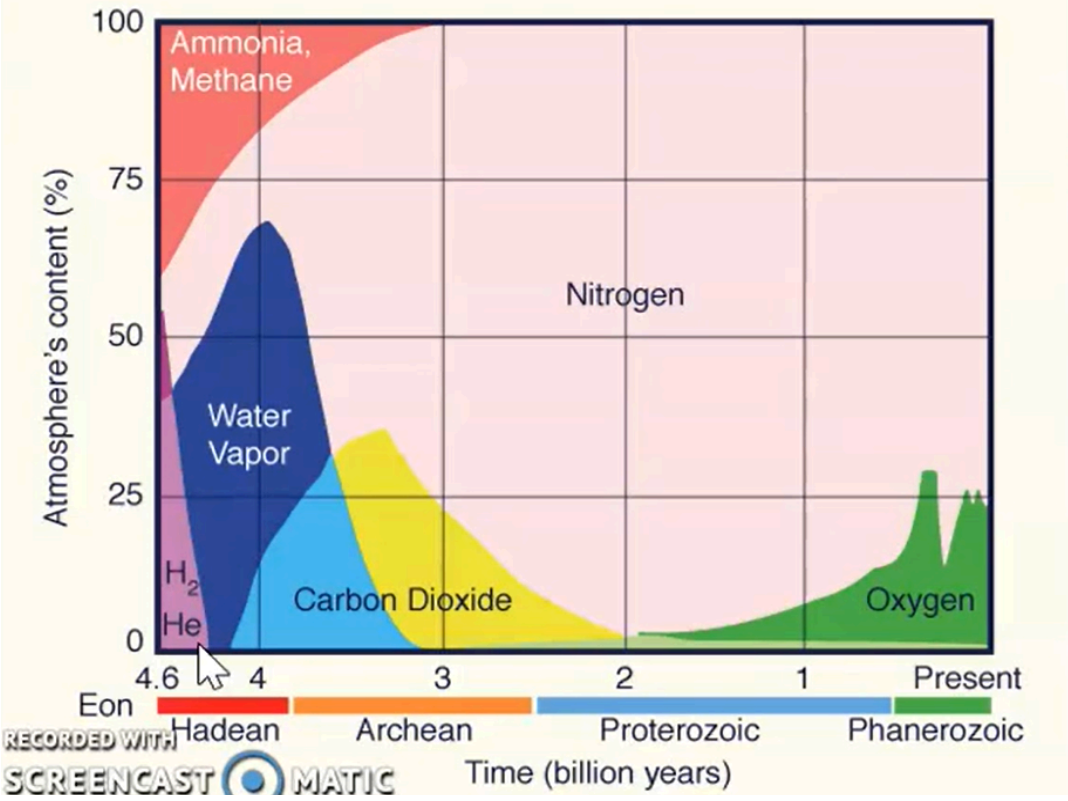
A fresh look at old times - 485 Million Years

I very much recommend you go back to some early CSSG-2 Studies in our Material Library CSSG-2 Materials Library . We looked at how our planet got to its current situation, starting back at its formation, 4.5.billion years ago:

- CSSG-2.2 Paleo Part 1 - the **last 800,000** years
- CSSG-2.3 Paleo Part 2 - the **first 4.6 Billion years** less 50 million years
- CSSG-2.4 Paleo Part 3 - the **latest 50 million years** - the Big Cooldown

In particular, the information in **Paleo Part 2** showed us the big picture - from the formation of the Planet up to the present. We saw:



https://www.youtube.com/watch?v=j0evKCTVh2I

Given the discussion in that study, including the chemistry and the air pressure before around 500 Million Years ago, I proposed that, for the purpose of understanding Climate Change, we can **ignore the period 4,600 (4.6 B) - 500 Million (0.5 B) years ago. The composition of the atmosphere was radically different from today.**

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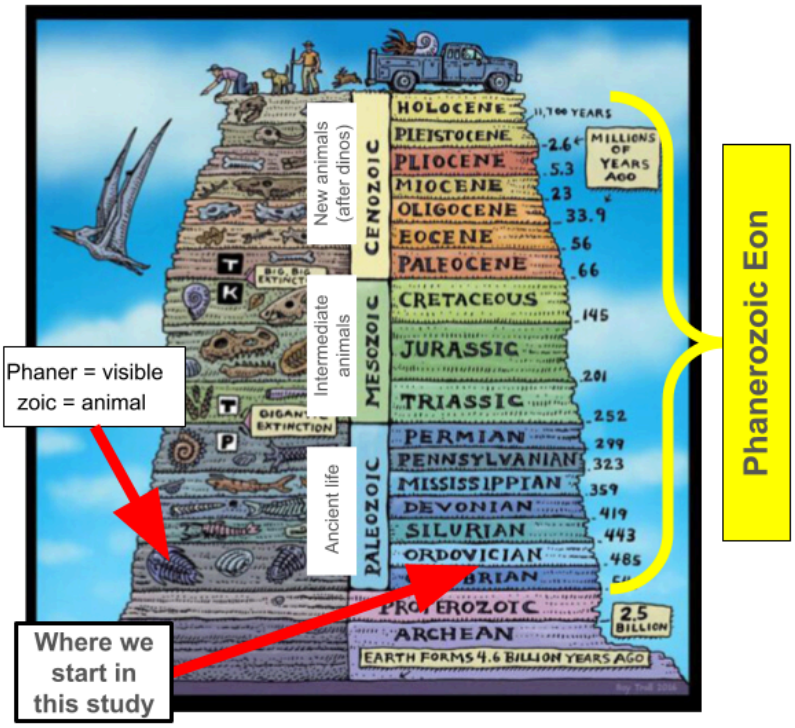
In fact, it wasn't until the Phanerozoic Eon (Phaner = visible; zoic = animal), which started around 540 million years ago that fossils became more available for our study and life was moving onto the land from the oceans. **Today's discussion concerns the period from 485 Million years ago (Mya)**, from the beginning of the Ordovician period (simply named after an area in Wales where certain fossils were found) when there was a great biodiversification. With the increase in oxygen in the atmosphere, the ozone layer was able to form, finally protecting the surface from killing ultraviolet rays from the sun. Because of the availability of fossils, we have the best understanding of this most recent eon.



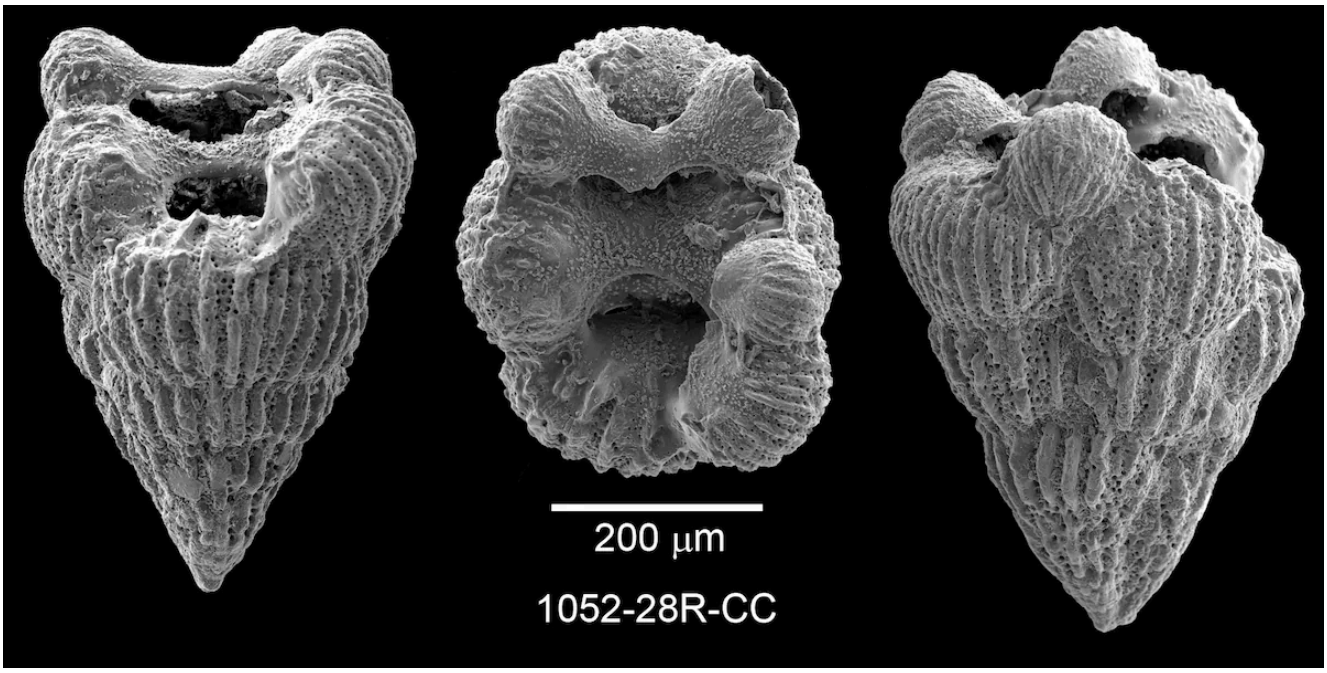
https://www.climate.gov/news-features/climate-qa/whats-hottest-earths-ever-been

As you might imagine, it's hard to get exact information from several million years ago, much less 400 Mya. And, no doubt, studies will continue for centuries. 10 years ago, the Smithsonian started renovating its Natural History Museum in D.C., and they wanted to better tie the fossil record with how the earth systems (temperatures, continental drifts, ocean and surface conditions, polar-equatorial temperature differences, etc) changed over long times. They tackled an update of the **timeline of global temperature and its relationship to CO2 levels** - of keen interest to climate change science. Their results have just been published and, because they introduced a new technique, the results may be more accurate.

We will see the latest synthesis by the Smithsonian shortly, but first let's glance at earlier versions.

Fundamental to sorting our ancient Temperatures and CO2 levels is PROXIES. What this means is that we don't have direct measurements of these conditions. NO thermometers, no CO2 meters - both of which are available now. As we saw in CSSG-2.2 we can actually get direct measurements of the air as far back as 800,000 years ago, because there are ice caps in Antarctica and Greenland where the ice is that old. Little bubbles of air reveal actual CO2, methane, etc. and oxygen isotopes which reveal temperatures.

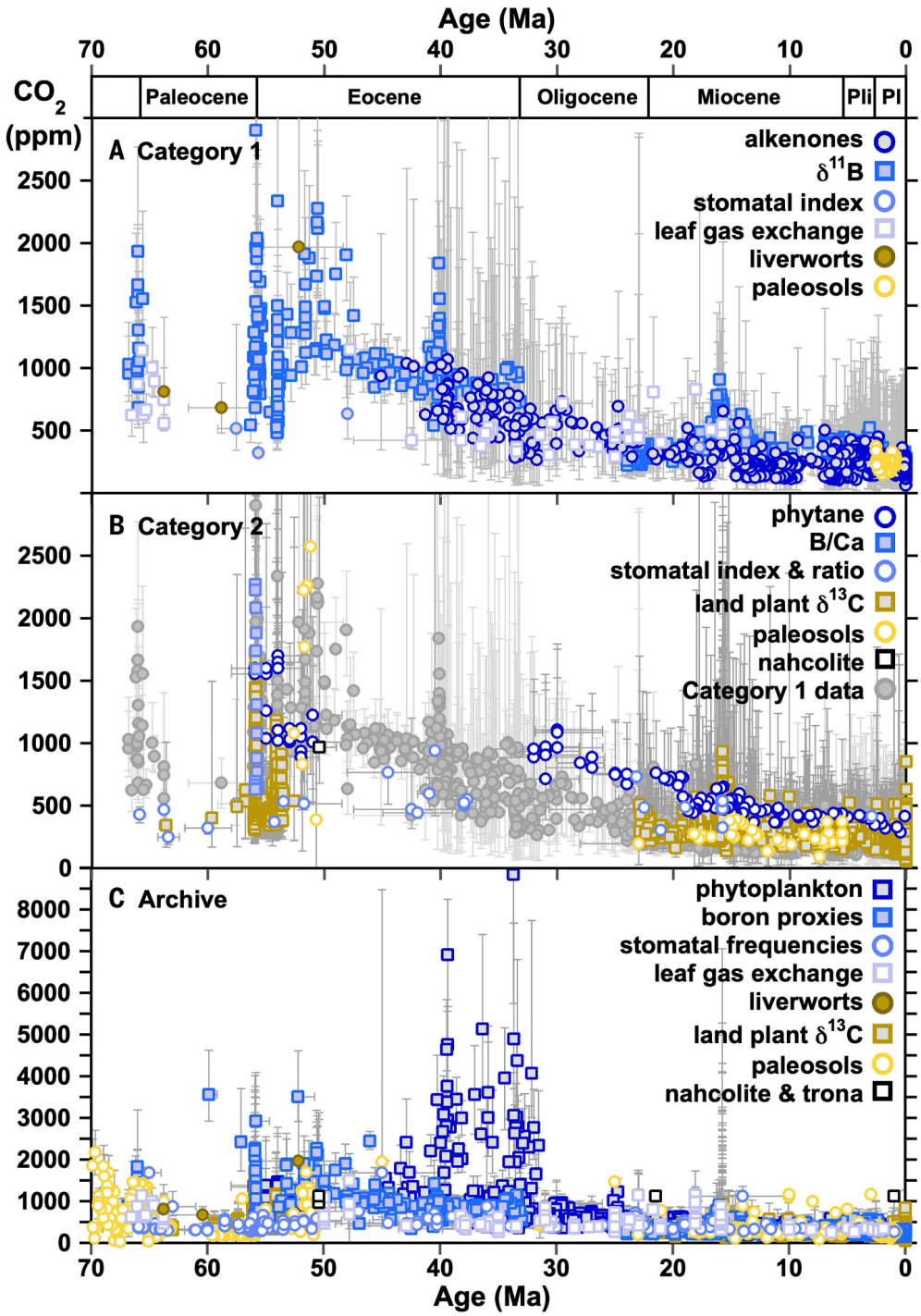
For earlier times, however, scientists have to use proxies. An example is



Microscopic, single-celled organisms called foraminifera have a fossil record that extends more than 500 million years. By examining their shell chemistry, scientists can gain insight into how climate changed in the past. (Brian Huber/Smithsonian)

And scientists wheedle a picture of how things were from data that can look like this.

Understanding Past Climate Forcings and Sensitivity | Identifying New Community-Driven Science Themes for NSF's Support of Paleoclimate Research: Proceedings of a Workshop | The National Academies Press



This kind of analysis produced rough, but helpful information. Look at the last 50 million years. Note that CO2 levels were coming down as the Himalayas emerged and reacted with that gas, taking it out of the atmosphere (see CSSG-2.4 Paleo Part 3 - the **latest 50 million years** - the Big Cooldown). Consistently, the temperature also was coming down.

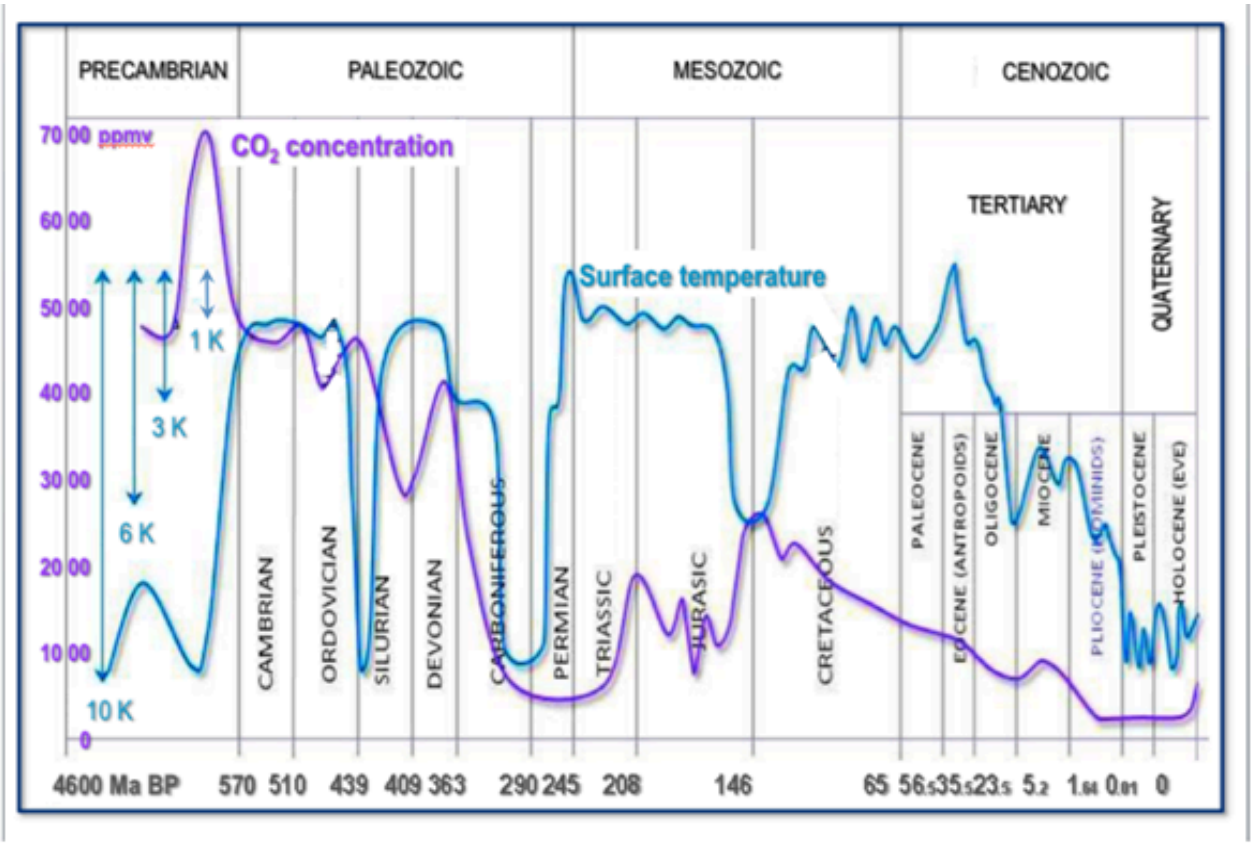
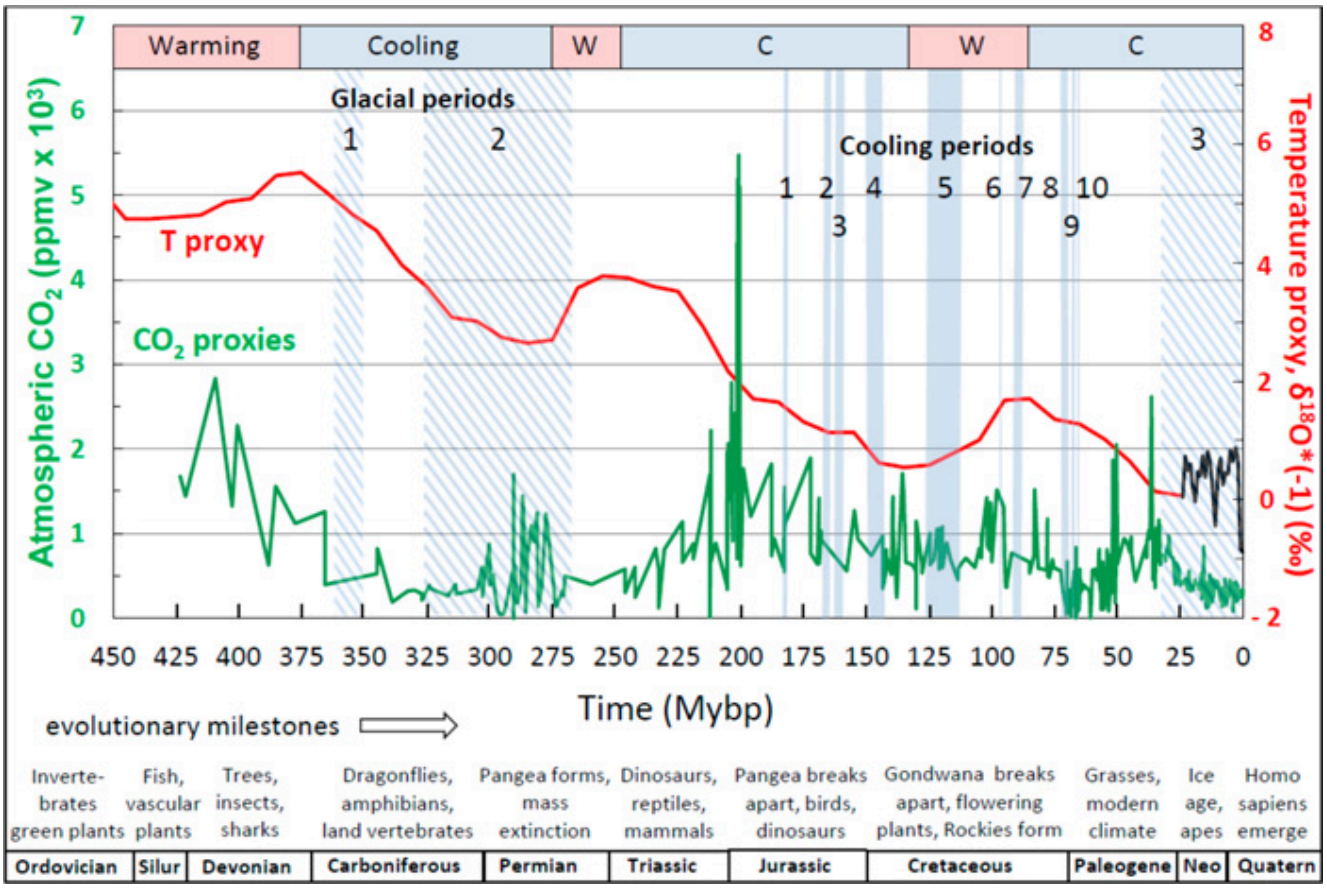


Figure 1. Graph of global temperature and atmospheric CO_2 concentration over the past 600 million years. Note both temperature and CO_2 are lower today than they have been during most of the era of modern life on Earth since the Cambrian Period. Also, note that this does not indicate a lock-step cause-effect relationship between the two parameters.[5]

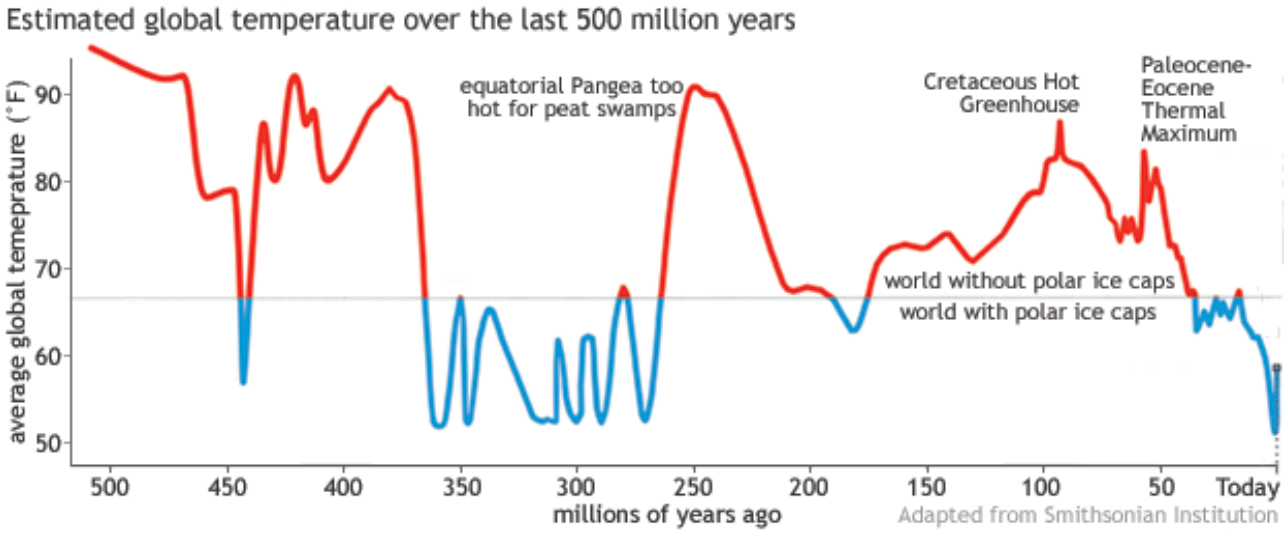
Net Zero: Three Graphs That Might Make You Skeptical - CO2 Coalition

And by 2017, this chart was published:

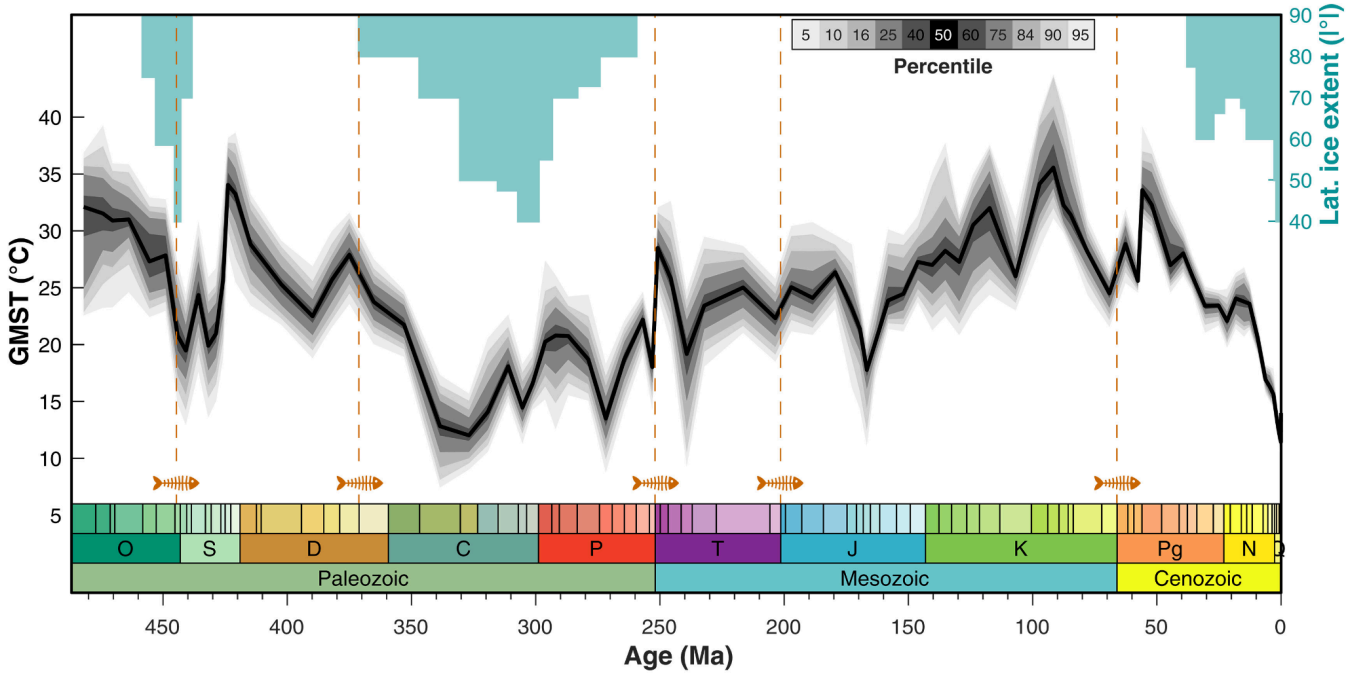


http://www.co2science.org/articles/V21/sep/a13.php

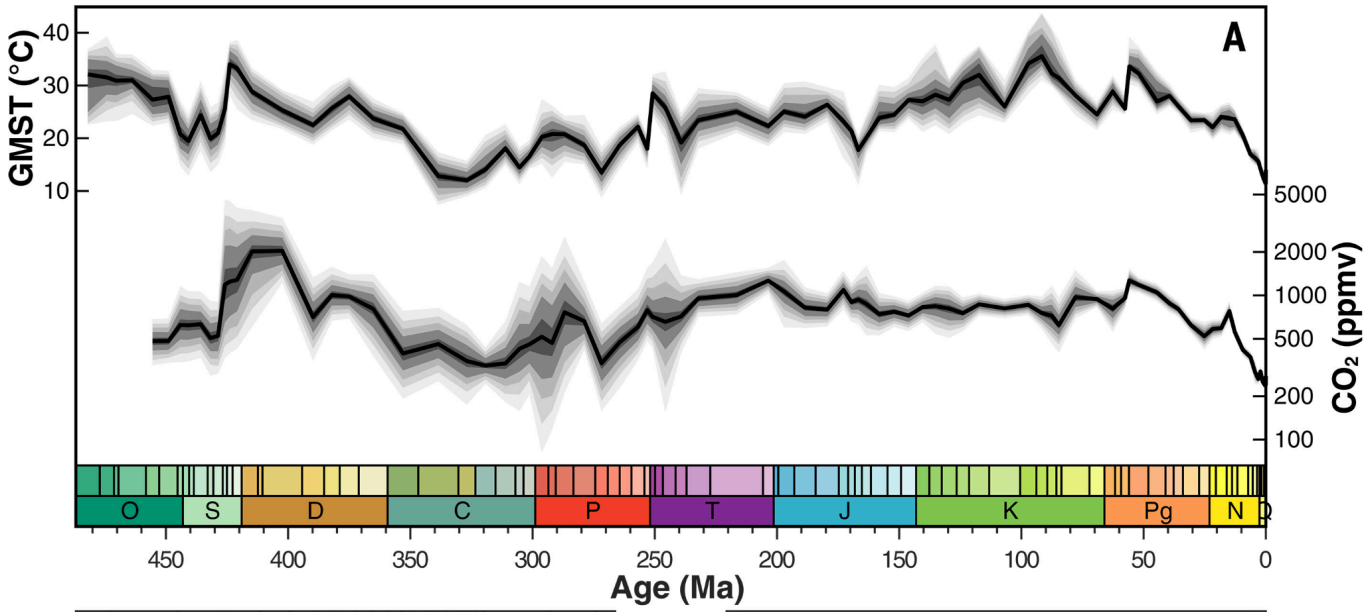
Here's an earlier version of temperatures used by the Smithsonian:



Compare it to their just-published analysis. The Smithsonian used a new technique of "data assimilation". First, they put all of that proxy data (over 150,000 data points from disconnected geographical locations and timeframes) into the database. The innovative step was tying that information to Earth System Models, which force more realistic consistencies in continental drifts, atmospheric chemistries, oceanic conditions, etc. This resulted in statistical constraints on how the proxy data is interpreted.



And now we have their latest pictures of how CO2 and Temperatures have been related:

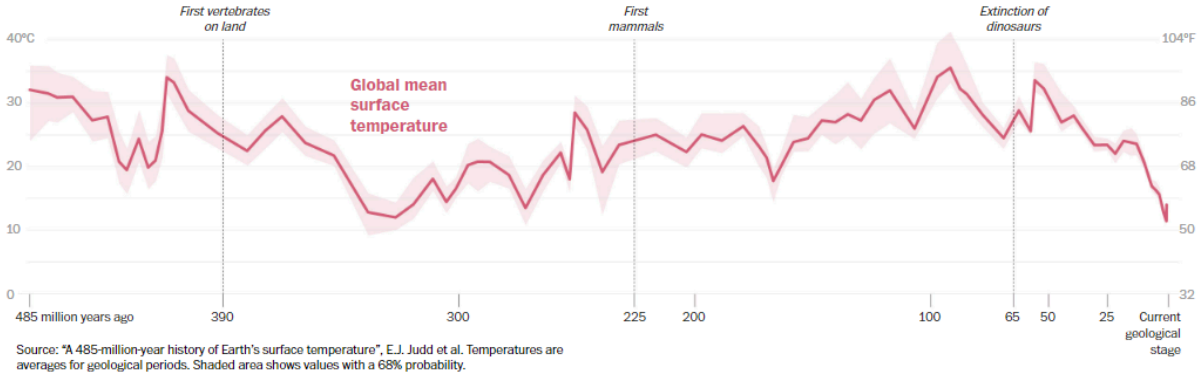


Next time, I hope to point out some very important insights for climate change predictions that this new analysis has uncovered. The Washington Post analysis did a great job, and I'll be using their materials. As always, when we see a sharp change of behavior, it's time to ask "WHY?".

Scientists have captured Earth's climate over the last 485 million years. Here's the surprising place we stand now.

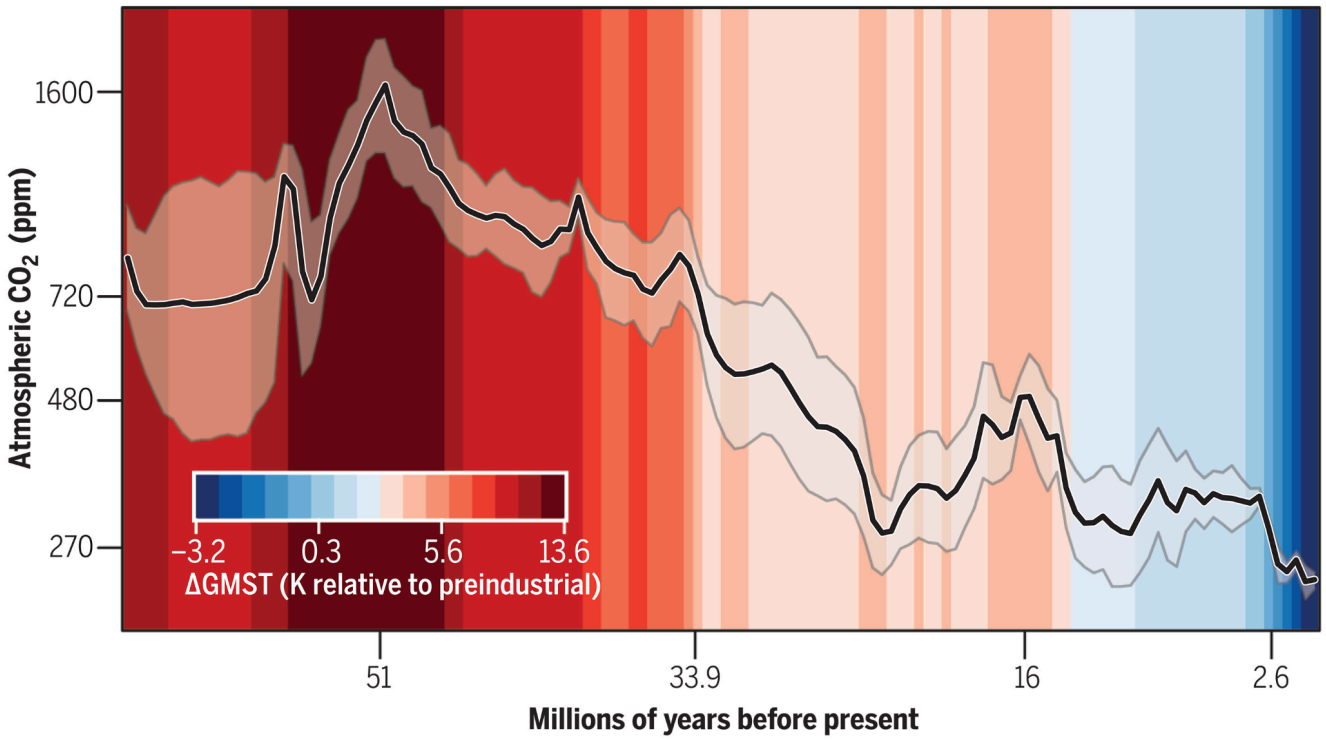
An effort to understand Earth's past climates uncovered a history of wild temperature shifts and offered a warning on the consequences of human-caused warming.

10 min 1928



Source: "A 485-million-year history of Earth's surface temperature", E.J. Judd et al. Temperatures are averages for geological periods. Shaded area shows values with a 68% probability.

Just for fun, here's another (2023) look at the last 50 million years as CO2 was taken up by the Himalayan rocks and the planet moved from hothouse to ice ages (indicated by the colors).



Toward a Cenozoic history of atmospheric CO2 | Science (2023)

References for this Discussion:

The New Study for the Smithsonian
https://www.science.org/doi/full/10.1126/science.adk3705

And a fantastic analysis of that study in the Washington Post
https://www.washingtonpost.com/climate-environment/2024/09/19/earth-temperature-global-warming-planet/

PUNCHLINES

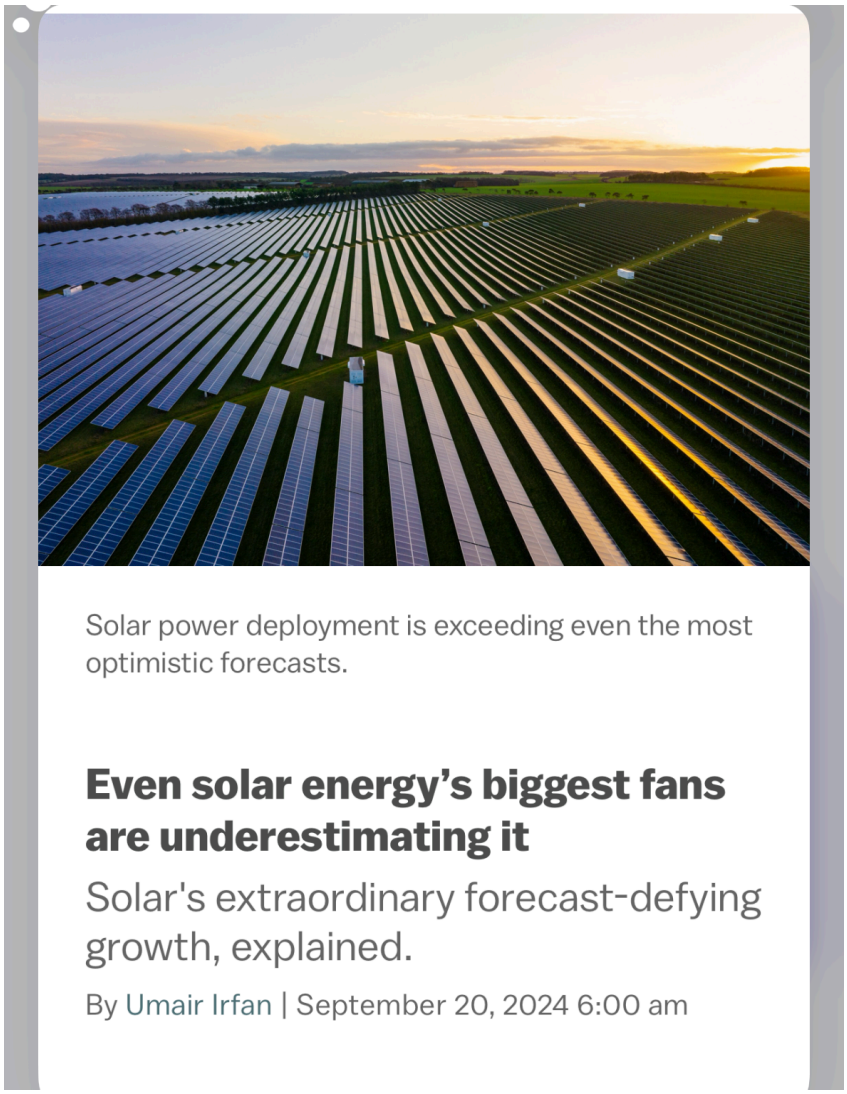
Data, analysis techniques, and insights into the behaviors of our planet continue to improve.

- We will discuss new understanding about how the climates might respond in the future
- Just as many new questions are exposed as not yet being understood. As an example, note that CO2 levels were pretty constant from 150 - 50 million years ago, while temperatures likely went higher.

Approximate "Cheat Sheet":

1 meter → 3 feet **1 degree Celsius (^{0}C)** → 2 degree Fahrenheit (^{0}F)
ppm = parts per million **CO_2** = Carbon Dioxide
1 tonne = 1000 kilograms = 2205 pounds **1 gigatonne (1 Gt)** = 1 billion tonnes
1 trillion tonnes (1Tt) = 1000 gigatons

GOOD NEWS CORNER



Solar power deployment is exceeding even the most optimistic forecasts.

Even solar energy's biggest fans are underestimating it

Solar's extraordinary forecast-defying growth, explained.

By Umair Irfan | September 20, 2024 6:00 am

https://apple.news/AmHnDF39cTOyE-c9xIuTCQQ

https://www.vox.com/climate/372852/solar-power-energy-growth-record-us-climate-china

Our Natural World

https://media.cnn.com/api/v1/loops/stellar/prod/video-swierk-juv-male-loop.mp4?c=original