The Essential Role of Photosynthesis in Defining Net Zero Carbon Dioxide Emissions for Equilibrium Calculations

Dave White, Chemical Engineer Climate Change Truth Inc. research@cctruth.org corresponding author

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

ABSTRACT

In this research manuscript, the authors seek to answer four essential questions relative to the current climate change conversation now underway globally: (Q1) What is the numerically defined goal for annual Net Zero Carbon Dioxide Emissions in gigatonnes essential for global atmospheric homeostasis? (Q2) Why is atmospheric CO_2 rising even though recent data support that CO_2 emissions have the rate of rise lowered by 50% since 2014 globally? (Q3) Are CO_2 cap and trade policies the best immediate intervention, or does globally increasing photosynthesis offer a more rapid and better long-term solution to climate change? (Q4) What strategies can be employed to have the greatest positive impact over the upcoming crucial twelve-year period?

Nothing absorbs carbon dioxide out of our atmosphere like photosynthesis, and therein lies the most under-discussed solution to the greatest problem of our time. A single hectare of healthy Amazon Rainforest can sequester up to 100 tons of CO_2yr^{-1} due to photosynthesis. And the fast-growing Empress Tree (Paulownia tomentosa) not only grows ten to twenty feet tall in its first year, but a single hectare of these trees can sequester up to 103 tons of CO_2yr^{-1} due to photosynthesis (Emily Chasan 2019).

Prior to the Industrial Revolution and long before global deforestation devastated Earth's delicate atmospheric ecosystem, forests around the world are estimated to have consumed up to 400 billion tons of CO_2yr^{-1}. As of 2019, that has been reduced dramatically as global forests consume less than 10 billion tons of CO_2yr^{-1} with photosynthesis (Max Roser 2015).

Significance Statement

The vast majority of climate experts agree that there has been a five-times increase in CO_2 emissions due to human related factors since 1870. While fossil fuel carbon have been confirmed to be approximately seven gigatons annually and does weigh in the climate change discussion, during this same period the photosynthetic consumption of carbon dioxide has been reduced by more than 97% due to incessant global deforestation. Historical forestry records indicate that prior to the 1900's, annual worldwide carbon dioxide consumption was estimated to have been around 400 gigatons due to photosynthesis. However, as of 2019, calculated estimates now have annual carbon dioxide consumption due to photosynthesis below ten gigatons.

(Q1) What Is the Numerical Goal for Annual Net Zero Carbon Emissions? (Net Zero CO_2e)

As a result of the global reduction in forest size, there has been a corresponding loss in photosynthesis and the natural carbon dioxide sequestration it creates. Estimates for global carbon dioxide sequestration have fallen from a minimum of 400 gigatons (healthy rain-forests and other forests) circa 1700 to as little as 10-12 gigatons annually, far below what is required to maintain global atmospheric homeostasis (Christine L. Goodale et al. 2002). The total photosynthesis in the Northern hemisphere is less than 0.7 $gtCyr^{-1}$ (2.57 $gtCO_2yr^{-1}$) (Christine L. Goodale et al. 2002).

Currently, the burning of fossil fuels releases approximately (total worldwide CO_2 emissions) 36.8 gigatons of carbon dioxide each year. In order for humanity to restore the global atmospheric homeostasis essential for life, we must aggressively plant trees and regrow our beleaguered forests as the foundation of any comprehensive strategy for reversing climate change. Deforesting has resulted in a massive global loss of carbon dioxide sequestration of more than 390 gigatons per year, that is simply no longer sustainable. Thus, we submit that the most pressing issue facing humanity in our climate change battle is not carbon dioxide emissions but, rather, the inability to absorb the carbon dioxide currently stranded in the atmosphere due to the significant reduction in photosynthesis.

Our forests are the lungs of our planet. Without them, we simply cannot breathe. The logic of the current climate science theory is based on the hypothesis that we can stop the dramatic shifts in weather patterns that threaten all life by achieving global atmospheric equilibrium as we remove excess carbon dioxide from the atmosphere. However, a major problem in this discussion of atmospheric equilibrium is that the phrase Net Zero Carbon Emissions (Net Zero CO_2e) has not been defined. What number, in gigatons, is the target goal that would give us atmospheric equilibrium? How much carbon dioxide needs to be consumed annually to get to the Net Zero CO_2e target goal?

Productive scientific communication for the development of a unified global solution to the greatest challenge in human history depends on scientific data that have been reviewed and scrutinized for accuracy before agreement can be reached. In today's climate change conversations, some climate change scientists have suggested that the Net Zero CO_2e target goal is zero, meaning that every year we would need to absorb 36.8 gigatons of CO_2. Others simply use the term Net Zero CO_2e without having any numerical idea of what the target goal is and thus how much carbon dioxide will need to be removed from the atmosphere each year in order to achieve equilibrium.

The definition of Net Zero CO_2e is, therefore, crucial to establishing a foundation for the entire climate change scientific community before it can develop practical strategies designed to stalemate the progression of the rise of atmospheric carbon dioxide and ultimately reverse its threatening course.

The author has calculated the Net Zero CO_2e to be 8.6 gigatons per year, and this research article will demonstrate in detail how that number was determined with data sets available in "References." As of 2019, the estimated global emission of carbon dioxide stands at 35.5 gigatons. Therefore, a Net Zero CO_2e of 8.6 gigatons means that in order for us to achieve atmospheric equilibrium and global environmental homeostasis, we must re-establish our ability to sequester 26.9 gigatons (26.9 billion tons) of CO_2 directly from the atmosphere each year.

Global reforestation is much more cost effective, time effective, and rapidly attainable than relying on industry and individual governments to curtail their pursuit of control and market share. After all, what is easier to do? (A) Plant trees, as Ethiopia has done with 350 million new saplings planted in twelve hours (NOAA weekly 2020), or (B) Reduce emissions of carbon dioxide, which has not worked to lower atmospheric carbon dioxide in the past. Additionally reducing emissions won't work for the future because the average residence time for carbon dioxide in the future is 150 years (Schwartz, 2018).

Logic dictates that with a global catastrophe facing all humanity, now is the time for action with proven, natural, and trusted mechanisms for restoring global atmospheric equilibrium.

The Photosynthesis Equation

Photosynthesis is the biological process by which the plant cell organelle, known as a chloroplast, is able to "change" carbon dioxide into glucose to support its production of energy (ATP) for cellular function, including the replicated biotransformation of CO_2 into glucose. Carbon dioxide is literally the preferred fuel source for all plant life. With an abundance of it stranded in our atmosphere, there is more than enough fuel to support mass global reforestation. Here is the biochemical equation for photosynthetic sequestration of carbon dioxide from the atmosphere for your reference: $6\ CO_2 + 6\ H_2O\ \lambda \rightarrow C_6H_{12}O_6 + 6\ O_2$

How Is Annual CO_2 Consumption Lost Due to Lost Photosynthesis?

1. Globally, we lose at least 1 gigaton of CO_2 consumption annually due to city

expansion into previously undeveloped lands. (Calculated by worldwide cities over 200k people Ha squared)

2. The IPPC Forestry Group estimates we lose 2-3 gigatons of CO_2 consumption annually from bio-mass burning due to forest fires, which excludes forest clearing for animal agriculture and wood commodity production.

3. Deforestation for animal agriculture and wood commodities in the Amazon Rainforest alone accounts for a minimal loss of 90 gt of CO_2 consumption annually (Brienen, R. et al. 2015).

According to the IPCC SR 1.5, the minimum carbon dioxide sequestration required is 45% of human carbon dioxide emissions by 2030 (Rogelj, J et al. 2018). This reduces our CO_2 emissions to 20 $GtCO_2\ yr^{-1}$ --in agreement with the statement of 25–30 $GtCO_2e\ yr^{-1}$ in chapter 2 of SR 1.5 However, there exists no reference to where the 25-30 GT $CO_2e\ yr^{-1}$ data came from. Planting two trees every year for every man, woman, and child on Earth each year for ten years will increase carbon sequestration from Earth's atmosphere by 1.4 gigatons each year and by 14 gigatons per year by the end of the first decade (see Northern Hemisphere Forest Photosynthesis below for explanation). We calculated the current worldwide photosynthesis from land and ocean surface, and it is 8.6 $GtCO_2e\ yr^{-1}$.· Additionally, the total oxygen produced is 17.74 Gt yr^{-1} (E. Kintisch, 2017). Oxygen levels are declining. The "natural" carbon dioxide emissions are above the fossil fuel emissions. A 45% cut in human emissions will bring us to 20 Gt yr^{-1} and not to equilibrium. Following are the calculations for the Northern and Southern Hemispheres.

Forest Photosynthesis

Northern hemisphere

Total forest hectares in the Northern Hemisphere are about 2050 million (CHRISTINE L. GOODALE et al. 2002). There are no rainforests in the NH like the Amazon Rainforest. The total photosynthesis in the Northern Hemisphere is less than 0.7 $GTCyr^{-1}$ (2.57 $GTCO_2yr^{-1}$) (CHRISTINE L. GOODALE et al. 2002). 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. This is not what lowers the oscillation at Mauna Loa during the Northern Hemisphere summer.

Forest Photosynthesis

Southern Hemisphere

The Southern Hemisphere (SH) has much less land than the Northern Hemisphere, but it does have rainforests. Unfortunately, the Amazon Rainforest has switched to become a massive CO_2 producer and oxygen sink (D. White, 2019), (Max Roser 2015), (Robert Scribbler 2020). Because decay ingests oxygen and emits carbon dioxide, the decay contribution from the Amazon Rainforest is now ten to fifteen billion more tons of CO_2 annually with a corresponding loss of oxygen. This is from a conservative calculation of five tons of decay per acre per year. Other research papers show that all tropical forests in the SH have switched to become oxygen sinks and carbon dioxide producers. One such paper from A. Baccini et al. shows this clearly (A. Baccini Et al. 2017).

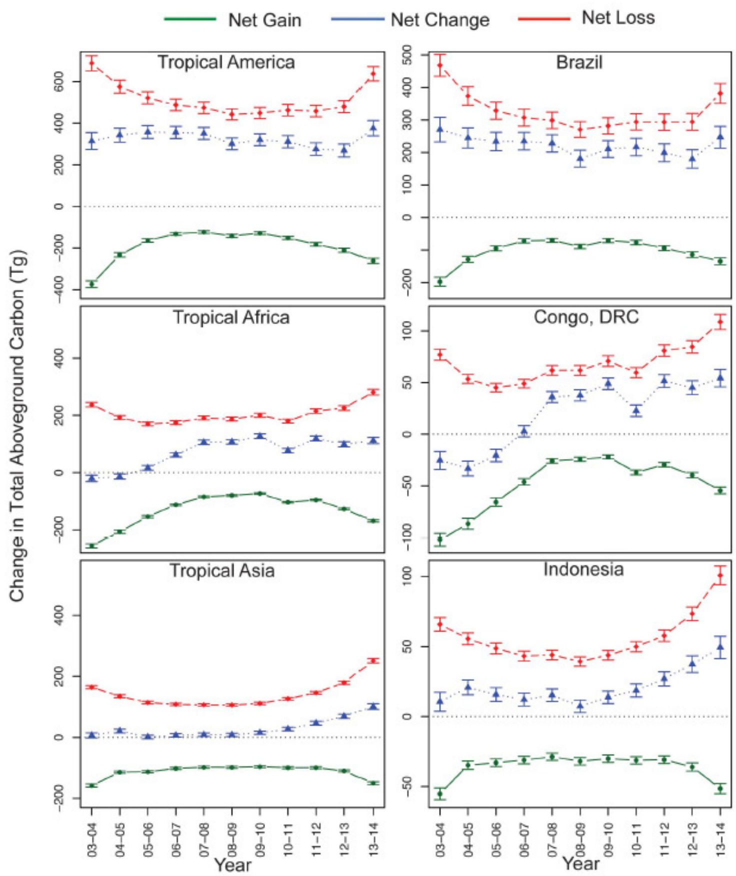


Figure 1. Most southern hemisphere tropical forests have switched to be an oxygen sink and carbon dioxide producer. Annual net change (95% confidence interval) in total carbon. Red lines indicate a loss in carbon; green lines indicate a gain. Blue lines reflect the difference between losses and gains. The vertical bars indicate the standard error of the change value. (A. Baccini Et al. 2017)

In 2009, the tropical forests in the SH started to switch to oxygen sinks and carbon dioxide emitters due to organic decay. Anthropogenic forest degradation and biomass burning (forest fires and agricultural burning) also represent relevant contributions. The decay from the over two billion acres remaining of the Amazon Rainforest cancels out any other land- and ocean-based photosynthesis in the SH (see ocean photosynthesis below). This is because of its switching to an oxygen sink and carbon dioxide emitter (see figure 2 below and the massive carbon dioxide release from the Amazon--the white arrow points to this area) (Takahashi, Taro et al. 2008).

All tropical forests in the southern hemisphere have switched to be an oxygen sink and carbon dioxide producer due to organic decay (Takahashi, Taro et al. 2008). Certainly, if the Amazon had not switched, then the carbon dioxide around it would have a much lower concentration. Up to 90 gigatons (90 billion tons) CO_2 consumption is lost annually from Amazon Rainforest switching, 2.5 times our carbon dioxide emissions at 35.1 $gtCO_2yr^{-1}$. The worldwide massive deforestation is why the average residence time of atmospheric carbon dioxide is increasing.

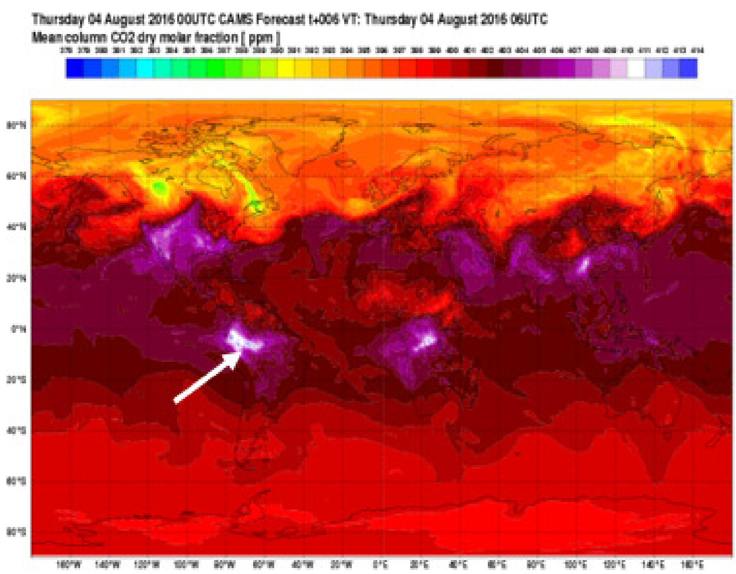
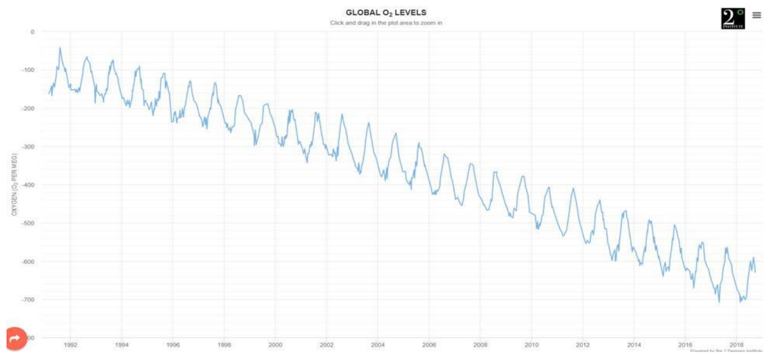


Figure 2. Amazon Rainforest Switched (Takahashi, Taro et al. 2008)

Oxygen Levels

Since the oxygen levels are decreasing, the photosynthesis must be less than that decrease (see Graph 1). The total worldwide oxygen needed is 39 Gt yr^{-1} (see Figure 3). The oxygen from declining photosynthesis and ocean outgassing produced is 17.74 GTO_2 yr^{-1}.



Graph 1 Oxygen Levels Decreasing (Oxygen Levels 2019)

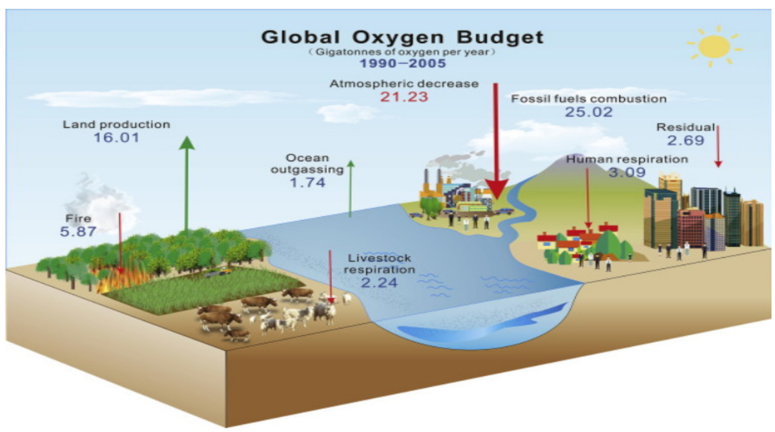
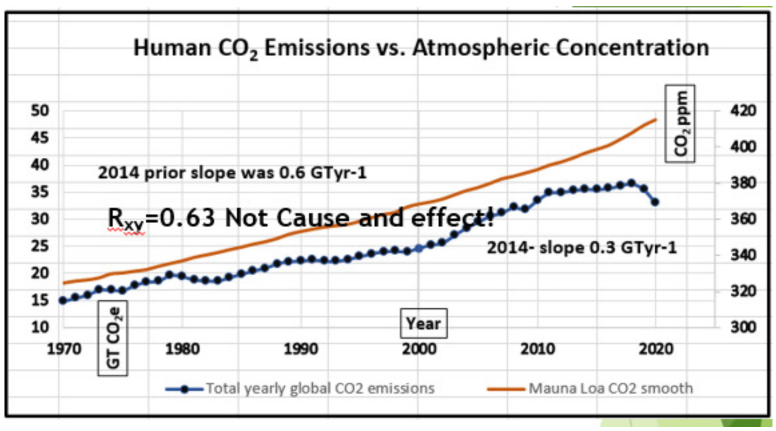


Figure 3. Worldwide Oxygen Budget (Jianping Huang et al 2018)

(Q2) Why is atmospheric CO_2 rising even though recent data support that CO_2 emissions have the rate of rise lowered by 50% since 2014 globally?

The logical reason that atmospheric CO_2 continues to rise in spite of CO_2 emissions rate of rise decreasing in half globally (see Figure 7) is that we do not have enough trees (primarily due to deforestation) to photo synthetically reabsorb carbon dioxide from the atmosphere. Additionally, the minimum residence time of atmospheric carbon dioxide is increasing (IPCC WG I 2003). As a result, the carbon that is still being emitted from all sources remains in the atmosphere and accumulates as a result of the 26.9 gigatons sequestering deficit gap. As countries like China, India, Pakistan, and Ethiopia have learned, our future is dependent upon trees and our ability to redevelop nature's carbon dioxide sinks. Reforesting our planet can substantially increase global photosynthesis to first meet, and then exceed, the 28.2 gigatons that must be absorbed annually and buy us the time we need to address the myriad, additional companion issues like ocean clean-up, animal agriculture, and biodegradable plastic solutions.

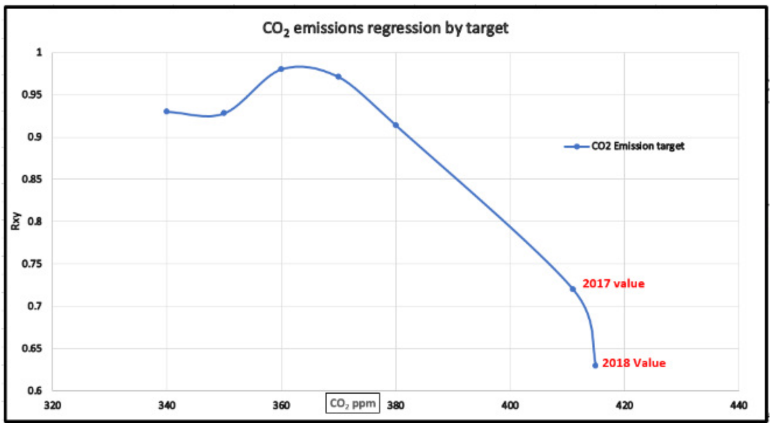
Atmospheric carbon dioxide concentration is still increasing even though the emissions slope has decreased 60% (see Graph 2). Additionally, the rate of rise of atmospheric CO_2 is still increasing (see Graph 6). This confirms no effect on atmospheric CO_2 rise by slowing emissions.



Graph 2. (D. White 2020)

Atmospheric CO_2 is a binary system statistically [6,18]. Two causes are CO_2 emissions and loss of photosynthesis. Each cause is multivariate. We have had mostly flat human emissions (0.3 GT/yr vs. 0.6 GT/yr) since 2014 (see Graph 2). However, atmospheric CO_2 is still going up and the rate of rise is increasing (Graph 8). In 2018, the Rxy correlation coefficient was 0.73 and not cause and effect. In 2021 it is now 0.63. The main author performed regression by target and CO_2 emissions correlate to 363 ppm of the rise in atmospheric carbon dioxide since 1950.

(D. White, 2019).



Graph 3. (D. White 2020)

Pearson's Regression by Target for CO_2 emissions (all)		
Target (ppm)	Rxy	Comment
340	0.93	
350	0.928078	
360	0.98	
370	0.970839	
380	0.914433	
411	0.72	
415	0.64	2019 Value

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

http://cctruth.org/regression.xlxs

Table 1. Pearson's Regression (D. White 2020)

Table 1 shows Pearson's regression by target starting at the inflection point (1950). Natural and human carbon dioxide emissions correlate to 363 ppm and are a contributor but

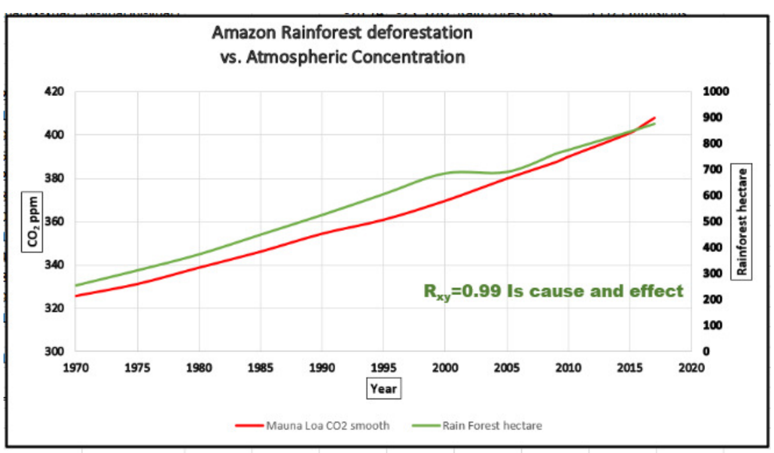
not the cause of the rise of atmospheric carbon dioxide since 1957.

Oxygen Levels

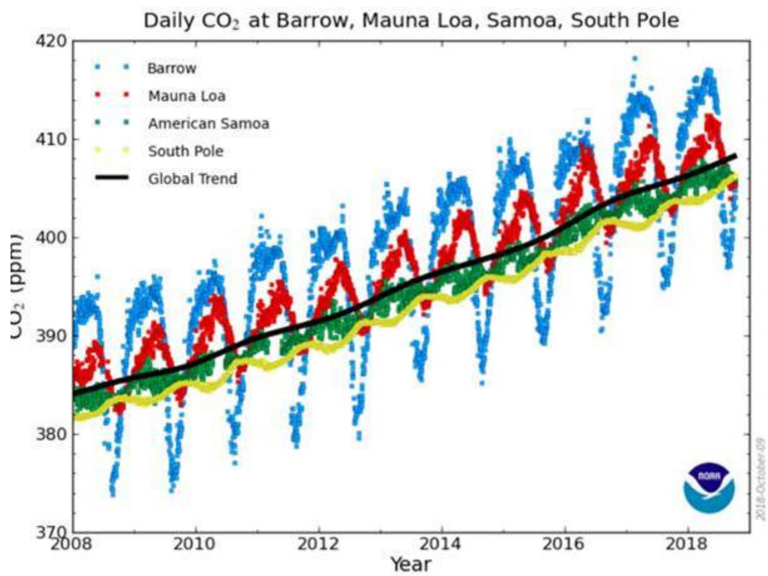
Since the oxygen levels are decreasing, the photosynthesis must be less than that decrease (see Graph 1). The total worldwide oxygen needed is 39 Gt yr^{-1} (see Figure 3). The oxygen from declining photosynthesis and ocean outgassing produced is 17.74 GTO_2 yr^{-1}.

Effective CO_2 Emissions

Effective CO_2 emissions are emissions per year after subtracting the total photosynthesis consumption for the year. For example, the worldwide emissions for 2018 are 37.1 GT. The worldwide photosynthesis is 9.2 GT. Thus, the effective emissions would be 27.9 GT. Calculating it this way tells the actual effect. Instead of the emissions effect being at 135 ppm of atmospheric CO_2, it would be 81 ppm from Effective CO_2 Emissions (ECE). This correlates well with total emissions effect at 363 ppm.



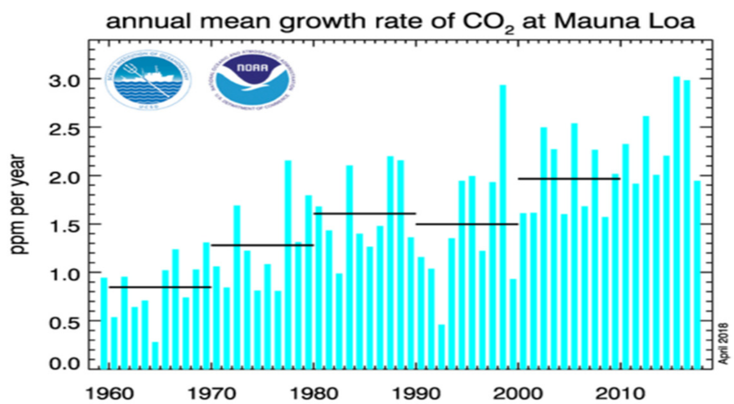
Graph 4. Rain forest deforestation vs. Atmospheric CO_2 rise.(D. White 2020)



Graph 5. Mauna Loa cycles. (NOAA gr 2020)

The oscillation at Mauna Loa starts as a very strong signal in South America and then fans out larger and larger until Barrow's Alaska. The countries in South America burn the Amazon Rainforest, the densest forest in the world, from October/November through May of the next year. Since 1950, an average of 30 million acres per year have been deforested and burned. So much CO_2 has been released that the trees and plants have grown too fast and died. This massive decay is what caused the Amazon Rainforest to switch to an oxygen sink and carbon dioxide producer. Hundreds of manuscripts have been published on this. Currently, the Amazon output is 15 $GTyr^{-1}$ of CO_2. The switching of the Amazon Rainforest is a 0.99 cause and effect correlation to the rise in atmospheric carbon dioxide and loss of oxygen since 1957. The oscillation at Mauna Loa increases during the seven months of the deforestation and burning in South America's spring and summer (see figure 4). Then at the end of May, the deforestation stops, and the Mauna Loa carbon dioxide data recede.

Figure 4. Amazon Rainforest burning (Kenzie Mastroe 2019)



Graph 6. Mauna Loa CO_2 Rate of Rise (NOAA gr 2020)

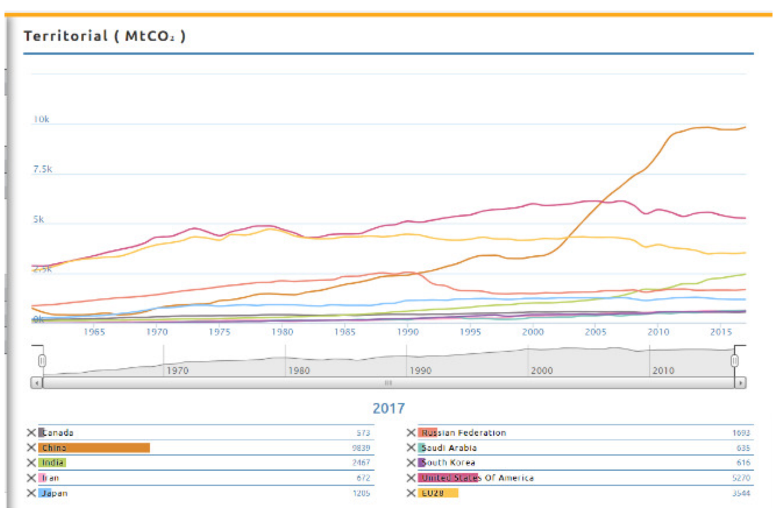


Figure 5. Global Carbon Emissions (Global Carbon Atlas 2020)

The rate of rise of atmospheric CO_2 is still increasing even though the global emissions have leveled off (see graph 6). All countries have lowered their carbon dioxide emissions except China and India (see figure 5). All pollutants are measured by mass and should be reported as such, not reported per capita. China is the worst polluter of carbon dioxide and has not reduced any emissions. The USA has been decreasing its CO_2 emissions since 2006, and Europe has been decreasing since 1990.

USA 2006: 6131 $MtCO_2$ and in 2018: 5270 $MtCO_2$ --a 15% decrease of carbon dioxide.

Europe 1990: 4479 $MtCO_2$ and in 2018: 3544 $MtCO_2$ --a 21% decrease of carbon dioxide.

Ocean Photosynthesis

The oceans in the NH are currently producing six billion tons of photosynthesis consumption of carbon dioxide (Natalya Gallo 2014). This decline is for many reasons. However, if the oceans are a pump, the area without CO_2 is similar to the area with CO_2 (see figure 6). Therefore, the output and the input cancel each other. Ocean photosynthesis is declining because of a lowering of pH (Natalya Gallo 2014). Excess carbon dioxide in the oceans disassociate to carbonate ions. This causes less carbon dioxide available for photosynthesis. The oceans out gassing of oxygen is 1.74 gtyr-1 (see figure 3). Photosynthesis is 1:1 carbon to oxygen. Therefore, the total worldwide ocean consumption of carbon dioxide is 1.74 gtyr-1

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 were 175 million (2017 data). Because people on cruise ships tend to eat more than usual, the wet weight of feces per person is maximum, at 1.5 kg (C. Rose, et al 2015). 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, there were 79,000 tons of solid waste in 2017. 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 carbon is 4. Thus, the weight increases by nine for each carbon converted. Consequently, 73 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 1.1 billion metric tons of carbon dioxide in the oceans. This decay over forty years 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. This port is in San Francisco. I called the person in charge and she said no vessel uses the facility to offload human waste. She also said most ships dump as soon as they get out of the harbor.

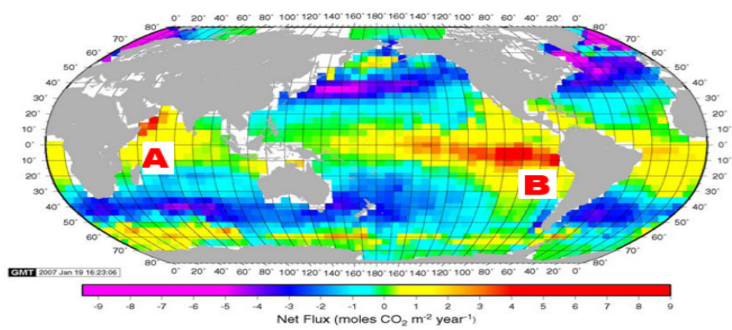


Figure 6. Takahashi 1997 Ocean Surface CO_2

Diatoms Effect

By assimilating the last fifteen years of satellite ocean chlorophyll in an established biogeochemical model, Cecile S. Rousseaux et al 2015 found that there are some significant changes in physical conditions, nutrients, and phytoplankton communities in the high latitudes. In the Northern Hemisphere, a shallowing of the mixed layer depth and a decline in nutrients affect differently the phytoplankton community, depending on the regions (Cecile S.

Rousseaux et al 2015).

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

In water: 0.0016 mm^2/s (D. White 2020)

CO_2 is more likely to diffuse in the air than in the ocean (D. White 2020). The diffusion length in air (bulk troposphere) is 2 cm per month toward the exosphere (D. White 2020), (Ficks diffusion 2018). 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 (Machida et aL. 2002). Flux = 2 cm per month towards the exosphere (Ficks diffusion 2018). Eddy Diffusion and mixing of the atmosphere are stronger drivers for transport of CO_2 to higher altitudes (Hans R. Schneider et al. 1989). The flux direction is correct. The flux number may or may not be correct.

This is because of varying pressures and temperatures from the troposphere to the exosphere. In the future, I will perform a rigorous calculation to determine the accurate flux number. CO_2 that goes into the ocean is from any disturbance of ocean surface (e.g. hurricanes) that allows CO_2 to enter the ocean (Takahashi, Taro et al. 2008). Most of the ocean's surface is at standard temperature and pressure at any time. Furthermore, the atmospheric winds distribute carbon dioxide evenly by latitude (see Graph 7 below). Except for temperature effect, every latitude has an equal chance to diffuse into the ocean. However, the concentrations in the flux graph are not close to what diffusion principles would indicate (see Figure 6 above). Takahashi et al. show southern hemisphere rates of change of ocean pCO_2 (see Table 3). If this were from diffusion flux, we would naturally expect the flux rate to be larger toward the equator and smaller toward the south pole. Figure 8 shows no such dependency. The top row is closest to the south pole and it shows the highest rate!

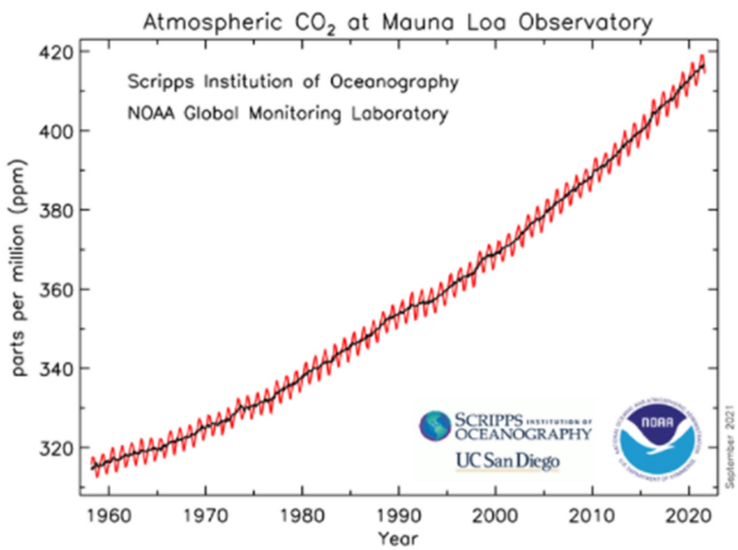
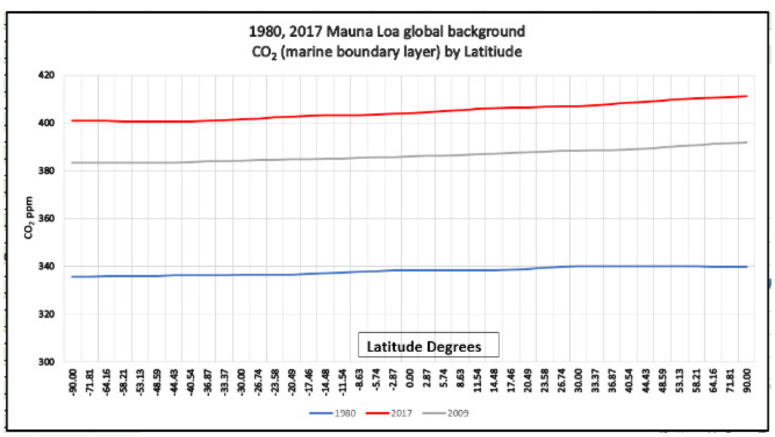


Figure 7. Mauna Loa CO2 rise since 1960. (9/24/2021)



Graph 7. CO_2 mixed by atmospheric winds. (D. White, P. Tans (NOAA) 2017)

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

Figure 8. Ficks First Law (Welty et al, 1984)

Mean rates of change in surface water pCO_2 and bulk water temperature of mixed layer (SST) estimated in six areas in the temperate South Pacific Ocean.

Locations	Lat.	Long.	Data period	Rate of change		No. of MOS.	Rate of change	
				pCO_2@SST (μatm y^{-1})	±σ (μatm y^{-1})		SST (°C y^{-1})	±σ (°C y^{-1})
Tahiti	15–20°S	135–145°W	11974–1997	2.00	0.39	16	0.033	0.034
Vanuata	20–25°S	165–175°E	1984–2006	1.30	0.27	35	−0.048	0.018
New Caledonia	25–30°S	170–180°W	1974–2005	1.05	0.09	17	−0.033	0.020
Tasmania	43–48°S	140–150°E	1984–2004	1.83	0.56	18	−0.051	0.062
New Zealand	45–50°S	170–180°E	1974–2006	1.42	0.30	37	0.001	0.027
S. of Tasmania	50–55°S	140–150°E	1984–2002	1.61	0.20	12	−0.044	0.064
Mean				1.5 ± 0.3	0.30	-	−0.02 ± 0.05	0.04

The rates are computed using mean monthly values. The temperatures are measured concurrently with pCO_2.

Table 3. Diffusion by latitude in SH (Takahashi, Taro et al. 2008)

Worldwide

The total worldwide consumption of carbon dioxide is 2.6 (NH) +6(NH ocean) = 8.6 gigatonnes per year. Therefore, we cannot lower atmospheric carbon dioxide by working on emissions. It is a waste of resources because emissions are not the primary cause. Logically, 90% of human carbon dioxide emissions are from the NH (see Figure 9). The Mauna Loa carbon dioxide data peak in May each year, and then decline until rising again in November (see Figure 10). The greater economic activity during the summertime in the NH produces greater amounts of carbon dioxide emissions. Then, in the fall each year, when there is less activity and it is not cold yet, emissions decrease. In November, the temperature drops in the NH, and more fossil fuel for heating is consumed. This increases the carbon dioxide emissions. In April, it starts warming and carbon dioxide emissions decline (see graph 8). However, the Mauna Loa carbon dioxide data show that concentration decreases during the same time that human emissions increase in the summer. Furthermore, the total photosynthesis in the NH forests is 2.6 gigatonnes per year.

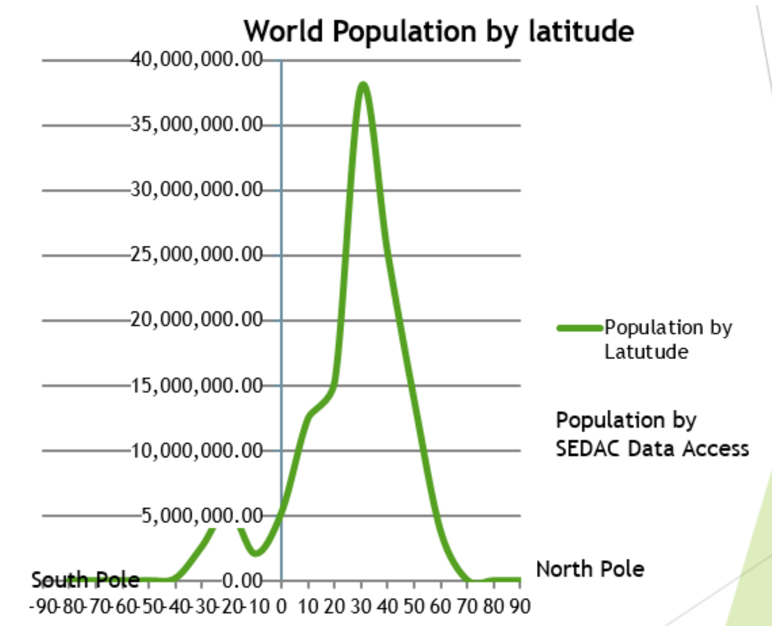


Figure 9. SEDAC Data Access Population (SEDAC 2020)

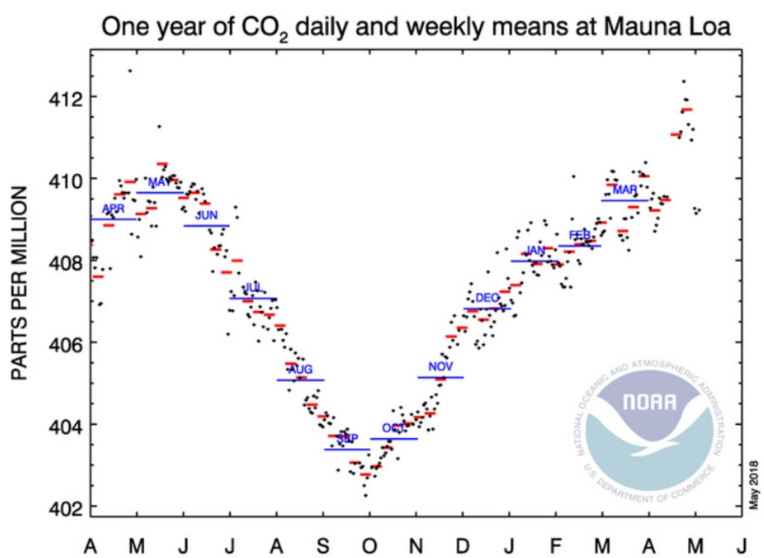
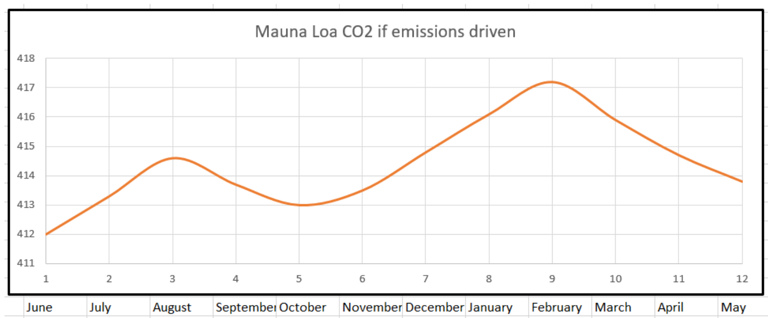


Figure 10. Mauna Loa oscillation. (NOAA weekly 2020)



Graph 8. Mauna Loa if emissions driven (calculated) (D. White 2020)

(Q3) Are CO_2 cap and trade policies the best immediate intervention, or does globally increasing photosynthesis offer a more rapid and better long-term solution to climate change?

Atmospheric CO_2 Residence Time

A 2003 IPCC report states that atmospheric carbon dioxide residence time was between 5 to 200 years (IPCC WG I 2003). However, since 2003, the residence time has been increasing. This means we have to wait more than 150 years for a change in our carbon dioxide emissions to take effect. This is also, why atmospheric CO_2 is increasing even though the worldwide emissions of CO_2 have leveled off. Residence time of a system increases in either of two cases:

1. Input is greater than the drain can handle; 2. The drain is restricted. For atmospheric carbon

2. dioxide, the drain restriction is the issue. This is why residence time is increasing. Cap and Trade will never lower atmospheric CO_2. We need to increase photosynthesis consumption, the drain, which will lower atmospheric CO_2 to a value around 330 ppm by 2031. This cannot be accomplished by emissions work. Anything we do with CO_2

emissions has not and will not have any effect on atmospheric CO_2 for hundreds of years.

Below is a copy of the data I collected on residence time (Table 2) based on the summary of Schwartz et al. of fifteen other manuscripts [35], and the constraints I used (Graph 9). Even at a residence time of 100 years, Mauna Loa CO_2 never stays low. This is because we have a massive loss of photosynthesis consumption.

Facts

Residence time was once five years; now it is more than 200 years. If anyone were to take a survey at a climate change conference and ask the question, "What is the current residence time of atmospheric CO_2?" most scientists would say somewhere between 200 and 400 years. In my presentation at a conference, I said it was 500 years and no scientist questioned it. Another way to look at residence time is a signature from past events, which lowered CO_2 emissions. For example the oil embargo in the 1970's, multiple recessions and the big worldwide recession in 2009. The current COVID-19 pandemic. These are examples of lowered worldwide emissions. Below is the current graph of Mauna Loa CO2. You can clearly see no signature from these events.

Residence Time (Years)	Author	Year
700	Allen	2009
610	Zickfeld	2013
500	Matthews	2008
300	Plattner	2008
270	Cao	2010
230	Zickfeld	2012
220	Solomon	2012
220	Knutti	2012
210	Gillett	2011
180	Frolicher	2010
150	Hare	2006

Table 2. Published papers stating atmospheric CO_2 residence time (Schwartz, 2018).

We have an experiment on US 26 eastbound just west of Portland, Oregon. A permit obtained from Oregon Department of Transportation. These sensors are NIST certified and calibrated within one part per million. Graph 9 shows the rate of rise of atmospheric carbon dioxide less than 3 ppm/yr. The blue line represents the difference between the treed area and a non-treed area. Each location has a wind directional measurement. This measurement can confirm bad data from crosswind for example. This experiment proves we can plant native shrubs and trees by roads and freeways instead of grass. This freeway has 161,000 autos per day on it, and approximately 460 auto exit (Sylvan exit 71) per day between the two sensor locations. The final day of testing was 6/12/2021.

Procedure:

Place sensors at 6am daily for two weeks every other month for one year.

Pick up sensors at 7pm and analyze the data.

Put SD memory card from sensor into computer.

Import the data into an Excel spreadsheet named “data”

Repeat for other sensor.

For each 10 seconds subtract the treed area from the non-tree area.

Sort data for “smallest to largest” from subtraction result.

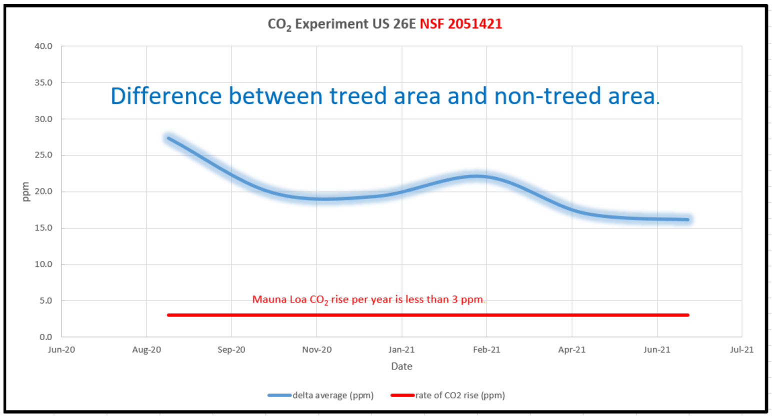
Remove negative numbers in the subtraction result.

The negative numbers are from wind gusts. We tracked this many times.

Calculate average for the day.

Repeat.

Things to note in the graph. At no time did the blue line go below the red line. On December 20th, a very dark and rainy day the difference was 9 ppm. In April through June we had very little rain. The graph shows this as lower difference. For photosynthesis we need these things, light, vegetation, moisture and carbon dioxide. Experiment Summary: This experiment proves we can plant native trees and shrubs instead of grass and they will eventually consume all the carbon dioxide from the vehicles. This is applicable for ±50° from the equator.



Graph 9. (D. White 2020-2021)

Atmospheric CO_2 is “extra,” meaning that it is not consumed by photosynthesis.

Assumptions

Constraints for Graph 10 below:

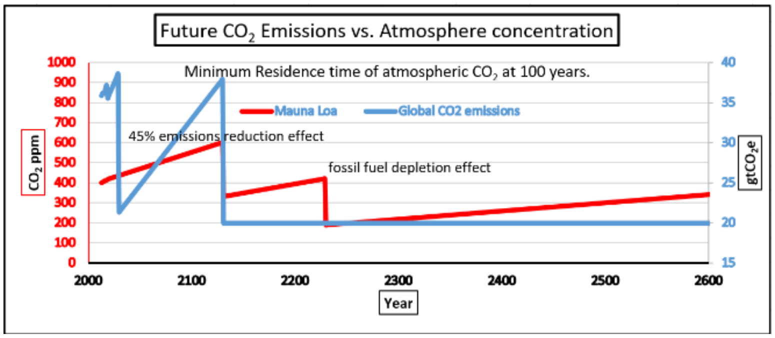
45% reduction in fossil fuel CO_2 emissions by 2030;

55% reduction in fossil fuel CO_2 emissions by 2130 due to depletion of those fuels;

By 2030, 45% reduction in the rate of rise of atmospheric CO_2.

By 2130, 45% reduction in CO_2 concentration

2230 55% reduction in CO_2 concentration and rate.



Graph 10. (D. White 2020)

Working to lower emissions will never lower atmospheric CO_2.

Even at a minimum residence time of 100 years, Mauna Loa carbon dioxide never stays low. We never reach equilibrium! (See Graph 9.)

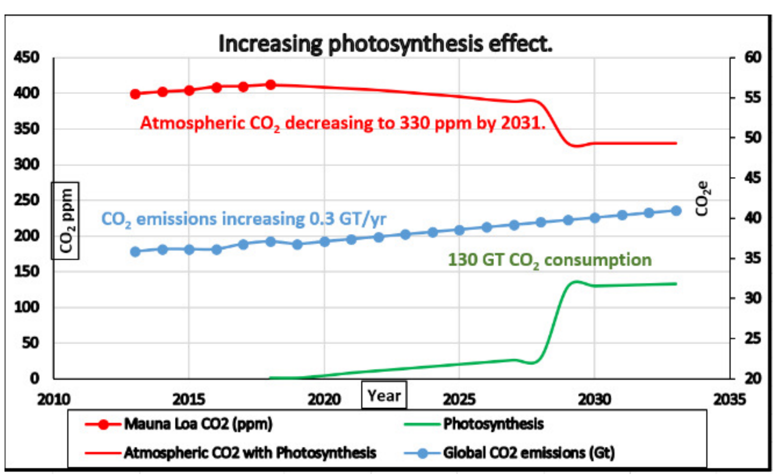
(Q4) What strategies can be employed to have the greatest positive impact over the upcoming crucial twelve-year period?

Planting trees will act as the single greatest weapon we have in the fight against climate change, and it is the only way to reduce atmospheric carbon dioxide to a value of 330 ppm by 2031 (Robert Scribbler 2020). When we plant trees *en masse* to regrow our forests, within twelve years we will be positioned to end climate change because this will increase the equilibrium from 8.6 GT to over 100 $GTyr^{-1}$ (See Graph 9). Our survival and the promise of life for future generations are dependent not upon cap and trade policies or mitigation strategies, but rather upon trees. This increases the equilibrium from 8.6 $GTyr^{-1}$9.2 GT to over 100 $GTyr^{-1}$ within twelve years (See Graph 10). The world economic forum recently announced a resolution to plant 1 trillion native trees [28]. We heartily endorse this effort (World Economic Forum Jan 2020).

CONCLUSION

In this research paper, we have answered the four main questions in the abstract. We have shown two methods for determining the calculation of the correct equilibrium point (NetZero CO_2): first, by calculating photosynthesis worldwide; and second, by calculating that the decreasing oxygen level worldwide is below what is needed for life. We have also shown that atmospheric CO_2 is still rising even faster although the CO_2 emissions rise has slowed by 50%. Question 4 is answered here. We showed how cap and trade policies would have zero effect on the rise of atmospheric carbon dioxide because the equilibrium point is too low. The strategy with the most positive effect on lowering atmospheric CO_2 is by increasing photosynthesis. This will in turn increase the equilibrium point to over 100 $GTyr^{-1}$. 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 native trees and shrubs, especially in those areas that have been deforested. This will cause atmospheric CO_2 to lower to 330 ppm by 2031 (see Graph 11). Use ecosia.org for internet search engine. Ecosia.org plants trees.

Dr. Tom Crowther (Crowther et al. 2019) 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}. Not every forest hectare is equivalent in photosynthesis consumption of CO_2. Rainforests consume 90-100 tons per hectare of carbon dioxide per annum. Other forests are from one quarter to 8 tons per hectare per annum.



Graph 11. Increasing Photosynthesis Effect (D. White 2020)

Acknowledgments

This research article has received no funding from any outside sources. All work performed by the authors has been done without any compensation. The goal of Climate Change Truth, Inc. Is to follow the data. The goal of The Energetic Health Institute Is to share Information from the heart for the betterment of all.

Data Availability Statement

Data will be available in the link provided. https://www.ncei.noaa.gov/

Conflict of Interest Statement

The authors have no conflict of interest that we are aware of.

Appendix 1.

Ideas on How to Plant Trees and Shrubs

Following is a government policy guide to lower atmospheric carbon dioxide quickly.

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 switching caused the recent rise in atmospheric carbon dioxide concentration of 53 ppm (D. White, 2019). 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 4 billion trees and will plant seven billion more in the next four years. Since May 2018, these countries have planted more than 4 billion trees.

References

2017 data http://www.repositioncruises.com/cruise-industry/#statistics

A. Baccini Et al. 2017 Tropical forests are a net carbon source based on aboveground measurements of gain and loss. Science 13 Oct 2017: Vol. 358, Issue 6360, pp. 230-234 DOI: 10.1126/science.aam5962

Brienen, R. *et al.* 2015 Long-term decline of the Amazon carbon sink. *Nature* 519, 344–348 (2015). https://doi.org/10.1038/nature14283

Emily Chasan 2019 "We Already Have The World's Most Efficient Carbon Capture Technology"

Bloomberg Businessweek August 2019. https://www.bloomberg.com/news/features/2019-08 02/we-already-have-the-world-s-most-efficient-carbon-capture-technology

Crowther et al. 2019 *Science* 05 Jul 2019: Vol. 365, Issue 6448, pp. 76-79 DOI: 10.1126/science.aax0848

D. White, 2019 Discovery: Reduction in Photosynthesis Correlation to Carbon Dioxide Increase, ACTA SCIENTIFIC AGRICULTURE (ISSN: 2581-365X) Volume 3 Issue 4 April 2019 https://actascientific.com/ASAG/pdf/ASAG-03-0393.pdf

D. White 2020 Statistical regression

https://issues.pangaea.de/secure/attachment/142070/regression.xlsx

Ethiopia 2019 Ethiopia Plants Over 350 Million Tress In A Day, Setting New World Record"

United Nations Environment August 2019. https://www.unenvironment.org/news-and-stories/story/ethiopia-plants-over-350-million-trees-day-setting-new-world-record

Ficks diffusion 2018 http://cctruth.org/Ficks%20diffusion.pdf

Flight Center, Greenbelt, 5 Maryland, USA

https://sites.agu.org/newsroom/files/2015/09/2015GB005139.pdf

Natalya Gallo 2014 Ocean Deoxygenation http://oceanscientists.org/index.php/topics/ocean-deoxygenation

Global Carbon Atlas 2020 http://www.globalcarbonatlas.org/en/CO2-emissions

CHRISTINE L. GOODALE et al. 2002 FOREST CARBON SINKS IN THE NORTHERN HEMISPHERE, Ecological Applications, 12(3), 2002, pp. 891–899 q 2002 by the Ecological Society of America http://www.eeb.cornell.edu/goodale/2002%20GoodaleEcolAppl.pdf

Jianping Huang et al 2018 The global oxygen budget and its future projection https://www.sciencedirect.com/science/article/pii/S209592731830375X

IPCC WG I 2003 https://archive.ipcc.ch/ipccreports/tar/wg1/016.htm

E. Kintisch, 2017 Amazon rainforest ability to soak up carbon dioxide is falling, doi:10.1126/science.aab0336, http://www.sciencemag.org/news/2015/03/amazon-rainforest-ability-soak-carbon-dioxide-falling, 2017

Machida et aL. 2002 VERTICAL AND MERIDIONAL DISTRIBUTIONS OF CO2 https://ps.uci.edu/~rowlandblake/publications/177.pdf

Kenzie Mastroe 2019 https://www.sheknows.com/living/articles/2086062/amazon-rainforest-fires-2019/

NOAA gr 2020 https://www.esrl.noaa.gov/gmd/ccgg/trends/gr.html

NOAA weekly 2020 https://www.esrl.noaa.gov/gmd/ccgg/trends/weekly.html

Oxygen Levels 2019 https://www.oxygenlevels.org/

Rogelj, J et al. 2018: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate carbon dioxide.

C. Rose, et al 2015, The Characterization of Feces and Urine: A Review of the Literature to Inform Advanced Treatment Technology, Crit Rev Environ Sci Technol. 2015 Sep 2; 45(17): 1827–1879.

Max Roser 2015 Very Long-Term Perspective on Deforestation in Specific Regions https://ourworldindata.org/forests

Cecile S. Rousseaux et al 2015 Global Modeling and Assimilation Office, NASA Goddard Space

SEDAC 2020 Center for International Earth Science Information Network - CIESIN - Columbia University. 2018. Population Estimation Service, Version 3 (PES-v3). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4DR2SK5

Hans R. Schneider et al. 1989 An Evaluation of the Role of Eddy Diffusion in Stratospheric Interactive Two-Dimensional Models https://doi.org/10.1175/1520-0469(1989)046<2079:AEOTRO>2.0.CO;2

Schwartz, 2018 Unrealized Global Temperature Increase: Implications of Current Uncertainties, 07 March 2018, DOI: (10.1002/2017JD028121)

Robert Scribbler 2020 https://robertscribbler.com/2016/08/05/carbon-sinks-in-crisis-it-looks-like-the-worlds-largest-rainforest-is-starting-to-bleed-greenhouse-gasses/

Takahashi 1997 Ocean Surface CO2 https://www.pmel.noaa.gov/co2/story/LDEO+Surface+Ocean+CO2+Climatology

Takahashi, Taro et al. 2008 Climatological mean and decadal change in surface ocean pCO2, and net sea–air CO_2 flux over the global oceans. https://doi.org/10.1016/j.dsr2.2008.12.009

Welty et al, 1984 Fundamentals of Momentum Heat and Mass transfer.

http://bcs.wiley.com/he-bcs/Books?action=index&bcsId=4049&itemId=0470128682

World Economic Forum Jan 2020. https://www.weforum.org/agenda/2020/01/one-trillion-trees-world-economic-forum-launches-plan-to-help-nature-and-the-climate/