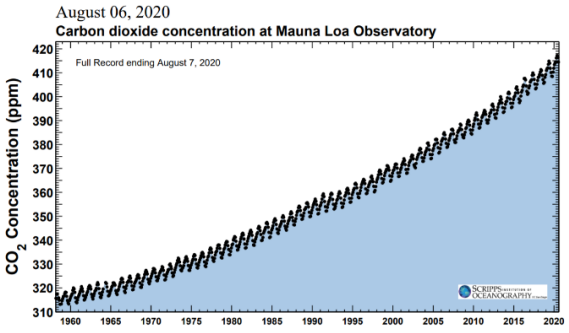
4. Increasing Atmospheric Carbon Dioxide.

Atmospheric carbon dioxide levels have been increasing since the beginning of the Industrial Revolution and emissions have accelerated over the past thirty years. We now have an understanding of atmospheric CO_2 levels going back over 800,000 years and through several ice ages.

Real timing monitoring of atmospheric CO_2, was established at Mauna Loa on Hawaii by David Keeling in 1958. It soon indicated that levels were increasing year on year.

In 1958 the level of atmospheric CO_2 was 316ppm and by August 28th, 2020 it had reached 411.56ppm.

(ppm stands for parts per million, in a sample of 1 million molecules of atmospheric gas 411.56 would be CO_2)



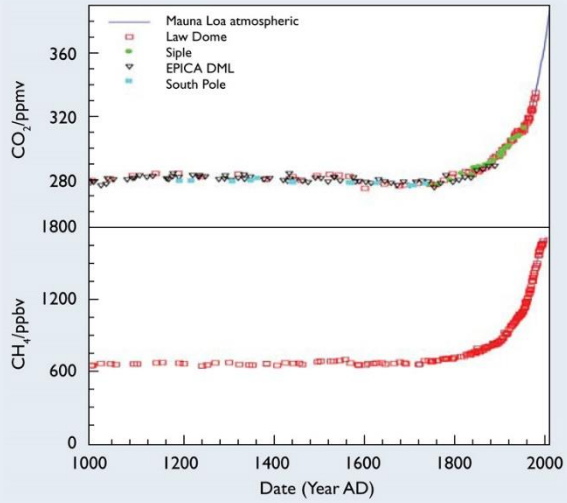
The annual saw cut shape to the curve reflects a reduction in atmospheric CO_2 when the trees and vegetation in the northern hemisphere start to produce leaves and begin photosynthesis drawing CO_2 out of the atmosphere. In the autumn, as leaves start to fall, they are decomposed though the activities of bacteria and fungi releasing some of this CO_2 back into the atmosphere.

Measuring historic levels. To determine atmospheric CO_2 levels before 1958, scientists have analysed gas bubbles which have been trapped in ice cores over past millennia. Ice cores have been collected and analysed from several different sites in Antarctic and Greenland.

Measurement of the changes in the concentration and proportion of rarer isotopes of hydrogen and oxygen have enabled dating of samples, similar to the more familiar carbon dating, and has provided a detailed record of the concentrations of atmospheric CO_2 and CH_4 going back hundreds of thousands of years.

This data shows that levels of atmospheric CO_2 and CH_4 were relatively stable over the past millennium until the end of the 18th century. The CO_2 graph is constructed using data points derived from different drilling sites and each site shows conformation with the overall trend and links seamlessly with the real-time emissions analysed at Mauna Loa since 1958.

Fig. 2: *CO_2 and CH_4 over the last 1,000 years*[1-4]



Analysis indicates that historical CO_2 levels fluctuated between approx. 180-280ppm and last reached 300ppm some 300,000 years ago when Homo sapiens didn't exist.

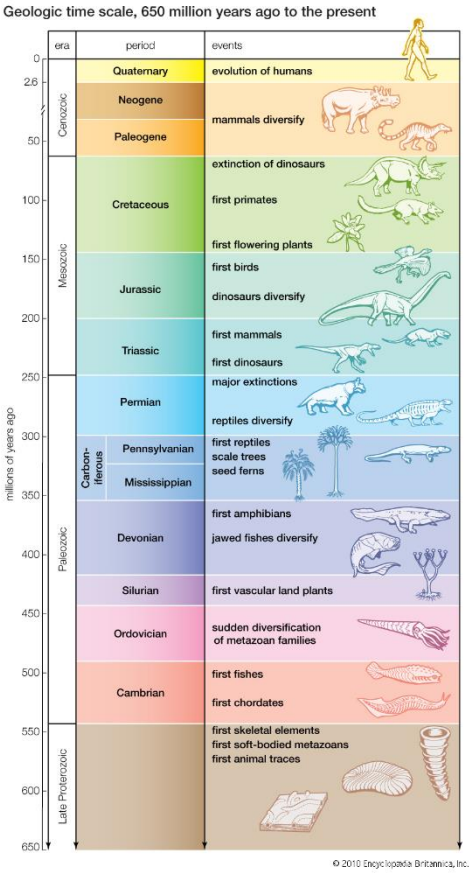
But there are always those who say 'but climate is always changing' or 'CO_2 levels have always fluctuated', well that's quite true. Fluctuations have been over a much greater range, but these were driven by the physical, chemical and biological processes that have applied over the planet's 4.5-billion-year development.

The early Earth's atmosphere was devoid of oxygen for some two billion years and made up of nitrogen and up to 25% CO_2. Oxygen was produced from some 3.5 billion years ago after the evolution of photosynthesising cyanobacteria, reaching present concentrations only in the last two billion years and replacing nearly all the atmospheric CO_2

Over the past billion years CO_2 levels have fluctuated between highs of circa 10,000 ppm to a low of 300ppm by the end of the Carboniferous period 300 million years ago. These fluctuations have resulted from the interactions of 1) the long term Milankovitch cycles that determine solar energy input, and 2) the aggregation or dispersal and relative positions of the 'drifting' continents which affect the redistribution of heat from the equators to the poles, and 3) much else.

The Devonian period saw the evolution of land plants, an essential precursor to the deposition of coal deposits in the Carboniferous period which combined optimum solar input, continental alignment, erosion, topography, climate and flora to enable coal deposition that reduced CO_2 atmospheric concentration from over 2,000ppm to 300ppm in 60 million years.

Consequently 'Life' has normally had the time and opportunity for evolution to fill all available ecological niches and adapt with the extinction of those species that fail to do so. Only where the rate of change was too fast, or the resulting conditions were incompatible with the requirements of the majority of species or individual organisms, have the previous five mass extinctions taken place.



The earliest species in the genus Homo evolved in East Africa about 2.5M years ago. It was called Homo habilis. Homo sapiens eventually evolved about 2-300,000 years ago. At no time since the evolution of the genus Homo have atmospheric CO_2 concentrations been as high as they are now.

Graphs reproduced from:

The British Antarctic Survey (Ice cores and Climate Change).

Scripps Institution of Oceanography, UC San Diego (The Keeling Curve)

Figure from Encyclopaedia Britannica