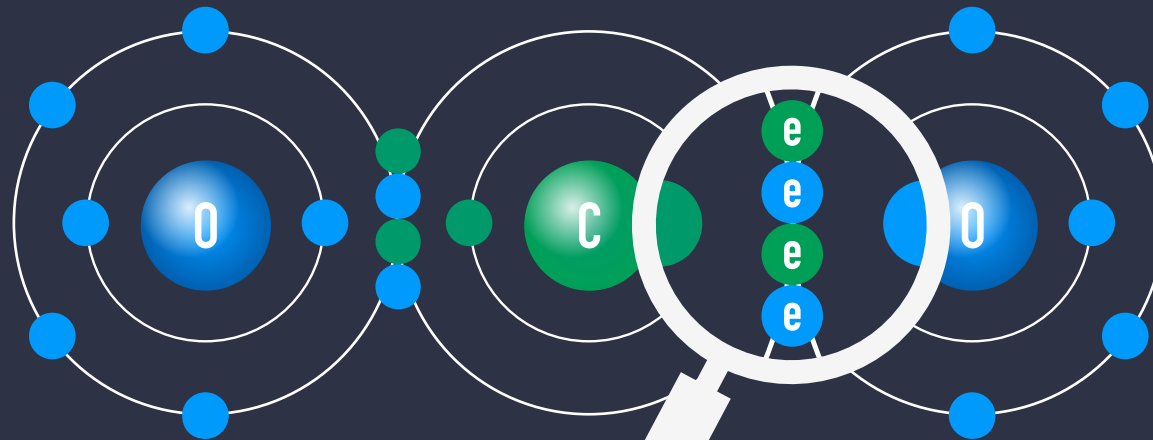


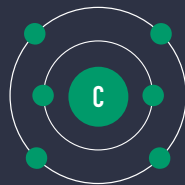
N° 1 THE WORLD OF CO₂

CO₂ – CARBON DIOXIDE MOLECULE
1 carbon atom and 2 oxygen atoms

e Each oxygen atom provides
2 electrons to the carbon atom



CARBON
Atomic N° 6
Solid



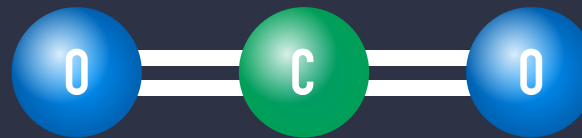
6 Protons and 6 Neutrons
6 Electrons 1s² 2s² 2p²
Electrons per shell: 2, 4
Carbon can form up to 4 bonds

OXYGEN
Atomic N° 8
Gas



8 Protons and 8 Neutrons
8 Electrons 1s² 2s² 2p⁴
Electrons per shell: 2, 6
Oxygen can form up to 2 bonds

CO₂ MOLECULE

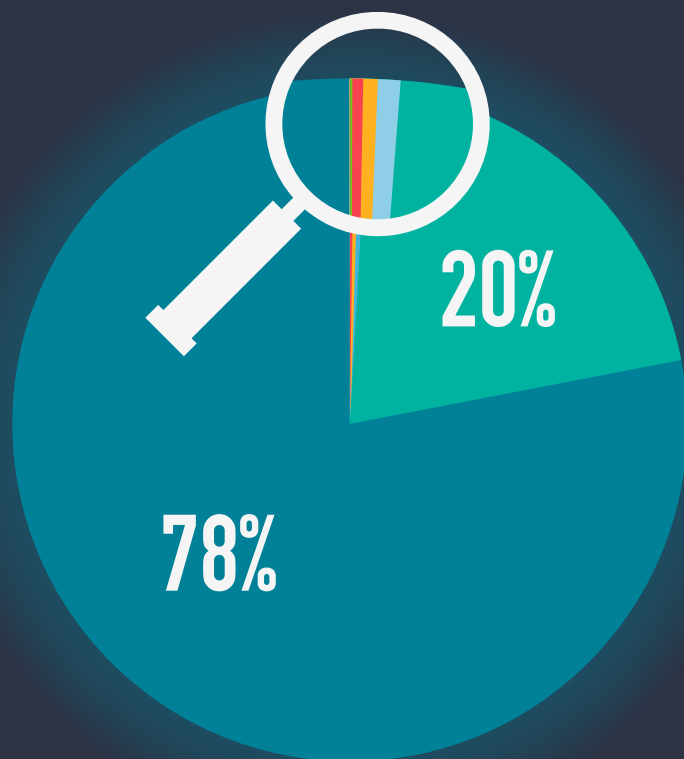


Reference: https://en.wikipedia.org/wiki/Carbon_dioxide

N° 2 THE WORLD OF CO₂

EARTH'S ATMOSPHERIC COMPOSITION

parts per million (ppm)



78% N₂ NITROGEN
780,840 PPM

20% O₂ OXYGEN
209,500 PPM

2.5% H₂O WATER*
25,000 PPM

.93% AR ARGON
9,300 PPM

.04% CO₂ CARBON*
415 PPM**

.01% REMAINING*
GASES

* The so called „variable gases“ are those present in small and variable amounts. These include **carbon dioxide**, methane, ozone, **water vapor**, and particulates among others.

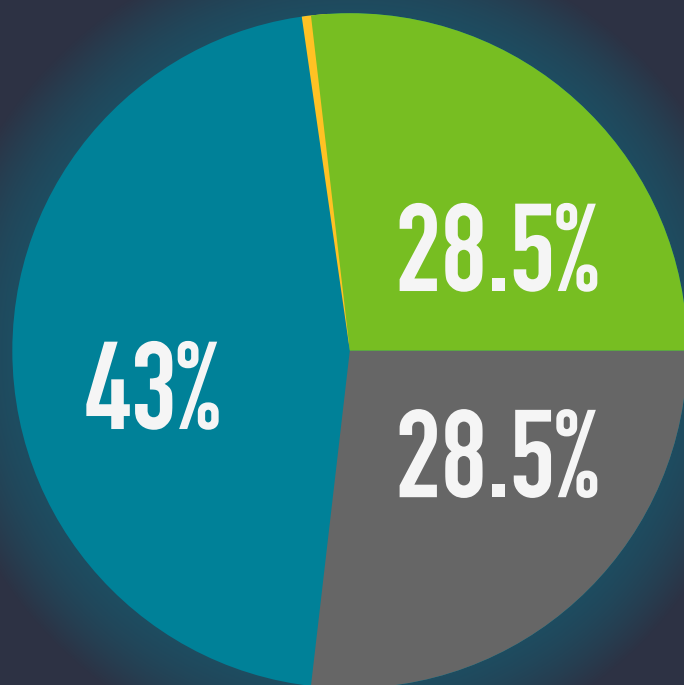
** 415 ppm (0.0415%) as of May 2019

(Measurement at Hawaii, Mauna Loa)

Below 150 ppm all plant life will begin to die.

N° 3 THE WORLD OF CO₂

NATURAL SOURCES OF CO₂ EMISSIONS



TOTAL
770 billion tons

43%

OCEAN ATMOSPHERE EXCHANGE

330 billion tons

28.5%

PLANT AND ANIMAL RESPIRATION

220 billion tons

28.5%

SOIL RESPIRATION

220 billion tons

0.03%

VOLCANIC ERUPTION

0.15 - 0.26 billion tons

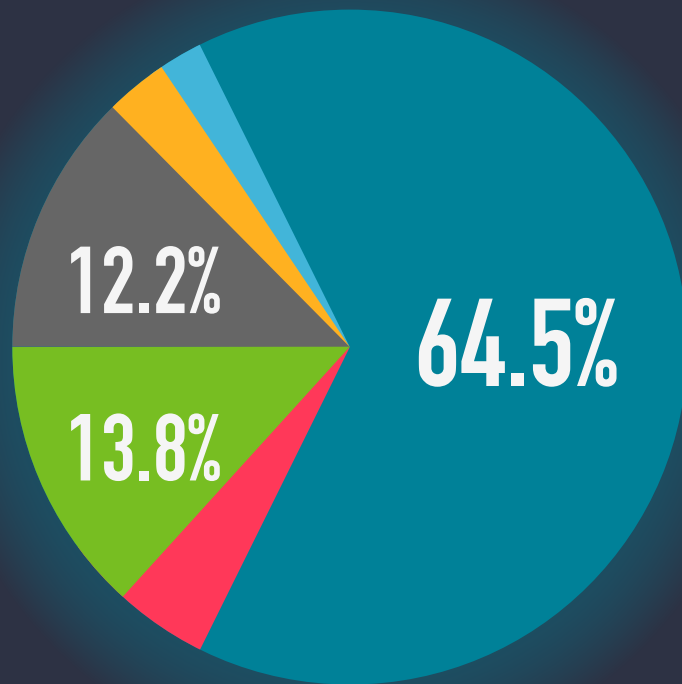
DISTRIBUTION

96.5% is naturally occurring

3.5% is man-made

N° 4 THE WORLD OF CO₂

GLOBAL ANTHROPOGENIC* CO₂ EMISSIONS



64.5%

ENERGY

Electricity, manufacturing, transport . . .

13.8%

AGRICULTURE

Cultivation and livestock

12.2%

FORESTRY

Logging industry

4.3%

INDUSTRY PROCESSES

Chemical, physical, electrical or mechanical

3.2%

WASTE

Recycling

2.1%

INTERNATIONAL BUNKERS

Energy storage

96.5% is naturally occurring

3.5% is anthropogenic*

*man-made

Reference: <https://watertechbyrie.com>

N° 5 THE WORLD OF CO₂

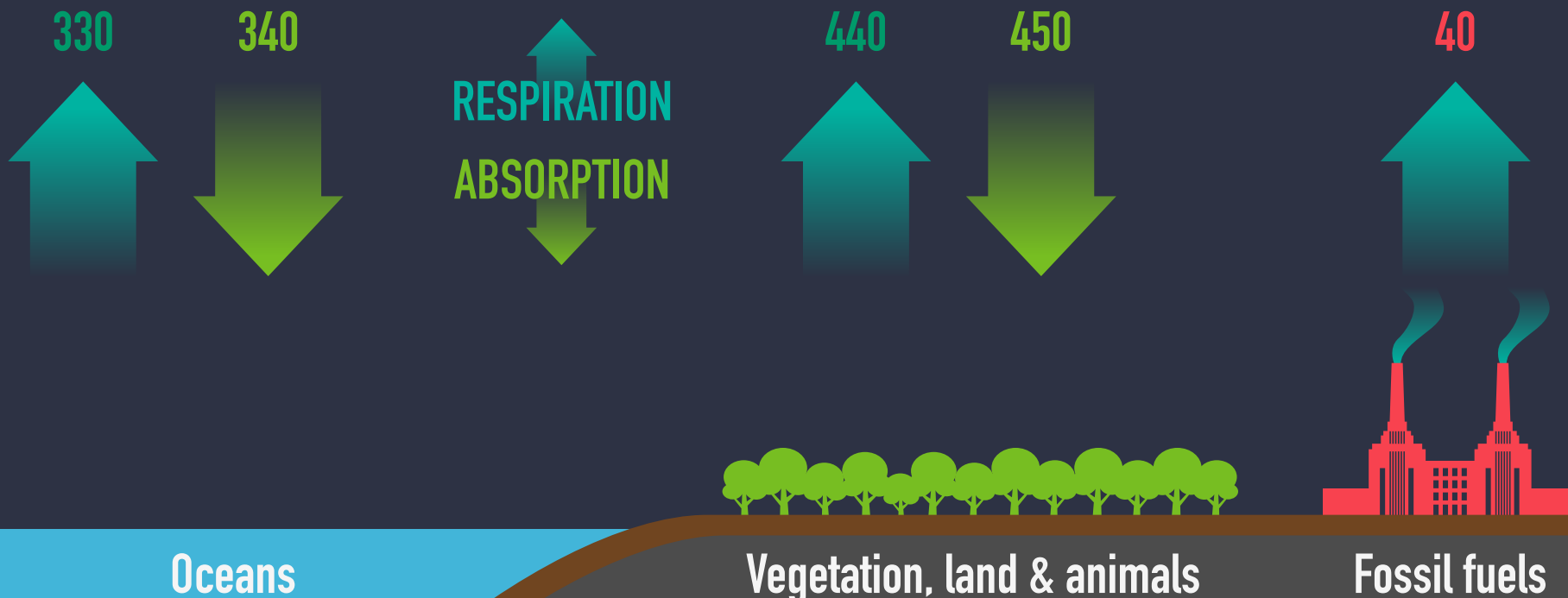
THE GLOBAL CARBON CYCLE

96.5% NATURAL SOURCES OF CO₂
Oceans, vegetation & land

*770 Billion metric tons

MAN-MADE CO₂ **3.5%**
Fossil fuel consumption

*40 Billion metric tons



Reference: <https://svs.gsfc.nasa.gov/12044>

*These are averages

N° 6 THE WORLD OF CO₂

CARBON AND PLANT RESPIRATION

LOWER ATMOSPHERIC CO₂

Plants are starved for energy

Higher density of Stomata to get more CO₂



SMALLER



DRAWBACKS

Need more water, grow slower and smaller

HIGHER ATMOSPHERIC CO₂

Plants have an abundance of energy

Lower density of Stomata needed to get CO₂



BIGGER



BENEFITS

Need less water, grow faster and bigger

N° 7 THE WORLD OF CO₂

PLANT CATEGORIES AND ABUNDANCE

The different pathways that plants use to capture CO₂ during photosynthesis



C3 PLANTS

90% of all plant life

C3 cycle (Calvin Cycle)

Wheat, rye, oats, rice, cotton,
sunflower, soybeans, spinach,
tomatoes, peanuts, potatoes . . .



C4 PLANTS

~5% of all plant life

C4 cycle (Hatch-Slack pathway)

Maize, sugarcane, sorghum,
weeds, grasses . . .



CAM PLANTS

Remaining plant life

Crassulacean acid metabolism

Pineapple, orchids, bromeliads,
cacti, wetland plants . . .

N° 8 THE WORLD OF CO₂

PHOTOSYNTHESIS, THE C3 VS C4 GAP

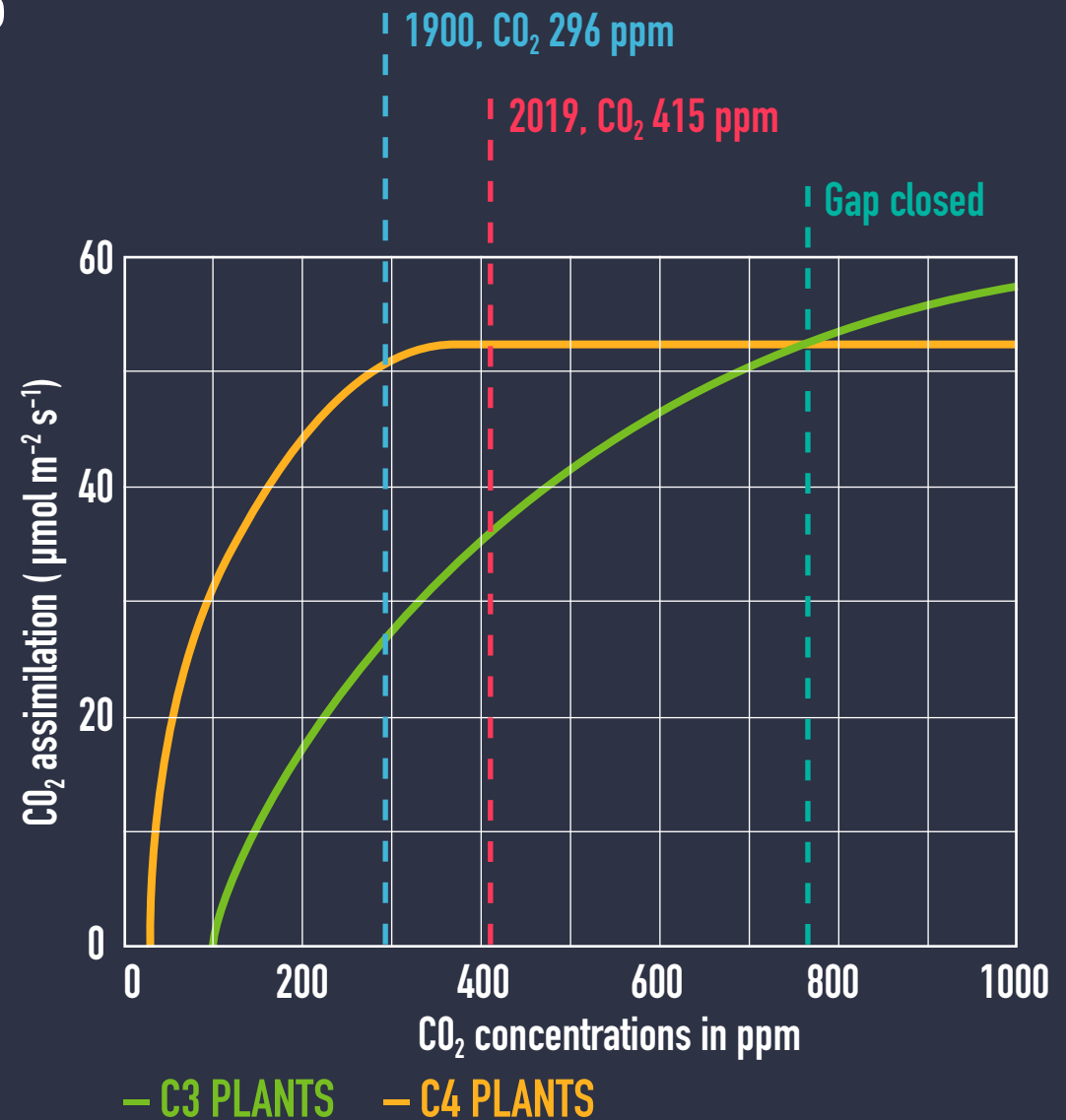
C3 PLANTS

- Are the most common plant life form
- Supply most of the world's food
- Less efficient at photosynthesis at lower CO₂ levels
- Not at maximum efficiency at present CO₂ levels
- Need less water as CO₂ levels rise

C4 PLANTS

- Are the less common plant life form
- Supply the least amount of the world's food
- More efficient at photosynthesis at lower CO₂ levels
- Are at maximum efficiency at present CO₂ Levels
- C4 plant crops are preferred in dryer climates

The photosynthetic efficiency gap between C3 and C4 plants will close as CO₂ levels rise to the level of 800 ppm.



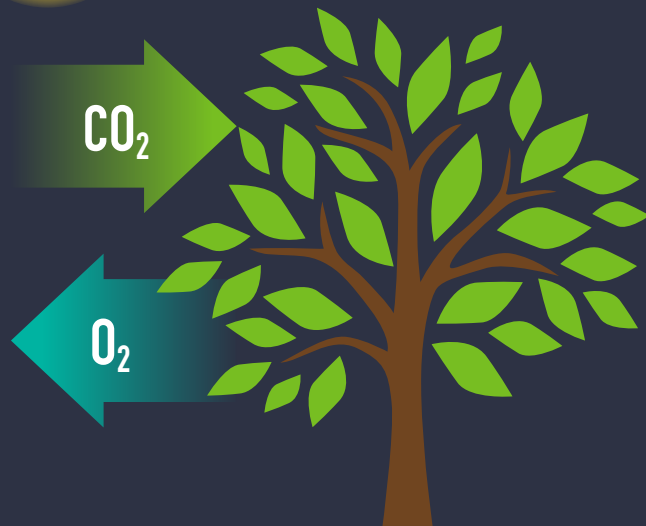
Reference: <https://buythetruth.wordpress.com/2009/06/13/photosynthesis-and-co2-enrichment/>

N° 9 THE WORLD OF CO₂

PLANT RESPIRATION AND CO₂



DAY



ABSORB MORE CO₂

Plants absorb CO₂ and release O₂

NIGHT



RELEASE LESS CO₂

Plants release CO₂ and absorb O₂

Plants absorb more CO₂ during the day than they release at night.

N° 10 THE WORLD OF CO₂

The logarithmic temperature rise of higher CO₂ levels.

GLOBAL TEMPERATURE INCREASE

Doubling of CO₂

3200 ppm CO₂

1600 ppm CO₂

800 ppm CO₂

415 ppm CO₂



Degrees rise

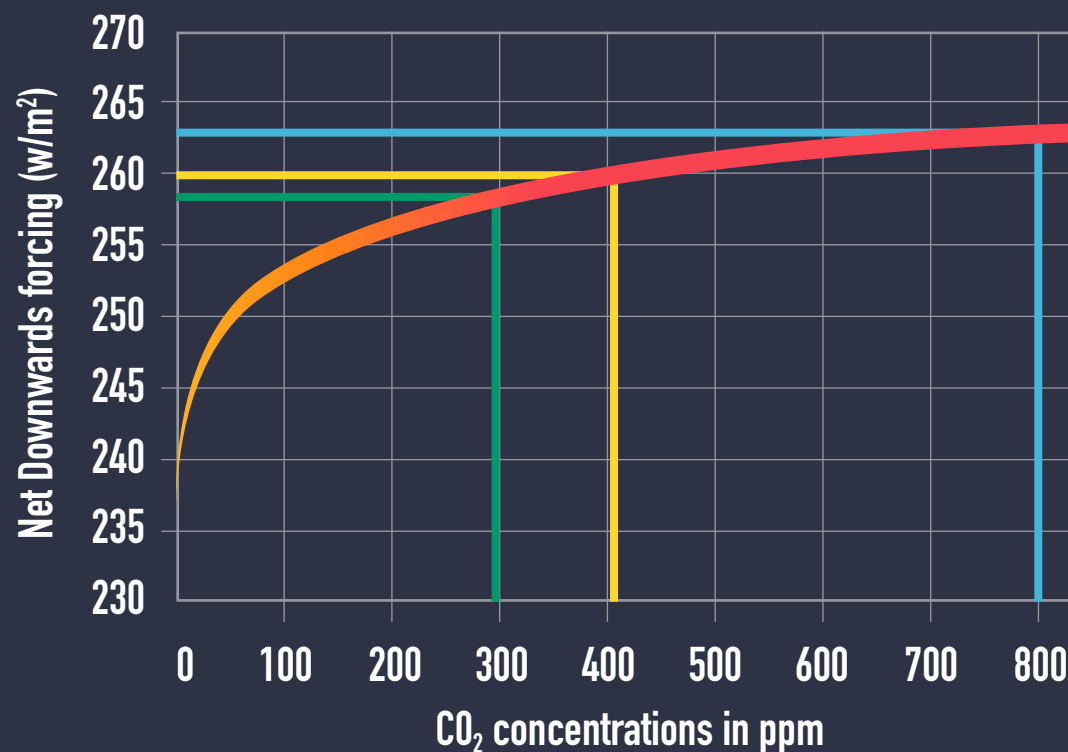
+1°

+1°

+1°

Present

$$\text{Forcing} = 2.94 \text{ Log}_2 (\text{CO}_2) + 233.6 \quad (R^2 = .997)$$



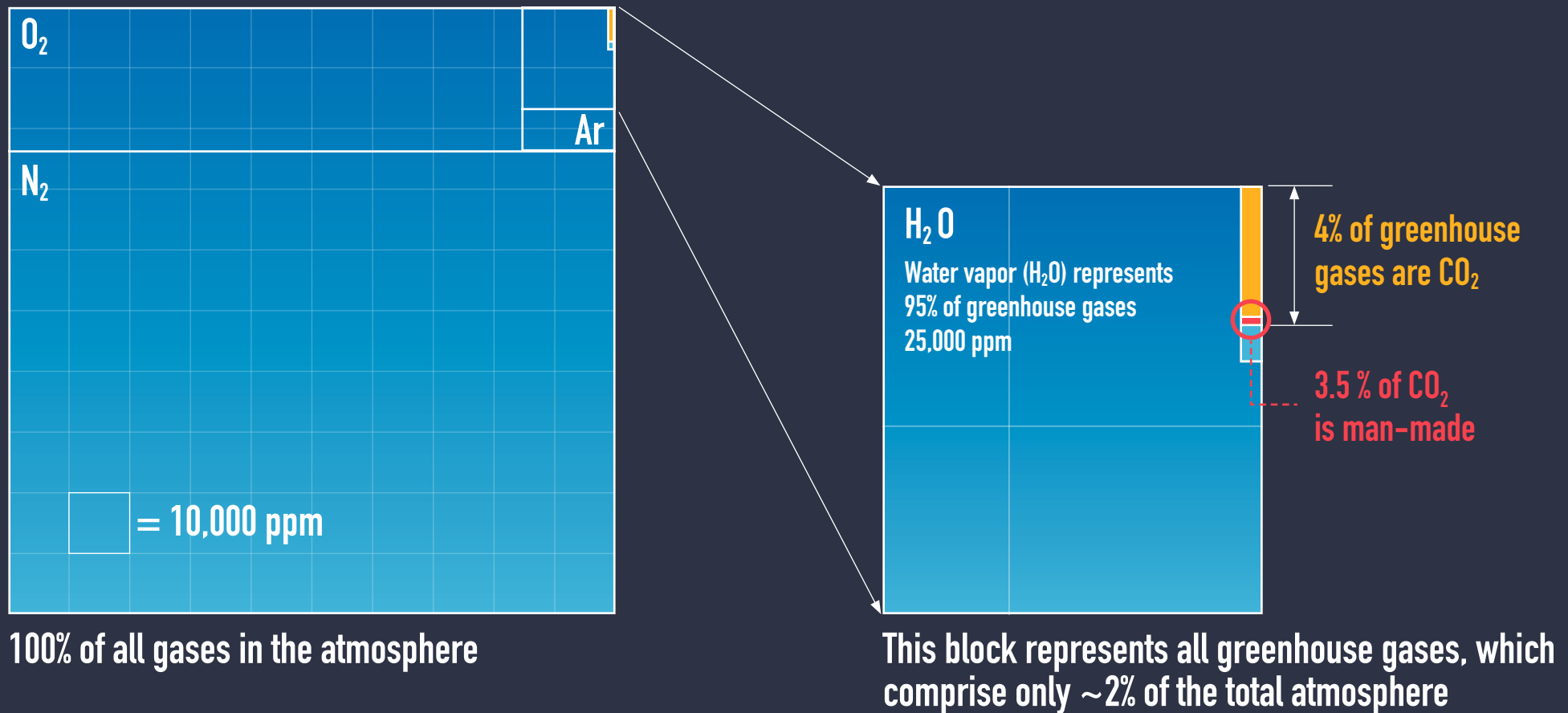
CO₂ Forcing Pre-Industrial Present Twice Present

Graphic by Willis Eschenbach (2006)

The logarithmic heating effect of carbon dioxide relative to atmospheric concentration.

N° 11 THE WORLD OF CO₂

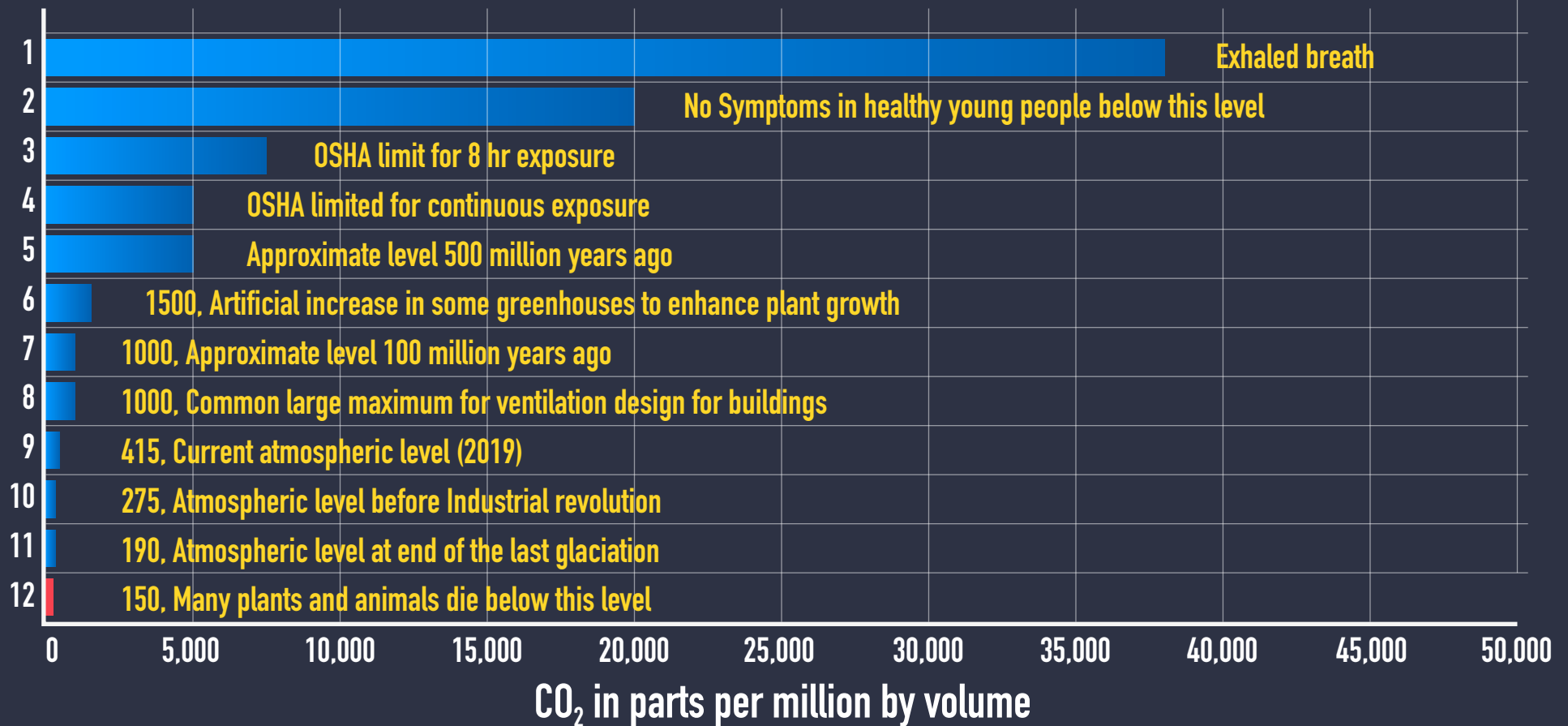
Earth's atmospheric composition in relationship to CO₂



N° 12 THE WORLD OF CO₂

Human respiration and CO₂ concentrations.

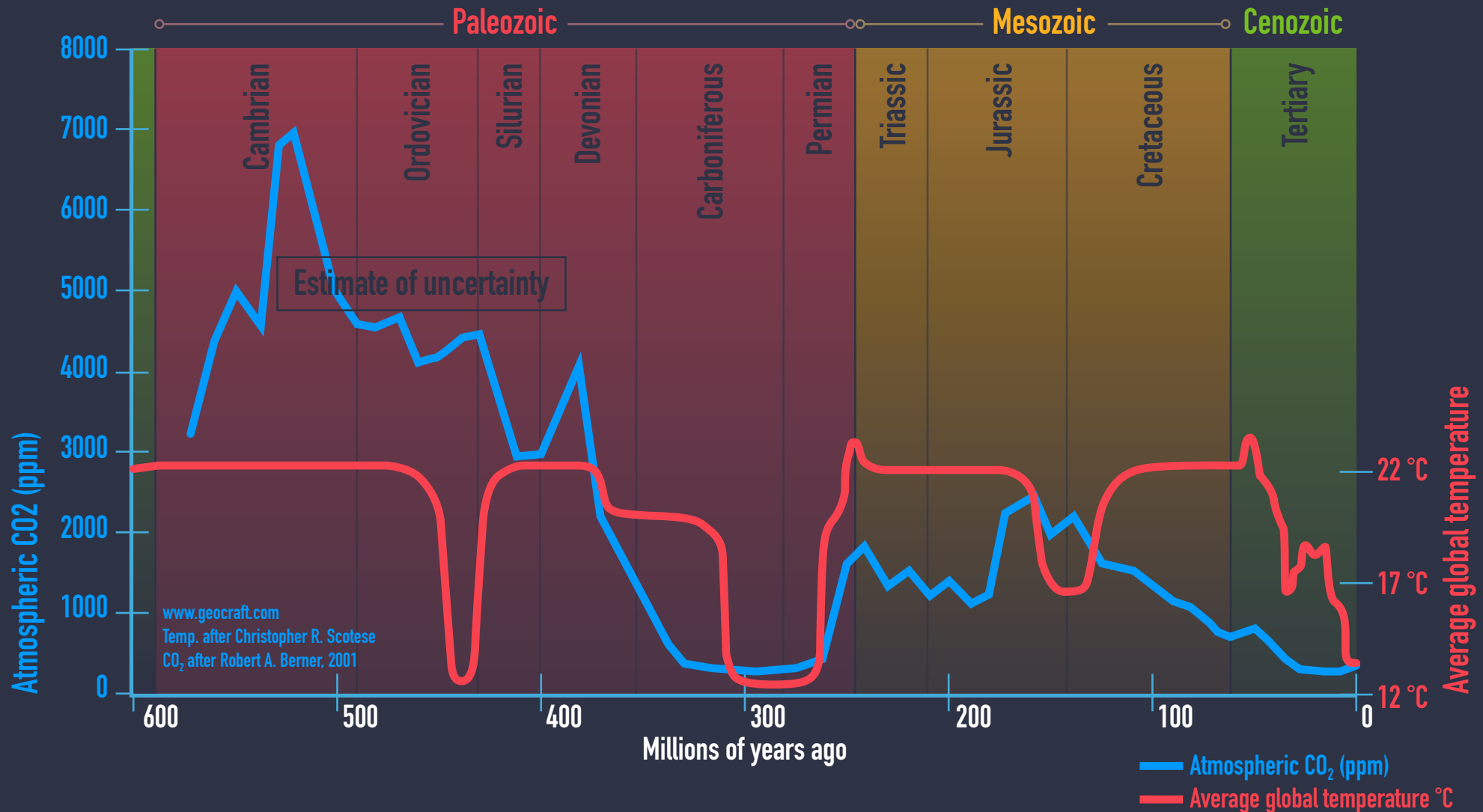
All animals and humans inhale oxygen and exhale CO₂. The proportion of exhaled CO₂ is about 3.8% or 38,000 ppm*. This exhaled CO₂ mixes with the ambient air and the concentration is quickly reduced to a harmless level. Enclosed rooms that are not well ventilated can lead to increased fatigue, headaches and sometimes a feeling of illness. (*parts per million)



Reference: <https://www.co2meter.com/blogs/news/10709101-what-is-carbon-dioxide>

N° 13 THE WORLD OF CO₂

600 million years of temperature change and atmospheric CO₂



Reference: <https://edberry.com/blog/climate/climate-physics/temperature-and-co2-history/>

N° 14 THE WORLD OF CO₂

THE COMPOSITION OF THE HUMAN BODY

Almost 99% of the mass of the human body is made up of six elements:

65.0 % oxygen

18.5 % carbon

10.0 % hydrogen

3.0 % nitrogen

1.5 % calcium

1.0 % phosphorus

1% Others including:

Potassium, Sulfur, Chlorine, Magnesium and all others

The organic molecules of the human body consist of carbon chains that are used to build carbohydrates, fats, nucleic acids and proteins. The breakdown of carbon compounds is the source of energy we need to live. **The air we breathe provides the oxygen needed to break the carbon bond, which then produces CO₂, that we exhale.**

Reference: <https://en.wikipedia.org>

