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

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ABSTRACT

In this research paper, 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 sequestration of carbon dioxide, in gigatonnes, essential for global atmospheric homeostasis? For the purposes of this discussion we have termed this numeric goal Net Zero Carbon Dioxide Emissions (NetZeroCO2e). We have determined that numeric goal to be NetZeroCO2e=8.6 gtyr-1 and demonstrate our consideration in calculating this number in the discussion below. (Q2) Why is atmospheric carbon dioxide rising even though recent data confirms that the Rate of Rise of carbon dioxide emissions has slowed by 50% since 2014 globally? We believe this is because Residence Time for atmospheric carbon dioxide has increased to hundreds of years due to massive deforestation and the subsequent loss of photosynthesis essential for carbon sequestration from the atmosphere. (Q3) Are carbon dioxide cap and trade policies the best immediate intervention, or can we quickly and effectively solve this global atmospheric problem by planting trees, increasing global photosynthesis, and carbon dioxide sequestration? (Q4) What strategies can be employed to have the greatest immediate & long-term positive impact over the upcoming crucial twelve-year period?

The single greatest known absorbers of carbon dioxide out of our atmosphere are living organisms that use photosynthesis, of which trees offer the greatest carbon sequestration potential known today. Therein lies the most under-discussed solution to the greatest problem of our time. Could it really be that planting trees in the billions over a 10 year period is really the most effective and cost-effective solution? The answer to that scientific inquiry is unequivocally affirmative. A single hectare of healthy Amazon Rainforest can sequester up to 100 tons of carbon dioxide annually due to photosynthesis. And the fast-growing deciduous 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 carbon dioxide annually due to photosynthesis (Emily Chasan 2019).

Prior to the dawn of the Industrial Revolution (circa 1760) 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 carbon dioxide per annum via photosynthesis. As of 2019, that has been reduced dramatically as global forests now consume less than an estimated 10 billion tons of carbon dioxide per annum via photosynthesis (Max Roser 2015).

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 gigatonnes (healthy rain-forests and other forests) circa 1700 to as little as 10-12 gigatonnes 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 carbon dioxide emissions) 36.8 gigatonnes 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. Our forests are the lungs of our planet. Without them, our planet, and all life dependent upon it, simply cannot breathe.

Significance Statement

The vast majority of climate experts agree that there has been a five-times increase in carbon dioxide emissions due to human related factors since 1870. While fossil fuel carbon emissions have been confirmed to be approximately thirty-seven gigatonnes annually and does contribute to the climate change discussion, during this same period the photosynthetic sequestration 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 gigatonnes due to photosynthesis. However, as of 2020, calculated estimates now have annual carbon dioxide consumption due to photosynthesis below ten gigatonnes. Deforestation has resulted in a massive global loss of carbon dioxide sequestration of more than 390 gigatonnes per year, an inconvenient truth that is simply no longer sustainable. This deforestation also caused the residence time of atmospheric carbon dioxide to increase to over 150 years. Therefore, anything we have done or will do to reduce emissions of carbon dioxide will have no effect for hundreds of years. 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. Additionally we coined a new variable. Effective Carbon dioxide emissions (ECE). ECE is calculated by subtracting the photosynthesis annually from total emissions of carbon dioxide.

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

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 (NetZeroCO_2e) has not been defined. What number, in gigatonnes, is the target goal that would give us atmospheric equilibrium? How much carbon dioxide needs to be consumed annually to get to the NetZeroCO_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 NetZeroCO_2e target goal is zero, meaning that every year we would need to absorb 36.8 gigatonnes of carbon dioxide. Others simply use the term NetZeroCO_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 NetZeroCO_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 lead author has calculated the NetZeroCO_2e to be 8.6 gigatonnes 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 gigatonnes. Therefore, a NetZeroCO_2e of 8.6 gigatonnes means that in order for us to achieve atmospheric equilibrium and global environmental homeostasis, we must re-establish our ability to sequester 26.9 gigatonnes (26.9 billion tons) of carbon dioxide 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) Deliberate endlessly and without action over international policy and legislation that global industry will ultimately challenge before a neutered version becomes a law that must then be enforced through costly regulatory investigation and subsequent legal action.

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 carbon dioxide 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 gigatonne of carbon dioxide 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 gigatonnes of carbon dioxide 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 carbon dioxide 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 carbon dioxide 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. Therefore this number is false. The lead author performed expert review of IPCC SR 1.5 Chapter two "Mitigation" (Dave White 2019).
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. **(Embellish this)**

Forest Photosynthesis

Southern Hemisphere

The Southern Hemisphere (SH) has much less land than the Northern Hemisphere, however it does have rainforests. At least six rain forests are in the SH (A. Baccini Et al. 2017). Unfortunately, the Amazon Rainforest has switched to become a massive carbon dioxide producer and oxygen sink (D. White, 2019), (Max Roser 2015), (Robert Scribbler 2020). Decay ingests oxygen and emits carbon dioxide, the decay contribution from the Amazon Rainforest is now ten to fifteen billion more tons of carbon dioxide annually with a corresponding loss of oxygen. This is from a conservative calculation of five tons of decay per acre per year. Other research published manuscripts show 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).

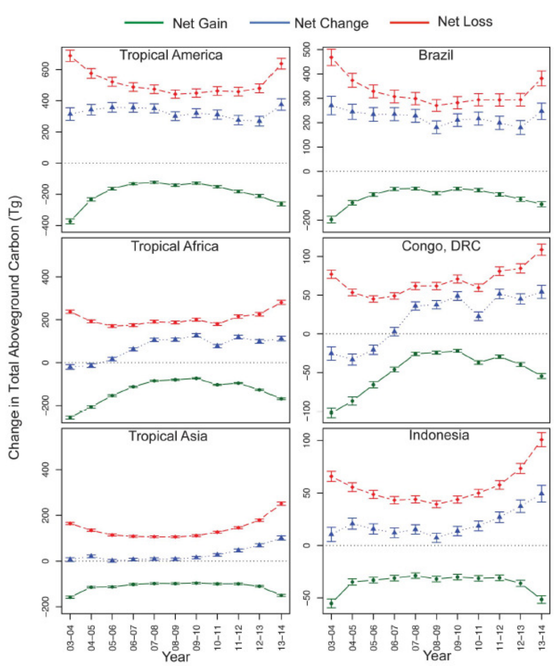


Figure 1. All southern hemisphere tropical forests have switched to be an oxygen sink and carbon dioxide producer. Annual net change (95% confidence interval) in total carbon. Red lines indicate a loss in carbon; green lines indicate a gain. Blue lines reflect the difference

between losses and gains. The vertical bars indicate the standard error of the change value. (A. Baccini Et al. 2017)

In 2009, the 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 gigatonnes (90 billion tons) carbon dioxide consumption is lost annually from Amazon Rainforest switching, 2.5 times our carbon dioxide emissions at 37.1 gt CO_2eyr^{-1}. The worldwide massive deforestation is why the minimum residence time of atmospheric carbon dioxide is increasing.

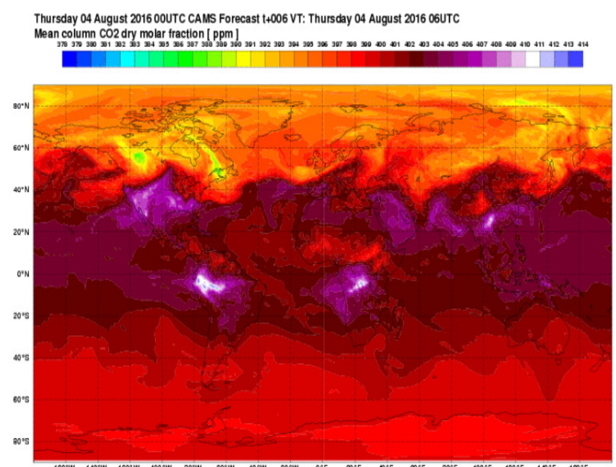
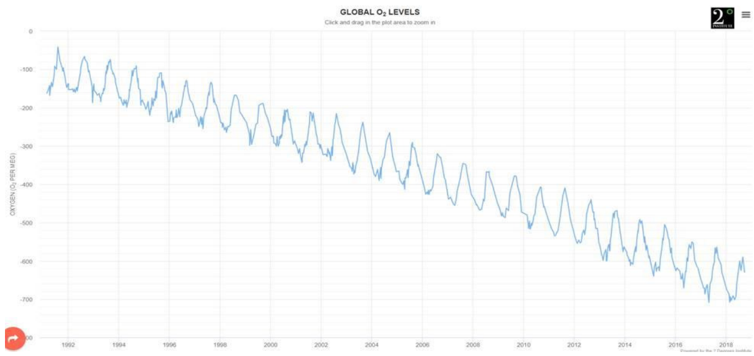


Figure 2. Amazon Rainforest Switched (Takahashi, Taro et al. 2008)

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 $gtyr^{-1}$ (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)

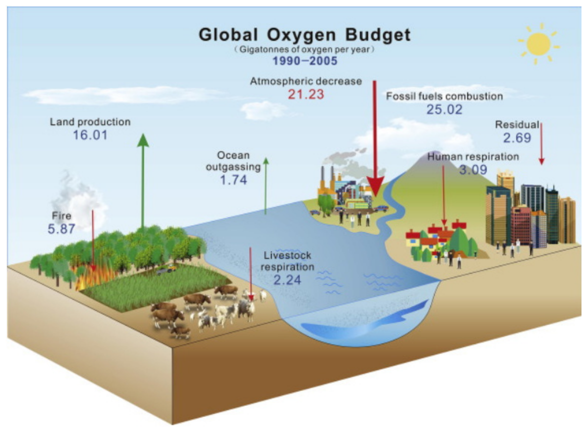
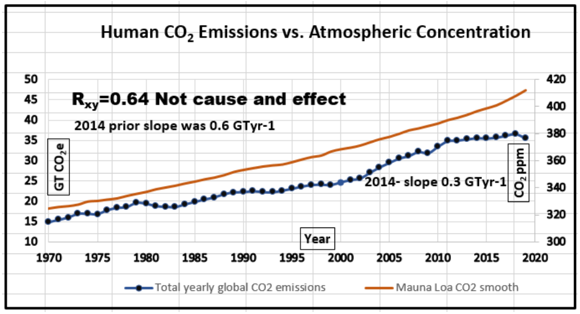


Figure 3. Worldwide Oxygen Budget (Jianping Huang et al 2018)

(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?

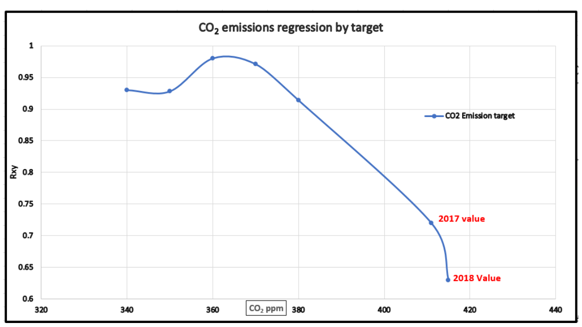
The logical reason that atmospheric carbon dioxide continues to rise in spite of carbon dioxide emissions rate of rise decreasing in half globally (see Figure 7) is that we do not have enough trees (primarily due to deforestation) to photosynthetically reabsorb carbon dioxide from the atmosphere. Additionally, 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 gigatonnes 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 gigatonnes 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 carbon dioxide is still increasing (see Graph 6). This confirms no effect on atmospheric carbon dioxide rise by slowing emissions.



Graph 2. (D. White 2020)

The lead author has graduate studies in Statistics. His graduate school statistics professor taught these truths. 1) Throw away what statistics we learned previously. 2) As much as we can we need to group data into two variables to make the analysis easier. 3) Just because two variables are increasing at the same time does not say they have a relationship any more than two people walking down a street together. Even if they turn into the same home, you need to investigate the relationship to see what kind it is. The lead author investigated the relationship of atmospheric carbon dioxide and carbon dioxide from emissions. 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 2019 it is now 0.64. The main author performed regression by target and CO_2 emissions correlate to 363 ppm (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

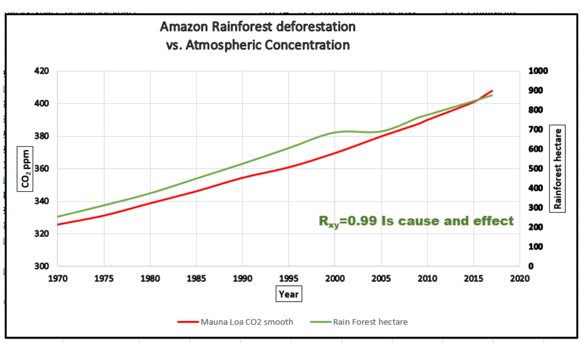
Table 1. Pearson's Regression (D. White 2020)

Table 1 shows Pearson's regression by target starting at the inflection point (1950).

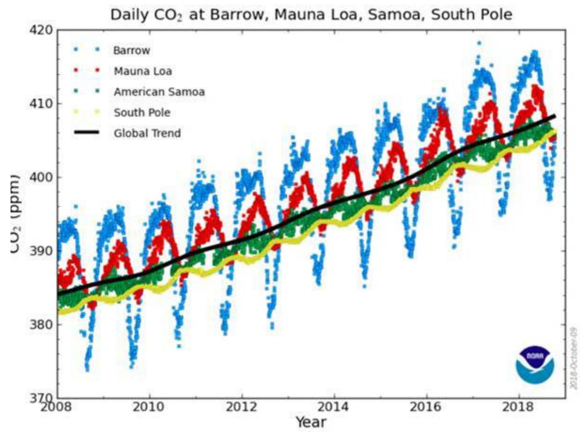
Natural and human carbon dioxide emissions correlate to 363 ppm and are a contributor but not the cause of the rise of atmospheric carbon dioxide since 1957.

Effective CO_2 Emissions

Effective carbon dioxide emissions are emissions per year after subtracting the total photosynthesis consumption for the year. For example, the worldwide emissions for 2019 are 35.9 gt. The worldwide photosynthesis is 8.6 GT. Thus, the effective emissions would be 27.3 gt. Calculating it this way and working backwards in time tells the actual effect. Instead of the emissions effect being at 135 ppm of atmospheric carbon dioxide, it would be 81 ppm from Effective carbon dioxide Emissions (ECE). This correlates well with total emissions effect at 363 ppm. See the ECE tab on the regression spreadsheet (D. White 2020 Statistical regression). The lead author made a linear reduction model of photosynthesis. This is reasonable since the main non-sustainable deforestation mass is the Amazon Rain-forest. The amount deforested per year in the Amazon Rain-forest is approximately the same.



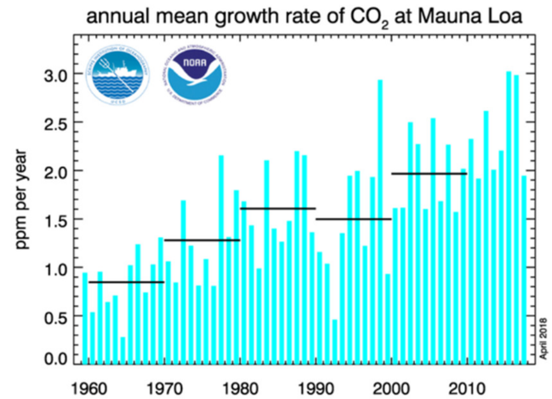
Graph 4. Rain forest deforestation vs. Atmospheric CO_2 rise.(D. White 2020)



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 carbon dioxide 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 papers have been published on this. Currently, the Amazon output is 15 $GTyr^{-1}$ of carbon dioxide. 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)

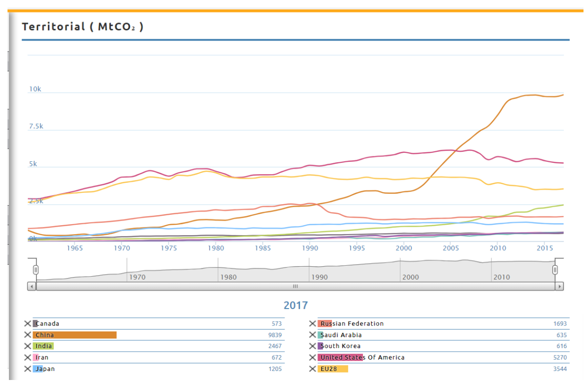


Figure 5. Global Carbon Emissions (Global Carbon Atlas 2020)

The rate of rise of atmospheric carbon dioxide 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 carbon dioxide 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 tCO_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 carbon dioxide is similar to the area with carbon dioxide (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 carbon dioxide by the decay process. For carbon dioxide the molecular weight is 36 and carbon is 4. Thus, the weight increases by nine for each carbon converted. Consequently, 73 million tons of carbon dioxide 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 carbon dioxide 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.

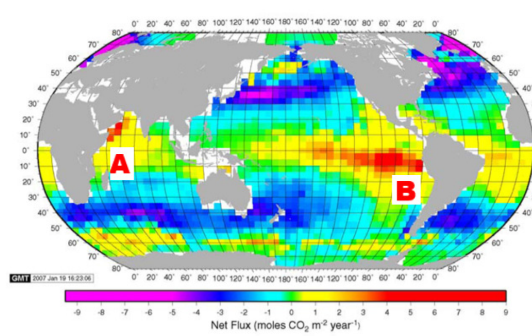


Figure 6. Ocean CO_2 Flux (Takahashi 1997)

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), carbon dioxide has the following diffusion coefficients:

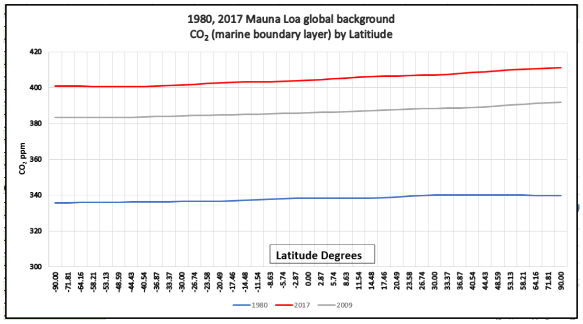
In air: 16 mm^2/s

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

carbon dioxide 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 carbon dioxide 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. Carbon dioxide that goes into the ocean is from any disturbance of ocean surface (e.g. hurricanes) that allows carbon dioxide 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 Figure 8). 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!

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

Figure 11. Ficks First Law (Welty et al, 1984)



Graph 7. CO_2 mixed by atmospheric winds. (D. White 2020)

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})	$\pm\sigma$ (μatm y^{-1})		SST (°C y^{-1})	$\pm\sigma$ (°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.

Figure 12. Diffusion by latitude in SH (Takahashi, Taro et al. 2008)

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. **Worldwide**

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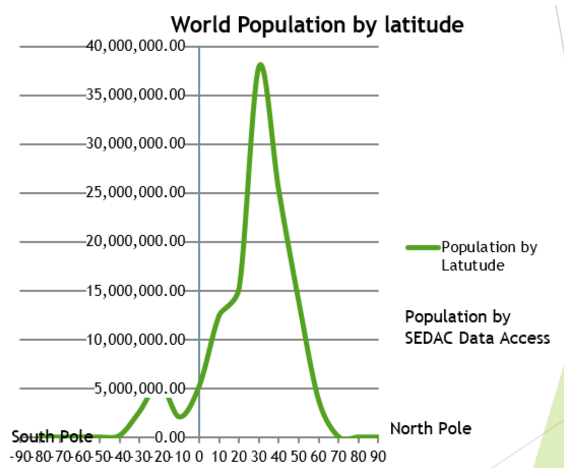


Figure 13. SEDAC Data access Population (SEDAC 2020)

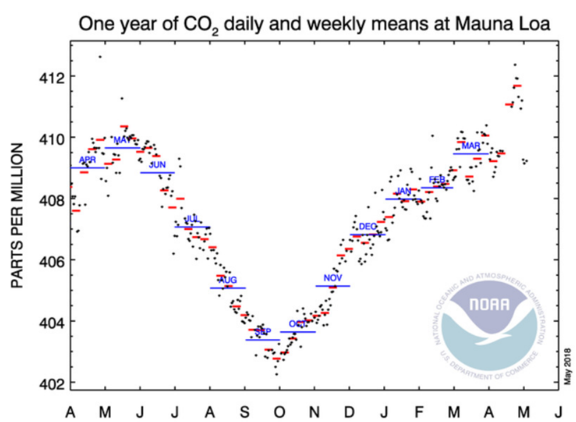
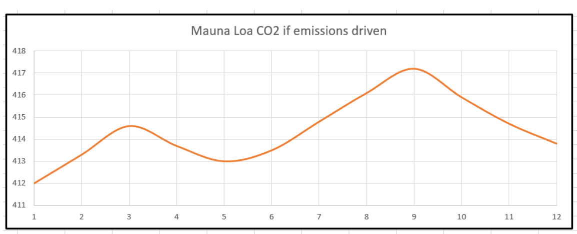


Figure 14. Mauna Loa oscillation. (NOAA weekly 2020)



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

Residence time is like standing water in a plugged kitchen sink. The water is “residing” longer than normal, but residence time is a range of time, depending on how plugged the sink is and whether the faucet is dripping. Atmospheric carbon dioxide is like the standing water in the sink, and the drain is the forest. Residence time is increasing due to massive, worldwide deforestation.

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 carbon dioxide is increasing even though the worldwide emissions of carbon dioxide 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 dioxide, the drain restriction is the issue. This is why residence time is increasing. Cap and Trade will never lower atmospheric carbon dioxide. We need to increase photosynthesis consumption, the drain, which will lower atmospheric carbon dioxide to a value around 330 ppm by 2031. This cannot be accomplished by emissions work. Anything we do with carbon dioxide emissions has not and will not have any effect on atmospheric carbon dioxide 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 carbon dioxide 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 carbon dioxide?” 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.

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).

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

Assumptions

Constraints for Graph 9 below:

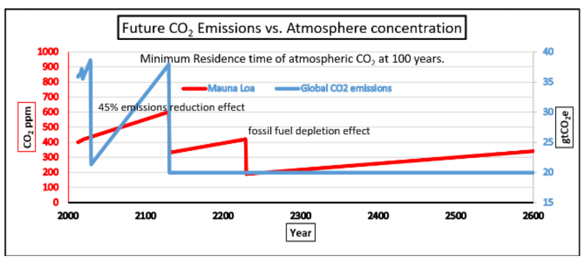
45% reduction in fossil fuel CO_2 emissions by 2030;

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 9. (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.)

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?

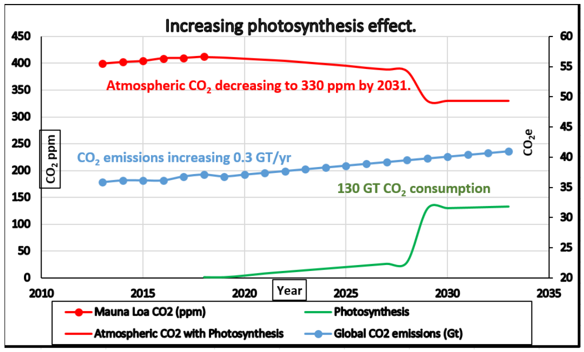
The vast number of IPCC (Intergovernmental Panel on Climate Change) reports indicate that atmospheric carbon dioxide is caused by increasing fossil fuel emissions of carbon dioxide. Many climate change scientists believe the IPCC reports without skepticism. The United States and Europe have worked on reducing emissions of carbon dioxide for thirty years, since circa 1990. The rate of rise of emissions of carbon dioxide has been reduced by 50% due to various efforts (e.g. LED lightbulbs, cleaner fuel-burning cars with better fuel economy, solar panels, and wind power); however, atmospheric carbon dioxide is still increasing (see graph 2). In addition, the residence time is increasing because of world-wide, non-sustainable deforestation (see table 2).

Therefore, it is obvious that atmospheric carbon dioxide is never lowered through efforts to reduce fossil fuel emissions of carbon dioxide (see graph 9). 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 carbon dioxide is still rising even faster although the carbon dioxide 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 carbon dioxide 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 carbon dioxide to lower to 330 ppm by 2031 (see Graph 10). 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 carbon dioxide to over 100 gt yr^{-1}. Not every forest hectare is equivalent in photosynthesis consumption of carbon dioxide. 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 10. Increasing Photosynthesis Effect (D. White 2020)

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Data Availability Statement

Data will be available in the link provided. This data is backed up nightly. https://cctruth.org/regression.xlsx has the data.

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Conflict of Interest Statement

The authors 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 life on Earth.

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 in science about climate change. For the past three years, he applied his chemical engineering degree to learning photosynthesis as a primary means to lower atmospheric carbon dioxide.
His graduate statistics professor taught that just because two variables are increasing at the same time doesn't mean they have a relationship any more than two people walking down the street together have a relationship—until they walk into the same home. Even then, one has to investigate the relationship to see what kind it is. Dave investigated the relationship of carbon dioxide emissions and atmospheric carbon dioxide. The rise of carbon dioxide since 1957 is only partially caused by emissions of CO_2 (363 ppm). The true cause is massive deforestation.
His research interests are evaporation from the ocean, rainforest deforestation effects, and diffusion of CO_2 through the atmosphere.

Henele E'ale (Dr. H)

Dr. H is a licensed Naturopathic Doctor and founder of the Energetic Health Institute, a school that promotes natural medicine and holistic strategies for healing our people and our planet.

He is deeply committed as well to promoting the responsible care of the environment and the health of all life on Earth.

Henele Eale graduated with a B.S. in Mechanical Engineering from UCLA in 1996, and with a Doctorate in Naturopathic Medicine from Southwest College of Naturopathic Medicine in 2007, with an emphasis in

Environmental (Detoxification from Chemical Body Burden) Medicine. Following graduation, he opened his first practice of natural medicine while also teaching at Arizona State University and several local technical schools. In 2010, he published his first work, 'Energetic Health, vol. 1', and in 2013 he founded the Energetic Health Institute to develop exceptional students into professionally certified Holistic Nutritionists. He has since authored over 120 peer-reviewed works on Natural Medicine, Organic Plant-based Nutrition, Meditation, Natural Detoxification, Clinical Fasting, Safe Use of Medical Cannabis, Myofascial Bodywork, Yoga, Botanical Medicine, Anatomy, Physiology, Biochemistry, Traditional Chinese Medicine, Ayurvedic Medicine, Holistic Business, Holistic Practice of Medicine, and Regenerative Agriculture.

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 seven billion tons worldwide annually (**REF**).

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.(**REF**)
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}) (REF).

All embassy environmental scientists have concurred with this science and have encouraged their countries to plant trees. China is planting millions of trees (REF) . India stopped deforestation of its rainforest and is planting trees (REF). Pakistan has already planted one billion trees and will plant nine billion more in the next four years (**REF**) . Since May 2018, these countries have planted more than 2.5 billion trees.