Total Solar Irradiance, gravity and temperature distribution of Earth, Mars and Venus

Emil Junvik
emil.junvik@gmail.com
2017-06-10

Abstract

The vertical mean temperature distribution and gravity are coupled to the power of total solar irradiance. A simple geometrical modification of the two-dimensional surface of the blackbody combined with a hemispherical solar irradiation is presented as an explanation of surface temperature. Radiative heat transfer is shown to explain effective temperature and troposphere temperature. The difference between the effective temperature of the perfect blackbody and the observed effective temperature, is found to match the energy needed for the force of gravity when expressed in units of thermal resistance, stress and pressure. The power source strength needed for the effective temperature to be radiated from the atmosphere is shown to be equal to a core temperature of 5770K by using the inverse square law. Altogether this combines to a basic framework of energy distribution inside the system of Earth. It is simply an extension to the blackbody model into a more realistic definition with absorption in depth of a volume, which inevitably leads to a fraction of the heat to be turned into work. The equations that is the result of the analysis of the earth system, is the same as those used for a hollow sphere with a charged shell and a conducting ball at the center which is positioned in an electric field. It is a suggestion for a new approach of understanding how solar radiation interacts with the planet. The method is used to analyze temperature distribution on Mars which confirms it as a useful model, although with some differences in the results. Venus, with its deep atmosphere, show similar correlation to spherical volumetric distribution, but all three planets have different relationships to Solar Irradiance. Altogether it is shown in this paper that on a bulk scale energy is what dominate the structure of the three planets independently of mass.

Keywords: earth temperature, heat transfer, solar constant, gravity
1. Introduction

Today we use a model to explain earth mean temperature distribution that is known as the greenhouse effect. It is explained by the IPCC(2007) as a process where heat radiated by the earth surface is retained by absorption in atmospheric gases at a lower temperature than the radiating surface. Fleming(1999) investigated the history of the greenhouse effect with a focus on citations of Joseph Fourier, finding a chain of references displaying a misunderstanding of Fouriers work which concerned the analytical theory of heat. Arrhenius and many others cited an article of Fourier as the first allusion of the greenhouse effect, although that name for the hypothesis was never used. The cited article is shown by Fleming to be a reprint of a descriptive memoir, rather than an article on terrestrial temperatures.

According to Fleming, the effect of Co2 was described with the analogy of windowpanes in a greenhouse up until the mid 20\textsuperscript{th} century when the radiative properties of the gas was investigated more thoroughly.

The greenhouse effect is used as an explanation for the difference between the observed effective temperature and the warmer surface. Instead of using the heat of insolation as the single source of heat for the surface, re-radiation by atmospheric gases of absorbed heat from the surface is added to the heat flux from the sun.

The theory use an average value of insolation distributed over the total surface area of the earth. The problem with using an averaged value in that way, is that it gives a result where the earth is heated at an intensity of 161\,W/m\textsuperscript{2} according to the energy budget presented by Trenberth, Fasullo and Kiehl(2009). This is equal to solar heating at -40C.

Heat and temperature is a question of instantaneous intensity, averaged irradiation per unit surface area over time cannot be used as an equal to instantaneous power from the heat source. Since the earth is in a steady state, the temperature distribution should be used to identify emissive power that is coupled to the intensity of solar irradiation of only half of the planets surface.

Trenberth, Fasullo and Kiehl also show a mean emissive power of 333\,W/m\textsuperscript{2} in the troposphere towards the surface, which is not a possible value for a troposphere at a mean temperature of 255\,Kelvin. Further, they show a different value emitted towards space, 239\,W/m\textsuperscript{2}, which is equal to the effective temperature. It seems like they use the effective temperature as the starting point for analysis, but a more straightforward approach would be to start the analysis by using the solar constant, coupling it to the temperature distribution and calculating emitted intensities using the Stefan-Boltzmann law $\sigma T^4$ to find the internal relationships.

Prevost stated that the emission of a body logically depends on the internal state solely, this is displayed logically in the draper point (J. R. Mahan 2002). From the observation of the fact that all solids glow at the same temperature, 798\,K, the logical conclusion is that the emitted
intensity depends on the temperature of the solid, and it is independent of the mass of the solid. Emission and temperature is an exclusive relationship. They can both be considered as an aspect of the constant flow of heat through matter, where the internal energy and the flow of heat from a body are independently related. Absorption is also exclusively dependent on temperature, which is confirmed by the Stefan-Boltzmann equation for radiative transfer of heat between two bodies of different temperature, \( \sigma(T_1^4 - T_2^4) \). The amount of heat absorbed in the colder body, usually called the transfer of heat, depends on the temperature. The amount absorbed/transferred is not emitted in a steady state out of equilibrium until temperature rise. Emission and absorption should not be viewed as cause and effect. They are related through the internal state, which is measured as temperature of the emitter. The temperature is cause of the emission, and absorption depends on the temperature of the emitter.

Today we have a wealth of information about solar irradiation and terrestial emission from satellite data and surface temperature data. Spectrums of terrestial emission show the quantum properties of atmospherical absorption and emission in detail. We can see how the increase of atmospheric absorption is connected to increase in greenhouse gases, especially Co2, which has a distinct band of absorption in the wavelengths of terrestial emission. In figure 1 we can see how these spectrums clearly show the lack of emission from Co2 in the troposphere, at wavelengths around 15\( \mu m \).

![Figure 1, Troposphere absorption spectrum, CO2 absorption band is seen as decreased intensity of emission around 15\( \mu m \).](image)

The absorption spectrum of the atmosphere explains the quantum actions of atmospheric molecules when heated by terrestial emission. Having functional theories in heat transfer to determine bulk properties of matter like temperature, it seems counter-intuitive to use quantum theory which is usually not used for these processes. The connection between decreasing emissive power in different bands by atmospheric gas molecules, and increasing emissive power of the surface, is not explained in a straightforward way. The independent relationship between emission and the internal state stand in contradiction to the greenhouse model, where emissive power of the surface is explained with the external atmosphere.
The common model of the blackbody use even irradiation from all directions of the surroundings to find the emission according to the inverse square law. The blackbody relate to the inverse square law as a point source of energy at the center of a body emit energy that decline to an intensity of $1/4$ into a surrounding spherical volume. In the case of the the blackbody surrounded by a heat bath of light, irradiation from all directions is equal to the emission at the surface from a heat source at the center of the body. The blackbody is isothermal, it has the same temperature throughout the whole volume. The infinitely thin, perfectly black surface absorb and emit all energy from two dimensions, defined as the density of surface flux, into the surroundings. Emission and absorption happen at the exact same radius. This is different in many ways from a planet with an atmosphere irradiated by a star at a distance in the infinite heat sink in the vacuum of space at ~3K. In addition earth is being heated at only half the surface area, absorbing in depth of a volume with several shells/layers of different temperatures, emitting to the surroundings in all directions. The blackbody model of absorption and emission needs to be corrected according to observed differences to couple the Earth temperature distribution to irradiation from the sun.

Bejan (2005) propose an approach to analyzing the climate system using the constructal law that can be applied to thermodynamic flows of energy. In the theory flows evolves into maximum dissipation of the power from the heat source over time in a non-equilibrium state. The constructional theory says that flow under natural conditions will do work on matter towards optimized flow efficiency. In the ideal case, the heat flow in the geometrical configuration of concentrical shells is only restricted by volume and geometry. Using only geometry represent the optimized heat flow. The results from using an optimized model used for heat flow seems to match reality with high accuracy. This optimized flow is a bit tricky to understand, or at least the reasons for it to be the configuration of reality on Earth. An explanation which would make sense is to view temperature distribution and gravity as expressions of a charged system. With charges at the outer shell (ionization) and a potential in gravity at the surface, such optimization of flowing energy would be the only possible state.

Using the average value of the solar constant as heat source power, we can easily find what the minimum necessary intensity of heat would have to be with minimum constrictions. The addition from internal generation of heat is only at an average fraction of 90$mW/m^2$ (Davies & Davies, 2010), which means that the sun has to account for all heat. What is emitted from the whole surface area of the solid sphere must be balanced by twice that amount in the instantaneous power, because half the surface area gets heated by insolation but the whole surface dissipates the heat at any given point in time. Both insolation and outgoing long wave terrestrial radiation flows at the rate of radiative heat transfer. When temperature distribution in the earth system is compared to the ideal case, earth behaves as a perfect blackbody with optimized flow in a finite volume, with the difference being caused by irradiation from the heat source on only one side.

This framework was used to investigate the energy distribution in the Earth System by using observed mean values of temperature and flux densities, and resulted in a modified version of the blackbody model for a non-equilibrium state. Temperature indicate relationships between potentials and the power of the flow is determined by the differences in temperature, although the flow of energy between potentials may be in form of work or heat, or a combination of both. Using observed mean temperatures and the inevitable emission that results from those energy densities, I suggest a way to define the relationship between the earth’s temperature distribution and solar irradiation.
2.1 The modified blackbody model of earth

We start by taking a look at the differences between the two-dimensional spherical surface of the absorbing and emitting blackbody, and the three-dimensional volume of Earth absorbing solar radiation.

To find the emitted intensity of the surface of the inner spherical shell, we need to account for absorption over $2\pi r^2$ from the received intensity from solar irradiation, TSI, over the disc that is the shadow of earth, $\pi r^2$.

Then we need to account for absorption in depth in a volume of $4/3\pi^3$ within the system. Two shells of concentric volumes need to be accounted for. Atmosphere and solid earth, which gives:

$$\frac{1}{2} TSI / \left(\frac{4}{3}\right)^2 = 382.78 W/m^2$$

Which is equal to a surface temperature of 286.6 Kelvin. This is very close to the average temperature given in the literature, which often is said to be 287-288K.

When the surface emission has been found, we can use the Stefan-Boltzmann equation for radiative heat transfer from the solar constant to the surface:

$$TSI - \left(\frac{1}{2} TSI / \left(\frac{4}{3}\right)^2\right) = 978.22 W/m^2$$

The transferred heat from the solar constant must follow the same laws as the emitted radiation, so with the inverse square law we find:

$$1/4(TSI - \left(\frac{1}{2} TSI / \left(\frac{4}{3}\right)^2\right)) = 244.6 W/m^2$$

Which gives us the effective temperature of 256.3 Kelvin.

If we use radiative heat transfer for the emissive power of the surface and the effective temperature:

$$\sigma(286.6^4 - 256.3^4) = 137.88 W/m^2$$

Which is equal to a tropopause temperature of 222K. Although this is acceptable accuracy, Cheng(1974) show experimental confirmation that ideal conditions give the result $\frac{\sigma T^4}{\pi}$ for black walls in concentric spheres. When used for the surface and tropopause we find an even better match:

$$\frac{\sigma T^4}{\pi} = 122 W/m^2, 215K$$
The first transformation of solar radiation through the volume of the outer shell, using the value of TSI, gives a result close to the value of direct irradiation at zenith on the surface (https://www.newport.com/t/introduction-to-solar-radiation):

\[ TSI/(4/3) = 1020.75 W/m^2 \]

And using the solar constant and the effective temperature for radiative heat transfer to the system gives a good match to the equatorial total solar irradiation observed in Botswana, (Luhanga, 1997):

\[ TSI - \sigma T_{\text{effective}}^4 = 1116 W/m^2 \]

Both are logical results, as the transformation through the outer shell gives a value that should represent what arrives at the surface from the bottom of the volume of the atmosphere, and the heat transfer to the troposphere should include both what is scattered, absorbed and thermalized in that volume, which is combined into total heat that arrives at the surface.

We now have a main structure of the system determined by only small modifications of the blackbody model, heat transfer and the inverse square law.

I also want to direct attention to the difference between the emitted effective temperature, and the true blackbody temperature of a perfect absorber and emitter of the solar constant.

If we use the solar constant to find the effective temperature that should be emitted from a perfect blackbody, we get:

\[ TSI/4 = 340.25 W/m^2 \]

The difference to observed effective temperature is:

\[ (TSI/4) - \sigma T_{\text{effective}}^4 = 95.7 W/m^2 \]

If I use this in a simple formulation of the first law of thermodynamics, \( \Delta U = Q - W \), gravity (g) can be expressed as work (W), and fits the value of gravity at the equator when using units for stress/pressure/thermal resistance. It is an exact match to the surface acceleration according to the Earth Fact sheet presented by NASA.

Consider gravity a force that acts in a point at the center of mass in a parcel of air, that has a surface area of 1m², and the mass of 1kg, laying statically above the surface of Earth. The force acting in the point at the center of mass in that parcel of air is:

\[ \sqrt{(TSI/4) - \sigma T_{\text{effective}}^4} = 9.78 W/m \text{ or } 9.78 m/s \]

If we use units of \( Nm^2 \) the force acting on the surface of the parcel is:

\[ (TSI/4) - \sigma T_{\text{effective}}^4 = 95.7 W/m^2 \]
The power of the source needed to raise the force radiated into the surroundings of the source according to the inverse square law is:

\[ 4\left(\frac{TSI}{4} - \sigma T_{\text{effective}}^4\right) = 382.8\, W/m^2 \]

And then we also find:

\[ TSI/\left(\frac{4}{3}\right)^2 = \sigma T_{\text{surface}}^4 + \sigma T_{\text{effective}}^4 + \sigma T_{\text{tropopause}}^4 = 8g^2 \]

Since this energy is radiated to the surroundings as \(1/4\pi r^2\), the internal source power in number of g:s generated by heat from the sun is \(32g^2\).

The source strength matches the surface emission of heat in the model. The difference between the true blackbody intensity of earth, and the missing heat in the emitted effective temperature is found to be equal to the force of gravity and the emissive power of the surface. This way all energy flowing in the system can be defined as heat using the same units throughout, \(W/m^2\), to account for total energy.

The acceleration towards the highest temperature in a point at the center of mass by the force of gravity, acts as thermal resistance exactly balancing the expanding force of heat. The work done as expansion of mass towards the vacuum is overcome by the resistance of gravity. This happens where the force of gravity equals the power of emission. The average intensity where the heat flow disconnect from the convection of fluid, is logically where heat emission is equal to the observed thermal resistance \(g^2 = 96\, W/m^2\). This explains the difference in emission to irradiation and fulfills the conditions for the term work in the first law. Observed from the outside, all energy in solar heat is accounted for in emission using the most fundamental principles of thermodynamics.

The tropopause emissive power of \(139\, W/m^2\) is a little higher than the mean temperature given in the literature, which is closer to \(125\, W/m^2\).

Notice that

\[ \sigma T_{\text{surface}}^4 = 3\sigma T_{\text{tropopause}}^4 \]

and

\[ \frac{(\sigma T_{\text{surface}}^4)}{4} = \frac{\sigma T_{\text{tropopause}}^4}{\frac{4}{3}} \]

In line with the divergence theorem we can see that the volume element is the sum of all sources for gravity, it accounts for the surface flux and the integrated volume that is the source power defined as Gauss gravity.

\[ \frac{1}{2} (TSI/(4/3)) = \frac{4}{3} \sigma T_{\text{surface}}^4 = 4g^2 + \frac{4}{3}g^2 \]

So for a negative gravity potential
\[ TSI = \frac{4}{3} \left( \sigma T^4_{\text{surface}} + \sigma T^4_{\text{tropopause}} - 4g^2 - \frac{4}{3}g^2 \right) = 0 \]

Gauss law of gravity use surface flux and volume integration for the corresponding density of the source. It is an approach where the volume must contain the sum of sources, and it has to be simultaneously equal to the vector field which is the result of surface flux. This is the same perspective as I use for the whole model.

The constrictions of the spherical volume is relative to the internal state represented in observed temperatures in the atmosphere. This is in contrast to inverse square law which results in surface excitance. The relationship where emission is dependent on the internal state is confirmed.

The equations are the same as for an electric field inside a sphere, \( \frac{Q}{Q} = \frac{4/3}{4/3} \). The behavior is identical as the surface creates a negative thermal charge surrounded by a gaussian surface between the inner sphere and outer shell, which is represented in the effective temperature radiation. The relations between energy densities between the volume and the shell surrounding it follows that of a charged hollow sphere. The internal field is determined by volume and the surface fluxes are given by \( 4\pi r^2 \) (fig.2).

Fig2, relationships between surface flux and the volume beneath the surface

Continuing this line of thought, using only observed heat flows, I propose a coupling to the internal temperature of earth. We start by considering that the emitted effective temperature needs a source strength according to the inverse square law at an intensity of:

\[ 4\sigma 256.3^4 = 978.22 W/m^2 \]

As shown in figure 2, using a total of 8 surfaces and volumes, 4 main layers counting from the core surface, the inverse square law transformation seems to be a way to find a coupling to the atmosphere and solar constant.

The earth core surface temperature, assumed to be about 6000K, can be coupled to the effective temperature and the solar constant through the inverse square law:

\[ TSI - \left( \frac{1}{2} TSI / \left( \frac{4\pi}{3} \right)^2 \right) = 4\sigma 256.3^4 = \sigma 5798^4 / 4^8 \]
Considering what the result is when using the commonly used effective temperature, 255 Kelvin, there seems to be a possible connection to the observed surface temperature, or effective temperature, of the sun:

\[ 4\sigma 255^4 = \sigma 5769.99^4 / 4^8 \]

When using the effective temperature given in the NASA fact sheet for bulk properties of Earth, 254 Kelvin:

\[ 4\sigma 254^4 = \sigma 5747^4 / 4^8 \]

Here follows a collection of some internal relationships found in the model:

\[ TSI = 1361W/m^2 \]

\[ I(\text{direct irradiance surface}) = TSI / (4/3) \]

\[ \sigma T_{\text{surface}}^4 = 1/2(TSI / \left( \frac{4}{3} \right)^2) \]

**effective temperature** = \( TSI / 4 \)

\[ Q(\text{observed effective temperature}) = \frac{TSI - \sigma T_{\text{surface}}^4}{4} \]

\[ TSI - \sigma T_{\text{surface}}^4 = 4\sigma T_{\text{effective}}^4 = \sigma T_{\text{core}}^4 / 4^8 \]

\[ Q(\text{tropopause temperature}) = \sigma T_{\text{surface}}^4 - \sigma T_{\text{effective}}^4 \]

\[ Q(\text{earth system}) = TSI - \sigma T_{\text{effective}}^4 \]
\[ TSI \left( \frac{4}{3} \right)^2 = 2\sigma T_{\text{surface}}^4 \]

\[ \sigma T_{\text{surface}}^4 = \sigma T_{\text{effective}}^4 + \sigma T_{\text{tropopause}}^4 \]

\[ TSI \left( \frac{4}{3} \right)^2 = \sigma T_{\text{surface}}^4 + \sigma T_{\text{effective}}^4 + \sigma T_{\text{tropopause}}^4 = 8g^2 \]

If using the tropopause temperature 218K:

\[ \sigma T_{\text{surface}}^4 = 3\sigma T_{\text{tropopause}}^4 \]

\[ \frac{\sigma T_{\text{surface}}^4}{4} = \frac{T_{\text{tropopause}}^4}{\frac{4}{3}} \]

\[ E(TSI) = \frac{4}{3} (\sigma T_{\text{surface}}^4 + T_{\text{tropopause}}^4) + 4g^2 + \frac{4}{3}g^2 \]

\[ g(\text{center of mass}) = \sqrt{(TSI/4) - \sigma T_{\text{effective}}^4} \]

\[ g(\text{force acting on surface}) = (TSI/4) - \sigma T_{\text{effective}}^4 \]

\[ g(\text{source strength}) = 4((TSI/4) - \sigma T_{\text{effective}}^4) \]

2.2 The modified blackbody model of Mars

It not that easy to find conclusive data on Mars temperature distribution as for earth, but insolation is given by NASA fact sheet for Mars, which should be reliable. A common value for surface mean temperature is 218K. According to [www.atmos.washington.edu](http://www.atmos.washington.edu) the observed effective temperature is 212K. The website gives a slightly higher value of insolation than NASA. Since the solar constant for earth has been corrected from \(~1370\, W/m^2\) to \(1360.8\, W/m^2\) not that long ago, I will use the lower value given by NASA. NASAs fact sheet for Mars gives a “blackbody temperature” of 210K, which in this case is used instead of “effective temperature”. The real blackbody temperature, though, would be 225K, since a blackbody absorbs and emit all radiation from the heat source.

TSI: \(586\, W/m^2\)

Surface temperature: 218K, \(128\, W/m^2\)

Effective Temperature: 225K, \(146.5\, W/m^2\)
Observed Effective Temperature: 212K, 114.5W/m² (210K, NASA)

To find effective temperature I use the same method as in chapter 2.1. Using radiative heat transfer and the inverse square law:

\[
\frac{TSI - \sigma T^4_{surface}}{4} = \sigma T^4_{effective}
\]

From that we find that effective temperature should be 212K which is equal to 114.5W/m².

When I try to find a way to connect gravity to the heat flow by using the difference between the true blackbody temperature and the observed effective temperature (212K), it does not show the same relationship as on earth:

\[(TSI/4) - \sigma T^4_{effective} = 32W/m²\]

This equation used for earth produced the force of gravity in units of thermal resistance, which had a source power equal to the emissive power of the surface. The square root of 32W/m² should then be equal to Mars surface acceleration, but that is not the case here. Using the inverse square law to follow the same procedure as for earth:

\[4((TSI/4) - \sigma T^4_{effective}) = \sigma T^4_{surface}\]

We can see that it results in the surface emissive power from the difference between true effective blackbody temperature, and the observed effective planetary temperature.

Gravity at Mars surface according to the NASA fact sheet is 3.71 m/s and surface acceleration is 3.69 m/s. Using heat transfer from the surface, we can see that:

\[\sigma(T^4_{surface} - T^4_{effective}) = g^2\]

The transfer equation gives \(g = 3.6778\), which is very close to the value of surface acceleration.

This can be used as the first law \(\Delta U = Q - W\) for the interaction between the surface and atmosphere:

\[\sigma T^4_{effective} = \sigma T^4_{surface} - g^2\]

When using the geometric approach for optimized flow through non-interacting shells in a spherical cavity, I found that Mars can’t be treated the same way as earth. There seems to be a difference in atmospheric composition that indicate that Mars atmosphere can’t be treated as a shell surrounding the solid sphere.

But the method seems to be useful in another way. Using a single shell for absorption gives the source power of the blackbody temperature given by NASA. When emitted from the solid sphere into the surroundings:

\[1/4 * (TSI/(4/3)) = 8g^2 = 109.8W/m² = 209.8K\]
This way the geometric albedo is included and the inverse square law gives the mean temperature. As you can see I did not compensate for hemispherical irradiation from the sun to find the mean temperature. If included:

$$1/8 \times (TSI/(4/3)) = 4g^2$$

The relationship of the sphere’s volume to gravity is confirmed:

$$TSI/(4/3) = 32g^2$$

We can see a difference to earth in that all solar energy accounted for in number of g:s is contained inside the solid sphere on mars, while on earth it is distributed throughout the solid and the atmosphere.

2.3 The modified blackbody model of Venus

TSI: 2601W/m²

Surface Temperature at pressure 92.1 atm: 740K

Temperature at pressure 1.066atm: 348K

Temperature at pressure 0.53atm: 300K

On Venus the surface has a very high temperature which can not be explained by direct heat from the sun since very little sunlight reach all the way down. There are three layers above the troposphere, using them for transformation through spherical concentric volumes gives:

$$TSI/(4\times(4/3)^3) = 1097W/m^2$$

By using the inverse square law, this is equal to a source power equal to surface temperature in the relationship:

$$4^2(TSI/(4\times(4/3)^3)) = 17552W/m^2 = 745K$$

As we can see, to find the surface temperature we need to treat the troposphere as a solid surface with an addition of another internal solid shell. The very high density of the gases, which is mostly carbon dioxide, might explain this.
The difference between the emissive power of the perfect blackbody and the emissive power of Venus effective temperature is:

\[(TSI/4) - \sigma T_{\text{effective}}^4 = 500 W/m^2\]

So, on Venus we find a relationship:

\[TSI - (TSI/4) = TSI/(4/3)\]

The emissive power of a perfectly black spherical volume absorbing the power of Venus Total Solar Irradiance, in depth, is equal to a sphere with the emissive power of Venus. The stratification in the deep atmosphere of Venus complicates further analysis, but some relationships can be found.

When trying to find the relationship to gravity/surface acceleration, it is not as straightforward as on Earth and Mars, but there is a correlation to hemispherical irradiation and a point source in the inverse square law:

\[\sqrt{1/2(TSI/4^2)} = \sim g = 9.015 W/m\]

Which gives:

\[TSI = 32g^2\]

Using the value of g given by NASA:

\[TSI = 32g^2 + g^2 = 2596 W/m^2\]

It is not the same accuracy as we see on Mars and Earth, but still shows the correlation between heat, gravity and emissive power in the volume.

2. Conclusions & Discussion

The Earth is in a steady state and the supply of energy is constant and limited with the surface being in equilibrium with the internal heat of the solid earth. This allows the distribution of energy above surface to easily be coupled to the solar constant and also determine the internal relationships in the atmosphere using observed average temperatures.

The whole system needs to be balanced internally between the different parts, as well as to absorbed heat from the sun and emitted intensity of terrestrial radiation instantaneously, to not experience rapid overheating or cooling.

The initial approach was to find what the temperatures would have to be in a non-interacting spherical structure, and those temperatures was found to be in line with averaged values from observations. I consider it as a ground state. Since energy is supplied at a somewhat constant rate by insolation and the model use average values, there is no need to account for the rotation of earth. All fluxes and temperatures are averages over time, day and night as well as the precession of earth in orbit, so they can readily be used to find internal relationships. The result is a non-rotating sphere with two shells, statically irradiated with constant, limited flow
of energy as heat, at a fixed location and distance from the heat source while being submerged in an infinite heat sink. The results imply that this optimized average flow in itself, is the cause for a fraction of heat to transform into a force, gravity.

Temperature has been shown since the birth of thermodynamics to be independently connected to emitted intensity. This relationship is central to this model and it gives a good match in a rough framework, especially for earth, accounting for total energy including the energy needed for the force of gravity. It indicates that energy, or heat, is the organizer of matter rather than the opposite.

These extreme simplifications into idealized conditions in the steady state, is based on the minimalistic relationships in optimization of a heat engine. The radiation entering from vacuum is related to the volume emitting to vacuum, but it can’t be considered as a cause of emission. The constructal law and the calculations made here, supports an approach where a new focus on old physics could produce answers to long standing questions. The fact that Earth can be defined as an externally heated engine with a point source at the center of a glowing mass, is the most reasonable and conservative assumption possible, because that is what we observe. From the analysis according to basic thermodynamic principles, the result was an obvious analogy of the heat engine, which leaves no other option but to include gravity as work.

The relationship between the sun and earth in terms of heat transfer raise a question about the greenhouse model and predictions of climate change. Considering the Stefan-Boltzmann equation for heat transfer between radiating bodies, the rate of transfer depends on the difference in temperature and the circumstances are what could be viewed as ideal.

How could then temperature data sets generate trends from anomalies showing increasing temperature without increasing intensity of solar irradiation?

Albedo, which refers mostly to the receptors of the human eye rather than properties of thermal radiation, might better be viewed as caused by temperature rather than being a cause of temperature. In this model insolation is reduced by 25% as a form of geometrical albedo when solar heat is absorbed in depth of the atmospheric spherical layer. The limitations arising in geometry seems to be a much more logical explanation of observations. The relation between physical reality and albedo is unclear, since albedo is a property of the whole surface, but reflection of irradiation is hemispherical.

The earth surface is in equilibrium with the absorbed solar energy into the solid sphere of earth. This is confirmed by the average addition to terrestrial surface emission from internally generated heat of only 90mW/m²(Davies, 2010). Almost all energy above surface is then considered to be solar energy, which is a large simplification. The model uses a conservative approach based on the observation that the only energy flowing through the system and the surrounding space, is solar heat/radiation. The model makes no assumptions of hidden or unknown sources of energy, not even for the force of gravity. It accounts for all energy and work in terms of heat emission based on temperature distribution.

The model is very simple, and the connection to core temperature is a bit of a stretch considering my low level of knowledge about the internal dynamics. But considering how
easily it fits with observation just by using these simple methods and the use of thermodynamic laws in combination with equations for electric fields, which together behaves as a simple heat engine according to the first law of thermodynamics, it gains some credibility. The fact that the equations are exactly the same as for the charged sphere, also raise the question about earth´s electric nature and the relationship to the sun.

In the chapter about the application to Mars, we can see that the approach is functional on other planets. Data on Mars planetary properties is not so vast and easily available as for earth, therefore I leave it as a less detailed model. Nevertheless, it shows that the main principles works beyond earth.

On Mars, the force of gravity is included in the heat flow as well, and it confirms that it is correct to include it as an important part of planetary heat flow. If gravity is considered as work in a thermodynamic system, on Mars we see that the work of gravity is the difference between surface temperature and effective temperature. Both on Earth and Mars there is a clear connection between the spherical cavity and gravity. This is confirmed in the analysis of Venus, although there seems to be a more complex stratification involved in the large atmospheric volume. We can see that on Mars there is barely enough heat to produce gravity that can sustain a steady atmosphere, while Venus has a massive inflation in a big volume with high pressure.

The modification of the blackbody model for temperature distribution makes such a good match that I consider it to solve the problem of earth´s surface temperature in a satisfactory manner. The accuracy raises the question about the validity of the greenhouse model.

In the greenhouse model the surface temperature is claimed to increase from absorption in atmospheric gases. But how that can be caused by the initial change, where increasing greenhouse gases show decreasing emission which in turn is inevitably coupled to decreasing temperature, is not very clear. To use a simple analogy of the problem in that explanation, it would compare to increasing the temperature of a running engine by cooling the exhaust.

Further analysis of other planets and the internal relationships within the solar system should be of interest, confirming or refuting this approach to temperature and/or gravity. It seems unlikely that the relationships shown in this paper is a coincidence, although it probably is necessary to adapt the model to local differences. Although my level of knowledge about the nature of black holes and other cosmological problems is low, I suspect it could be useful there as well.

As a very rough and basic framework, the model mainly serves as a tool for increasing understanding of heat in a planetary system, but increasing the resolution of the model according to observed distribution at different latitudes and the connected altitude distribution at those latitudes, as well as diurnal oscillation, could make it more useful for realistic, real-time predictions globally.
4. References

P. Cheng, S. S. Dua 1974, Exact solutions for multi-dimensional radiative transfer in non-isothermal spherical media


Web references


http://www.cgd.ucar.edu/staff/trenbert/trenberth.papers/BAMSmarTrenberth.pdf (last checked 20170518)

http://www.solid-earth.net/1/5/2010/, doi:10.5194/se-1-5-2010 (last checked 20170518)

https://www.newport.com/t/introduction-to-solar-radiation (last checked 20170605)

https://nssdc.gsfc.nasa.gov/planetary/factsheet/earthfact.html(last checked 20170518)