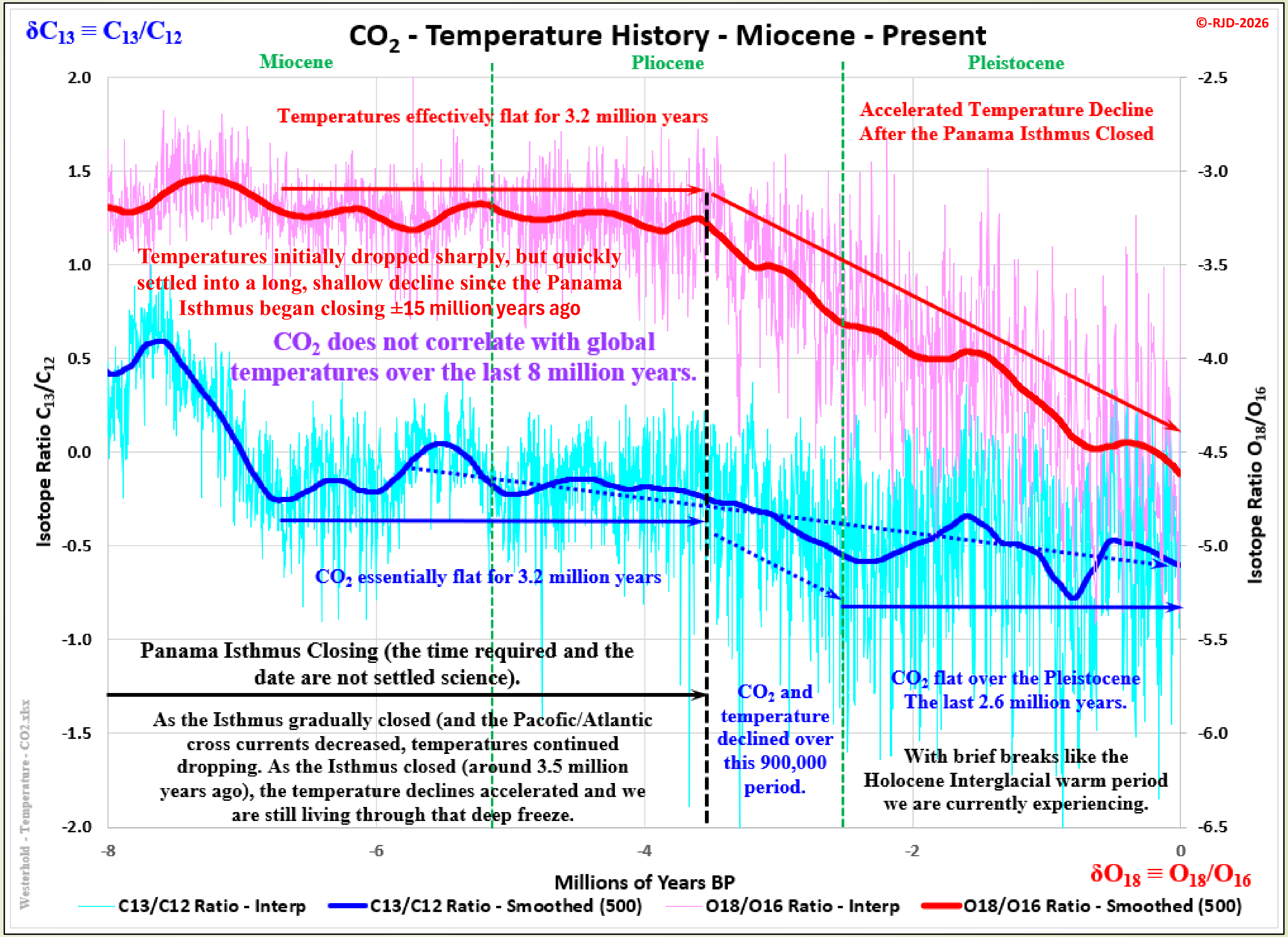
GSM – Grand Solar Minimum. You really should do the Research!

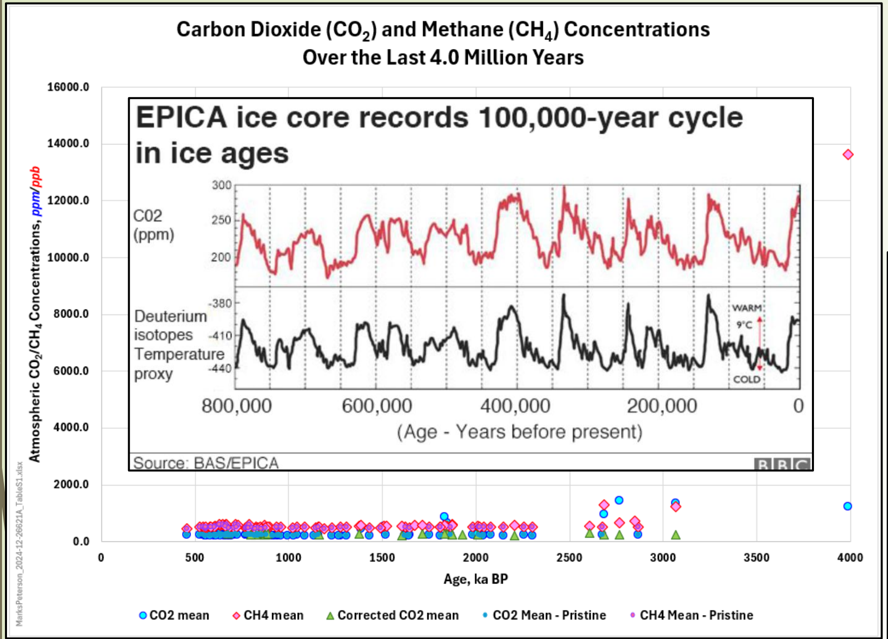
# CSS-81a Historical $CO_2$ and $CH_4$ Concentrations – Westerhold et al 2020

More info ? climatechangeandmusic.com

The chart to the right shows the benthic foraminifera carbon and oxygen isotope ratios presented in Westerhold et al's 2020 paper, "*An astronomically dated record of Earth's climate and its predictability over the last 66 million years*". The carbon isotope ratio ($\delta C_{13} \equiv C_{13}/C_{12}$) is a proxy for atmospheric carbon dioxide concentrations. The oxygen isotope ratio ($\delta O_{18} \equiv O_{18}/O_{16}$) is a proxy for global temperature. This chart covers the last 8 million years. The Westerhold et al data goes back 66 million years and was covered in detail in my CSS-10 – A Ride Through the Cenozoic post. Sadly, for the All $CO_2$, All the Time alarmist community, major climate change over the Cenozoic is driven by plate tectonics and extraterrestrial impacts, not $CO_2$. The major climate change trends (temperature) are not reflected in the $CO_2$ isotope ratio data. The initial temperature decline (15 million years ago) began during the late Miocene and continued through the Pliocene (coinciding with the Antarctic re-glaciation and the Panama Isthmus closing) and then accelerated significantly (3.6 million years ago) into the Pleistocene Ice Age) when the Isthmus finally closed. This post will focus on the last 3 million years. Based on this data, $CO_2$ was essentially flat with declining temperatures.

**$CO_2$-$CH_4$ Westerhold et al 2020**



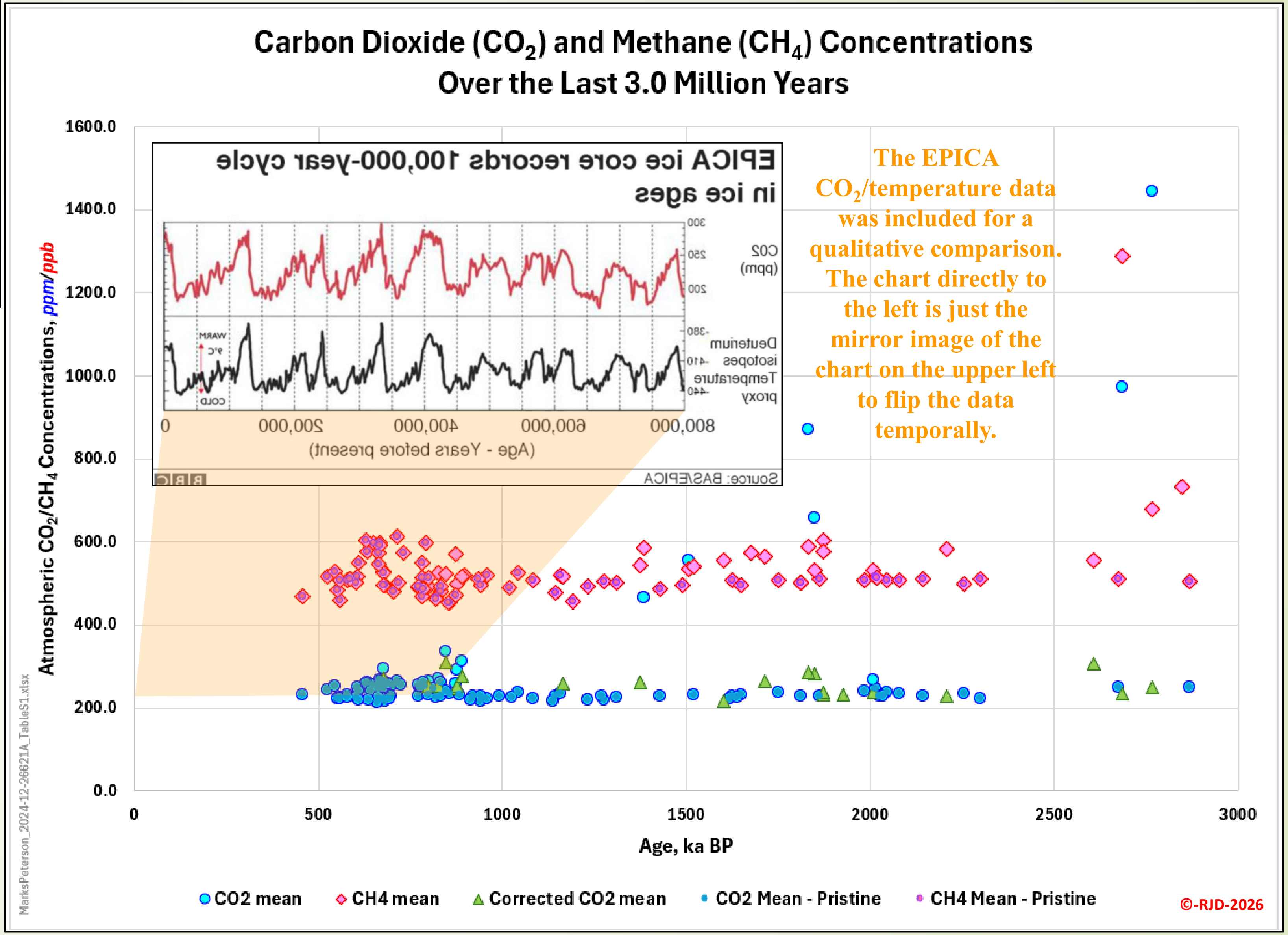





More info ? climatechangeandmusic.com

# Historical $CO_2$ and $CH_4$ Concentrations – Marks-Peterson et al 2025

**In March 2026, Marks-Peterson et al published their paper, *"Broadly stable atmospheric $CO_2$ and $CH_4$ levels over the past 3 million years"* in Nature. Their December 2024 submission can be accessed here. This ice core data covers the last 4 million years (chart to the left). The chart below focuses in on the last 3.0 million years. This is the full data set.**




**$CO_2$-$CH_4$ Marks-Peterson et al 2025**

**Note, $CO_2$ concentrations are shown in blue (ppm). $CH_4$ concentrations are shown in the red spectrum (ppb). Both molecule concentrations have been relatively stable over the last 2.5 million years. Marks-Peterson et al have categorized the data points as means, corrected means, pristine (higher confidence). There is some scatter in the the data, but not much since 2.5 million years ago. The $CH_4$ data has a little more scatter than the $CO_2$ concentration. The corrected $CO_2$ mean points can be independent as well as being associated with some of the $CO_2$ mean data points. The 2026 Marks-Peterson et al data density is far lower than the Westerhold et al 2020 data density. The fluctuations within the Marks-Peterson data are however still consistent with the Westerhold data shown on the first slide. Remember, $CO_2$ concentrations have fluctuated between roughly 180 (during the deep glacial maximums) and 300 ppm (during the warmer interglacials) over the historical ice core data. These fluctuations are Milankovitch Cycles related.**

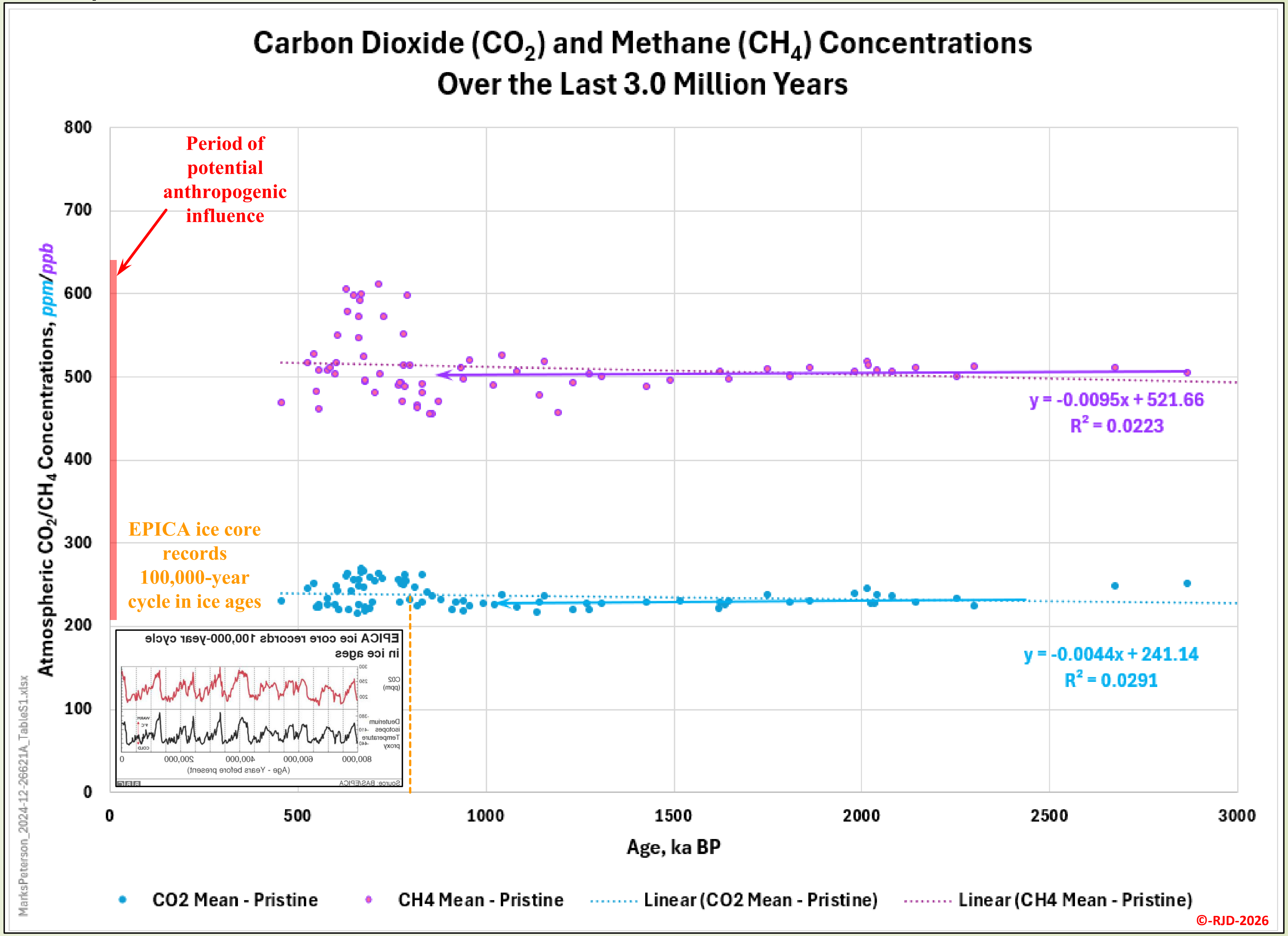
# CSS-81c Historical $CO_2$ and $CH_4$ Concentrations – Marks-Peterson – "Pristine"

More info ? climatechangeandmusic.com

GSM – Grand Solar Minimum. You really should do the Research!

This slide focuses in on the Marks-Peterson's "pristine" data. The more recent data (less than 1,000,000 years ago) has more fluctuations than the earlier data. This would likely be related to the data density. Resolution gets progressively worse as you go further back in time. Both $CO_2$ and $CH_4$ are close to statistically flat. Their regression lines are rising slightly overall, but the earlier data (pre-800,000 years BP) was trending down for 2,000,000 years. Absolutely zero of these data points has been influenced by humanity, given our $CO_2$, etc. emissions only began to rise noticeably 176 years ago (1850) with most of our emissions (87%+) having occurred post-1950. The period of potential anthropogenic influence has been highlighted on the chart. The EPICA data shows Both $CO_2$ and Antarctic temperatures. The temperature fluctuations are ±8 °C and they are moving in unison with (i.e.: they correlate with) the changes in $CO_2$ concentration. But as has been shown many times over, the temperature is driving the $CO_2$ concentrations (i.e.: temperatures move first. The earlier data shows that average $CO_2$ and $CH_4$ data is virtually flat. The Milankovitch cycles are likely present, but the resolution is too low to see.

## $CO_2$-$CH_4$ Marks-Peterson "Pristine"



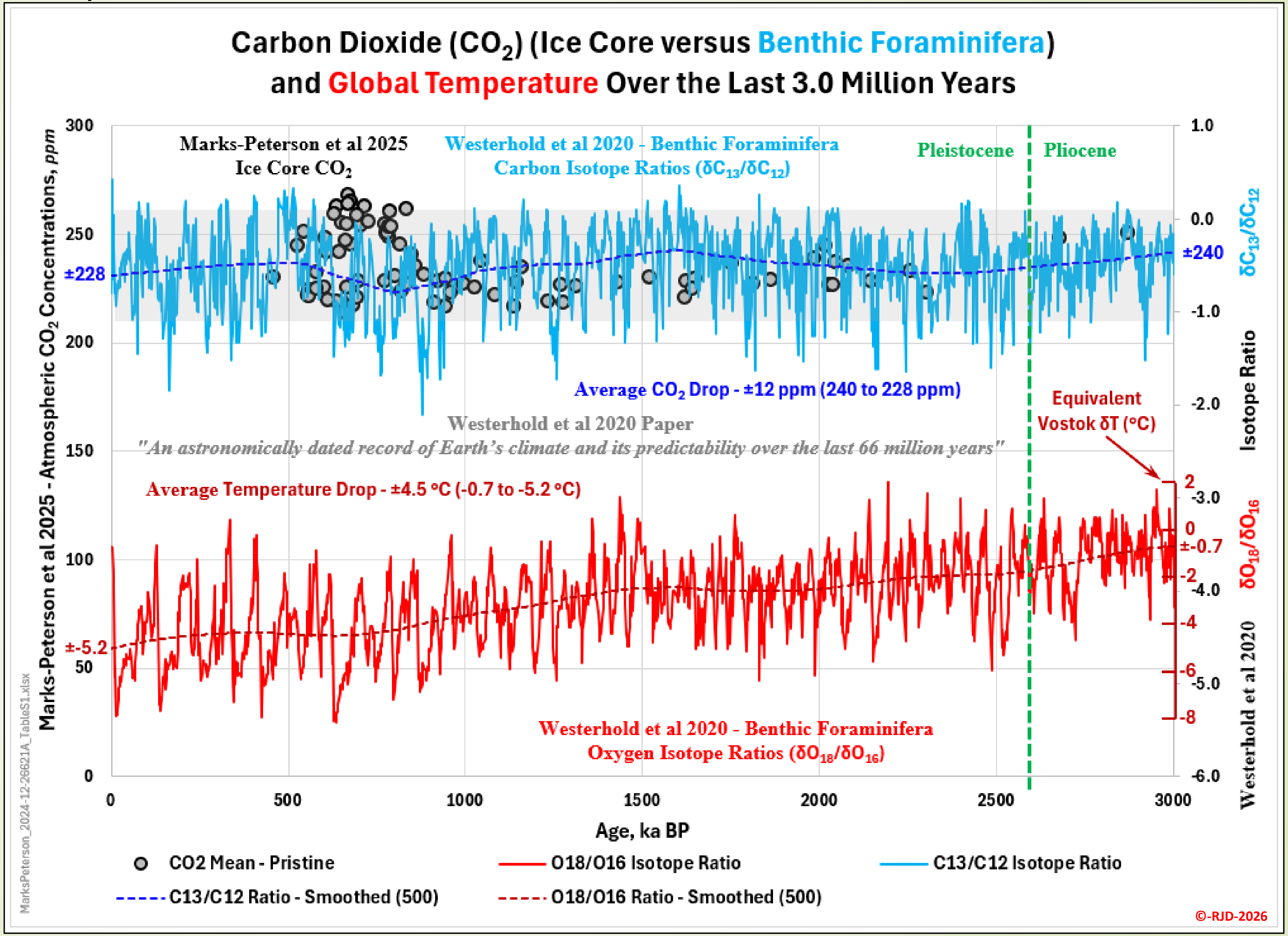
# CSS-81d Historical $CO_2$ and $CH_4$ Concentrations – Marks-Peterson vs Westerhold

More info ? climatechangeandmusic.com

GSM – Grand Solar Minimum. You really should do the Research!

Plotting the Westerhold et al $CO_2$ data (as a benthic foraminifera carbon isotope ratio ($\delta C_{13} \equiv C_{13}/C_{12}$)) against the Marks-Peterson et al $CO_2$ ice core data shows that $CO_2$ has remained in relatively narrow concentration band. The average change over this 3,000,000-year period is just 12 ppm (i.e.: statistically flat (or stable in Marks-Peterson terminology)). The Westerhold et al data also includes the oxygen isotope ratio ($\delta O_{18} \equiv O_{18}/O_{16}$, a proxy for temperature), as shown on the first slide. Over this 3,000,000-year period, the average temperatures dropped roughly 4.5 °C. Remember, the temperatures began dropping around 3.5 million years ago when the Panama Isthmus closed. The minor change in $CO_2$ concentrations (12 ppm) over the last 3.0 million years is not not responsible for the 4.5 °C temperature drop. $CO_2$'s contribution to the 4.5 °C would be 0.42 °C using the IPCC's high end $CO_2$ Equilibrium Climate Sensitivity (ECS, 5.7 °C). Their low end ECS (1.8 °C) would be just 0.13 °C. The actual $CO_2$ contribution is lower than 0.13 °C , given that the IPCC models all (self admittedly) run too hot using their 1.8 to 5.7 °C ECS range. $CO_2$ is not driving the climate over the last 3 million years based on the long-term trends.

**$CO_2$-$CH_4$ Marks-Peterson Westerhold**



CSS-81e

# Historical $CO_2$ and $CH_4$ Concentrations – Holocene $CO_2$-Temperature

More info ? climatechangeandmusic.com

GSM – Grand Solar Minimum. You really should do the Research!

There is another period where $CO_2$ concentrations have been very stable, the Holocene warm interglacial period that we are currently living through. $CO_2$ levels remained within a very tight range (±15 ppm) throughout the last 12,500 years, consistent with the high-end range of the Marks-Peterson and Westerhold data sets. As with the last 3 million years, the temperatures are fluctuating independently of the average $CO_2$ concentration (265 to 280 ppm). During both periods the 'climate' is changing but with no help from $CO_2$ (human or otherwise). The climate can obviously change without humanity's input. Now, $CO_2$ concentrations have been rising since 1850 (as shown in the chart to the right) and cannot be ignored. The data is plotted to reflect the All $CO_2$, All the Time alarmist narrative (i.e.: 1.07 °C ≡ 140 ppm). Can $CO_2$ forcing be active since 1850? Of course it can, but so are the natural forcings that drove the planet's climate prior to 1850. Is it a coincidence that the planet's magnetic field strength generally correlates with the global temperature over the entire Holocene, and not just the last 176 years like $CO_2$? No. The magnetic field strength is a climate change contributor and a reflection of the solar system's gravitational and EM interactions affecting our planet's climate.

**$CO_2$-$CH_4$ Holocene $CO_2$ Temperature**