CSS-3a

# How much does atmospheric $CO_2$ concentration affect the energy radiated out to space?

More detail? Search "Ronald Davison climate"

**The answer to that question can be easily illustrated by using the University of Chicago's MODTRAN software (examples below).**

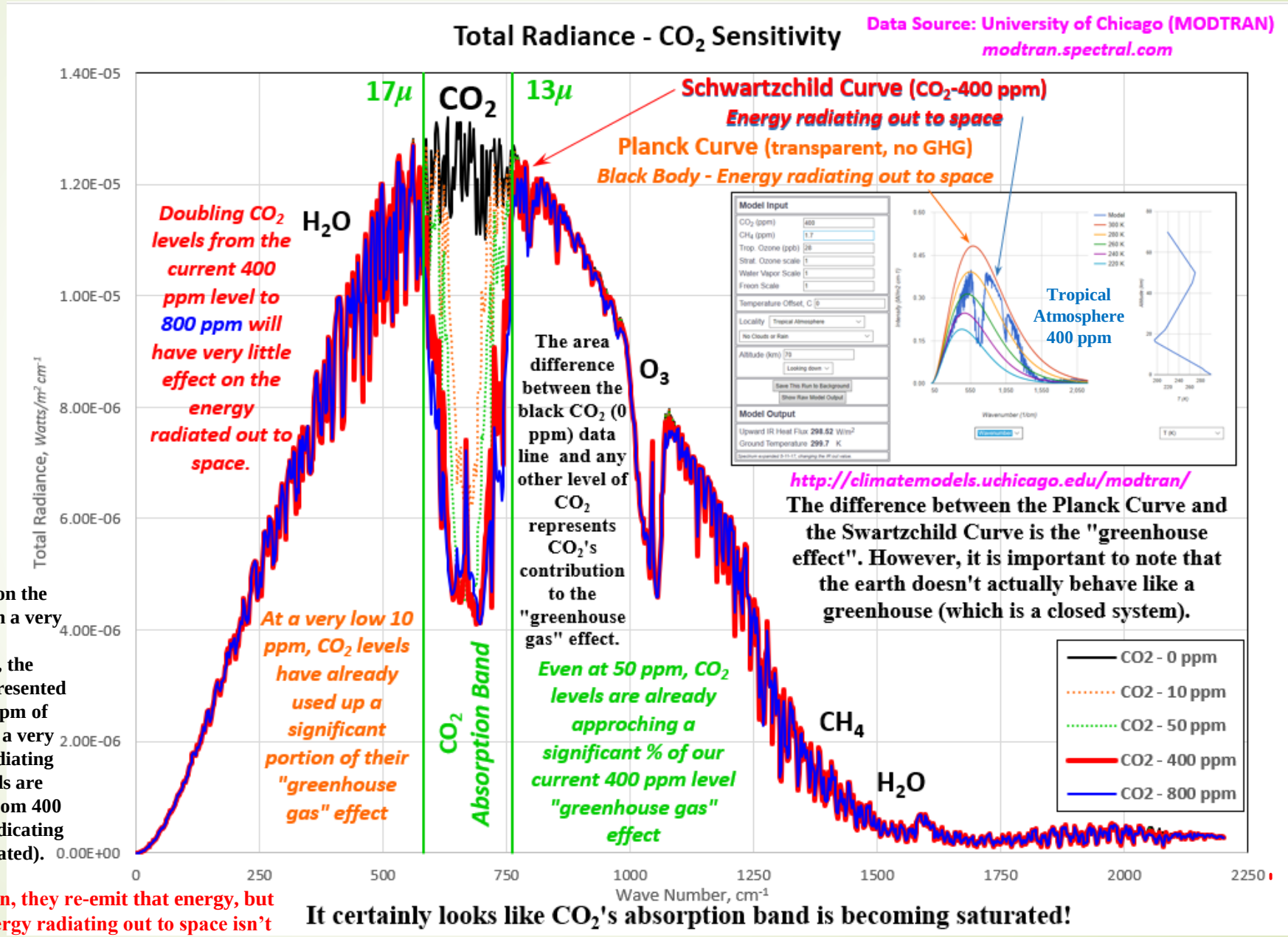
MODTRAN software description

"The MODTRAN software computes line-of-sight (LOS) atmospheric spectral transmittances and radiances over the ultraviolet through long wavelength infrared spectral regime (0 - 50,000 $cm^{-1}$; > 0.2 μm). The radiation transport (RT) physics within MODTRAN provides accurate and fast methods for modeling stratified, horizontally homogeneous atmospheres. The core of the MODTRAN RT is an atmospheric "narrow band model" algorithm. The atmosphere is modeled via constituent vertical profiles, both molecular and particulate, defined either using built-in models or by user-specified radiosonde or climatology data. The band model provides resolution as fine as 0.2 $cm^{-1}$ from its 0.1 $cm^{-1}$ band model. MODTRAN solves the radiative transfer equation including the effects of molecular and particulate absorption/emission and scattering, surface reflections and emission, solar/lunar illumination, and spherical refraction. The underlying physics and algorithms used in MODTRAN are well established." From the MODTRAN website.

**The red curve in the large graph (blue curve in the small graph) is the Schwartzchild Curve (at a $CO_2$ concentration of 400 ppm, roughly the current levels). Satellites measuring the energy radiating out to space produce essentially the same profile. The Planck Curve (the gold curve in the small graph) is what the profile would look like if the atmosphere was transparent, with no GreenHouse Gases (GHG). Most of the GHG effect (Planck-Schwartzchild difference) is due to the presence of water vapour (a much more important GHG than $CO_2$).**

## $CO_2$-CS MODTRAN

**$CO_2$ has a very noticeable effect on the energy radiating out to space but in a very narrow Absorption Band (AB, 13 – 17 μm). With no $CO_2$, the Schwartzchild Curve would be represented by the black curve. The first 10 ppm of $CO_2$ added to the atmosphere has a very noticeable effect on the energy radiating out to space. Additional $CO_2$ adds are increasingly less effective. Going from 400 to 800 ppm is hardly noticeable (indicating that the AB may indeed be saturated).**




**It certainly looks like $CO_2$'s absorption band is becoming saturated!**

**When $CO_2$ molecules absorb the earth's thermal radiation, they re-emit that energy, but they don't re-emit that energy unidirectionally. If the energy radiating out to space isn't changing much, the energy being re-emitted to the atmosphere is also not changing much.**

CSS-3b

# So how much does $CO_2$ warm the planet? That depends on the $CO_2$ Climate Sensitivity Value.



**The $CO_2$ Climate Sensitivity is somewhere around 1 °C. Essentially, that means the global temperature will rise 1 °C every time the $CO_2$ concentration doubles (i.e.: $CO_2$'s warming capacity declines exponentially as the value rises). Not a very effective "GreenHouse Gas" (GHG) once $CO_2$ concentrations are greater than 300 or 400 ppm.**

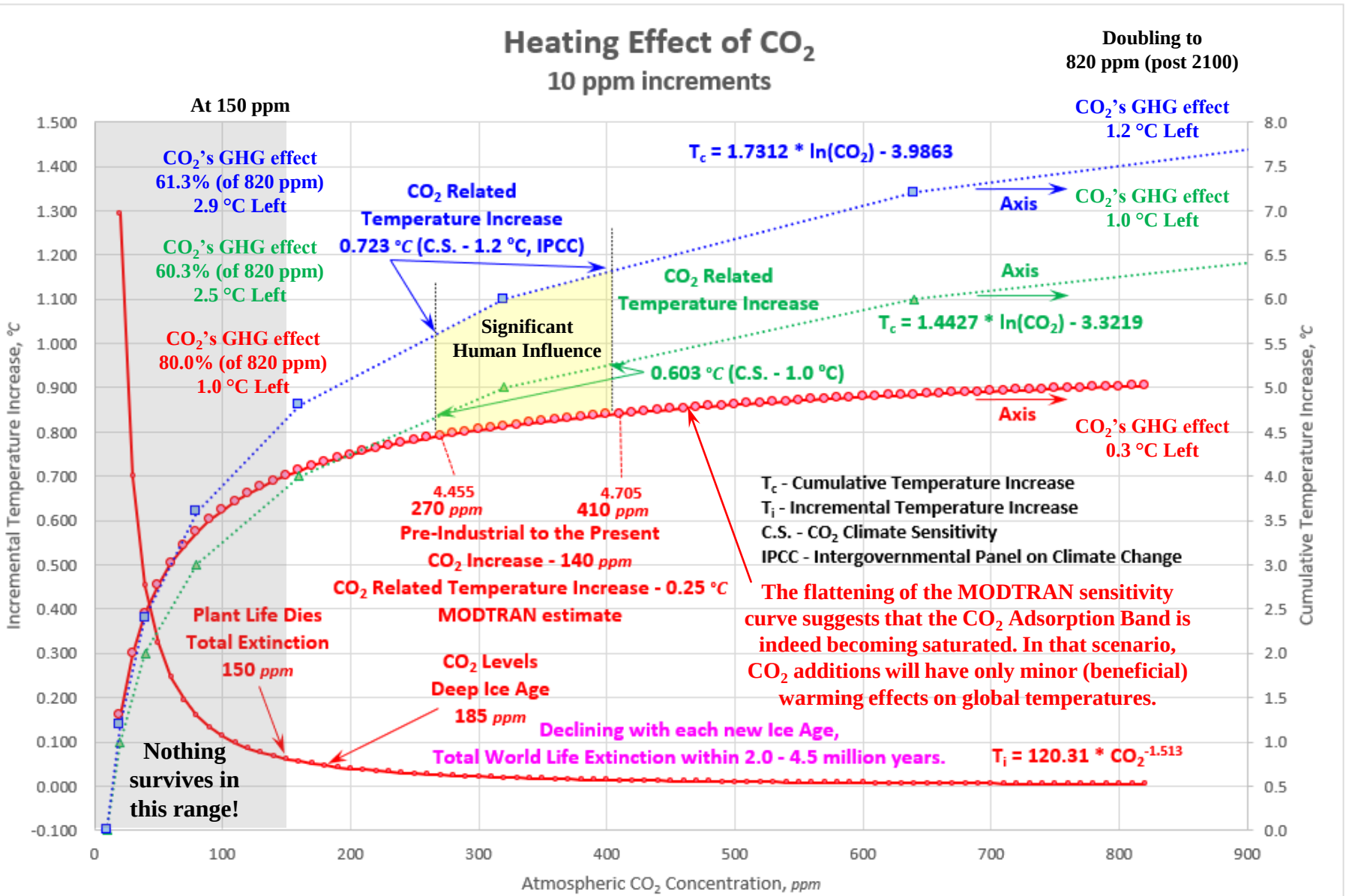
**The $CO_2$ Climate sensitivity curve associated with the MODTRAN model is less than 1 °C. A significant percentage (80%) of $CO_2$'s GHG effect has already been established by the time the atmospheric $CO_2$ concentration reaches 150 ppm (the point where plant life dies). Very little $CO_2$ warming (less than 0.3 °C) will occur by 2100.**

**More detail? Google "Ronald Davison climate"**

**$CO_2$-CS Comparison**

**The green curve represents a $CO_2$ Climate sensitivity of 1 °C. 60.3% of $CO_2$'s GHG effect has already been established at 150 ppm. Doubling current $CO_2$ would only warm the atmosphere 1.0 °C later in the 22nd century.**

**The blue curve represents a $CO_2$ Climate sensitivity of 1.2 °C. 61.3% of $CO_2$'s GHG effect has already been established at 150 ppm. Doubling current $CO_2$ would only warm the atmosphere 1.2 °C later in the 22nd century.**




**The plot on the next page uses a $CO_2$ CS of 1.35 °C (which assumes all the MTR warming is due to $CO_2$). And still the warming is not dangerous.**

# So exactly how much can $CO_2$ actually warm the planet?

Keep perspective when looking at the $CO_2$ Concentration Profile (Figure 1). The changes in $CO_2$ are dramatic, the possible theoretical temperature changes associated with $CO_2$ are not. Refer to OPS-12 to see the correlation between $CO_2$ and Global Temperature (i.e.: there is no correlation/causation on these time scales).

**The answer to the above question depends on $CO_2$'s climate sensitivity. The climate sensitivity can essentially be defined by two parameters (the Transient Climate Response (TCR) and the Equilibrium Climate Sensitivity (ECS)). The ECS will be higher than the TCR. For practical purposes, I'll focus on the TCR. The ECS requires thousands of years to reach equilibrium (and that assumes that we are currently near an equilibrium state (which is not that likely)).**

**The IPCC uses a TCR range of 1.0 – 2.5 ºC (from their AR5 Assessment report). Judith Curry et al looked at the TCR and came up with a range of 1.31 - 1.36 ºC based on a variety of time periods (assuming that all of the warming is due to $CO_2$ with adjustments based on the IPCC's AR5 aerosol forcing estimate). I'll use 1.35 ºC for the example laid out on this page. The actual TCR will go down significantly when solar forcings, ocean cycles, etc. are factored in.**

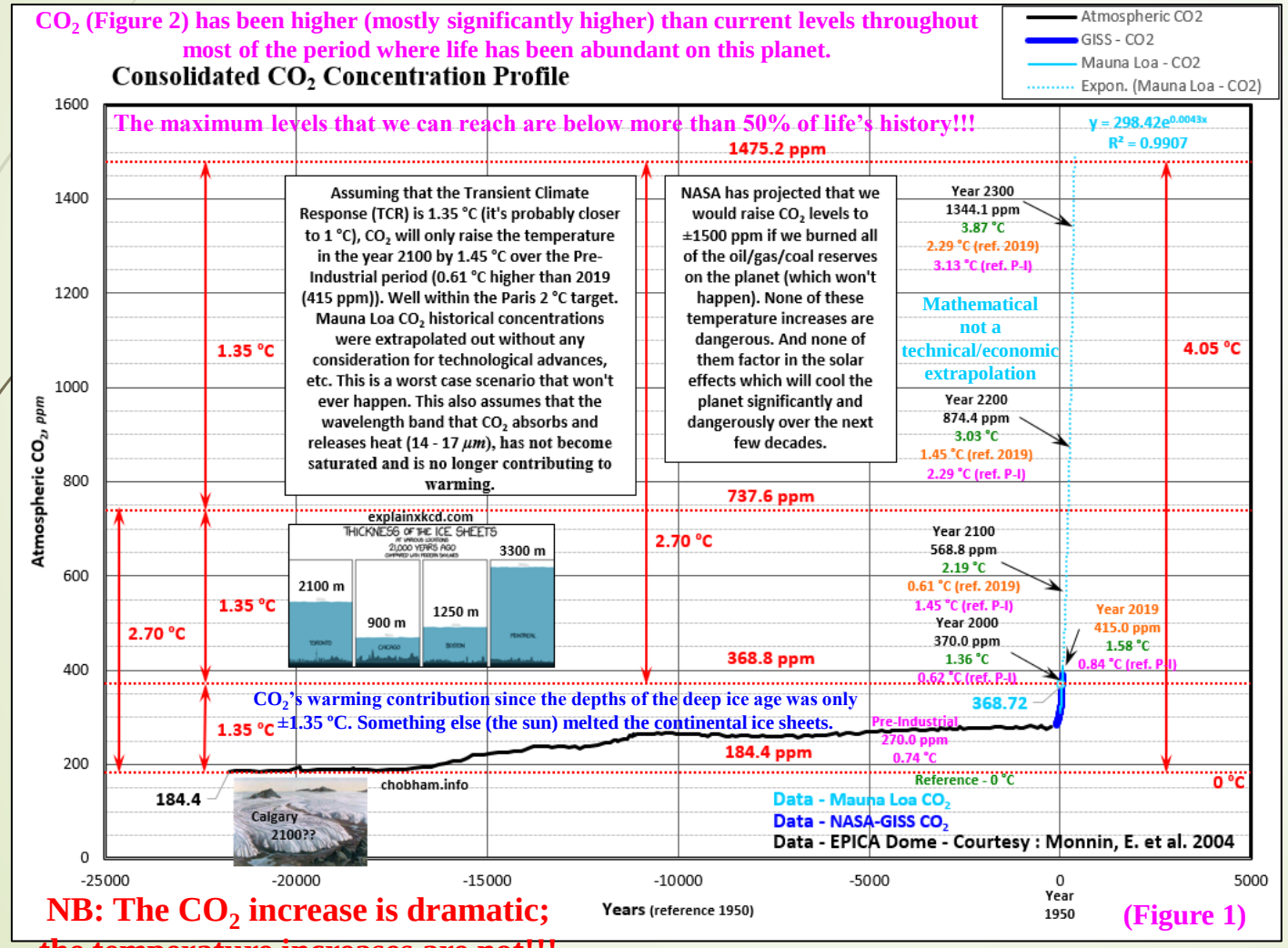
Ignoring solar activity is an extremely dangerous path forward. The sun hasn't suddenly stopped driving the climate despite what the IPCC/alarmist crowd has decreed. The coming Grand Solar Minimum (GSM) will drop temperatures.

**More detail? Google "Ronald Davison climate"**

**$CO_2$-CS**
**$CO_2$ Changes**

We will soon be very thankful for whatever warming $CO_2$ has provided over the last 70-80 years. Hopefully, that $CO_2$ warming will be enough.

$CO_2$ (Figure 2) has been higher (mostly significantly higher) than current levels throughout most of the period where life has been abundant on this planet.



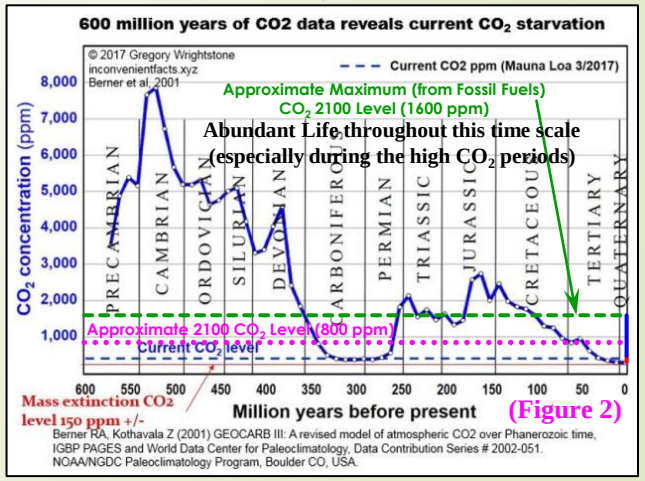

(Figure 1)

**NB: The $CO_2$ increase is dramatic; the temperature increases are not!!!**

**So what does a TCR of 1.35 ºC actually mean?**

**Every time $CO_2$ doubles, the global temperature increases by 1.35 ºC. That means that $CO_2$ can only increase global temperatures in 2100 by 1.45 ºC over Pre-Industrial levels (0.61 ºC over current levels). That's good news since the Paris target was higher at 2 ºC. When all solar activity forcings are accounted for properly, the TCR estimates will drop into the 1 ºC range (and possibly lower). Much lower if the narrow $CO_2$ absorption band (14 – 17 $\mu$m range) is saturated. The IPCC adds in positive feedbacks to come up with their alarmist projections (which are based on unproven theories (water vapor positive feedbacks) programmed into their unsubstantiated computer simulations).**

**$CO_2$ warming will not be dangerous at any of these levels and will in fact be beneficial. The changes in atmospheric $CO_2$ appear to be drastic, but the temperature response is not (even if you assume that the solar forcings are negligible (which they're not)).**




(Figure 2)

# $CO_2$ Climate Sensitivity (CS) Summary



**$CO_2$'s theoretical Climate Sensitivity (± 1 °C) is very simply not capable of catastrophic temperature increases!!!**

**The IPCC reported $CO_2$ CS includes their "fudge factor". Another CAGW theory with no supporting empirical data. No empirical data, no scientific basis.**

**There is no empirical Temperature/$CO_2$ dataset that shows $CO_2$ driving the climate on any statistically significant historical time scale and there is no empirical data set to back up the IPCC's "fudge factor" (unless you're willing to admit that the ignored solar forcings account for $CO_2$'s shortcomings in the historical information).**

**$CO_2$-CS Summary**

**More detail? Google "Ronald Davison climate"**

1. **$CO_2$ Climate Sensitivity is not settled science, but the historical Modern Temperature Records (MTR, 1750 - Present) show the maximum $CO_2$ CS is around 1.35 °C. Given that 80%+ of human $CO_2$ emissions have occurred post 1950, the temperature rise pre-1950 must be primarily natural (which would reduce the $CO_2$ CS down to the 1.0 °C range).**
2. **None of the reasonable $CO_2$ CS estimates will lead to catastrophic global temperature increases. In fact the $CO_2$ increases will be beneficial from both a fertilization viewpoint, expanded arable acreage and longer growing seasons.**
3. **How do the Catastrophic Anthropogenic Global Warming alarmists produce their doomsday scenarios?**
   - **They start with the highest $CO_2$ CS available (IPCC – 1.2 °C).**
   - **Then they use a theoretical positive water vapor feedback to multiply the $CO_2$ CS by 2 – 4 times. There are several problems with that arbitrary "fudge factor". Firstly, it is just a theory with no empirical back-up. Secondly, additional water vapor in the atmosphere doesn't necessarily lead to warming. On the contrary, more water vapor is more likely to lead to more cloud cover (a small but important aspect of climate change that no one understands completely), more precipitation and (gasp) cooling.**
   - **They use the RCP-8.5 emissions scenario. A very unlikely scenario where coal use increases by a factor of seven times and is still 50% of the world's energy supply in 2100. Layer in an estimate of 12 billion people by 2100 (the UN population estimate is a peak of 10 billion by 2070 followed by a steep decline), minimal technological advancements and an unrealistic increase in $CH_4$ emissions from the current 3 ppbv/year to 21 ppbv/year for the next 80 years and voila, unrealistically higher temperatures.**
   - **And there's also the CAGW alarmist habit of ignoring the source of 99% of the energy that reaches this planet (you know, our sun). That will be harder to do given that the new CMIP6 computer protocol recognizes the solar high energy particle and cosmic ray forcings and can now model the MTR without $CO_2$ forcing.**

**In the previous Climate Short Story (CSS-2), I showed how ridiculously inept the IPCC models were when applied to the temperature/$CO_2$ history over the Holocene interglacial we are living through. Those models are that much more ludicrous/useless when applied to the last 600 million years (Figure 2 on the previous slide, the period where life has thrived on this planet). The planet's atmospheric $CO_2$ concentration has been significantly higher (75 - 80% of the time) through most of that period than the high estimate for 2100 (800 ppm). Historical $CO_2$ concentrations of 4,000 + ppm were not catastrophic to life and given that humans can't produce enough $CO_2$ to reach those levels, we should be OK.**