Do high levels of CO2 in the past contradict the warming effect of CO2?

What The Science Says:
Climate and CO_2 levels have always varied together. During past ice ages CO_2 levels were low, and during warm periods CO_2 was higher.

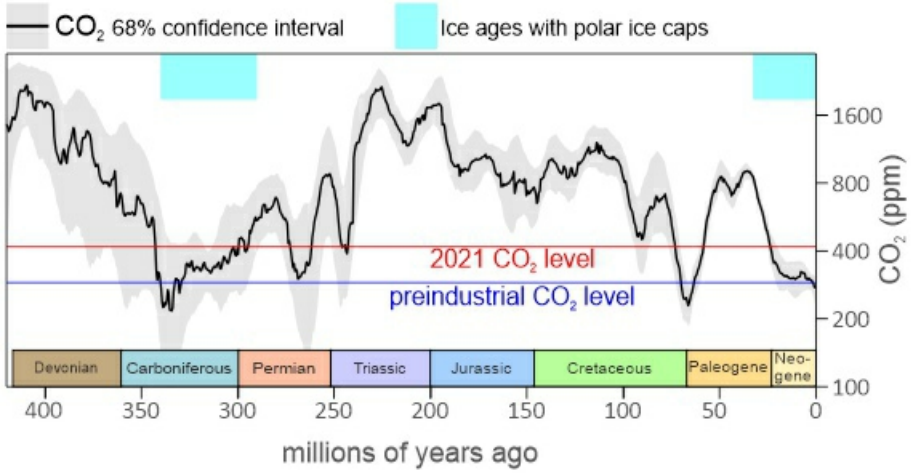
Climate Myth: CO2 was higher in the past
"The killer proof that CO2 does not drive climate is to be found during the Ordovician-Silurian and the Jurassic-Cretaceous periods when CO2 levels were greater than 4000 ppmv (parts per million by volume) and about 2000 ppmv respectively. If the IPCC theory is correct there should have been runaway greenhouse induced global warming during these periods but instead there was glaciation."
(The Lavoisier Group)

Climate and CO_2 levels have always varied together. During ice ages CO_2 levels were low, and during warm periods CO_2 was higher. In the Eocene (56-34 million years ago) there were no polar ice caps, temperatures were about 10ºC hotter than the 20th Century, and CO_2 was about 1,500ppm (Westerhold et al. 2020, Rae et al. 2021). During the last Ice Age, CO_2 varied between about 180 and 300ppm as ice sheets waxed and waned with orbital wobbles (Rae et al. 2021). CO_2 was also about that level during the Paleozoic Ice Age, 340-290 million years ago (Foster et al. 2017).

Early attempts to estimate CO_2 for that long ago in Earth's past were broad-brush and very uncertain (eg Royer 2006), leading to the high CO_2 estimates referred to in the myth. New data and refined techniques have since clarified the picture considerably. The 2006 estimates, for example, averaged data across 10-million-year timesteps, the 2017 data in the figure below used 0.5-million-year timesteps, and newer compilations don't average across timesteps. At the same time, CO_2 and temperature uncertainties have reduced considerably so that climates from the geological past are now a useful reality check for climate models (Tierney et al. 2020, IPCC 2021, see the intermediate version for more detail).

Data for the Ordovician are still quite uncertain, but they indicate CO_2 was about 2,400ppm and falling before the end-Ordovician glaciation (Pancost et al. 2013). Glaciation at higher CO_2 levels than today was possible at that time for a variety of reasons including a less-bright Sun back then (see the intermediate version). The Jurassic and Cretaceous span 134 million years with several hothouse episodes and several cooler episodes, with CO_2 varying from about 600ppm to about 1500ppm accordingly (Witkowski et al. 2018), but there was no glaciation in that time.

Earth's **long-term** climate (over millions of years) is governed by the balance between CO_2 emitted into the atmosphere by volcanoes and CO_2 removed from the atmosphere by weathering of rocks (Joel 2017). This has prevented runaway climates and kept Earth's climate generally habitable for about 4 billion years, but it can be outpaced by **abrupt** greenhouse gas releases (e.g. at the end-Permian mass extinction), or removals (e.g. "Snowball Earth" periods).



CO_2 levels for the last 420 million years, showing periods with ice ages. Note this curve is smoothed and too low resolution to show spikes in CO_2, eg at the end-Permian, end-Cretaceous, PETM, etc. Data from Foster et al. nature communications 2017. Late Paleozoic Ice Age per Rolland et al. EPSL 2019. Preindustrial CO_2 278 ppm, 2021 CO_2 420ppm (CO2.Earth). Newer data zooming in on the last 66 million years can be found on the intermediate tab.

SkepticalScience.com

Skeptical Science explains the science of global warming and examines climate misinformation through the lens of peer-reviewed research. The website won the Australian Museum 2011 Eureka Prize for the Advancement of Climate Change Knowledge. Members of the Skeptical Science team have authored peer-reviewed papers, a college textbook on climate change and the book Climate Change Denial: Heads in the Sand. Skeptical Science content has been used in university courses, textbooks, government reports on climate change, television documentaries and numerous books.