Atmospheric Carbon Dioxide Equilibrium Calculation

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Keywords: carbon dioxide increase, carbon dioxide scavenging, climate change, Amazon Rainforest

ABSTRACT

Prior to the dawn of the Industrial Revolution (circa 1700) and long before global deforestation devastated Earth's delicate atmospheric ecosystem, forests around the world are estimated to have been 400 billion hectares. [7]. As of 2019, global forests are four billion hectares. Estimates for carbon sequestration have fallen to as little as 10-12 gigatons annually, far below what is required to maintain global atmospheric homeostasis [3]. Currently, all life on Earth combined (including the burning of fossil fuels) releases approximately 37.1 gigatons of carbon dioxide each year. In order for humanity to restore the balance and order to the environment that our lives depend upon, we must devise a plan that is economically, logistically, and logically attainable within the span of the upcoming twenty-year window which we have to address the looming catastrophe before us.

Simply stated, Earth's ecosystem must be able to absorb all of the carbon dioxide produced each year if we are to arrest global warming at current levels and then begin to reverse this unrelenting warming trend and the corresponding climate changes that accompany it.

While helpful, the answer may not be in Cap and Trade policies for regulating emissions or mitigation strategies that will prove to be massive economic failures, but rather in aggressively re-growing our beleaguered forests globally.

Our forests are the lungs of our planet. When they are healthy, Earth is healthy. Restoring Earth's forests to their pre-Industrial Revolution grandeur is the most rapid and effective solution for saving humanity's future.

Significance Statement

Saying something as significant as "Available pathways that aim for no or limited (less than 0.1°C) overshoot of 1.5°C keep GHG emissions in 2030 to 25–30 GtCO2e yr^{-1} in 2030 (interquartile range)" is wrong. The IPCC used a simulation instead of calculating the equilibrium [15]. See appendix 2.

Atmospheric Carbon Dioxide Equilibrium Calculation

According to the IPCC SR15, the minimum carbon sequestration required is to remove 45% of human carbon dioxide emissions by 2030. This reduces our CO_2 emissions to 30 $GtCO_2$ yr$_{-1.}$ Matching the statement of 25–30 GtCO2e yr−1 in chapter 2 of SR 1.5. However, planting one tree every year for every man, woman, and child on Earth for ten years will increase carbon sequestration from Earth's atmosphere by 0.7 gigatons each year and by 7 gigatons by the end of the first decade. This equals the 45% reduction in human emissions stated by IPCC SR1.5 2019. [1]

The IPCC SR15 report in chapter 2, page 95, says the equilibrium is 25–30 GtCO2e yr^{-1} [1]. It goes on to say, "Available pathways that aim for no or limited (less than 0.1°C) overshoot of 1.5°C keep GHG emissions in 2030 to 25–30 GtCO2e yr^{-1} in 2030 (interquartile range)". However, there exists no reference to where this data came from. We calculated the current worldwide photosynthesis from land and ocean surface, and it is 9.2 GtCO2e yr^{-1}. Additionally, the total oxygen needed is 17.74 Gt yr^{-1} [2]. We have oxygen levels declining. Therefore, the equilibrium for lowering human emissions of carbon dioxide is less than 17 Gt yr^{-1}. The current "natural" emissions are calculated by 280 (baseline)/415 (current)*37.1 gt=20.2Gt yr^{-1}. A 45% cut in human emissions will bring us to 30 Gt yr^{-1} and not to equilibrium. The point we need to get to is below the natural emissions. Following are the calculations for the Northern and Southern Hemispheres.

Northern Hemisphere

Forest Photosynthesis

Total forest hectares in the Northern Hemisphere is about 2050 million [3]. There are no rainforests in the NH like the Amazon Rainforest. The coastal forests with more rain will consume 5 tons per hectare. Per year the forests like the Cascade and Rocky Mountains in the US consume 1.5 tons per HA. Other forests like those in eastern Oregon and more arid locations consume 0.25 tons per HA [4]. So the most that photosynthesis from vegetation in the NH could be is 1050(50% of 2050HA)*0.25 + 615(30%)*1.5+410(20%)*5= 3.2 billion tons of consumption per year. Increased biomass from the Earth warming and higher troposphere carbon dioxide concentrations do not produce enough photosynthesis to offset the massive deforestation around the globe [5]. Dave has studied photosynthesis for three years now. This is not what brings down the oscillation at Mauna Loa.

Southern Hemisphere

Forest Photosynthesis

The Southern Hemisphere has much less land than the NH; however, it has rainforests. The Amazon Rainforest has switched to become a massive CO_2 producer and oxygen sink [6], [7], [8]. However, the decay contribution from the Amazon Rainforest is ten billion more tons of CO_2 annually with a corresponding loss of oxygen of five tons per acre per year of decay. Anthropogenic forest degradation and biomass burning (forest fires and agricultural burning) also represent relevant contributions. The over two billion acres remaining cancel out any other land and ocean based photosynthesis in the SH. This is because of its switching to an oxygen sink and carbon dioxide emitter. See figure 1 below and the massive carbon dioxide release from the Amazon.

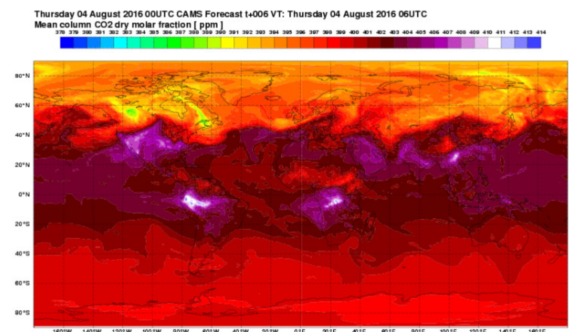


Figure 1. Amazon Rainforest Switched

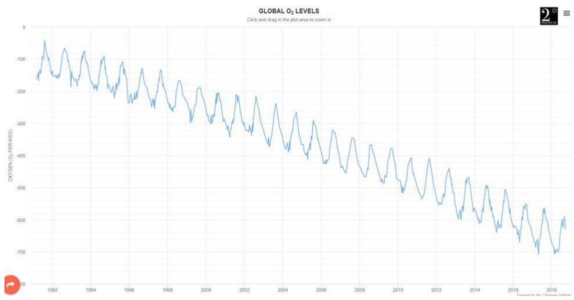
Oxygen Levels

Since the oxygen levels are decreasing, the photosynthesis must be less than that decrease. See graph 1. The total worldwide oxygen needed for animals is 17.7 Gt yr^{-1}. See Figure 2. The natural emissions are 20 Gt yr^{-1}.

Therefore, we cannot lower atmospheric carbon dioxide by working on emissions. It will not work and it is a waste of resources.

Solution for CO2 rise

Planting trees and shrubs is the only way to reduce atmospheric carbon dioxide [8]



Graph 1 Oxygen Levels Decreasing

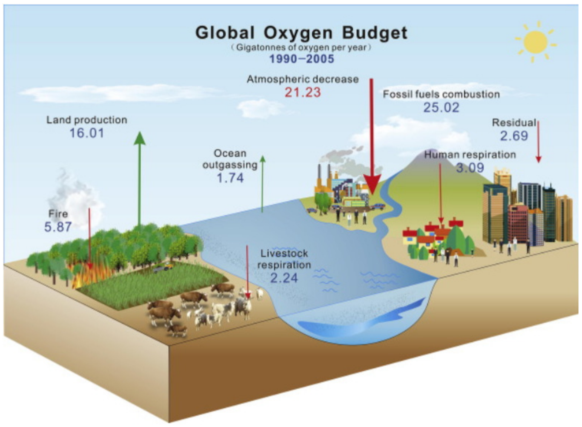


Figure 2. Worldwide Oxygen Budget

Atmospheric Carbon Dioxide Rise

Atmospheric carbon dioxide is still increasing even though the emissions slope has decreased 60%. See Figure 3. Additionally, the rate of rise is still increasing. See Figure 4. This confirms how there exists no effect on atmospheric CO_2 by slowing emissions.

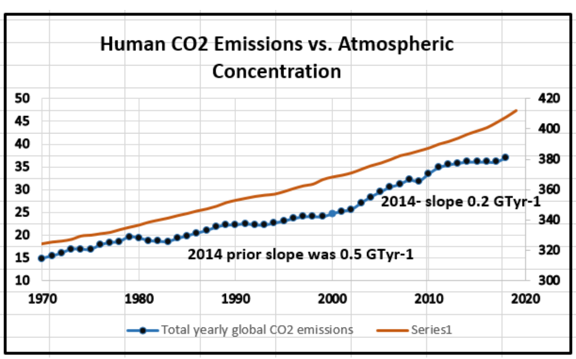


Figure 3.

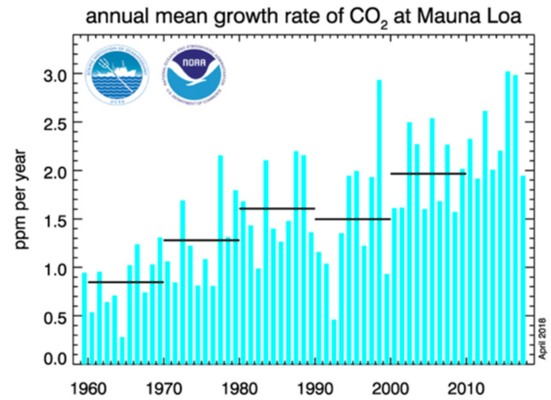


Figure 4.

Ocean Photosynthesis

The oceans in the NH are currently producing six billion tons of photosynthesis consumption of carbon dioxide. However, if the oceans are a pump, the area without CO_2 is similar to the area with CO_2. See figure 5. Therefore, the output and the input cancel each other. Ocean photosynthesis is declining because of a lowering of pH [10], [11]. Excess carbon dioxide in the oceans disassociate to carbonate ions. This causes less carbon dioxide available for photosynthesis.

Cruise Ship Effect

In 2017, 25 million passengers traveled on cruise ships. The ships with on-board sewage treatment plants are so few that their effect is negligible. Thus, with the average cruise lasting seven days, the total passenger days are 175 million. Because people on cruise ships tend to eat more than usual, the wet weight of feces per person is maximum, at 1.5 kg[14]. The excrement is 30% dry weight. Therefore, the mass is .3*1.5=0.45 kg. Each passenger contributes a little over 0.45 kg of solid waste per day. Therefore, we have 79 million tons of solid waste. Most of this is long-chained hydrocarbons with 50 -125 carbons each. These will be converted to CO_2 by the decay process. For CO_2 the molecular weight is 36 and C is 4. Thus, the weight increases by 9 for each C converted. Consequently, 700 million tons of CO_2 were added from cruise ships in 2017. Since 1990, the decay of human waste dumped into the oceans from cruise ships, based on the reported number of passengers each year, has resulted in a total of 9.7 billion metric tons of carbon dioxide in the oceans. This decay has removed oxygen and produced carbon dioxide in the oceans.

If all the cruise ships were made to offload their passengers' waste products at ports and the rivers were cleaned of their pollution (e.g. the Petite Nèthe River near Antwerpen, polluted with horse manure), the ocean CO_2 would decrease. Only one port on the west coast of the USA has a facility to treat passengers' waste products, but no one is utilizing it.

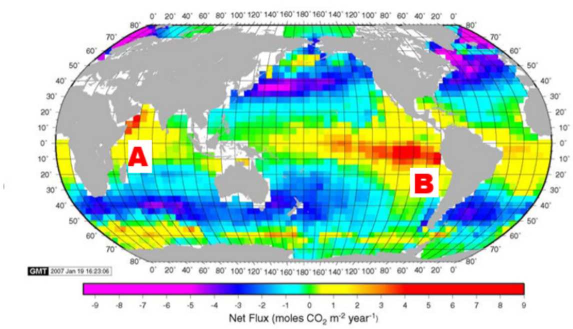


Figure 5. Ocean CO_2 Concentration

Diffusion of CO_2 in the Troposphere

Greenhouse gases, like all gases, diffuse until they are equidistant to each other at any given pressure and temperature combination. At STP (Standard Temperature and Pressure, 25C, 1 Atmosphere), CO_2 has the following diffusion coefficients:
In air 16 mm^2/s, and
In water 0.0016 mm^2/s.

CO_2 is more likely to diffuse in the air than in the ocean [9]. The diffusion length in air is 2 cm per month toward the exosphere (Figure 6). The ocean-air interface diffusion is 14.8 cm per day in the direction of the atmosphere. The driving force for diffusion is much greater in the direction of the exosphere, where the concentration was 25 ppm in 2017. One year later, In 2018, the concentration had increased to 40 ppm. Flux = 2 cm per month towards the exosphere. CO_2 that goes into the ocean is from any disturbance of ocean surface (e.g. hurricanes) that allow CO_2 to enter the ocean. Most of the ocean's surface is at standard temperature and pressure at any time.

$$J = -D \cdot \frac{dc(x)}{dx} \qquad \text{(Unit: D: cm}^2\text{/sec; J: number/cm}^2\text{/sec)}$$

Figure 6. Ficks First Law

Worldwide

The total worldwide consumption of carbon dioxide is 3.2+6=9.2 billion tons per year. We need 17.7 Gt yr^{-1} of oxygen for life on earth [13].

CONCLUSION

The correct equilibrium point is less than 17 Gt yr^{-1}. We have shown two methods for determining the achievement of the correct equilibrium point. First, by calculating photosynthesis worldwide. Second, by calculating that the decreasing oxygen level worldwide is below what is needed for life. The current photosynthesis, then, is less than the worldwide need for oxygen, which is 17.7 Gt yr^{-1}. The only way to lower atmospheric carbon dioxide is to increase photosynthesis. The correct solution is to stop non-sustainable deforestation of large rainforests, such as those in India and the Amazon River Basin and its tributaries, and to plant 200 billion trees and shrubs. This will cause atmospheric CO_2 to lower to 330 ppm by 2031. See figure 5.

Dr. Tom Crowther [16] published a paper on increasing photosynthesis with recommendations of where to plant. The study found that most of the land suitable for restoring forests is in six countries -- Russia (151 million hectares), USA (103 million hectares), Canada (78 million), Australia (58 million), Brazil (50 million), and China (40 million). Appendix 1 shows how to plant the trees and shrubs. This will increase consumption of CO_2 to over 100 Gt yr^{-1}.

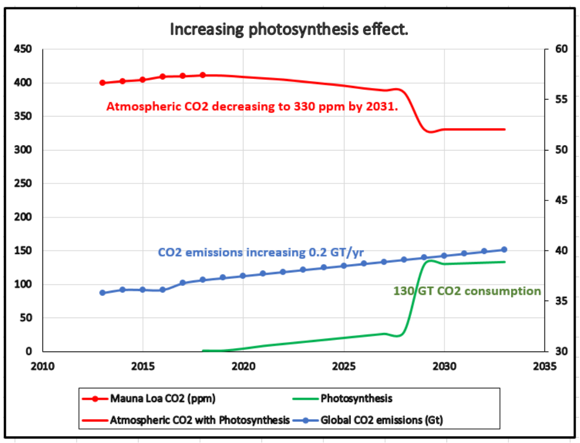


Figure 5. Increasing Photosynthesis Effect

Acknowledgments

Funding sources. We have zero funding at this time. The only objective of Climate Change Truth, Inc. is to follow the data.

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Conflict of Interest statement

We have no conflict of interest that we are aware of.

Biography

David (Dave) White

Dave Is a chemical engineer currently working on climate change and serving as an editor for the Asta Scientific Agriculture Journal. He has thirty years of work experience since his graduation in 1984.

He is deeply committed to promoting the responsible care of the environment and the health of all species.

Dave White graduated in chemical engineering in 1984 with a master studies in statistics. During his time at Oregon State University, Dave worked on a cross-flow, counter-current scrubber for coal-fired power plants. When he moved to Hillsboro with his wife, he worked in the semiconductor industry as a lithography scientist, using regressions analysis daily to find quick solutions to issues. In 2007, Dave and Dr. Tom Wallow produced a paper on ArF double patterning for semiconductors. This multi-patterning scheme is widely used in today's semiconductor manufacturing plants. In 2011, Dave started a consulting business in semiconductor lithography. Six years later, Dave founded the non-profit Climate Change Truth, Inc. to seek the truth about climate change. His research interests are evaporation from the ocean, rainforest deforestation effects, and diffusion of CO_2 through the atmosphere.

Appendix 1.

Ideas on How to Plant Trees and Shrubs

Following is a government policy guide to lower atmospheric carbon dioxide quickly. When these actions are taken, atmospheric carbon dioxide consumption will increase by 2-3 billion tons worldwide annually.

We can keep emissions at 37 Gt yr^{-1} without any new reduction plans. A refocus on planting trees and shrubs is what is required. Native plants that produce oxygen year round are preferred.

1. Put pressure on Brazil and other Amazon rainforest countries to stop deforestation as soon as possible. Stop the biomass burning that puts 300 million tons of carbon dioxide into the atmosphere each year, which causes the switching of the rainforest to an oxygen sink and CO_2 producer. This caused the recent rise in atmospheric carbon dioxide concentration of 53 ppm [6]. Then, after ten years, finish burning what is needed at 10% per year for ten years.
2. Provide space where the public can come and plant trees and shrubs on government-owned lands. The cost would be minimal. A website could be created to document each planting area.
3. Plant shrubs in all freeway medians and sides. This would pay for itself within two years because of lower maintenance costs. Plant native shrubs at a minimal spacing so all light is used in photosynthesis. This will take in 1 ton of CO_2 emissions per acre per year right at the source of auto emissions. The space would not need to be mowed every week in the summer.
4. Get schools involved to plant massive numbers of trees and shrubs on their property and on government property as in 1 above.
5. Add trees and shrubs to parks.
6. Give tax incentives for businesses to plant trees and shrubs. People can plant shrubs on roofs which can structurally handle dirt with minimal spacing and drip irrigation, creating "green roofs."
7. Attend to wildfires quickly. Get a retainer for a jet plane to use from the start of any wildfire.

When we do these things worldwide, we will increase carbon dioxide consumption by 2-3 billion tons per year (not including the effects of rainforest renewal, which eventually will consume 60-100 Gt yr^{-1}).

All embassy environmental scientists have concurred with this science and have encouraged their countries to plant trees. China is planting millions of trees. India stopped deforestation of its rainforest and is planting trees. Pakistan has already planted one billion trees and will plant nine billion more in the next four years. Since May 2018, more than 1.5 billion trees have been planted.

Appendix 2.

Simulation Scenarios

This is the response I received from the IPCC on where the 25-30 $GtCO_2e\ yr^{-1}$ comes from.

Dear Dave,

Thank you very much for your question on the assessment of quantitative pathways in the SR15.

The statement is taken from Table 2.4, bottom section, third row, first column, rounded to multiples of 5.

The assessment in this table is based on the ensemble of quantitative pathways compiled by the IAMC and IIASA for the IPCC SR15 process (https://doi.org/10.22022/SR15/08-2018.15429).

The Python script for preparing this table is available under an open-source license at https://data.ene.iiasa.ac.at/sr15_scenario_analysis/assessment/sr15_2.3.3_global_emissions_statistics.html (see https://doi.org/10.22022/SR15/08-2018.15428 for the scientific reference of the assessment notebooks).

Neither the statement nor the table does make any assertion about an equilibrium, it is merely an assessment of the pathways at a specific point in time.

I do hope that this clarifies your request.

Best regards,
Daniel
Dr. Daniel Huppmann
Research Scholar, Energy Program (ENE)

The International Institute for Applied Systems Analysis (IIASA) Schlossplatz 1, A-2361 Laxenburg, Austria

A scenario is only as good as its inputs and constraints. This is especially true for predicting future values. The constraints should be natural emissions and zero emissions. These were not used; thus, wrong conclusions were obtained. It appears that IPCC is using only past data to predict future events. This explains why none of the previous IPCC predictions, including the so-called "Climate Emergency", worked or will ever yield the desired result. Looking at Figure 6 below, I see two issues. There exists no boundary condition at 20 Gt. This is well known to be "natural" emissions level, which would be when all humans are removed from the earth. The other issue is that the simulation drops below that and below zero. It is impossible to have negative emissions.

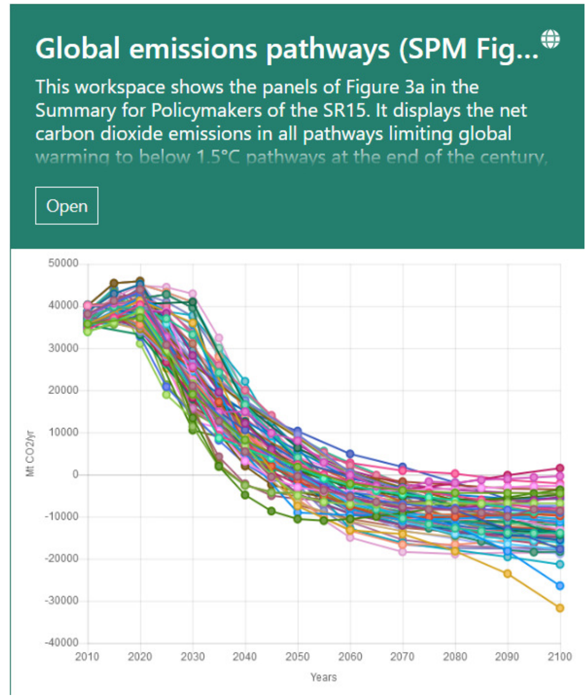

Figure 6. IPCC Simulation.

Except for lagging temperature, not one of the IPCC projections is accurate.

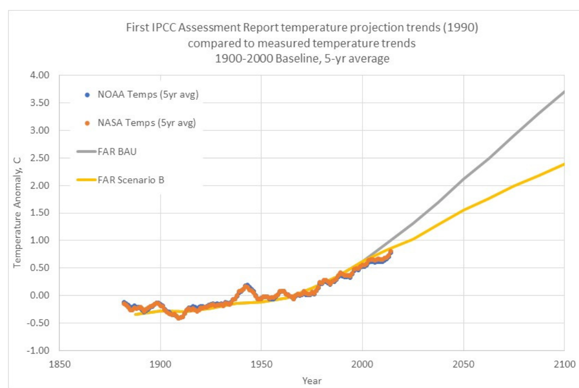

Figure 7. IPCC Temperature Lagging