THE VENUSIAN ATMOSPHERE AND ITS CONTRIBUTION TO THAT PLANET'S "RUNAWAY" GLOBAL WARMING

BY JULES KALBFELD

PART 1
INTRODUCTION

The planet Venus has entered the carbon dioxide (CO_2)/ global warming discussion because its atmosphere is 96.5% (965,000 ppm.) CO_2 and its surface temperature is higher than that of Mercury which is closer to the Sun. Since radiant energy varies inversely as the square of the distance (S) traveled from its source ($E \sim 1/S^2$) and Mercury's distance from the Sun is about 1/2 that of Venus, Mercury should be exposed to 4 times the Solar energy that Venus is and should experience markedly higher surface temperatures than Venus. Venus is also about 2/3 the distance from the Sun as the Earth is. Using that same relationship "$E \sim 1/S^2$", the surface temperature of Venus would be expected to be about 2.25 times that of the Earth. However, the average temperature of Venus' surface is actually about 20 times that of the Earth's surface.

$E = 1/S^2$

For Venus/Mercury $E = 1/(1/2)^2 = 1/(1/4) = 4/1 = 4$

For Earth/ Venus $E = 1/(2/3)^2 = 1/(4/9) = 9/4 = 2.25$

These factors have been combined to infer that Venusian "runaway" global warming is primarily induced by the high concentration of CO_2 in its atmosphere. This paper is intended to focus on isolated aspects of CO_2's contribution to Venus' global warming and to thereby promote a discussion of its true influence on Venus' global temperature.

AUTHOR'S NOTE

The following discussion is going to involve some illustrative equations that are critical to the development and support of its presentation. The numerical data will be presented in each equation with their applicable terms. Like terms, appearing above and below the divisor lines in each equation will be struck through with single lines to cancel each other from the final results. Having the final results of each calculation described in the proper terms is a good indication that the data were properly manipulated. Like terms in more complicated equations will be presented in like colors so as to make the arithmetic easier for the reader to follow.

PART 2
A COMPARISON OF THE TOTAL MASS OF CARBON DIOXIDE IN THE ATMOSPHERE OF VENUS RELATIVE TO THAT OF EARTH

All other factors being equal, the ability of any object to capture, store, transport and transfer heat energy is directly proportional to its mass (g). This relationship is so well established that it is essentially axiomatic.

The literature reports the concentrations of the component gases of our atmosphere as volume fractions of the atmosphere; Liters of gas per liter of atmosphere (Lgas/Latm).

The thermal properties of all objects are functions of their masses. Therefor, it is important to convert the volume fractions of those gases to their mass factions; grams of gas per gram of atmosphere (g_{gas}/g_{air}). The mass fraction of any gas within its respective atmosphere can determined by application of Equation 1 as long as all density measurements are made at the same temperature and pressure.

The density (D) of any gas is usually reported as its mass in grams (g) divided by its volume in Liters (L). D = g/L. The surface density of the Earth's atmosphere (air) is equal to 1.2928 g/L at Standard Temperature and Pressure (STP) conditions[1]. The density of CO_2 is equal to 1.9770 g/L at STP conditions[1]. The concentration of CO_2 in the Earth's atmosphere is 390 parts per million (ppm.) on a volume of CO_2 (L_{CO2}) per volume of air (L_{air}) basis.[3]

EQUATION 1

$$\text{Mass fract. of gas} = \frac{\text{Vol. fract. of gas } (\cancel{L_{gas}}/\cancel{L_{atm}}) \text{ X Density of gas } (g_{gas}/\cancel{L_{gas}})}{\text{Density of Atmosphere } (g_{atm}/\cancel{L_{atm}})} = \frac{g_{gas}}{g_{atm}}$$

The volume fraction of CO_2 in air = 390 L_{CO2}/1,000,000 Lair = 0.00039 L_{CO2}/L_{air}.

The mass fraction of CO_2 in the Earth's atmosphere can be determined by applying established data to Equation 1, above:

EQUATION 2

$$\text{Mass fraction } CO_2 = \frac{\frac{390\ \cancel{L_{CO2}}}{1{,}000{,}000\ \cancel{L_{air}}} \text{ X } 1.9770\ g_{CO2}/\cancel{L_{CO2}}}{1.2928\ g_{air}/\cancel{L_{air}}} = 0.000596\ g_{CO2}/g_{air}$$

Mass fraction CO_2 = 596 ppm. on a mass of CO_2/mass of air basis.

The mass of the Venusian atmosphere is about 93 times the mass of the Earth's atmosphere and is 96.5 % (965,000 ppm.) CO_2 and 3.5 % (35,000 ppm) Nitrogen (N_2). However, It is unclear from the literature whether the the concentrations of the gases in Venus' atmosphere are presented in volume % or mass %. For the sake of continuity, this discussion will assume that the literature concentrations are given in terms of volume % or volume fraction (Vf) and that value will be converted to mass % or mass fraction (Mf). Gas pressures are presented in terms of Earth atmospheres (ATM_E) where 1 ATM_E equals Earth's atmospheric sea level pressure.

Volume fraction of CO_2 is expressed here as Vf_{CO2}

Mass fraction of CO_2 is expressed here as Mf_{CO2}

Volume fraction of Nitrogen (N_2) is expressed here as Vf_{N2}

Mass fraction of N_2 is expressed here as Mf_{N2}

Density of CO_2 at 1 ATM_E is expressed here as D_{CO2}

Density of N_2 at 1 ATM_E is expressed here as D_{N2}

$$Mf_{CO2} = \frac{(Vf_{CO2} \times D_{CO2})}{(Vf_{CO2} \times D_{CO2}) + (Vf_{N2} \times D_{N2})} = \frac{0.965 \times 1.977}{(0.965 \times 1.977) + (0.035 \times 1.2506)}$$

$$Mf_{CO2} = \frac{1.908}{1.908 + 0.044} = \frac{1.908}{1.952} = 0.977$$

$$Mf_{N2} = \frac{(Vf_{N2} \times D_{N2})}{1.952} = \frac{0.044}{1.952} = 0.023$$

Thus it can be shown that the Venusian atmosphere contains 152,451 times the mass of CO_2 as does the Earth's atmosphere.

$$\frac{\frac{93 \times 977{,}000}{\cancel{1{,}000{,}000}}}{\frac{596}{\cancel{1{,}000{,}000}}} = \frac{90{,}861{,}000}{596} = 152{,}451$$

Assuming that the specific heat capacity of CO_2 is the same on Venus as it is on Earth, the CO_2 in the Venusian atmosphere should be able to Trap, store, transport and transfer 152,451 times as much heat as the Earth's CO_2. At first glance, the comparatively huge total heat capacity of Venus' atmospheric CO_2 could be considered a major contributor to that planet's higher than expected surface temperature and thus, lend credence to the notion that Venus' "run away" global warming is due primarily to CO_2.

PART 3
THERMAL EFFECTS OF AN EARTH EQUIVALENT ATMOSPHERE ON VENUS

Some insight into the role of CO_2 in Venus' "run away" global warming might be demonstrated by hypothetically replacing the Venusian atmosphere (ATM_V) with one that is identical in composition to that of the Earth's (AIR_V) and examining the influences of such factors as relative proximity to the Sun, relative albedo, relative density and relative specific heat capacity of Venusian "AIR" (AIR_V) on that planet's temperature and atmospheric lapse rate. .

PART 3A
RELATIVE PROXIMITY TO THE SUN

The Earth's sea level atmospheric pressure is 1013.25 millibars (mbar) or 1 Earth atmosphere (ATM_E) and its mean temperature at that pressure is 22^o C. Temperature and pressure measurements of the Venusian atmosphere[4] at altitudes of 100 km to 0 km were recorded by the Magellan and Venus Express space probes. Those data were tabulated such that altitudes were presented in 5 km increments, temperature data from each of those 5 km increments were presented in ^{o}C and pressure values associated with each of those increments were presented in fractions or multiples of ATM_E. This discussion is, primarily, concerned with the temperature associated with 1 ATM_E of pressure within the Venusian atmosphere (ATM_V). That pressure can be found between the altitudes of 50 and 55 km where the respective temperatures are 75^o C and 27^o C and their respective pressures are 1.066 ATM_E and 0.5314 ATM_E. The temperature associated with 1 ATM_E can be derived from the interpolation of those two data sets and was, thus, mathematically determined to be 69.1^o C.

$$\frac{75^{o}\ C - x^{o}\ C}{75^{o}\ C - 27^{o}\ C} = \frac{1.066\ ATM_E - 1\ ATM_E}{1.066\ ATM_E - 0.5314\ ATM_E}$$

$$\frac{75^{o}\ C - x^{o}\ C}{48^{o}\ C} = \frac{0.066\ \cancel{ATM_E}}{0.535\ \cancel{ATM_E}}$$

$$75^{o}\ C - x^{o}\ C = 0.123 \times 48^{o}\ C$$

$$75^{o}\ C - x^{o}\ C = 5.904^{o}\ C$$

$$x^{o}\ C = 75^{o}\ C - 5.904^{o}\ C$$

$$x^{o}\ C = 69.1^{o}\ C$$

This exercise indicates that the Venusian atmosphere would be expected to have a temperature of 69^{o} C at 1 Earth atmosphere (ATM_E) of pressure. Because Venus is about 2/3 of the Earth's distance from the Sun, it is exposed to about 2.25 times more solar radiation than is the Earth.

$$E = 1/S^2$$
$$E = 1/(2/3)^2 = 1/(4/9) = 9/4 = 2.25$$

Exposure of Venusian "air" (AIR_V) to 2.25 times the solar radiation that the Earth's air receives would result in a calculated temperature of 49.5^{o} C at 1 ATM_E of pressure.

Earth's mean temperature at 1 ATM_E = 22^{o} C
Venus' exposure to solar radiation/ Earth's exposure = 2.25
Calculated Temp. of AIR_V at 1 ATME = 22^{o} C X 2.25 = 49.5^{o} C

A comparison of Earth and Venus atmospheric temperatures at what is essentially an equivalent pressure presents an opportunity to compare a mathematically expected temperature to that which was measured at that pressure on Venus. Disregarding differences in the atmospheric composition of both planets at that pressure, should help to illustrate and define the role of CO_2 in Venus' planetary heat retention. When comparing atmospheres of identical composition and pressure, proximity to the Sun becomes a major variable effecting heat exposure, absorption and retention. As discussed above, Venus' relatively shorter distance from the Sun exposes it to about 2.25 times the Solar energy that the Earth experiences. The simple calculation, above, suggests an expected temperature of 49.5^{o} C, which is only 19.5^{o} C less than the temperature of the CO_2 rich Venusian atmosphere that was measured at 1 ATM_E pressure. That difference is extremely small when considering the fact that the CO_2 mass fraction of the Venusian atmosphere is 1,639 times its concentration in the Earth's atmosphere.

$$\frac{\text{mass fraction of } CO_2 \text{ in Venus' atmosphere}}{\text{mass fraction of } CO_2 \text{ in Earth's atmosphere}} = \frac{977{,}000\ \cancel{\text{ppm.}}}{596\ \cancel{\text{ppm.}}} = 1{,}639$$

It has been suggested that a 25% increase in the concentration of CO_2 in the Earth's atmosphere over the past 100 years has resulted in the global warming of its surface and atmosphere. If a 25% increase in the Earth's 596 ppm mass fraction of CO_2 in its atmosphere could cause as much as a 1° C increase in its surface temperature, where the atmospheric pressure is 1 ATM_E, then Venus' 977,000 ppm. mass fraction of CO_2 in its atmosphere could be expected to trap,store,transport and/or transfer enough heat to cause a maximum temperature increase of 6,557° C at that same pressure.

$$596 \text{ ppm} \times 0.25 = 149 \text{ ppm}$$

$$\frac{\text{Mass fraction of CO2 in } ATM_v}{0.25 \times \text{Mass fraction of } CO_2 \text{ in } AIR_v} = \frac{977{,}000 \text{ ppm}}{149 \text{ ppm}} \times 1^{\circ}\text{ C} = 6{,}557^{\circ}\text{ C}$$

That temperature increase is about 95 times the measured temperature (69.1° C) of the Venusian atmosphere at 1 ATM_E, thus, giving the terminology "run away global warming" and its connection to CO_2 the appearance of being an exaggeration of reality.

PART 3B
RELATIVE ABSORPTION OF SOLAR RADIATION BY THE VENUSIAN ATMOSPHERE AND VENUSIAN "AIR"

The albedo or the fraction of energy reflected by Venus and its atmosphere (ATM_V) is equal to 0.65. What ever energy is not reflected, is absorbed. Thus, Venus and its atmosphere absorb 35% of the energy that it is exposed to. The Earth and its atmosphere, with an albedo of 0.37, absorb 63% of the energy that they are exposed to. Considering absorption only, a Venusian atmosphere of "air" would absorb 1.8 times as much energy as the true Venusian atmosphere (ATM_V). Multiplying this factor by the mathematically computed AIR_V temperature of 49.5° C at 1 ATM_E pressure gives a new AIR_V expected temperature of 89.1° C, at that pressure and in an atmosphere containing only 596 ppm CO_2 as opposed to 977,000 ppm CO_2. This factor deepens the shadow of doubt surrounding CO_2's role in causing the "run away" global warming of Venus and its atmosphere.

$$\frac{\text{Energy Absorption of } AIR_v}{\text{Energy Absorption of } ATM_v} = \frac{0.63}{0.35} = 1.8$$

$$1.8 \times 49.5^{\circ}\text{ C} = 89.1^{\circ}\text{ C}$$

PART 3C
RELATIVE SPECIFIC HEAT CAPACITY OF VENUSIAN ATMOSPHERE VS. SPECIFIC HEAT CAPACITY OF VENUSIAN "AIR"

EXERCISE 1.

DETERMINING THE COMPOSITE SPECIFIC HEAT CAPACITY OF THE VENUSIAN ATMOSPHERE RELATIVE TO THAT OF THE EARTH'S ATMOSPHERE

This exercise is broken down into three parts. The first part is to demonstrate that the specific heat capacity of the Earth's atmosphere can be determined from the sum of the specific heat capacities of each of the component gases multiplied by their mass percent concentrations in the atmosphere. The resulting sum is essentially identical to the literature value for the specific heat capacity of the Earth's atmosphere (1.0035 J/gK) at 1ATM$_E$ and 25^o C.[5] The second part of this exercise will use the same method to determine the composite specific heat capacity of Venus' atmosphere. Having established those data, a new expected Venusian "AIR" temperature of 105.2^o C can be calculated (part 3) for 1 ATM$_E$ pressure.

In the calculations below, The mass fraction of each gas within its respective atmosphere was determined by applying volume fraction and density data to Equation 1.

Literature data for Specific Heat Capacity were given in Joule (J)/gK. The literature value for the Specific Heat Capacity of Air is 1.0035 J/gK. K represents temperature in Kelvin.

Pertinent physical data for Earth's atmosphere:

Density of Earth's atmosphere at STP conditions = 1.2928 g/L[1]

Nitrogen gas (N_2)

Density = 1.2506 g/L [1]
Specific heat capacity = 1.040 J/gK [5]
Concentration = 78.084 volume % [1] = 75.53 mass %
1.040 J/gK X 0.7553 = 0.7855 J/gK

Oxygen gas (O_2)

Density = 1.4290 g/L[1]
Specific heat capacity = 0.918 J/gK [5]
Concentration = 20.946 volume % [1] = 23.153 mass %
0.918 J/gK X 0.2315 = 0.2125 J/gK

Argon gas (Ar)

Density = 1.7837 g/L[1]
Specific heat capacity = 0.5203 J/gK [5]
Concentration = 0.934 volume % [1] = 1.288 mass %
0.5203 J/gK X 0.0129 = 0.0067 J/gK

Carbon dioxide gas (CO_2)

Density = 1.9770 g/L[1]
Specific heat capacity =0.843 J/gK [2]
Concentration = 0.0390 volume % [3] = 0.0596 mass %
0.843 J/gK X 0. 000596 = 0.0005

Sum of specific heat capacities X mass percent concentrations = 1.0052 J/gK
Literature value for the specific heat capacity of air = 1.0035 J/gK

Having validated this method for determining the composite specific heat capacity of the Earth's atmosphere, it can be used to determine the composite specific heat capacity of the Venusian atmosphere.

The contributions of CO_2 and N_2 to the composite specific heat capacity of ATM$_V$ can be determined from the following calculations:

Pertinent physical data for Venus' atmosphere:

Carbon dioxide gas (CO_2)

Specific heat capacity = 0.843 J/gK
Concentration = 96.5 volume % [4] = 97.7 mass %
0.843 J/gK X 0.977 = 0.8236 J/gK

Nitrogen gas (N_2)

Specific heat capacity = 1.040 J/gK

Concentration = 3.5 volume % [4] = 2.3 mass %

1.040 J/gK X 0.023 = 0.0239 J/gK

Sum of specific heat capacities X mass percent concentrations = 0.8475 J/gK

Comparing the specific heat capacities of Venusian "AIR" to that of the Venusian atmosphere, both at 1 ATM_E produces a new computed AIRv temperature of 105.2° C at that pressure

$$\frac{\text{Specific Heat Capacity of } AIR_V}{\text{Specific Heat Capacity of } ATM_V} = \frac{1.0035 \text{ J/gK}}{0.8475 \text{ J/gK}} = 1.184$$

1.184 X 89.1 °C =105.5 °C

RELATIVE DENSITY OF VENUSIAN "AIR" VS. VENUSIAN ATMOSPHERE

The density (D) of air at 1,ATM_E and 0° C is 1.2928 g/L. The density of the Venusian atmosphere (ATM_V) is essentially 1.9516 g/L at that same temperature and pressure.

D of ATM_V = (D of CO_2 X mass fract of CO_2) + (D of N_2 X mass fract of N_2)
D of ATM_V = (1.977 X 0.977) + (1.2506 X 0.023) = 1.9315 + 0.0288
D of ATM_V = 1.9603

Once again, hypothetically replacing the Venusian atmosphere (ATMv) with that of the Earth (AIRv) and examining the effects of that exchange will produce a new computed Venusian temperature of 69.6° C.

$$\frac{\text{D of } AIR_V}{\text{D of ATMV}} = \frac{1.2928}{1.9603} = 0.6595$$

New computed Venusian temperature = 0.6595 X 105.5° C = 69.6° C

It has been shown that if a hypothetical atmosphere, equivalent in composition to that of the Earth (AIR_V), were to replace the true atmosphere of Venus (ATM_V) at a pressure of 1 ATM_E, its calculated temperature (69.6° C) would be essentially the same as the measured temperature of ATM_V (69° C) at that pressure in Venus' CO_2 rich atmosphere.

The combined influence of proximity to the Sun, the ratio of absorption (1.00 - albedo) AIRv/ATMv, the ratio of density AIRv/ATMv and the ratio of specific heat capacity AIRv/ATMv of AIR_V would result in an AIRv temperature of 69.6° C at 1 ATM_E pressure. The collective influence of these four factors on the temperature of an Earth equivalent atmosphere on Venus can be expressed in a single composite ratio AIRv/ATMv, having a value of 3.155.

Proximity to the Sun = exposure to solar radiation = Venus/ Earth = 2.25

$$\text{Relative absorption} = \frac{(1.00 - \text{albedo } AIR_V) = 1.00 - 0.37 = 0.63}{(1.00 - \text{albedo } ATM_V) = 1.00 - 0.65 = 0.35} = 1.8$$

$$\text{Relative specific heat capacity} = \frac{AIR_V = 1.0035 \text{ J/gK}}{ATM_V = 0.8475 \text{ J/gK}} = 1.1841$$

$$\text{Relative Density at } 1ATM_E = \frac{AIR_V = 1.2928 \text{ g/L}}{ATM_V = 1.9603 \text{ g/L}} = 0.6595$$

Composite AIR_V/ATM_V ratio = 2.25 X 1.8 X 1.1841 X 0.6595 = 3.163

Multiplying the Earth's atmospheric temperature (22º C) at 1 ATM pressure by this combined AIRv/ATMv ratio (3.163) gave the same results as applying these ratios individually, thus allowing its use in other analyses of atmospheric phenomenon that are collectively affected by these important properties.

3.163 X 22º C = 69.6º C

PART 4
A COMPARISON OF THE LAPSE RATE OF AN EARTH EQUIVALENT ATMOSPHERE ON VENUS TO THE LAPSE RATE OF VENUS' ATMOSPHERE

The fact that altitude can influence temperature variations within our atmosphere is generally considered to be common knowledge. The higher we go the colder it gets. More importantly, atmospheric temperature varies with altitude at a somewhat fixed rate, known as its "LAPSE RATE". The environmental lapse rate can simply be defined as the rate of reduction in atmospheric temperature with an increase in altitude at a specific time and location. The International Civil Aviation Organization has established an International Standard Atmosphere, having an average temperature lapse rate of 6.49º C/ km of altitude.[6] Even though this observation of lapse rate was established on Earth, it is considered to be valid for any gravitationally supported atmosphere. This notion implies that Venus should have its own atmospheric temperature lapse rate.

Temperature recordings from the Magellan and Venus Express space probes displayed a straight line increase in atmospheric temperature associated with a decrease in altitude ("reverse" lapse rate) from about 60 km (-10º C) to 0 km (462º C).[4] This represents a 472º C temperature increase associated with a 60 km decrease in altitude or a lapse rate of 7.87º C/km.

$$\frac{-10^{o}\ C + 462^{o}\ C}{60\ km} = \frac{472^{o}\ C}{= 60\ km} = 7.87^{o}\ C/km$$

.

The same strategy can be applied to compute a theoretical surface temperature of Venus under an Earth equivalent atmosphere.

The starting point for this reverse lapse rate study is the 50 km elevation, where Venus' atmosphere has a pressure of about 1 ATM_E and a measured temperature of 69º C. As discussed previously, an Earth equivalent atmosphere at that altitude above Venus was computed to have a theoretical temperature of 69.6° C. This study can use the established Earth atmosphere lapse rate of 6.5° C/km to estimate a minimum (T_{min}) Venusian surface temperature (394° C) or an adjusted AIR_v atmospheric temperature lapse rate to estimate a maximum (T_{max}) surface temperature for Venus (1,096° C). The four factors (exposure, absorption, specific heat capacity and density) used to suggest an AIR_v temperature of 69.6° C at 1 ATM_E on Venus all have an influence on the temperature lapse rate of that planet's atmosphere. Thus, the composite AIR_v/ATM_v ratio (3.163) could be applied to estimating a temperature lapse rate (20.55° C/km) for an Earth equivalent atmosphere on Venus (AIR_v) and a maximum temperature for Venus' surface.

$$T_{min} = 69^{o}\ C + (6.5^{o}\ C/\cancel{km} \times 50\ \cancel{km}) = 69^{o}\ C + 325^{o}\ C = 394^{o}\ C$$

$$\text{Lapse rate for } T_{max} = 3.163 \times 6.5^{o}\ C/km = 20.55^{o}\ C/km$$

$$T_{max} = 69^{o}\ C + (20.55^{o}\ C/\cancel{km} \times 50\ \cancel{km}) = 1{,}096^{o}\ C$$

When the tabulated altitude, temperature and pressure data From the Magellan and Venus Express space probes are displayed graphically (Fig. 1), they generate a straight line which represents the atmospheric temperature lapse rate for Venus. . Some deviation towards higher temperatures should be observed in that line near Venus' surface if its CO_2 rich atmosphere were actually capturing and storing reradiated heat, thus causing its "run away" global warming.

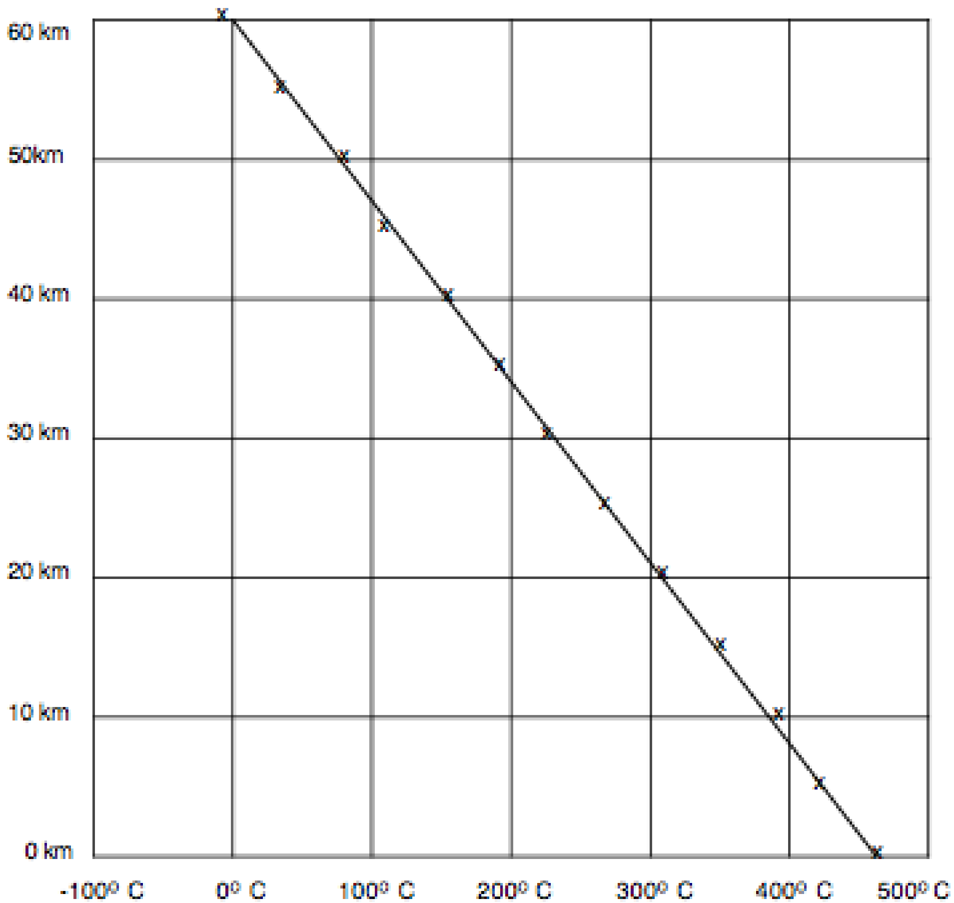

Figure 1.
Temperature Lapse Rate of the Venusian atmosphere, which was constructed from a table of altitude, temperature and pressure measurements that were reported by The Magellan and Venus Express space probes.

PART 5
CONCLUSION

Venus is the hottest planet in the Solar system. Venus is hotter than Mercury which is 1/2 of it's distance from the Sun. Venus' atmosphere has 93 times the total mass of the Earth's atmosphere and is 97.7 mass% CO_2. The total mass of CO_2 in Venus' atmosphere is 152,451 times the total mass of CO_2 found in the Earth's atmosphere and the mass fraction of CO_2 in Venus' atmosphere is 1,639 times its mass fraction in Earth's atmosphere. These facts have led to the generally accepted conclusion that CO_2 has caused "run away" global warming of Venus and its atmosphere. This conclusion been extrapolated to reenforce the notion of CO_2 induced global warming on Earth.

The preceding simple "thought experiment" [7] was designed to explore some possible thermal consequences of an Earth equivalent (in composition) atmosphere on Venus (AIR_V) at a pressure equal to Earth's sea level atmospheric pressure. The results of this "experiment" illustrate that such an atmosphere on Venus would most likely have the same temperature (69^o C) as was measured in Venus' atmosphere at Earth's sea level pressure by the Magellan and Venus Explorer space probes.

A table of Venusian atmospheric altitude, temperature and pressure data that was collected by the Magellan and Venus Express space probes was used to construct a graph (Fig. 1) depicting the (reverse) temperature lapse rate for the Venusian atmosphere from an altitude of 60 km down to it's surface. That graph was a straight line, with no deviations, indicating that there were no layers within Venus' atmosphere that had trapped and stored reradiated heat.

This study, though hypothetical in nature, tends to question the role of CO_2 in the "run away" global warming of Venus and it's CO_2 rich atmosphere. It also tends to minimize the notion of CO_2 acting as a green house gas in general.

AUTHOR'S NOTE:
Other factors, such as axial tilt, sidereal rotation period, large variations in wind velocities, etc. can potentially effect the temperature of Venus and it's atmosphere. However, the intention of this paper is to totally focus on CO_2 and it's contribution to the temperature of Venus and it's atmosphere. J.K.

REFERENCES

[1] Glover, Thomas J., *POCKET REF, SECOND EDITION (2000)*, Sequoia Publishing, 8 & 9.

[2] *HANDBOOK OF CHEMISTRY AND PHYSICS*, The Chemical Rubber Company

[3] *WIKIPEDIA THE FREE ENCYCLOPEDIA*. http://en.wikipedia.org/wiki/Atmosphere_of_Earth.

[4] *WIKIPEDIA THE FREE ENCYCLOPEDIA*. http://en.wikipedia.org/wiki/Atmosphere_of_Venus

[5] *WIKIPEDIA THE FREE ENCYCLOPEDIA*. http://en.wikipedia.org/wiki/Heat_capacity, pp 23-24

[6] *WIKIPEDIA THE FREE ENCYCLOPEDIA*. http://en.wikipedia.org/wiki/Lapse_rate

[7] *WIKIPEDIA THE FREE ENCYCLOPEDIA*. http://en.wikipedia.org/wiki/Thought_experiment

Jules Kalbfeld e-mail: julesk@chamberscable.com