

Hot Spots vs. Green House Gases - Contribution to Global Warming – New Theory and Index  
Alec. Feinberg, DfRSoft

Abstract

*In this paper we provide a simple thermodynamic proof that manmade Hot Spot heat generation would also create global warming even if CO<sub>2</sub> emissions were at normal levels. We introduce the concept of global warming industrial revolution equilibrium heat index to establish this proof. We define manmade hot spot emission as unnatural heat emission produced by man that would not have occurred prior to the industrial revolution. The CO<sub>2</sub> theory of global warming, while central to the issue as a huge part of the problem, has created a diversion to this other likely major contributor, namely hot spots contribution to global warming. It is obvious that there is a major focus on CO<sub>2</sub> emissions and absolutely no focus on hot spot reduction in terms of solving the global warming crisis. This paper will hopefully provide motivation for the mitigation of hot spot creation. Knowledge of the root causes of the global warming problem is important to addressing the problem properly.*

**1. Introduction**

We introduce the concepts of hot spots defined as *manmade emission of excessive unnatural heat emission produced by man that would not have occurred prior to the industrial revolution*. We exemplify hot spots further in Section 3 and provide a quantitative example in Section 2. First we will provide the general proof that without CO<sub>2</sub> increase, we would still have some global warming. It is not unreasonable to assume that other authors have shown concern related to heat generation contributing to global warming. However, we address this problem with a different approach to shed insight. Furthermore, while other authors may have shown concern, no actual work is taking place to mitigate or try to calculate this issue properly to judge its significance.

**1.1 Global Warming Industrial Revolution Equilibrium Heat Index**

In order to provide this proof, we first define the global warming industrial revolution equilibrium heat index  $I_{IR-G}$  as

$$I_{IR-G} = \left( \frac{dS_{generated} / dt}{dS_{released} / dt} \right)_C \quad (1)$$

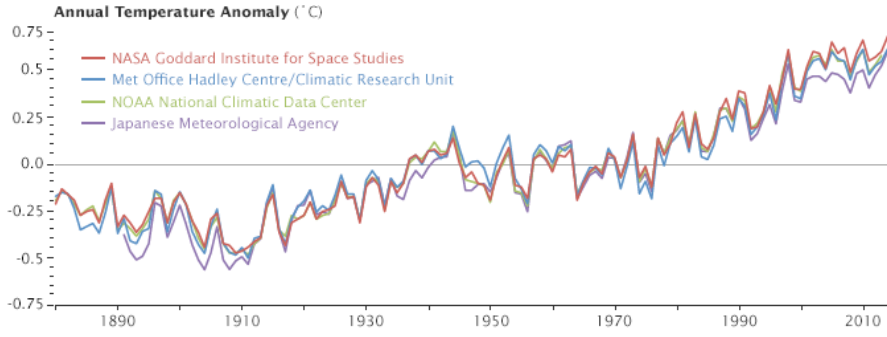
This differs from the Earth's energy budget as the index will be normalized to the industrial revolution. That is, rather than look at the Earth's total energy budget, we look at what is different between the start of the industrial revolution to present day. To do this we enclose the Earth and its atmosphere denoted by C above, then  $S_{generated}$  is the entropy generated inside of C while  $S_{released}$  is the entropy released out of C both taken per unit time in the above equation.

*For those readers not comfortable with entropy variable, one may substitute heat Q to replace S which will provide the same intuition.*

We now normalize the index  $I_{IR-G}$  as follows

$$I_{IR-G} = \begin{cases} 1 & \text{for } t \approx IR \\ > 1 & \text{for } t \geq IR \end{cases} \quad (2)$$

where  $t=IR$  indicates the time t which is the start of the Industrial Revolution (IR). For example, during the ice age,  $I_{IR-G} \ll 1$ . Emission of CO<sub>2</sub> from volcanoes for example created CO<sub>2</sub> friendly atmosphere warming the Earth. Around the time of the industrial revolution, the Earth temperature was about 0.8C cooler than present day 2019. The figure below shows global warming trends since  $t=IR$ .



**Figure 1** Global temperature increase since  $t=IR$

### 1.2 Entropy Change at $t=IR$

For  $t=IR$  we assume that  $S_{generated}$  is only due to solar heating of the Earth, all other entropy contribution enclosed by C are taken to be zero so that entropy generated is totally due to solar heating

$$S_{generated} = S_{solar} \quad (3)$$

Since  $I_{IR-G} = 1$  then we must have

$$dS_{generated} / dt = dS_{released} / dt \quad (4)$$

Therefore

$$dS_{generated} = dS_{released} \quad (5)$$

Because of natural levels of  $CO_2$  at  $t=IR$ , some entropy is of course unreleased, we model  $S_{generated}$  as

$$S_{generated} = (S_{released})_{Out\ of\ C} + (S_{Unreleased})_C \quad (6)$$

Here, the unreleased entropy is the entropy of the system enclosed by C (Earth plus atmosphere). By Equation 4 then

$$\frac{d(S_{Unreleased})_C}{dt} = 0 \quad or \quad (S_{Unreleased})_C = Constant \quad for \ t=IR \quad (7)$$

That is the relative amount of entropy enclosed by C at  $t=IR$  is relatively constant. At this point, we make the assumption that this unreleased entropy is due to normal levels of  $CO_2$  at  $t=IR$ , the start of the industrial revolution.

### 1.2 Entropy Change for $t > IR$

After the industrial revolution started at present day we have

$$\frac{d(S_{Unreleased})_C}{dt} = \left( \frac{dS_{CO_2+}}{dt} + \frac{dS_{Hot\ Spots}}{dt} \right) \quad for \ t > IR \quad (8)$$

where

$$d(S_{Unreleased}) = \begin{cases} dS_{CO_2+} & Entropy\ Increase\ due\ to\ new\ CO_2\ increase\ t > IR \\ dS_{Hot\ Spot} & Entropy\ Increase\ due\ to\ fraction\ of\ heat\ not\ escaping\ C \end{cases} \quad (9)$$

This represents only the change in entropy. For example, a hot spot will emit radiation, some fraction of the radiation will increase the entropy enclosed by C and most of the heat radiated will escape the Earth's atmosphere (see Example below). We are only concerned with the fraction of hot spot heat amount that does not escape. Thus we are not saying that all heat generated by hot spots creates global warming, it is only a fraction that does not escape the Earth's atmosphere and is reflected back that contributes to C added entropy since  $t > IR$  at present day (see quantitative fuel example 2.1 below). Then the IR Global index change is

$$I_{IR-G} = \left( \frac{dS_{generated} / dt}{dS_{released} / dt} \right)_C = \left( \frac{dS_{released} / dt + dS_{unreleased} / dt}{dS_{released} / dt} \right)_C = \left( 1 + \frac{\frac{dS_{CO2+}}{dt} + \frac{dS_{Hot Spots}}{dt}}{dS_{released} / dt} \right)_C > 1 \quad (10)$$

We see that even if  $\frac{dS_{CO2+}}{dt} = 0$ , we still would have  $I_{IR-G}$  greater than 1. This means that global warming would occur even if CO<sub>2</sub> levels were not increased. Although this seems like an obvious statement, the index and thermodynamics is important in helping realize the enormous problems occurring every day.

**2. Which is greater,  $dS_{CO2+}$  or  $dS_{Hot Spots}$**

What has caused this entropy increase to C creating this small but important rise of 0.8C since t=IR present day is the question. The end result shown in Figure 1 as a 0.8C rise in global temperature. This rise in entropy since t=IR, is it due to primarily to  $dS_{CO2+}$  or  $dS_{Hot Spots}$ , or something else. In terms of manmade Global warming we should not ignore either contribution

$$d(S_{Unreleased})_C = (dS_{CO2+})_C + (dS_{Hot Spots})_C \quad (11)$$

Currently, there is little effort to reduce Hot Spot creation (such as electric cars, better albeto construction etc in road work and building). It is as if we assume that all the Hot Spot creation escapes C (the Earth and its atmosphere). This is likely an enormous error in judgment. In fact, what if

$$(dS_{Hot Spots})_C > (dS_{CO2+})_C \quad (12)$$

We see that there is no formal assessment of this question, and perhaps the problem is too enormous to tackle. We provide a basic perhaps insightful example.

**2.1 Example of C Heating due to Hot Spot Gasoline Use in USA:**

*How many joules of heat is generated and anticipated to be captured by C from US heat emissions of aircraft and automobiles per day?*

*This is an example of how such an estimate would be calculated and is by no means a definitive answer.*

*The USA consumes 390 Million gallons gas per day and 186 million gallons of aviation gasoline. According to estimates there is 120 Million Joules in a gallon of gas. Let's assume 70% of this goes into heat (roughly the automotive efficiency and assume the same for aircraft) and the rest goes into work. Thus the heat generated per day in the US is*

$$\text{Hot Spot Heating Due to Cars and Planes in US} = 0.7 \times 120E6 \text{ Joules/Gallon} \times (390E6 + 186E6) \text{ gallons} \\ = 4.84E16 \text{ Joules per day}$$

*Now we need to make an assumption, we will assume that 99.5% escapes C*

*Hot Spot Heating Due to Cars and Planes is then US=2.4E14 joules captured by C due to hot spots trapped by green house gases. That is*

$$(dQ_{Hot Spots})_C = 2.4E14 \text{ Joules per day}$$

*The Hot Spot entropy increase per day due to fuel in the USA is*

$$(dS_{Hot Spots})_C = 2.4E14J / 300K = 8E11J / K \text{ per day}$$

*We assumed 99.5% escapes the Earth atmosphere this is a total guess. Nevertheless it is unrealistic to assume that it all escapes. That is Green house gases get excited by any heat not just solar infrared emission. Then it is re-radiated some back to Earth. Now one 100 Watt light bulb is 100Wx3600sec\*24 Hrs=8.6E6 joules per day. Then this Hot Spot emission form USA fuel is about the heat generated by 28 Million, 100 watt light bulbs all creating C heating per day.*

*It is difficult to know the contribution this created to Global warming as this calculation is in error and is provided only as an example.*

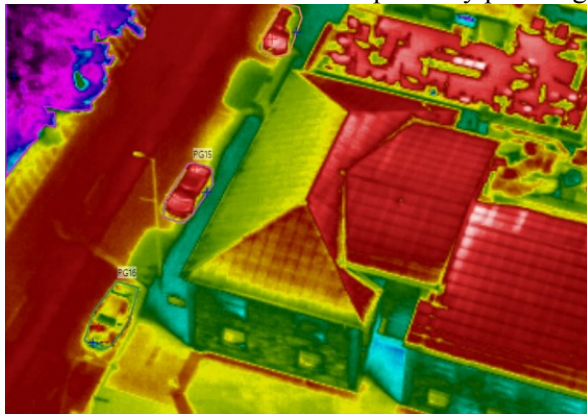
**3. Examples of Hot Spots**

We have defined hot spots as manmade emission of excessive unnatural heat emission produced by man that would not have occurred prior to the industrial revolution. Table 1 is an incomplete list that further defines hot spots example items.

*Table 1 Some Key Examples of Hot Spots*

<b>Hot Spot Example</b>	<b>Comment</b>
Burning Fossil Fuels	Due to Emission of Heat
Burning Coal Fuel	Due to Emission of Heat
Explosion (Bombs)	Due to Emission of Heat
Nuclear Power	Due to Emission of Heat
Engines (Cars)	390 Million gallons gas per day in the USA
Aviation	186 million gallons of aviation gasoline in USA
Roads – Conversion Solar to heat Roof Tops	Black pavement black Roofs, both have very low Albedo compared to no roads and no roof tops. We take the difference from $t > IR$ . Here we need to subtract out what would occur if we had no roads & roof tops just Earth absorption.
Buildings – Conversion Solar to heat and Air condition Use	Again a decrease in Albedo from $t > IR$ . Here we need to subtract out what would occur if we had building. Then we need to add the effect of energy heat emitted from air conditioner use.

We see there had been no attempt in city planning to reduce hot spot emissions.



**Figure 1** Thermal image showing a Hot Spot emission from black roof tops and roads

Roads all over the world are covering the Earth with Asphalt, having very low albedo creating hot spot emissions.



**Figure 2** The increase of Black asphalt roads all over the world. Here displayed in the U.S. New pavement is getting blacker today with lower albedo.

**Biography**

**Alec Feinberg** is the founder of DfRSoft. He has a Ph.D. in Physics and is the principal author of the books, Design for Reliability and Thermodynamic Degradation Science: Physics of Failure, Accelerated Testing, Fatigue, and Reliability Applications. DfRSoft provides consulting in reliability and shock and vibration, training classes and DfRSoftware. Please contact us if you need help. Alec has provided reliability engineering services in diverse industries (AT&T Bell Labs, Tyco Electronics, HP, NASA, etc) for over 35 years in aerospace, automotive and electrical and mechanical systems. He has provided training classes in Design for Reliability & Quality, Shock and Vibration, HALT and ESD. Alec has presented numerous technical papers and won the 2003 RAMS best tutorial award for the topic, “Thermodynamic Reliability Engineering.”