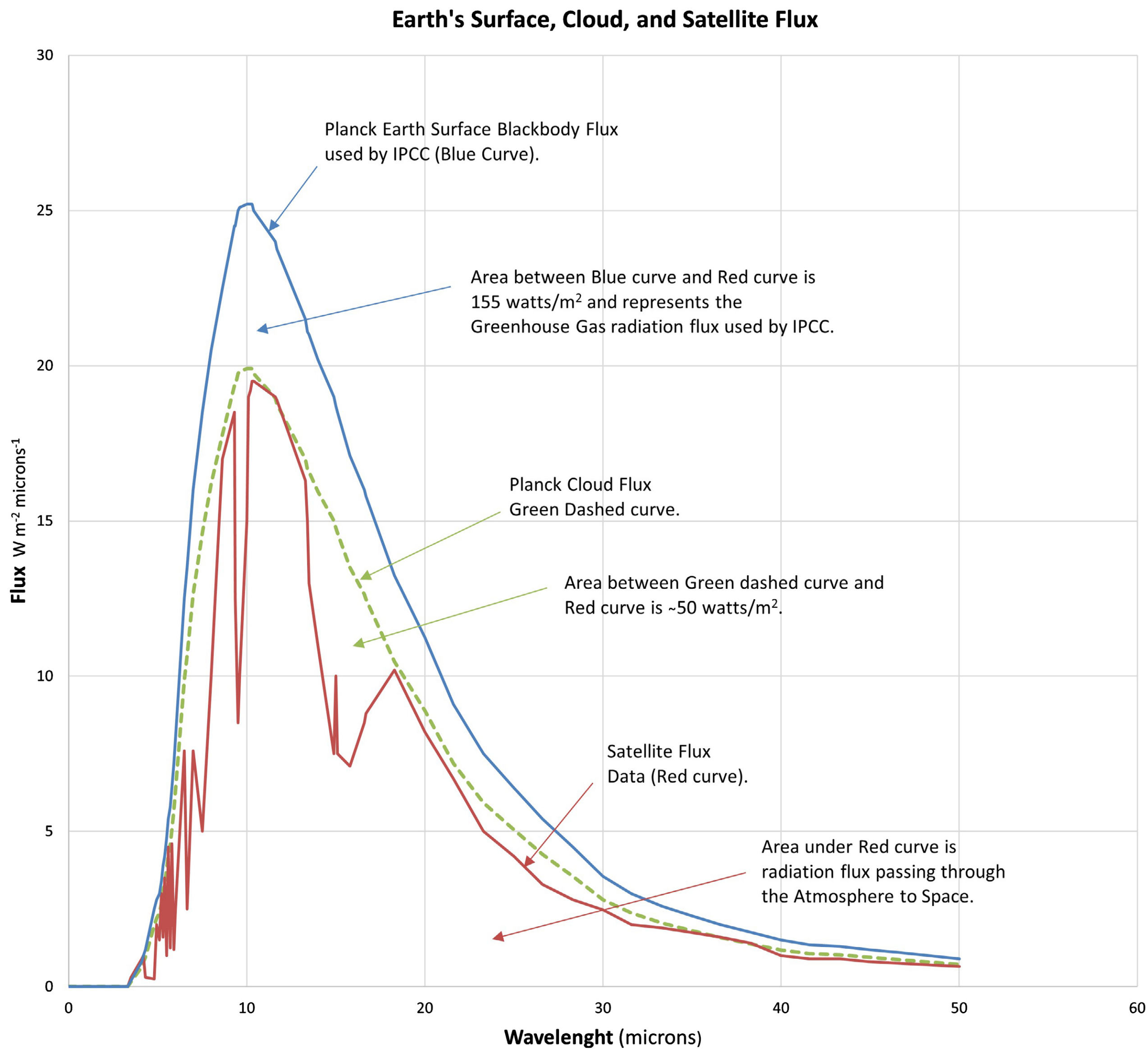

Figure 2. An extrapolation of the data shown in Kiehl and Trenberth [17] with an added curve (green) showing the Planck calculated amount based on cloud emissions at a temperature of 20˚F with an emissivity of 0.98.

4.2. IPCC's Assumption That Earth Had an Emissivity of 1

The IPCC assumed the Earth was a blackbody and had an emissivity of 1. A calm ocean (without whitecaps) would have an emissivity of about 0.98. On the other hand, if land was under the clouds surveyed by the satellite, then the emissivity goes down to about 0.88. The average emissivity for the world is about 0.93. If the world emissivity was selected, it would lower the Greenhouse Gas radiation flux from 155 watts/m^2 (see Paragraph **3.5.4**) to 128 watts/m^2 or a reduction of 17.5%. If a land emissivity was used (0.88), it would reduce the radiation flux to 108 watts/m^2, representing a reduction of 30.4%. In either event, the use of an emissivity of 1 would have the effect of overstating the Greenhouse Gas Radiation flux.

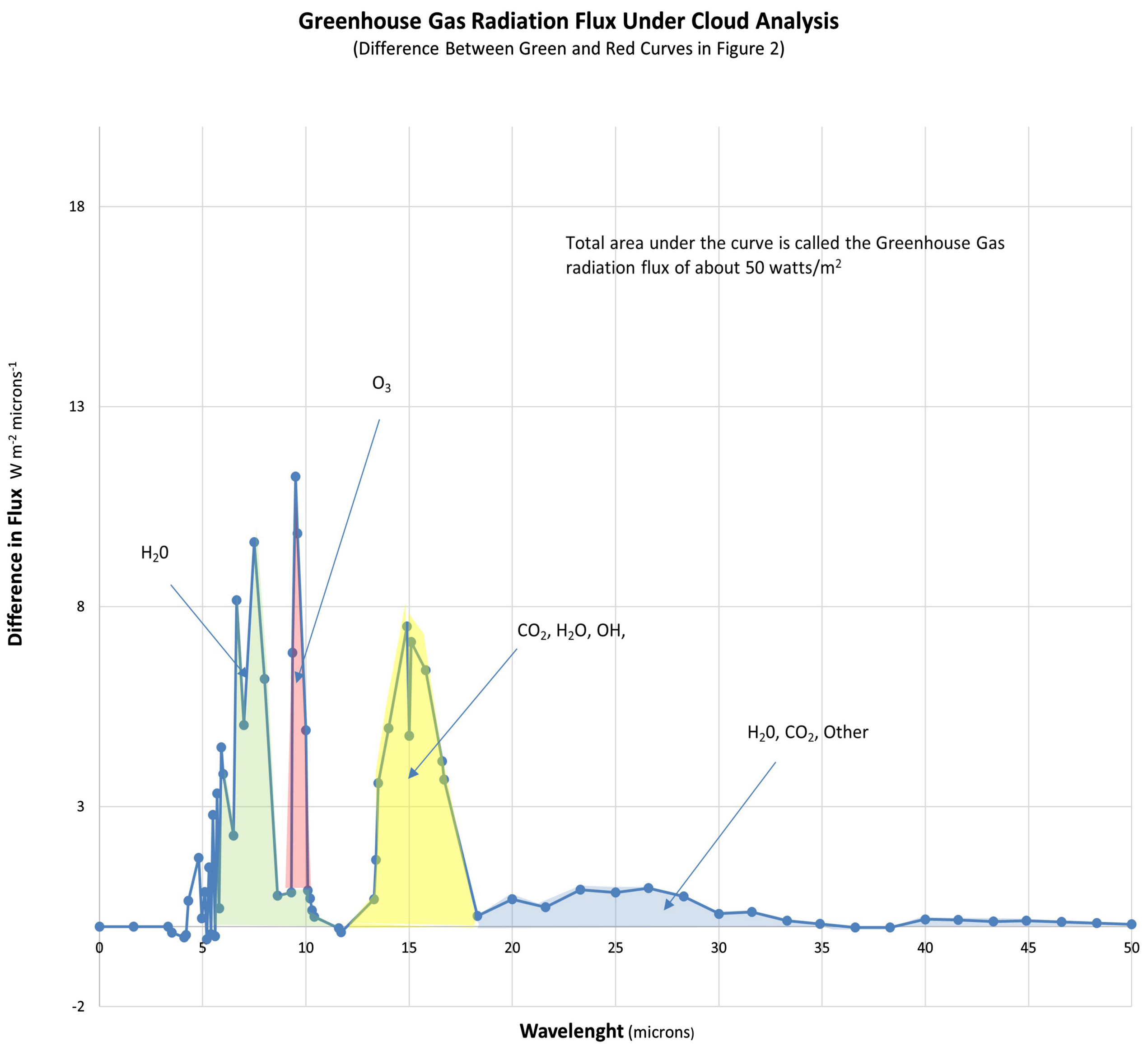

Figure 3. The difference in flux between the calculated theoretical flux and the measured satellite data as shown in **Figure 2**. The chemical notations identify which gases have absorbance bands in those wavelengths.

4.3. Re-Emissions & Scatter

The radiation flux leaving the cloud has a direction, a straight path from the clouds to the photon detector. The clouds are at the top part of the troposphere, making it necessary for them to travel across the stratosphere on their way to the satellite. If a photon in that path hits a Greenhouse Gas molecule, it could be absorbed. This is shown in **Figure 4**.

The sketch illustrates that after the 16 μm photon is absorbed, it is re-emitted and scattered in a random direction. Studies have shown that the majority of the absorbed photons are re-emitted as photons having about the same energy. The back radiation concept in the IPCC model shows an 83% return (324/390). Studies have also shown that the absorption and re-emission process is fast, taking

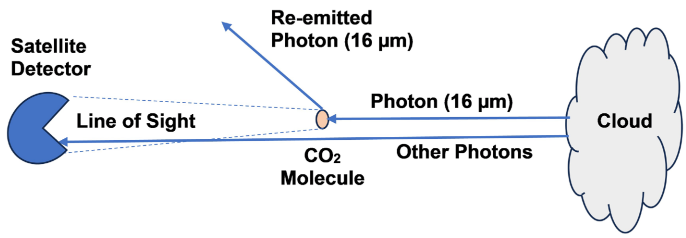

Figure 4. A sketch of a photon with a wavelength of 16 µm that left a cloud. It was absorbed by a CO_2 molecule in the stratosphere, and then re-emitted as a photon with the same energy but in a scattered direction. Other photons pass from the cloud and are not absorbed. A satellite is positioned above a cloud and equipped with an infrared photon counter.

only about 1 to 2 microseconds [24]. Moreover, while it is usually expected to observe single photon re-emissions, there are cases where multiple photons are emitted [28].

The re-emitted photon that leaves the Greenhouse Gas molecule scatters. It is similar to Rayleigh scattering associated with particles but dealing with photon re-emissions. This is illustrated in **Figure 4**. It shows that the absorbed and scattered photon has a wavelength of 16 µm. That wavelength was selected because it represents one of the absorption peaks of CO_2. Photon scattering is an extremely complex process [29]. However, since the satellite is located more than 160 km (100 miles) away from the cloud, the likelihood of the re-emitted 16 µm photons reaching the small detector is essentially zero. The scattering issue occurring in the stratosphere explains why the majority of photons with a hypothetical 16 µm wavelength may go undetected. The radiation flux remains the same as the re-emitted photons simply scatter in different directions. This would be analogous to the Greenhouse Gas molecules acting as tiny photon reflectors, applying only to specific wavelengths. This makes satellite spectral data regarding photon counters with a potential detection flaw (uncertainty).

An argument could be made that the detector will sense the scattered radiation from other Greenhouse Gas molecules in the stratosphere, and everything will cancel out. That argument could fail for several reasons. First, if the re-emissions from adjacent molecules cancel out the absorbed photons, then the photon counter would not show any absorption. Second, the fact that the satellites are aimed at specific clouds is done for a reason. If the scattered emissions were evenly dispersed, then aiming it at a particular location wouldn't yield significantly different results. But they do show diverse results and that's why they aim them at specific locations.

5. Alternate Climate Model Based on Clouds

When the cloud cover dropped about 4.1% between 1982 and 2018 and the temperature increased at the same but inverse slope, it created a possible correlation. Is there also causation [13]? Clouds cover about 67% of the atmosphere's surface [30]. They absorb all the infrared radiation emitted from the Earth below them [23]. This observation suggests that the short term atmospheric temperatures might be controlled by clouds.

5.1. What Are Clouds?

Almost all clouds, aka aerosols, are composed of water droplets and ice crystals. However, there are other types of clouds, such as those produced by volcanoes. This study is directed to water-based clouds only. NOAA classifies water-based clouds into four broad categories [31]. Ciro-form clouds are very white and look like curls of hair. They are located at the higher elevations and typically appear in advance of low-pressure fronts before mid-latitude storms and large tropical systems. The next type of cloud is called a Cumulo-form. They look like white fluffy cotton balls. They usually appear as dense with distinct boundaries with flat bases. They occur at altitudes where the water vapor is actively condensing. The Strato-form clouds look like blankets or layers. They usually appear from non-convective rising air. The last and biggest group is called the Nimbo-form and is the source of most of the rain. Clouds are exceedingly complex systems and are continuously forming, dissolving, changing, and moving.

5.2. A Cloud Based Climate Model

We developed a thermodynamic model similar to the one the IPCC proposed. **Figure 5** displays this particular concept, which concentrates on clouds and water vapor as the thermodynamic driving force. It was designed to comply with the Laws of Thermodynamics and the Radiation Laws set forth by Kirchoff, Planck and Stefan-Boltzmann. **Figure 5** is a modified glimpse model based on a theoretical one square meter surface having all the instantaneous flux values and temperatures. The one square meter surface in the model represents a surface composed of 70% ocean water and 30% land. The atmosphere in the model is composed of air with the same constituents and properties as the Earth's air, with overhead cloud cover taking up 67%. The goal was to be a representative slice of the world. Like the IPCC model, it does not exist in reality. The assumptions, weaknesses (uncertainties), and comments in **Table 1** are relevant to this model.

Although the oceans are available as a heat regulator in this model, it was not needed because the energies balanced.

5.2.1. Non-Cloud Portion

On the left-hand side of **Figure 5**, the diagram shows 198 watts/m^2 (yellow) coming from the sun. This is divided into two branches. One relating to 30 watts/m^2, which is reflected from the Earth's surface. The other branch of 168 watts/m^2 is absorbed by the Earth's surface. The 67 watts/m^2 of the sun's radiation flux (IPCC model) was also divided into two branches. One branch of 44 watts/m^2 is absorbed by the clouds (67%), and the second branch of 23 watts/m^2 is absorbed by the Greenhouse Gases. High energy sunlight and sensible heat

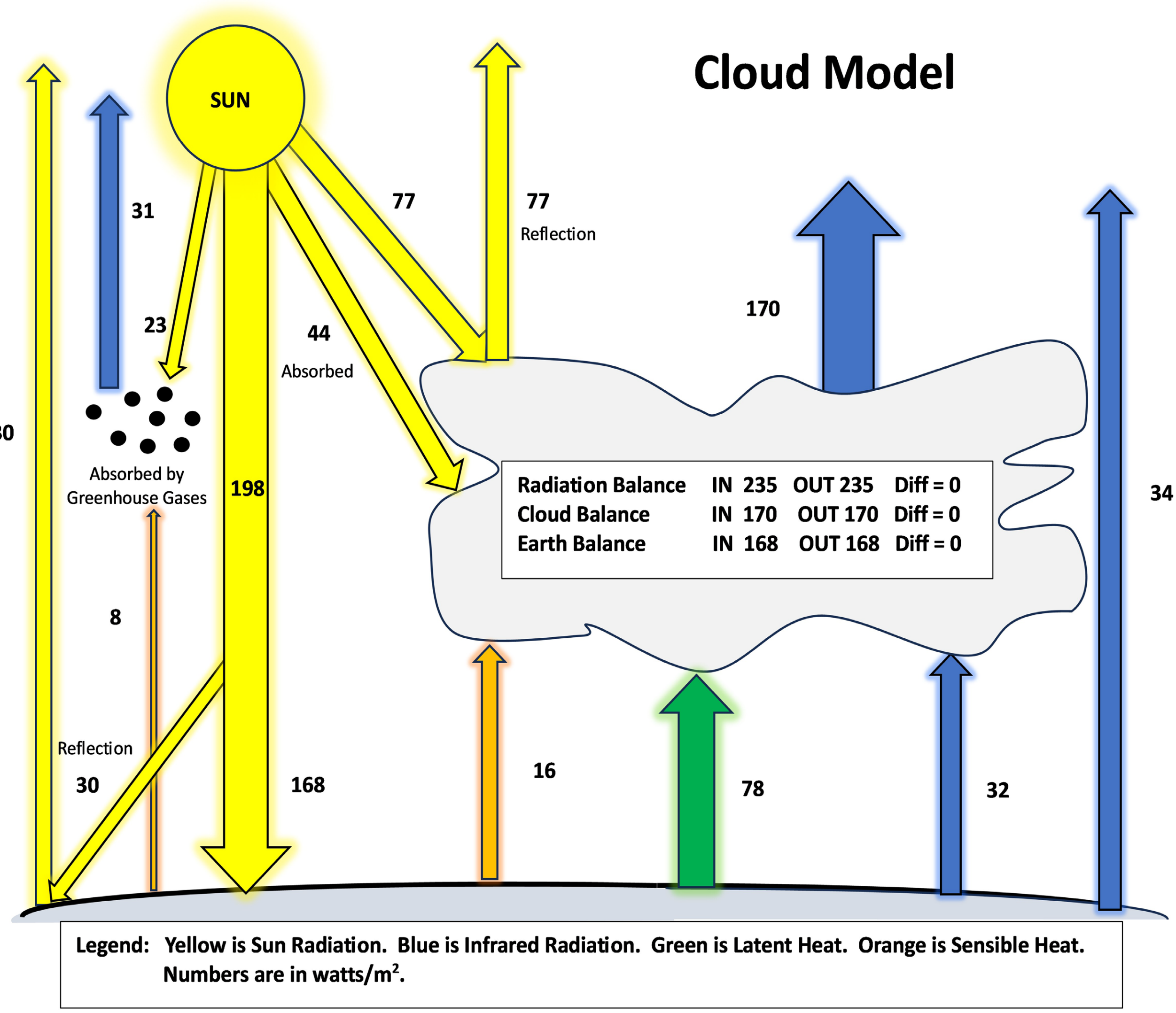

Figure 5. A thermodynamic heat balance for the world based on a Cloud Model. The flux values for incoming radiation, the latent heat (evaporation/condensation) and sensible heat (thermals) were adopted from the model shown in the 1995 IPCC Assessment Report [10]. All the infrared radiation values (blue) were calculated independently.

can be absorbed by water vapor, which is a Greenhouse Gas. The energy is re-emitted as infrared radiation. See Paragraph **5.4**. On the right-hand side of the figure, the infrared flux (blue) travelling out of the atmosphere from the Earth was calculated to be 34 watts/m^2. These calculations are discussed in Paragraph **5.6**.

5.2.2. Cloud Portion

There is 16 watts/m^2 of sensible heat (67%) absorbed by the clouds. The IPCC model showed the sensible heat as 24 watts/m^2. But that was split into two branches (16 and 8) in accordance with the cloud percentage. Sensible heat is a heat transfer process where it results in a change in the temperature without a change in the phase, *i.e.* going from a liquid to a gas or solid.

The upward direction of the sensible heat indicates a vertical vector quantity and has a direction. A significant amount of this heat is carried by the winds horizontally, which is not shown in the model. These horizontal winds are responsible for equalizing much of the temperature differences between day and night.

The IPCC model showed 78 watts/m^2 of vertical latent heat. The term evapotranspiration as used in the IPCC model is probably too narrow. That term is usually used in agriculture where water is transpired by plants and, to a lesser extent, by animals. Simple evaporation of surface water, especially from the oceans, transports a vast amount of latent heat, which is then condensed to create clouds. The clouds absorb the entire latent heat flux in this model, as it is the crucial process responsible for cloud formation. It is recognized that latent heat can be associated with non-cloud formation. For example, melting and freezing on the Earth's surface, such as sea ice. Other non-cloud processes include fog, dew forming on colder surfaces, ground frost, etc. But the vast amount of the latent heat is related to cloud formation.

In the Cloud Model, the infrared radiation flux going into the cloud from the Earth's surface was calculated to be 32 watts/m^2. These calculations are shown in Paragraph **5.5**. The infrared flux leaving the cloud was calculated to be 170 watts/m^2. Those calculations are set forth in Paragraph **5.7**.

5.2.3. Reflection Portion

The reflected portion of the Cloud Model is shown as 77 watts/m^2 of sunlight that is reflected from the clouds and 30 watts/m^2 that is reflected from the Earth's surface. Reflection is a crucial element since it relates to diverting high-energy photons away from Earth. This issue is discussed in Paragraph **5.3**. Reflected radiation is not absorbed and is therefore not included in the energy balances.

5.2.4. Energy Balances

The world radiation energy balance for the Cloud Model shows that the flux absorbed by the Earth from the sun was 235 watts/m^2 (168 + 44 + 23). The energy leaving the Earth is also 235 watts/m^2 (31 + 170 + 34). This is consistent with the IPCC Model, which showed a net incoming flux of 235 watts/m^2 (168 + 67) and a net outgoing flux of 235 watts/m^2 (165 + 30 + 40). Although each model arrived at the same result, they both reached that conclusion by different methods.

The Earth surface energy balance for the Cloud Model shows 168 watts/m^2 coming in. The amount leaving the Earth's surface is the same (8 + 16 + 78 + 32 + 34). The IPCC Model shows the amount entering the Earth's surface at 492 watts/m^2 (168 + 324), and the same amount leaving (24 + 78 + 390). The IPCC model shows the amount of infrared flux was far more than the amount absorbed from the sun. This suggests a perplexing contradiction, namely that the earth's atmosphere is producing net heat independently of the sun.

The cloud model energy balance shows 170 watts/m^2 entering (44 + 16 + 78 + 32) and 170 watts/m^2 leaving. There is no specific cloud energy balance provided in the IPCC model (**Figure 1**).

5.2.5. Differences and Similarities between Models

The differences deal mostly with the Earth's surface energy balance and the various component fluxes. For example, the IPCC model has a 492 watts/m^2 flux coming into the Earth's surface and the same amount leaving. The Cloud Model is considerably lower at 168 watts/m^2 entering and leaving the Earth's surface. The outgoing radiation from the cloud in the IPCC model appears to be 30 watts/m^2 whereas it is 170 watts/m^2 in the Cloud Model. There were 40 watts/m^2 of infrared travelling from the surface into space through an atmospheric window in the IPCC model. There were only 34 watts/m^2 from the Earth to space in the Cloud Model.

However, there were some unexpected similarities. If the 324 watts/m^2 of back radiation were eliminated from the IPCC model and factored out from the outgoing 390 watts/m^2, then they would match the Cloud Model with respect to the Earth surface flux (168 watts/m^2). Also, reducing the Earth's infrared outgoing flux to 66 watts/m^2 in the IPCC model, would then match the Cloud Model's outgoing surface flux of 66 watts/m^2 (32 + 34). This is a remarkable coincidence since entirely different methods were used to arrive at the results.

5.3. Reflectivity

Reflection is extremely important in the cloud model, because clouds are the largest reflector of the sun's high energy radiation. It is a phenomenon that humans have been aware of since they first looked into a pond of water and saw themselves staring back. And yet, very few know why and how it happens. Reflectivity is the ratio of the intensity of the reflected light to the incident light. It varies from 0 meaning no reflection to 1 which represents a perfect reflector. Various elements are considered including angles, surface area, solid verses liquid, index of refraction, roughness, emissivity, materials, wavelength, temperature, and many other factors.

5.3.1. Angle

Normally, there must be an incident angle to have a reflection. And the angle of incidence is equal to the angle of reflection. The solar cell industry found that reflectance increases with the angle of incidence [32]. While a high reflectance is unfavorable for solar cells, it plays a positive role in keeping the Earth cool.

With respect to direct overhead reflection, there is some controversy. Some argue that it forces all perpendicular photons to be absorbed. Others argue that the reflection occurs and is simply perpendicular to the incoming light. Some take a cancellation approach. They argue that destructive interference annuls the photons, or that the time reversal symmetry theory prevents the same photons from travelling in opposite directions.

5.3.2. Surface Area

Reflected photons increase in proportion to surface area. However, this is limited by the size of the reflecting surface. If the surface is smaller than the wavelength of the radiation, then there is essentially no reflection.

5.3.3. Solid versus Liquid

Ice crystals are more efficient in reflecting light than liquid droplets. Cloud water droplets can be between 5 and 20 μm while ice crystals are often ten times larger. Reflections by ice at 100 μm had a scattering value of 0.73 while droplets with a diameter of 10 μm had a scattering value of 0.16 [33]. Scattering is good for dissipating heat, but bad for reflecting an image.

5.3.4. Index of Refraction

The index of refraction of water is 1.333 while it is 1.309 for ice. A higher index indicates that the atoms are more apt to absorb energy. This means it is probably less reflective [34].

5.4. Calculation of the Infrared Radiation Emitted by the Greenhouse Gases

This relates to the 31 watts/m^2 of infrared flux emitted by the Greenhouse Gases shown on the left side of **Figure 5** with the blue arrow. This was a combination of the incoming short wave radiation (23 watts/m^2-yellow arrow) and the clear sky portion of the sensible heat (8 watts/m^2-orange arrow). However, it raises a couple of questions. Can Greenhouse Gases absorb the short wave radiation and the kinetic energy from the sensible heat? The answer is yes.

Water vapor has 4 absorption peaks near 1 micron wavelength, which are wavelengths included in the sun's radiation spectra. CO_2 has no absorption peaks in this area. Hence, the water vapor can absorb a portion of the radiation from the sun. In addition, the water vapor constitutes about 99% of all other Greenhouse Gases combined [13].

Water molecules can be excited by collisions with other molecules, and hence the sensible heat can be transferred. Water vapor is the only Greenhouse Gas with a broad range of absorption and emission peaks. As such, it can absorb and emit infrared energy with many wavelengths. Together with its concentration, it makes water vapor the single most important component in the Greenhouse Effect [13] [18].

5.4.1. Is There Enough Water Vapor?

Are there enough water vapor molecules in the atmosphere to absorb the high energy radiation from the sun and then emit this energy in the form of infrared? In order to answer this question, we need to determine the number of moles of Greenhouse gases (*i.e.* water vapor) in the atmosphere above the one square meter surface shown in **Figure 5**. This can be estimated by taking a hypothetical column of air as shown in **Figure 5** and extending it to the top of the troposphere. The troposphere is the first layer of the atmosphere and contains the vast majority of the atmospheric mass (between 75% and 80%). The stratosphere contains about 19% - 20%.

5.4.2. What Is a Mole?

A mole represents the weight of a specific number of atoms and molecules known as Avogadro's number (6.022 × 10^{23} molecules/mole). A mole of any element or compound contains the same number of molecules as a mole of any other compound. Regardless of the varying weights, the total count of molecules remains constant. Moles of different liquids or solids may occupy different volumes. However, gases are unique. Under the same conditions, a mole of nitrogen gas will take up the same volume as a mole of water vapor, which is the same as a mole of CO_2. That means the volume percent of a gas will also represent its mole percent.

As shown in **Table 2**, the total volume in the air column is about 11,000 m^3. The density of air in that column varies from 1225 g/m^3 at sea level to 390 g/m^3 at the top. Selecting an average density of 807.5 g/m^3 yields a total of 8,882,500 g. Dividing that mass by the molecular weight of air (29) shows that there are 306,293 moles. However, 97% of the air is composed of non-absorbing gases. Removing the non-absorbing gases (nitrogen, oxygen, argon) reduces the number of moles that absorb the radiation in the column to 9188, *i.e.* Greenhouse Gas moles.

5.4.3. How Much Energy Can a Mole of Photons Absorb?

This is a routine calculation done at most colleges and will not be repeated here. However, from a technical standpoint, it is important to note that a mole of photons does not exist due to the fact that photons lack both mass and atomic or molecular structure. However, because photons are absorbed and emitted by atoms and molecules, the photon-mole might be used as a **proxy** for Avogadro's number (6.022 × 10^{23}). But acting as a proxy has its limitations. Atoms and molecules have many electron shells and jumping from one electron state to another, also known as a quantum, can result in releasing multiple photons.

In this regard, there can be more photons released than the number of atoms or molecules in Avogadro's number. However, using photon molar quantities can still be a useful tool in estimating the energies associated with each mole of molecules.

The energy of a particular wavelength photon can be calculated using Planck's equations. Knowing the energy of each photon allows the calculation of the total energy in a photon-mole (Avogadro's number). For example, a photon with a wavelength of 6.7 µm, can absorb/emit 17,860 watts/photon-mole.

Table 2. Greenhouse gas moles and photon energy.

Sufficient Mass to Absorb Radiation				
Volume	Density	Mass	Moles	G-Gas Moles
11,000 m^3	807.5 g/m^3	8,882,500 g	306,293	9188
Energy in a Mole of Photons				
Photons/Mole	Planck's Constant	Wavelength	Energy/mole	
6.022 × 10^{23}	6.6 × 10^{-34} J sec/photon	6.7 µm	17,860 watts	

The wavelength of 6.7 μm was chosen since it is within one of the many peaks of water vapor. There are 9188 moles in the column. This means that there is sufficient Greenhouse Gases in the column to absorb and emit 31 watts of radiation energy per second. But there are several dynamics that can reduce the 17,860 watts/photon-mole.

For example, all the molecules will not absorb and emit photons at the same time. There must be a conservation of energy. There are selection rules that control transitions between energy states. At high intensities, absorption can become saturated. Photon intensity decreases by the inverse square law. Cascading re-emissions will add to the proton source and push the system to a steady-state condition. Steady state represents a balance where the photon inputs and outputs are equal. These will be major limiting factors.

5.5. Calculation of Infrared Energy Emitted by the Earth and Absorbed by the Clouds

In this paragraph, the focus is on the infrared radiation emitted by the Earth's surface and how it is captured by the clouds overhead. It is shown by a blue arrow on the right-hand side of **Figure 5** with a flux value of 32 watts/m^2. This flux value was calculated using Stepan-Boltzmann Equation (4).

The high temperature (T_h) is the average Earth's surface temperature of 59˚F. The low temperature was the average temperature of the cloud base and was determined to be 35˚F. The temperature of the cloud base is typically warmer than the temperatures in other areas of the clouds. The reason for this is that when water vapor condenses, it releases a significant amount of energy, which is called latent heat. In addition, the bottoms of the clouds are continuously absorbing infrared radiation from the Earth. The area under the clouds was 0.67 square meter surface area. The Earth's surface average emissivity of 0.937 was used since the Earth's surface was the emission source. Because of the excess capacity of the Greenhouse Gases (almost entirely composed of water vapor) to absorb infrared radiation, an absorptivity (emissivity) of 1 was used.

This information and calculations are summarized in **Table 3**. The first column is a description of the component, the second column is from equation number 4, and the third column contains the values.

Table 3. Infrared flux emitted by earth & absorbed by clouds.

Description of Component	Equation	Value
Average Surface Temperature	T_h	288.15˚K (59˚F)
Average Temperature of Bottom of Clouds	T_l	274.8˚K (35˚F)
Area under Clouds	A	0.67
Emissivity of the Surface	e	0.937
Stefan-Boltzmann Constant	σ	5.670373×10^{-8} watts/m^2·K^4
Absorption by Clouds	e	1
Calculated Energy Flux	U	28.7 watts/m^2
Increased Flux by 12% (Paragraph 2.5)	U	**32 watts/m^2**

The Kelvin temperature is also provided since the Stefan Boltzmann equation 4 requires the absolute temperature scale. The area under the clouds is simply the percent of the cloud cover over the Earth and is used in the one square meter glimpse model shown in **Figure 5**. The emissivity and absorption values are discussed above. The flux value was increased by 12% because the Earth's average temperatures do not reflect the average flux values. This is discussed in Paragraph 2.5.

5.6. Calculation of Infrared Energy Emitted by the Earth without Clouds

This relates to the infrared radiation released by the Earth's surface and is transmitted to space. It is represented by the blue arrow in **Figure 5** with a value of 34. The flux value was calculated using Equation (4). The high temperature (T_h) was the average surface temperature of 59˚F. The area without clouds was 0.33 square meter surface area. The Earth's surface average emissivity of 0.937 was used. These values are set forth in **Table 4**. Determining the low-temperature receiver presented a more difficult problem. If the vacuum of space is used, it has a temperature of 2.7˚K or minus 455˚F. That would produce an energy flux of 9.9×10^{-7} watts/m^2, *i.e.* essentially zero. Would selecting that temperature be appropriate? An analogy would be like doing a heat transfer calculation for a house in Florida but using an outside temperature from the north pole. There needs to be a more rational basis for determining this atmospheric temperature.

As discussed in Paragraph **5.4**, the surface radiation has to pass through 9,188 moles of Greenhouse Gases. However, the temperature of the surface produces a radiation wavelength that is withing the infrared radiation window. The Greenhouse Gases absorb about 6% of the infrared radiation in this zone [13].

This reduces the number of moles capable of absorbing the radiation to 551 moles. But as shown earlier in **Table 2**, 1 mole of photons can theoretically handle 17,860 watts. This capacity constitutes a significant impediment for the infrared radiation escaping without being absorbed. But there are offsetting conditions.

Table 4. Infrared flux emitted by earth without clouds.

Description of Component	Equation	Value
Average Surface Temperature	T_h	288.15˚K (59˚F)
Average Temperature of Troposphere	T_l	263.7˚K (15˚F)
Area without Clouds	A	0.33
Emissivity of the Surface	e	0.937
Stefan-Boltzmann Constant	σ	5.670373×10^{-8} watts/m^2·K^4
Absorption by Greenhouse Gases	e	1
Calculated Energy Flux	U	30.39 watts/m^2
Increased Flux by 12% (Paragraph 2.5)	U	**34 watts/m^2**

The Greenhouse Gas absorption is not all transferred into thermal heat. Within one or two microseconds, the molecules re-emit the infrared radiation having the same energy level [24]. This process is repeated over and over again in a cascading process until steady-state is reached. Because of the speed of the photons and the short re-emission time, it is possible that steady state will be reached quickly. Based on steady-state being achieved, the most appropriate lower temperature should be based on the mid-point in the molar amount of the Greenhouse Gas in the troposphere.

Once reaching the midpoint, the molar concentration starts to decrease, making it easier for the cascading re-emissions to escape. This midpoint appeared to be between 3.5 km and 4 km in altitude. We chose to use the average of 3.8 km. An altitude-temperature calculator translated this elevation to have a temperature of about 15˚F.

Using Equation (4) and applying a high temperature of 59˚F, a low temperature of 15˚F, an area of 0.33 m^2, an absorption of 1, it calculates a flux of 30.39 watts/m^2. This flux was increased by 12% to **34 watts/m^2**.

5.7. Calculation of Infrared Energy Emitted by the Clouds

The calculations of the radiation flux leaving the cloud (170 watts/m^2) are addressed in this section. There are three main points considered in this calculation: 1-the cloud top temperature, 2-the emissivity, and 3-the surface area of the water droplets.

5.7.1. Cloud Top Temperature

The clouds form and float at various elevations. Satellite infrared detectors may not be reliable in identifying overshooting of the tops [35]. Clouds are typically classified as high (6 - 18 km), mid (2 - 8 km), and low (0 - 2 km) [31]. And these clouds are further divided into three regions: polar, temperate, and tropical. The cloud top height also depends on the latitude [36]. We selected a height slightly over 9 km. Using the temperature/altitude converter, this translated to a temperature of −48˚F.

5.7.2. Emissivity

The emissivity of the cloud tops has been reported to vary dramatically depending on the cloud type and height. Emissivity of lower clouds can be nearly 1, mid clouds averaging about 0.79, and for high clouds it goes down to about 0.35 [20]. This is probably why the tops of the clouds reflect so much sunlight. A highly reflective surface has a low absorptivity and therefore low emissivity. We selected an emissivity of 0.98 based on water frost crystals [19].

5.7.3. Surface Area

This created a major problem in the analysis. Clouds are made up of ice crystals and water droplets. The smaller the particle size, the greater the surface area. Droplets and ice crystals can average around 0.1 mm in diameter and smaller [37]. The surface-area-to-volume ratio of the top half of a spherical water droplet with that diameter is 90,000. The surface-area-to-volume ratio of the top of a sphere with a diameter of 1 meter is 9. This illustrates a massive increase in the surface area. Radiation emissions, absorptions, and reflections are based on surface area, as well as other factors. Hence, increasing the surface area will emit more infrared radiation than a smaller surface area.

There are limiting factors. The vast amount of surface area may be apportioned between those surfaces reflecting radiation (could be 65% based on an emissivity of 0.35) and those emitting radiation. In addition, when these small droplets or ice crystals emit radiation, it reduces the energy available for the next emission cycle. These issues, and others, represent a complicated factor in need of further research. We used a 1 m^2 surface area, which represents 100%.

With a cloud emissivity of 0.98, a surface area of 1 m^2, and a temperature of −48˚F, Equation 4 calculates an energy flux of 152 watts/m^2. When this is boosted by 12%, it reaches **170 watts/m^2**.

5.8. How Much Energy Flux Is Cloud Related?

The thermodynamic effect from clouds is illustrated in **Table 5**. When it comes to radiation, the Earth deals with two components: the high-energy sunlight it receives, and the calm, low-energy infrared radiation it emits. If all of the sunlight incoming sources (4 yellow arrows) shown in **Figure 5** are added together it shows there are 342 watts/m^2 entering. The clouds reflect 22.5% of that sunlight and the Earth's surfaces reflect another 8.7%. That leaves 235 watts/m^2 of the sun's radiation being absorbed.

The outgoing infrared sources (three blue arrows) show 235 watts/m^2 leaving the Earth, which balances with the energy absorbed from the sun. Hence, including reflection, the clouds are responsible for 72.2% (77 + 170/342) of the radiation process for the Earth (22.5%-reflection + 49.7%-infrared). Adding another 9.1% relating to water vapor as a Greenhouse gas, results in water being responsible for 81.3% of the radiation thermodynamic process of the Earth.

Table 5. Incoming & outgoing radiation.

Type of Flux	Direction	Amount (watts/m^2)	Percent
All Sunlight Radiation	Incoming	342 total	100%
Reflected by Clouds	Outgoing	77	22.5%
Reflected by Earth Surface	Outgoing	30	8.7%
Infrared Radiation	Outgoing	235 total	
From Earth to space	Outgoing	34	9.9%
From Clouds	Outgoing	170	49.7%
From Water Vapor	Outgoing	31	9.1%
From CO_2	Outgoing	0.095	0.04%

The contribution by CO_2 is only 0.04%, which is too insignificant to cause any measurable impact. That is because, in part, the high energy sunlight that is absorbed by the atmosphere (23 watts/m^2) cannot be absorbed by CO_2. Only water vapor has a concentration and a spectral band that can absorb a significant portion of these higher energy photons. That leaves the 8 watts/m^2 of sensible heat available to excite the CO_2 molecules. But the concentration of CO_2 is exceedingly low (421 ppmv) compared to water vapor (30,000 ppmv) [13]. The table provides compelling evidence that the thermodynamic process of the Earth is primarily controlled by clouds. In 2013 the IPCC proclaimed (page 573) that clouds contribute to the largest uncertainty to their estimates on the Earths energy budget [26]. They rejected a cloud model because it was "*impossible to resolve with numerical simulations on computers, and this is not expected to change in the foreseeable future*". (p. 582).

The IPCC also rejected the cloud models because "*studies do not span the large space and time scales needed to fully determine the interactions among different cloud regimes and the resulting net planetary radiative effects*" (pg. 586).

There was no discussion as to why the "large space and time scales" were not needed with CO_2. It is possible that those studies were not conducted because clouds did not fit within their definition of "Climate Change", *i.e.* those caused by man-made activities. **Figure 5** demonstrates that a Cloud Based model can be successfully developed in compliance with the Radiation Laws and the Laws of Thermodynamics.

6. Summary

The Intergovernmental Panel on Climate Change (IPCC) model has been used since 1995 to help predict future world temperatures. But it has limitations, which are discussed in this study. It uses average temperatures to equate an average energy flux. But the temperature under the Stefan-Boltzmann flux calculation is a fourth power operation, while averaging is a first power computation. The model assumes that all energy fluxes remain constant, and the Earth acts like a blackbody when emitting infrared radiation. Neither of those conditions exists. By specifically defining Climate Change as being caused by human activities, the IPCC restricts the range of highly likely causes to only those that can be attributed to humans.

They used a satellite that was directed at the top of a cloud and assumed the data were infrared radiation flux emitted from the Earth's surface. Based on this assumption, they calculated a Greenhouse Gas longwave radiation flux of 155 watts/m^2. Assuming the satellite measured emissions from the tops of clouds, instead of the earth's emissions filtered by the clouds, then the longwave radiation flux would be reduced to 50 watts/m^2.

In the IPCC model, they reported that there were 324 watts/m^2 of infrared back radiation **coming** from the atmosphere and **absorbed** by the Earth. This is more than the radiation absorbed from the sun (168 + 67 = 235) and raises a conflict with the First Law of Thermodynamics. Plus, the atmosphere has a temperature lower than the Earth's surface which indicates a violation of the Second Law of Thermodynamics. The Second Law states that the net heat flux is a vector quantity and travels from hot to cold. In order for it to comply with this law, the average temperature of the atmosphere would have to be 144˚F, which it is not.

The IPCC showed no back heat flow attributed to the latent or sensible heat components. The model only properly showed a net flux vector in the up direction going from hot to cold. They provided no explanation for this inconsistency when applied to radiation.

There were gaps in the satellite data which aligned with various peak absorption bands of Greenhouse Gases. The amount of absorption appeared larger than expected. It is likely that the scattering phenomenon, caused by the Greenhouse Gases absorbing and re-emitting the radiation, produced the gaps.

Based on the analysis of data, we developed an alternate climate model that complied with the known Radiation Laws and the First and Second Laws of Thermodynamics. It was cloud-based. Of the net radiation leaving the Earth (235 watts/m^2), the clouds took up the largest portion, contributing 49.7%. The clouds accounted for an additional 22.5% of the total reflected radiation energy. When these two processes are taken together, then the clouds account for 72.2% of the Earth's thermodynamic system. If outgoing radiation includes water vapor at 9.1%, then the total contribution by atmospheric water accounts for 81.3% of the Earth's total radiation system. The CO_2 contribution was less than 0.04% and too small to have a measurable effect.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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