# We are in a $CO_2$ drought – Not much time left for life on planet Earth

Brendan Godwin
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**Abstract**

At the current permanent sequestration rate of $CO_2$ into Limestone, all life of all forms on planet Earth could be extinct in as short as 54,286 years as we run out of $CO_2$.

## The circle of life on planet Earth

Oxygen $O_2$, Carbon Dioxide $CO_2$, water $H_2O$ and Sun light form the circle of life on our planet Earth. All of our food comes either directly or indirectly from plants. All the protein grain crops we eat directly. Cattle eat grass and we eat cattle. All our food is processed $CO_2$. Without plants there is no life of any form on Earth.

When plants grow they are fed with water. They breath in $CO_2$ and, through a process of photosynthesis with the Sun, they breath out $O_2$. Animals and humans breath in that $O_2$ and breath out $CO_2$. We humans breath out 40,000 ppm of $CO_2$. Plants need a minimum of 150ppm of $CO_2$ to grow.[i] The more $CO_2$ they get the less water they need and *visa versa*.[ii] Commercial greenhouses up the amount of $CO_2$ in the greenhouse to 1,000 – 2,000 ppm for optimal plant growth.[iii]

The effect of increasing levels of atmospheric CO2 on plant growth. The numbers are additional CO2 above ambient, and total atmospheric CO2, suggesting relative CO2 starvation from right to left.


Atmospheric CO2 is an essential plant fertilizer, delivered free daily to every plant on earth and is not a toxin. At levels

The numbers in the photo's indicate the amount of additional CO2 that has been introduced into the atmosphere, and the numbers below the total atmospheric CO2 content in parts per million.

THE CO2 DEBATE https://www.dr-robert-fagan.com/the-co2-debate/

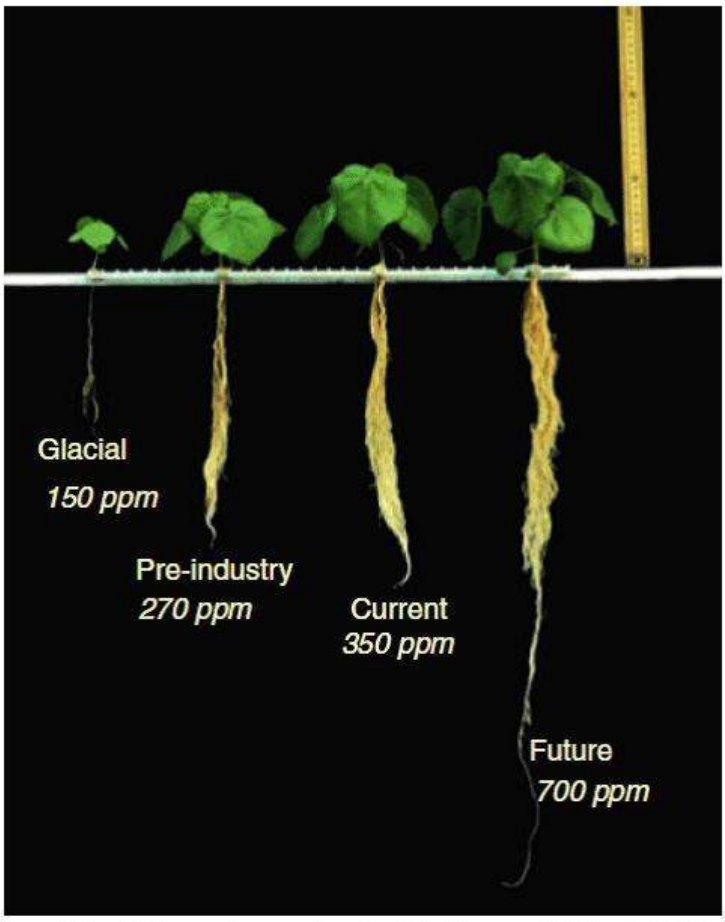
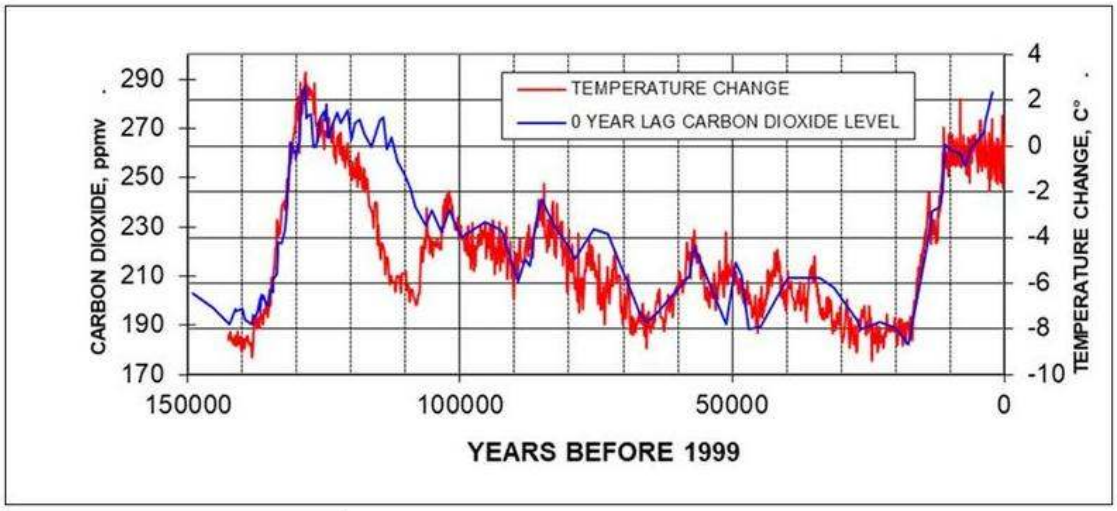



**Fig. 15 from the review by Gerhart and Ward 2010**

Without $CO_2$ we are all extinct.

**Sequestration**

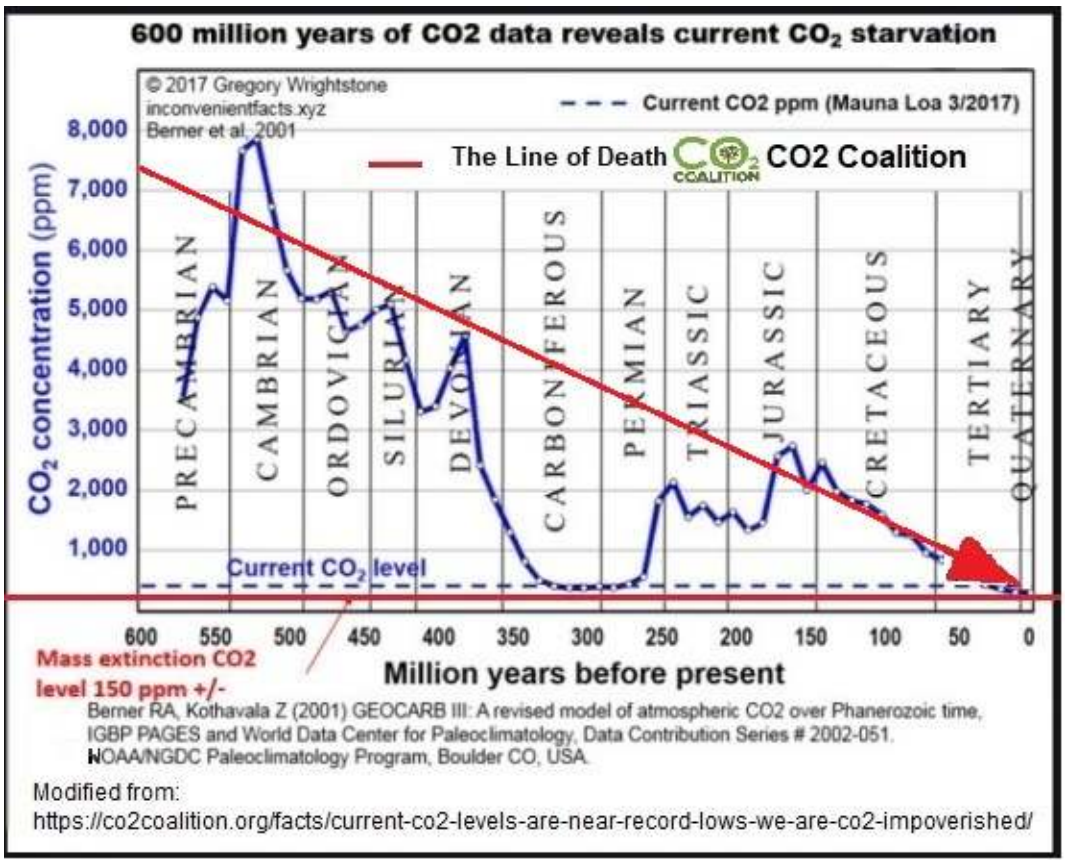
During ice ages the cold oceans sequester $CO_2$ out of the atmosphere and into the oceans.[iv] During the last ice age which ended just 12,000 years ago, $CO_2$ dropped to 180 ppm. Plants do not grow with $CO_2$ at 150 ppm or less. There is evidence of plant stress during this last ice age period.[v] All our food comes from plants. Without $CO_2$ there will be no plants and therefore no life on planet Earth at all. We were a mere 30 ppm short of the total extinction of all life on Earth.




CO2 & T from Vostok data

Pangburn 2008

Further, $CO_2$ is outgassed back into the atmosphere during interglacial warm periods. But it is also sequestered out of the oceans and into limestone. This is a permanent sequestration out of the ocean/atmosphere system. $CO_2$ has been gradually taken out of the system for the past 500 mil years. We are now in a severe $CO_2$ drought. We are only a few more ice ages away from there being not enough $CO_2$ to sustain life on Earth when all life will go extinct.



**Types of Limestone**

There are two different types of limestone. Biological Limestone where organisms capable of forming calcium carbonate, crushed coral, shells and skeletons, can thrive and easily extract the needed ingredients from ocean water. Coral reefs become limestone the moment that the living polyp builds the calcium carbonate chamber in which it lives. And Chemical Limestone formed from the weathering materials of calcium carbonate and calcium from limestone and igneous rock. The materials in biological limestone already contain carbon in the form of calcium carbonate $CaCO_3$. The weathering products of igneous rocks capture carbon by reactions with seawater and ground waters to form limestone. The capture of the $CO_3$ ion is the main process, and that comes from the breakdown of carbonic acid. Weathered limestone contains some carbon as $CO_3$ and captures $CO_2$ from the ocean. Most limestone is biological and comes from coral reefs. Chemical limestones *are thought to be less abundant than biological limestones*.[vi]

Most Limestone is essentially what used to be coral reefs. [vii] The term 'sand' means a clastic (broken reef debris) grain size of about 0.1mm to 1mm. Most sandstones consist of quartzose clastic material, but some limestones are also composed of sand-sized grains of carbonate; these latter rocks are called calcarenites.[viii] When defining limestone and sandstone, the scientists at the time decided that all rocks containing Calcium Carbonate $CaCO_3$ were classified as limestone.[ix] Then there is sedimentary limestone formed from Urey's reaction which is both a recycling of limestone previously sequestered from the atmosphere along with the weathering components of igneous rocks.

Coral is an animal. It's food source is algae called zooxanthellae which lives in the tissues of coral. The algae use *sunlight and carbon dioxide* (from the ocean waters) *to make sugars in the process of photosynthesis* which *make up 98 per cent of the food for the coral*.[x] Limestone masses accumulate from coralline debris in mainly shallow waters in all oceans of the world, and are transformed by time and by plate tectonic processes into major outcrops on land and in the highest of mountains.

For a geology lesson on the make up and formation of limestone from a geologist, see the following short video.[xi]

> "*Guadalupe Mountains in West Texas, which is another 270 million year old limestone formation. It's an ancient coral reef which is thousands of feet thick. As sea levels rose, the coral reef grew with it. . . . Coral reefs adjust to whatever the current sea level is. The sea levels have always been moving up and down so long as there has been oceans on the Earth. Yet coral reefs have thrived and prospered despite changes in sea level, changes in temperature and changes in atmospheric carbon dioxide*."

Below is another example of an ancient coral reef, the Winjana Gorge in the Canning Basin of Western Australia.

*Note the classic buildup of a reef complex. There is the active reef core where much of the coralline activity takes place; basinwards one gets an active erosional foreslope of coarse clastic material (broken reef debris) cemented by secondary calcite; these deposits extend further into the basin and gradually become laminated muddy limestones. Behind the reef core one gets more laminated limey rocks – back-reef finer grained limestones comprised of limey silts and mud.*[xii]

Tony Heller makes the distinction between Earth and Venus. Venus has 96% $CO_2$ in it's atmosphere. Earth has the equivalent amount of $CO_2$ in limestone and carbonate rocks. The difference between the two planets is that Earth has 71% oceans with lots of water. That allows coral reefs and shellfish to grow and extract $CO_2$ into what ultimately becomes limestone. Without oceans, Earth would still have 95% atmospheric $CO_2$.

Limestone can be found 8,000 feet up the Grand Canyon and also at the top of Mt Everest.

> "*As two crustal plates collide, heavier rock is pushed back down into the earth's mantle at the point of contact. Meanwhile, lighter rock such as limestone and sandstone is pushed upward to form the towering mountains. At the tops of the highest peaks, like that of Mount Everest, it is possible to find 400-million-year-old fossils of sea creatures and shells that were deposited at the bottom of shallow tropical seas. Now the fossils are exposed at the roof of the world, over 25,000 feet above sea level.*
>
> *The peak of Mount Everest is made up of rock that was once submerged beneath the Tethys Sea, an open waterway that existed between the Indian subcontinent and Asia over 400 million years ago."*[xiii]

"The summit of Mount Everest was actually the seafloor 470 million years ago" [xiv]

Patrice Poyet wrote in his book:

> "*99.9618% of the $CO_2$ ever present in the atmosphere has been removed by natural processes over geological times and stored in one form or another, the major storage being limestones and carbonated rocks more generally,* [xv] *see e.g. for a discussion of Urey's reaction* (*Kellogg et al., 2019*).
>
> > The reaction extracts $CO_2$ from the atmosphere in acid rain that reacts with calcium silicates, the products are transported to the oceans where organic and inorganic processes results in the deposition of calcium carbonates.
> >
> > The basic reaction combines atmospheric $CO_2$ with a calcium silicate to generate a calcium carbonate plus silica."[xvi]

The calcium silicates that Urey refers to are the byproducts of weathering of limestone and igneous rocks.[xvii]

Returning to Poyet.

> "*carbonate weathering is not a significant contributor to changes in the amount of atmospheric $CO_2$ (Berner and Berner, 2012). This understanding is based on the following reaction showing that the weathering of carbonate on land is exactly compensated by the opposite precipitation reaction in the ocean*[56]"
>
> *(Anorthite)* $CaAl_2Si_2O_8+2CO_2+3H_2O \Rightarrow Ca^{2+}+2HCO_3^- + Al_2Si_2O_5(OH)_4$ *(Kaolinite)* *(69)*
>
> *In this mono-directional reaction we use 2 moles of $CO_2$ whereas the precipitation of calcite (using $Ca^{2+} + 2HCO_3^-$) will just liberate one (therefore the ocean operate as a $CO_2$ sink);*"[xviii]
>
> "*The carbonate reservoir (limestones and sediments) is the largest carbon reservoir at the surface of the Earth along with the fossil organic carbon reservoir. Accumulating during the Earth's geological history (essentially during the Proterozoic era), its size is estimated as > 50,000 000 Gt-C (carbonate), in the range [66,000,000 Gt-C – 100,000,000 Gt-C] and the fossil organic is > 13,000,000 Gt-C*[61] *(kerogen) (Berner and Berner, 2012). The amounts of C stored in the atmosphere and in the ocean are dwarfed in comparison at respectively 875 Gt-C (2019) and [36,000-38,000] Gt-C.*" [xix]

{E.g. There is 75,428 to 114,286 times more $CO_2$ in carbonate rock in the Earth's crust than in the atmosphere}

> **"*carbonate weathering . . . of continental surfaces consumes 0.3 Gt $yr^{-1}$ of atmospheric carbon.*"**[xx] [Emphasis added]

Limestone and sandstone form 1% of the Earth's crust with limestone being 0.25% and sandstone being 0.75%. The thickness of the Earth's crust varies with different reference sites but averaging them comes to a global average of 20 Klms thick. If you were to uniformly distribute all the limestone and sandstone evenly over Earth's surface it would be 200 metres thick with limestone being 50 metres thick.

Carbon, in all its forms, is only 0.03% of the Earth's crust[xxi] which, if you spread that evenly over the Earth's surface would only be 6 metres thick.

Contained in all the limestone is calcite or calcium carbonate $CaCO_3$, which came out of the atmosphere as $CO_2$ millions of years ago. There are many geochemistry equations involved with all these processes.[xxii]

**Igneous rock**s

> Igneous rock is formed through the cooling and solidification of magma or lava.
>
> Igneous and metamorphic rocks make up 90–95% of the top 16 kilometres (9.9 mi) of the Earth's crust by volume.[xxiii] Igneous rocks form about 15% of the Earth's current land surface.[xxiv] Most of the Earth's oceanic crust is made of igneous rock.
>
> There are relatively few minerals that are important in the formation of common igneous rocks, because the magma from which the minerals crystallize is rich in only certain elements: silicon, oxygen, aluminium, sodium, potassium, calcium, iron, and magnesium. These are the elements that combine to form the silicate minerals, which account for over ninety percent of all igneous rocks.[xxv]

**The weathering question**

Weathering of limestone and igneous rocks breaks the rock down into soluble calcium bicarbonate which is transported by the river systems back into the oceans. Some atmospheric carbon dioxide reacts with this and it ultimately forms sedimentary layers on the sea floor to form sedimentary limestone.

> *A particularly important form of dissolution is carbonate dissolution, in which atmospheric carbon dioxide enhances solution weathering. Carbonate dissolution affects rocks containing calcium carbonate, such as limestone and chalk. It takes place when rainwater combines with carbon dioxide to form carbonic acid, a weak acid, which dissolves calcium carbonate (limestone) and forms soluble calcium bicarbonate.*[xxvi]

This source of limestone is nothing much more than recycling of limestone that has already been sequestered out of the system. There is a small amount of extra atmospheric $CO_2$ added to it. It is certainly not the major source of limestone on Earth.

The IPCC have just 0.15% of $CO_2$ being sequestered out of the atmosphere into weathering of carbonate rocks, which is quite minuscule,[xxvii] and all is transported by rivers into the oceans to reform once again as limestone.

A portion of this 0.15% reacts with the calcium from the weathering of igneous rock which captures $CO_2$ dissolved in the rivers and oceans. This forms into limestone in the oceans.

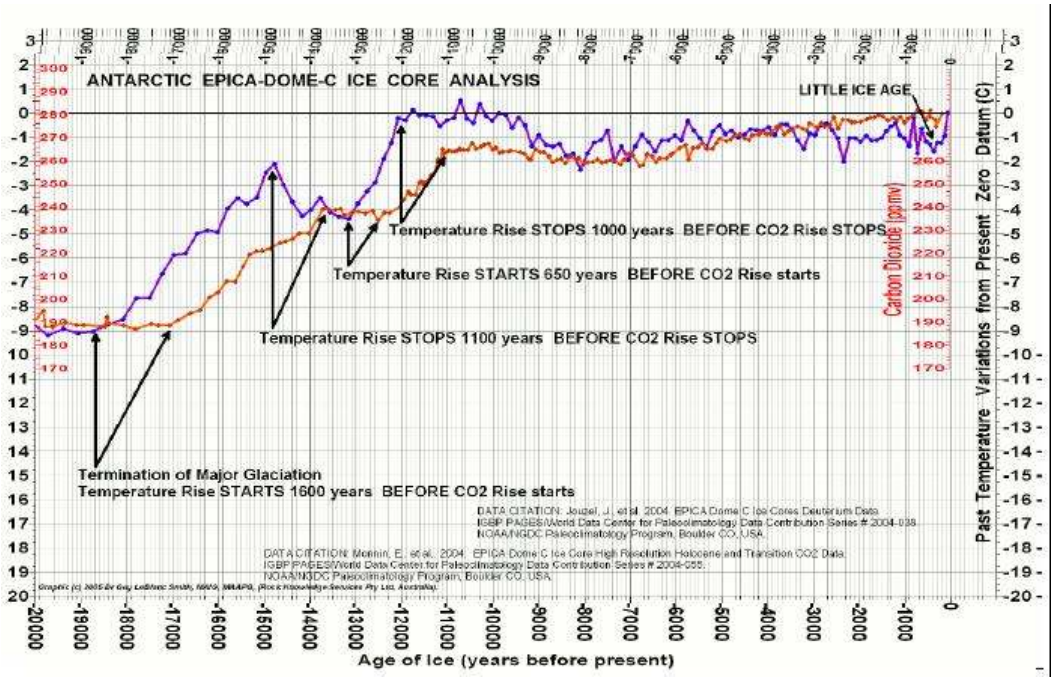
The permanent sequestration of $CO_2$ out of the ocean/atmosphere system via the weathering of igneous rocks into sedimentary limestone plays a reasonably significant role in the total permanent sequestration.

The mantle and core will continue to release $CO_2$ via volcanoes, as it has done so since the beginning of planet Earth. But if you look at the concentration of atmospheric $CO_2$ over geological timescale chart above, volcanic emissions have never been enough to prevent the decline of $CO_2$ over time meaning the permanent sequestration via coral into limestone and weathering of igneous rocks into limestone by far outweighs volcanic release back into the system.

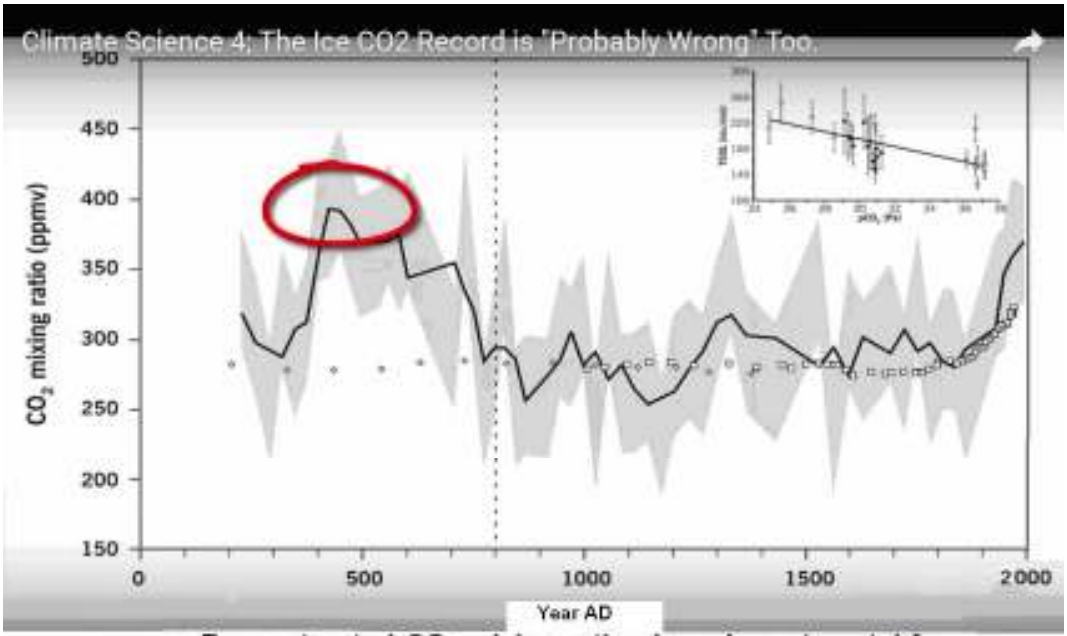
**Not much time left**

Our Sun has been burning for approximately 4.5 billion years and still has approximately another 4.5 billion years to go. Human civilization will not last that long. At the current rate that $CO_2$ is being sequestered into limestone we will be lucky to last another 2 to 3 ice ages, 200,000 to 300,000 years before all the $CO_2$ will be sequestered out of the ocean/atmosphere system, atmospheric levels will drop below 150 ppm and all life on Earth above sea level will be extinct. Life below sea level will go on for another few hundred thousand years before all the oceans stocks have been sequestered into limestone and then all sea life will also go extinct.

If you look at the concentration of atmospheric $CO_2$ over geological timescales chart above and extend that down trend line, it has almost passed the 150 ppm level. We were a mere 30 ppm short of that level in the last ice age. However we may have been given a reprieve. The warm oceans are currently outgassing and forming a new higher equilibrium with the atmosphere. That should be sufficient to see us through the next ice age. That is not a guarantee though. There is always the error of mixing proxy with measured data. Ice core proxy data shows $CO_2$ levels during the current Holocene not rising above 300 ppm until the 20$^{th}$ century.




From a study of stomatal frequency in fossil leaves, $CO_2$ levels were shown to be as high as 500 ppm during the current Holocene.[xxviii]




Reconstructed $CO_2$ mixing ratios based on stomatal frequency counts on *Tsuga heterophylla* needles for A.D. 800–2000. Black line connects means of 3–5 needles per sample; thick white line shows three-point moving average. Gray area indicates confidence interval of ±1 root mean standard error. White squares—$CO_2$ data from Law Dome ice core (Etheridge et al., 1996); white diamonds—$CO_2$ data from Taylor Dome ice core (Indermühle et al., 1999).

Kouwenberg et al 2004

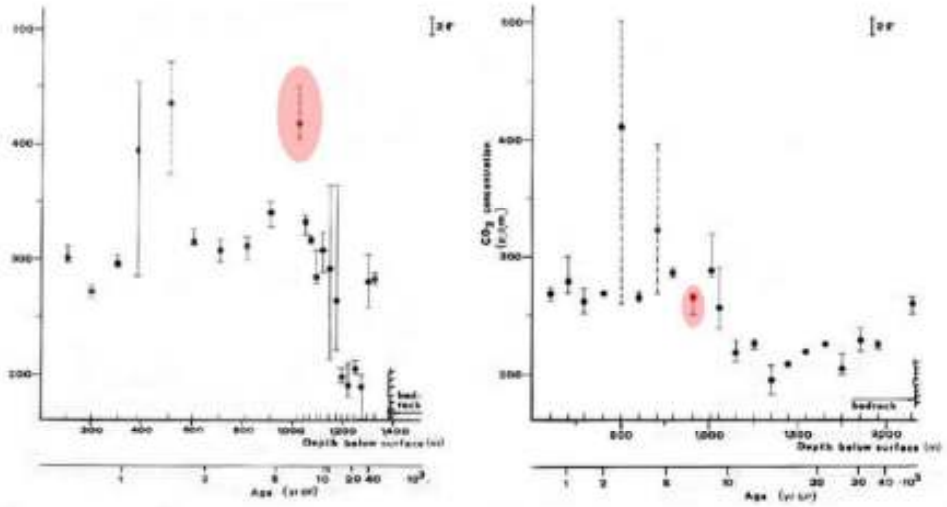


Figure 74. *$CO_2$ concentrations in the bubbles and total carbonate content of: a, the Camp Century core; b, the Byrd core. The $CO_2$ concentrations are presented with the lowest, highest and median values for each depth. The dashed lines indicate depths were drill fluid was observed in the large sample. Maximum $CO_2$ values of 500 ppm at 500m (~300 years) for the Byrd Core. Modified after: Fig.1 in (Neftel, 1982) with anomalies as pink ellipses ~7,000-year BP added.*

Poyet, P., 2021. The Rational Climate e-Book. Ch. 2.4.5

Referring to the last ice age and Holocene periods, Dr Robert Ian Holmes says:

> *Why does the plant stomata record show a highly variable record for atmospheric $CO_2$, ranging by 250ppm, when at the same time the ice core record for the same period shows a monotonic record varying by just 20ppm?*

He puts the variance down to the Knudsen diffusion effect. And cites *Kowalewski et al 2006*,[xxix] *Johnsen et al 2001* & *Jaworowski et al 1992*.

> *Now this is when the pressure in there to diffusion happens in the ice. So above a pressure of 300 bar this diffusion may significantly effect the $CO_2$ record contained in the ice. Effectively minimising variations by reducing maximums and the minimums. So the dissociation pressure for $CO_2$ may be set as low as 5 bar say Jaworowski 1992.*[xxx] *Very important questions are raised here whether the ice core record for $CO_2$ mirrors the true variability and the true maximums of historical atmospheric $CO_2$ levels.*

Holmes says: *the ice core record for $CO_2$ is almost certainly wrong*.

If Poyet's calculations are correct, the time for that extinction event could be even shorter. There are 38,000 Gt-C in the ocean reservoir. Poyet calculates that the weathering of continental surfaces consumes 0.3 Gt $yr^{-1}$ of atmospheric carbon. To that we need to add the sequestration into coral which is greater. Say 0.4 Gt $yr^{-1}$ (estimate) making a total of 0.7 Gt $yr^{-1}$. Dividing that into the 38,000 Gt-C in the ocean we get just 54,286 years left before all the ocean $CO_2$ reservoir is used up.

All of this means that it is entirely possible we could drop down below 150 ppm in $CO_2$ concentrations during this coming ice age. Our time left on planet Earth could be very short, less than 1 ice age. Dr Robert Fagan is more conservative. He has a depletion rate for $CO_2$ at 4ppm/million years. At that rate we have 100 million years left.[xxxi] Javier Vinós says:[xxxii]

> *Continental silicate weathering by $CO_2$ is a process dependent among other things on temperature. If the planet's temperature decreases, silicate weathering rate slows down leading to $CO_2$ accumulation*

**The solution**

The only way to avert life extinction is to process all that limestone and get the $CO_2$ back into the atmosphere. We would have to do it on a much larger scale than we are currently doing it though. Total human $CO_2$ emissions into the atmosphere from making cement from limestone and burning fossil fuels are just 4%-6% of the total emissions.[xxxiii] The oceans are outgassing at a much faster rate that that.[xxxiv] Once the next ice age sets in and the cold oceans sequesters the $CO_2$ back into the oceans and further into limestone, that will likely be at a faster rate than 4%-6% We would not be able to keep up. We would need to up that rate of emission to save life on planet Earth.

Strange as it may seem we have people who are trying to bury $CO_2$ underground and remove it from the atmosphere. They seem hell bent on fast tracking the extinction of life on Earth.

**We have enough Oxygen**

One final point. Some of the residents of planet Earth are concerned that the removal of forests reduces the rate that $CO_2$ is changed back to $O_2$. Plus burning fossil fuels and manufacturing cement is increasing the rate $O_2$ is changed back to $CO_2$. I.e. They are concerned we will run out of $O_2$ to breath while at the same time concerned that increasing $CO_2$ is causing some sort of damage to the climate system.

Firstly, fossil fuels contain no $CO_2$, they only contain carbon C. When burnt, the C reacts with the $O_2$ in the air to produce $CO_2$. Burning $CO_2$ reduces the amount of oxygen in the air.

Cement on the other hand is made from limestone. Limestone contains calcite or calcium carbonate $CaCO_3$. $CO_2$ is a by product of cement manufacturing from Limestone in a chemical process and is released to the atmosphere during that process. Cement manufacturing does not use any atmospheric oxygen.

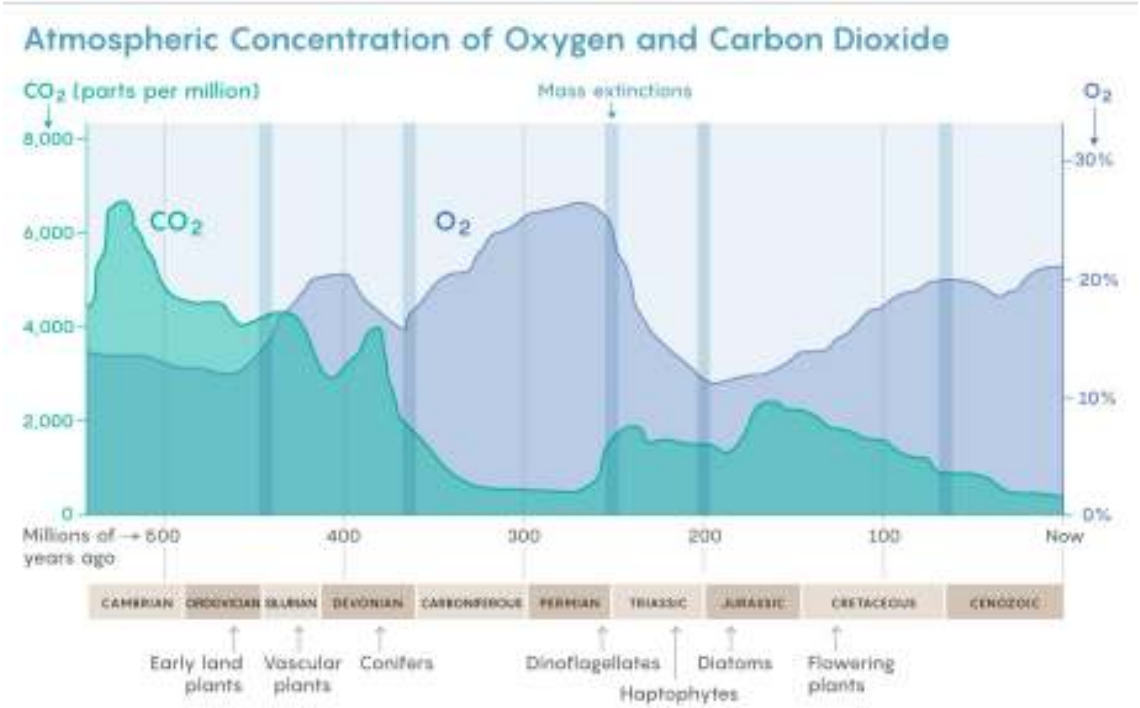
Over the past 500 mil years $O_2$ levels have overall gradually risen and ranged between approx 12%-25%. At 21% now it is close to it's 500 mil year all time high. At the same time, however, $CO_2$ concentrations have steadily fallen from several thousand ppm to just 180ppm 20,000 years ago during the last ice age. Whilst we need $O_2$ to

breath, we also need $CO_2$ for photosynthesis for food production. All our food comes from plants. Plants do not grow without $CO_2$.

Dinosaurs lived between about 245 and 66 million years ago when $O_2$ was 12%-18% and $CO_2$ was 1,000ppm-2,000ppm. There was enough $O_2$ for them to breath and plenty of $CO_2$ for plant growth which they needed for food.

Humans can breath at 10,000 feet where $O_2$ is 14.3%[xxxv]

| Altitude (Feet) | Altitude (Meters) | $O_2$ Monitor Reading | Effective Oxygen Percentage | Similar Location |
|---|---|---|---|---|
| Sea Level | Sea Level | 20.9% | 20.9% | Hypoxico HQ - New York, NY |
| 10,000 | 3048 | 14.3% | 14.3% | Leadville, CO (10,200 ft. - 3109m) |




xxxvi

$CO_2$ emissions from burning fossil fuels, and hence, the reduction of $O_2$ in the atmosphere, is only a few percent of total $CO_2$ emissions. $O_2$ levels are up near their all time highs over the past 500 mil years. The small about of $O_2$ used to burn fossil fuels is not going to make a huge difference to total atmospheric levels. Carbon is only 0.03% of Earth's crust. However we are all but totally out of $CO_2$ to grow our food crops. We are at an historic 500 mil year low. We are in a severe $CO_2$ drought. The small amount of $CO_2$ we are currently emitting is no where near enough. We need way way more. Burning all the fossil fuels will not be enough and make little difference to Earth's atmospheric oxygen levels. There is not enough stored carbon in fossil fuels in the Earth to be able to restore atmospheric and ocean $CO_2$ levels back to normality.

We need to process the $CO_2$ out of limestone. That does not reduce $O_2$ in the atmosphere and will mean stockpiling cement.

**$CO_2$ has zero effect on the climate system**

But to say that $CO_2$ is causing some sort of damage to the climate system is hysterics.

$CO_2$ has zero effect on the climate. No one has ever provided any scientific proof that it does. They only have theories. There are zero scientific papers in the empirical records that show, from observations based on experiment, $CO_2$ has a warming effect on Earth. There are experiments that show the contrary. The following papers explain why $CO_2$ has zero effect on climate.[xxxvii]

If you were to excite almost every $CO_2$ molecule in the atmosphere with IR Radiation you do not generate enough energy to boil a kettle. There is not enough energy in all $CO_2$ molecules to provide any warming effect at all to the Earth.[xxxviii] In any event, the warming of the $CO_2$ molecules in the atmospheric is energy the Earth's surface gave up to the molecules. In giving up that energy the Earth's surface cooled creating a balance. There is no net extra warming and no new heat.[xxxix]

The only thing that keeps this $CO_2$ warming scare alive is climate models. These are more appropriately called mathematical illusions. They are all unverified and unvalidated. They are all based on false assumptions namely that $CO_2$ has a radiative forcing effect. No one has ever measured this mythical warming of the Earth from radiation from a couple of $CO_2$ molecules. There are just two scientific papers in the empirical records where there was an attempt to measure this mythical warming. They measured zero.[xl] These experiments show from measurements that there is zero radiative forcing effect from radiation from atmospheric molecules including water vapor. If the warming from radiation from these molecules is zero, it follows that the radiation forcing effect can only be zero. Despite all of this the mathematical illusions continue to falsely assume $CO_2$ has a radiative forcing value.

**Conclusion**

The Earth is in a severe $CO_2$ drought. Almost all the $CO_2$ that was ever present in our atmosphere has been permanently sequestered out into limestone. We are a miniscule amount short of not having enough to sustain any form of life on Earth.

There can be no concern with $CO_2$ levels until they reach toxic levels and that is very high. Considering the US military allow extended life in submarines with $CO_2$ levels at 7,000 ppm. The International Space Station is 5,000 ppm. Humans exhale 40,000 ppm from our lungs. It is 20,000 ppm inside a bike helmet. 4,000 ppm has never prevented the Earth from plunging into an ice age.

We are at the end of this interglacial warm period and about to enter the next ice age. During the last ice age the north pole ice cap extended down to London. New York

was under a kilometer of ice. Canada and Russia were under a number of kilometers of ice. Most of the world's arable land was under ice. We had almost no humans then. We now have close to 10 bill people to feed. The cold oceans will sequester most of the $CO_2$ out of the atmosphere. There will be very little land to grow food crops for all those people and little $CO_2$ for photosynthesis.

We need $O_2$ and $CO_2$. What is the best ratio? 15%-20% for $O_2$ and 1,000-2,000 ppm for $CO_2$ seems reasonable and sensible.

The Earth is currently in a severe $CO_2$ drought. Getting $CO_2$ back up to 2000ppm will make almost zero difference to oxygen levels and make no difference to the Earth's climate. But it will extend life on our planet.


## Acknowledgements

I would like to acknowledge and thank Patrice Poyet for all the valuable research he conducted and published in his e-book *The Rational Climate e-Book* and to the many reviewers, most of whom do not wish to be named.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"*Dippery et al. (1995)* found the most extreme response, where low [$CO_2$] (150 ppm) prevented reproduction in the modern $C_3$ annual, A. theophrasti, as a result of the abortion of all flower buds that drove the fitness response to zero. This finding suggested that 150 ppm $CO_2$ may be near the threshold for successful completion of the life cycle in some $C_3$ species. "

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https://youtu.be/2Lye5liWuZw

[iv] ***Observations and modelling of the global distribution and long term trend of atmospheric $^{14}CO_2$***
Levin et al; 2017
https://www.tandfonline.com/doi/abs/10.1111/j.1600-0889.2009.00446.x

***Basic physics and chemistry to assess the arguments used to attribute the growth of the $CO_2$ in the air to human activities***
Camille Veyres, Jean-Claude Maurin 2020
https://onedrive.live.com/?authkey=%21AA9HrXbpJ0VLtzI&cid=DDC6747C11603709&id=DDC6747C11603709%213992&parId=DDC6747C11603709%213313&o=OneUp

***Physical pathways for carbon transfers between the surface mixed layer and the ocean interior.***
Levy, M., et al., 2013.
Global Biogeochemical Cycles, Vol. 27, p. 1001-1012, DOI: 10.1002/gbc.20092
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/gbc.20092
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When the oceans are warm, they outgas $CO_2$, and when the oceans are cold atmospheric $CO_2$ dissolves into the oceans (***Fisher et al. 1999***).

***No Experimental Evidence for the Significant Anthropogenic Climate Change***
J. Kauppinen and P. Malmi (2019)
https://arxiv.org/pdf/1907.00165v1.pdf
The major part of the extra $CO_2$ is emitted from oceans [6], according to Henry`s law.

"12.742. ***Marine Chemistry. Lecture 8. Dissolved Gases and Air-sea exchange***" (PDF). Retrieved 2014-05-05.
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The science is this. Solubility of $CO_2$ in water decreases with T. Just like in beer, soda and Champagne.
http://www.engineeringtoolbox.com/gases-solubility-water-d_1148.html

[v] ***Effects of low and elevated $CO_2$ levels on $C_3$ and $C_4$ annuals***,
J. K. Dippery, D. T. Tissue, R. B. Thomas and B. R. Strain, Oecologia, Vol. 101, p. 13 (1995).
https://www.researchgate.net/publication/226937604_Effects_of_low_and_elevated_CO2_on_C3_and_C4_annuals/download

***Carbon starvation in glacial trees recovered from the L Brea tar pits, southern California***

Ward et al 2004
https://www.pnas.org/content/pnas/102/3/690.full.pdf

***Ice Age flora extinction reveals fresh plant biodiversity clues***
February 13, 2013 9.10am AEDT
http://theconversation.com/ice-age-flora-extinction-reveals-fresh-plant-biodiversity-clues-12174
Authors: Jan Wisniewski

***Fossil evidence for a hyperdiverse sclerophyll flora under a non–Mediterranean-type climate***
Sniderman et al
https://www.pnas.org/content/110/9/3423

***The Rational Climate e-Book – Final First Edition***
https://www.researchgate.net/publication/351348366_The_Rational_Climate_e-Book_-_Final_First_Editionpdf
Poyet, P., 2021. The Rational Climate e-Book: Cooler is Riskier. The Sorry State of Climate Science and Policies. Final First Edition, April 19th, 125 Figures, 185 Equations, 473 pp., e-ISBN 978-99957-1-929-6, DOI: 10.13140/RG.2.2.28648.80640;

"As studied by *Barry et al. (2002)* and reported by other authors (e.g. *Cerling et al., 1998*), a remarkable aspect of the change in the fauna of the Pakistan Siwalik sequence is that the mammalian herbivore assemblage evolves from a $C_3$-dominated to a $C_4$-dominated diet, apparently reflecting total replacement of the prevailing vegetation, the evidence pointing to global ecological change in the late Miocene, driven by gradual $CO_2$ starvation of $C_3$ plants and their replacement by $C_4$ plants (*Barry et al., 2002*)"
Ch. 2.4. Let's get back to some Geology, Astronomy, etc. 2.4.1 Past Climates - The last 66M years and the Paleocene-Eocene Maximum. – Page 136.

[vi] ***Limestone***
***What is Limestone and How is it Used?***
Article by: Hobart M. King, PhD, RPG
https://geology.com/rocks/limestone.shtml

For a comprehensive overview of limestone see also
***Limestone***
Samuele Papeschi
https://geologyistheway.com/sedimentary/limestone/

[vii] Ibid: ***Limestone***
***What is Limestone and How is it Used?***

[viii] See ***Limestone*** "*Classification of Limestones*" - Samuele Papeschi
https://geologyistheway.com/sedimentary/limestone/
See also: ***Sandstone*** - Samuele Papeschi
https://geologyistheway.com/sedimentary/sandstone/

[ix] ***What Is Sandstone?***
Everything you need to know about this sedimentary rock
Praveen P.N
By Andrew Alden
https://www.thoughtco.com/what-is-sandstone-1441016

***Carbonate Rocks*** - Samuele Papeschi
https://geologyistheway.com/sedimentary/carbonate-rocks/

[x] 03. ***SPONGES & CORALS***
3(d) ***Structure, Classification and Function of Corals***
https://www.qm.qld.gov.au/microsites/biodiscovery/03sponges-and-corals/structure-classification-function.html

[xi] ***The Difference Between Earth And Venus***
By Tony Heller, Real Climate Science, Nov 22, 2019

https://realclimatescience.com/2019/11/new-video-the-difference-between-earth-and-venus/

[xii] Geoff Derrick. Geologist. Personal correspondence.

[xiii] ***The Geology of Mount Everest***
The History of the World's Tallest Mountain
By Stewart Green
Updated May 18, 2018
https://www.liveabout.com/geology-of-mount-everest-755308

[xiv] ***Summit Limestone***
http://www.montana.edu/everest/facts/summit-limestone.html

[xv] IBID ***The Rational Climate e-Book*** Poyet 2021; [Ch. 2.3.4) Temperature results from the Gravitational Lapse Rate – Page 50]

[xvi] ***On the Role of the Urey Reaction in Extracting Carbon From the Earth's Atmosphere and Adding It to the Continental Crust***
November 2019; Frontiers in Astronomy and Space Sciences 6
DOI: 10.3389/fspas.2019.00062
Louise Helen Kellogg; Donald L. Turcotte; Harsha Lokavarapu
https://www.researchgate.net/publication/336979504_On_the_Role_of_the_Urey_Reaction_in_Extracting_Carbon_From_the_Earth's_Atmosphere_and_Adding_It_to_the_Continental_Crust

[xvii] Calcium silicate comes from limestone and is a key ingredient in cement manufacturing.
***Cement Manufacturing Process***
Jalal Afsar August 30, 2012
https://www.engineeringintro.com/uncategorized/cement-manufacturing-process/

[xviii] Ibid. Poyet 2021 Page 53.

[xix] Ibid. ***The Rational Climate e-Book*** Poyet 2021; Ch 2.3.5) $CO_2$ removal from the Atmosphere. Page 54.

[xx] IBID. ***The Rational Climate e-Book*** Poyet 2021; Ch 2.3.5) $CO_2$ removal from the Atmosphere. 54 & 55.

[xxi] ***Chemical Composition of the Earth's Crust - Elements***
https://www.thoughtco.com/chemical-composition-of-earths-crust-elements-607576
By Anne Marie Helmenstine, Ph.D. February 18, 2020

[xxii]
a. Colder ocean waters accept more $CO_2$ into solution; warmer ocean waters release $CO_2$ as $CO_2$ is less soluble in cooler waters.
b. Calcium carbonate occurs dissolved in seawater and fresh waters.
c. Calcium derives from the weathering of Ca-bearing minerals in rocks, like plagioclase, and it is present in water as $Ca^{2+}$ ions.
d. Atmospheric $CO_2$ dissolves in water producing $H_2CO_3$ (carbonic acid), a weak acid, following the reaction: **$CO_2(gas) + H_2O(liquid) \rightleftharpoons H_2CO_3$**
e. $H_2CO_3$ dissociates in water as carbonate [$CO_3^{2-}$] and bicarbonate [$HCO_3^-$] ions:
f. $H_2CO_3 \rightleftharpoons H+ + HCO_3$ and $HCO_3^- \rightleftharpoons H+ + CO_3^{2-}$
g. The precipitation of calcium carbonate [$CaCO_3$] from water is, hence, balanced by the reaction: $Ca_2+ + 2HCO_3^- \rightleftharpoons CaCO_3 + H_2CO_3$

Calcite is slightly soluble in water, where it dissociates to $Ca^{2+}$ and $(CO_3)^{2-}$, following the reaction:

$$Ca^{2+} + (CO_3)^{2-} \rightleftharpoons CaCO_3$$

The dissolution of carbonates is favoured by low temperature, high pressure, or high amounts of $CO_2$ dissolved in water. On the other hand, high temperatures, low pressures, or any process leading to a decrease of dissolved $CO_2$ favour the precipitation of carbonates from water. In nature, the balance between dissolution and precipitation is controlled both by inorganic and organic processes. In particular, many marine life forms are responsible for the formation of the vast majority of carbonate rocks, since organisms

either produce shells and other skeletal parts of carbonates or cause the precipitation of carbonate as a by-product of their activities.
***Carbonate Rocks*** - Samuele Papeschi
https://geologyistheway.com/sedimentary/carbonate-rocks/

[xxiii] *Prothero, Donald R.; Schwab, Fred (2004). Sedimentary geology : an introduction to sedimentary rocks and stratigraphy (2nd ed.). New York: Freeman. p. 12. ISBN 978-0-7167-3905-0.*

[xxiv] 15% is the arithmetic sum of the area for intrusive plutonic rock (7%) plus the area for extrusive volcanic rock (8%).[1]

1. *Wilkinson, Bruce H.; McElroy, Brandon J.; Kesler, Stephen E.; Peters, Shanan E.; Rothman, Edward D. (2008). "Global geologic maps are tectonic speedometers—Rates of rock cycling from area-age frequencies". Geological Society of America Bulletin. **121** (5–6): 760–779. Bibcode:2009GSAB..121..760W. doi:10.1130/B26457.1.*

[xxv] https://en.wikipedia.org/wiki/Igneous_rock

[xxvi] **Wikipedia**
https://en.wikipedia.org/wiki/Weathering

***Factors controlling carbonate dissolution rates quantified in a field test in the Austrian alps***.
Geomorphology. 68 (3–4): 201–212.
Lukas Plan, (June 2005).
doi:10.1016/j.geomorph.2004.11.014.
https://www.sciencedirect.com/science/article/abs/pii/S0169555X04003101?via%3Dihub
https://coek.info/queue/pdf-factors-controlling-carbonate-dissolution-rates-quantified-in-a-field-test-in-th.html

[xxvii] **IPCC AR5 Ch 6 Pg 471**

[xxviii] IBID ***The Rational Climate e-Book*** Poyet 2021 Final 1st Ed.; Ch. 2.4.5 Page 192. Glaciers, Ice-Cores, Arctic and Antarctic. Fig. 75.
The Sorry State of Climate Science and Policies. Final First Edition, April 19th, 125 Figures, 185 Equations, 473 pp., e-ISBN 978-99957-1-929-6, DOI: 10.13140/RG.2.2.28648.80640
https://www.researchgate.net/publication/351348366_The_Rational_Climate_e-Book_-_Final_First_Editionpdf

See also:

***The Ice $CO_2$ Record is "Probably Wrong" Too***
https://youtu.be/WNEQo6lk9ko
1000frolly
Robert Ian Holmes PhD

***Atmospheric $CO_2$ Fluctuations during the Last Millennium Reconstructed by Stomatal Frequency Analysis of Tsuga heterophylla Needles***
L.L.R. Kouwenberg; Friederike Wagner-Cremer; Wolfram Michael Kürschner; Henk Visscher
January 2005 Geology 33(1):33
DOI: 10.1130/G20941.1
https://www.researchgate.net/publication/46653974_Atmospheric_CO2_Fluctuations_during_the_Last_Millennium_Reconstructed_by_Stomatal_Frequency_Analysis_of_Tsuga_heterophylla_Needles

[xxix] ***Quantifying low rates of summertime sublimation for buried glacier ice in Beacon Valley, Antarctica September 2006***
Antarctic Science 18(03):421 - 428
DOI: 10.1017/S0954102006000460
Kowalewski; David Marchant; J.S. Levy; James Head
https://www.researchgate.net/publication/231963656_Quantifying_low_rates_of_summertime_sublimation_for_buried_glacier_ice_in_Beacon_Valley_Antarctica

[xxx] ***Do glaciers tell a true atmospheric $CO_2$ story?***
April 1992 - Science of The Total Environment 114(12):227-284
https://doi.org/10.1016/0048-9697(92)90428-U
Z. Jaworowski; Tom Segalstad; N. Ono
https://www.researchgate.net/publication/223504148_Do_glaciers_tell_a_true_atmospheric_CO2_story

[xxxi] Ibid Fagan.

[xxxii] ***Climate of the Past, Present and Future: A scientific debate, 2nd ed.***
by Javier Vinós; 2nd Ed., 2022
https://www.amazon.com/Climate-Past-Present-Future-scientific-ebook/dp/B0BCF5BLQ5; Page 145

[xxxiii] **IPCC AR5 Ch 6 Pg 471**

***Scrutinizing the carbon cycle and $CO_2$ residence time in the atmosphere***
Hermann Harde 2017
http://www.sciencedirect.com/science/article/pii/S0921818116304787/

[xxxiv] ***Increase in $CO_2$ Concentrations is coming from the Oceans***
Brendan Godwin ; March 2021
https://www.researchgate.net/publication/350162788_Increase_in_CO_2_Concentrations_is_coming_from_the_Oceans

[xxxv] https://hypoxico.com/altitude-to-oxygen-chart/

[xxxvi] ***How Earth's Climate Changes Naturally (and Why Things Are Different Now)***
https://www.quantamagazine.org/how-earths-climate-changes-naturally-and-why-things-are-different-now-20200721/
https://d2r55xnwy6nx47.cloudfront.net/uploads/2020/07/CO2-chart-2.jpg

For an alternative source of paleo oxygen data see:

***Evolution and physiology of neural oxygen sensing***
August 2014 - Frontiers in Physiology 5(302)
http://dx.doi.org/10.3389/fphys.2014.00302
Kauê Machado Costa; Daniela Accorsi-Mendonça; Davi JA Moraes; Benedito H Machado
https://www.researchgate.net/publication/264759228_Evolution_and_physiology_of_neural_oxygen_sensing

[xxxvii] ***Delay Time for Terrestrial InfraRed Radiation to escape Earth's Atmosphere-2020b***
https://www.researchgate.net/publication/346967791_Delay_Time_for_Terrestrial_InfraRed_Radiation_to_escape_Earth's_Atmosphere-2020b

***The misleading Greenhouse Effect Theory is falsified by experiment***
https://www.researchgate.net/publication/348077950_The_misleading_Greenhouse_Effect_Theory_is_falsified_by_experiment

***Earth cannot heat itself by it's own radiation***
Published on May 26, 2022
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*https://www.essoar.org/doi/10.1002/essoar.10511457.1*

[xxxviii] ***Can InfraRed radiation energy from RAG molecules heat the Earth?***
Brendan Godwin; 18th March 2021
DOI: 10.13140/RG.2.2.35982.69446
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https://www.essoar.org/doi/10.1002/essoar.10508859.3

[xl] ***The Response of the Ocean Thermal Skin Layer to Variations in Incident Infrared Radiation***
Elizabeth W. Wong Peter J. Minnett (23 March 2018) https://doi.org/10.1002/2017JC013351
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And:

***A Discussion on the Absence of a Measurable Greenhouse Effect***.
Postma, J. E., 2012
Principia Scientific International, 84 pp., October, 22, 2012,
http://principia-scientific.org/publications/Absence_Measureable_Greenhouse_Effect.pdf

> *No "greenhouse effect" is observed in the measured data.*

A third experiment was conducted that did not measure real atmospheric and Earth data. A synthetic earth surface and atmosphere was build and a GHE was simulated. The experiment was conducted poorly and a lot of experimental data was missing.

However at the conclusion of the experiment a paper was written and published. Raising the $CO_2$ level from 0.04% to 100% made no difference to measured temperatures in the synthetic atmosphere. The greenhouse effect was zero.

***The Influence of IR Absorption and Backscatter Radiation from $CO_2$ on Air Temperature during Heating in a Simulated Earth/Atmosphere Experiment***
Thorstein O. Seim, Borgar T. Olsen; 2020
Atmospheric and Climate Sciences, 10, 168-185.
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