

GLOBAL WARMING AND CO₂ DURING THE PAST CENTURY

Little doubt exists that global temperatures have risen during the past several centuries. Temperatures have risen approximately 1° C (1.8° F) per century since the coldest part of the Little Ice Age ~400 years ago, but the rise has not been linear. Global temperatures have warmed and cooled in numerous 25-35 year cycles, well before atmospheric CO₂ began to rise significantly.

Two episodes of global warming and two episodes of global cooling occurred during the twentieth century (Figs 1,2). The warming and cooling was somewhat more pronounced in the Northern Hemisphere than the global average, probably because of the greater land mass area in the Northern Hemisphere. Overall, temperatures rose about 0.8 °C (1.4° F) during the century, which is about the same rate of warming as has occurred since the Little Ice Age.

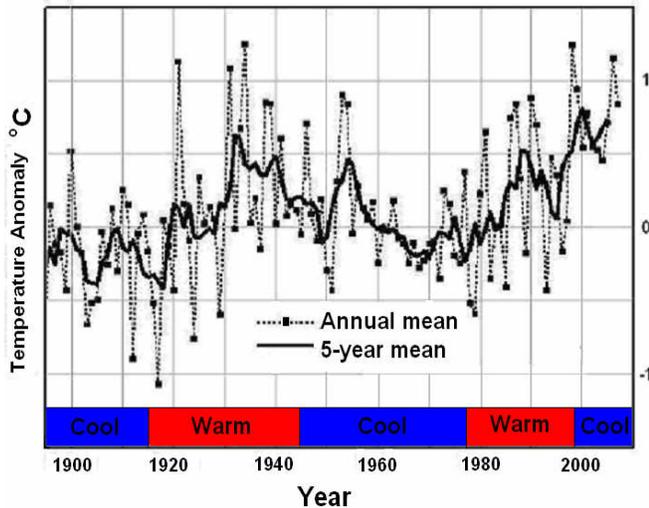


Figure 1. NASA GISS global temperatures 1895 to 2007.

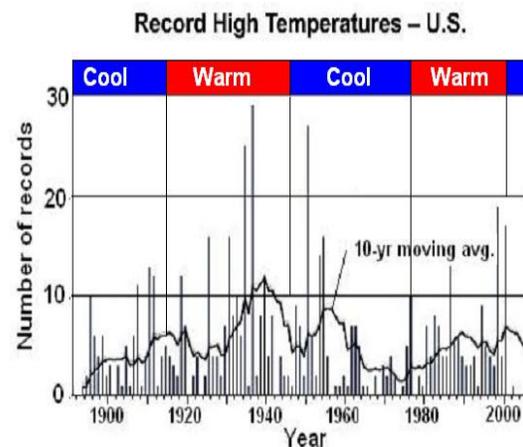


Figure 2. Record high temperatures in the U.S. during the 20th century. Note that the greatest number of high temperatures were recorded in the 1930s.

1880 to 1915 cool period. Atmospheric temperature measurements, glacier fluctuations, and oxygen isotope data from Greenland ice cores all record a cool period from about 1880 to about 1915, reaching a low about 1890. Many cold temperature records in North America were set during this period. Glaciers advanced, some nearly to terminal positions reached during the Little Ice Age about 400 years ago. During this period, global temperatures were about 0.9 °C (1.6 ° F) cooler than at present. From 1880 to 1890, temperatures dropped 0.35 °C (0.6° F) in only 10 years. From 1890 to 1900, temperatures rose 0.25 °C (0.45 ° F) in 10 years, after which temperatures dipped slightly (0.15 °C (0.3 ° F) until about 1915. The 1880 –1915 cool period shows up well in the oxygen isotope curve of the Greenland Ice Sheet (Fig. 3)

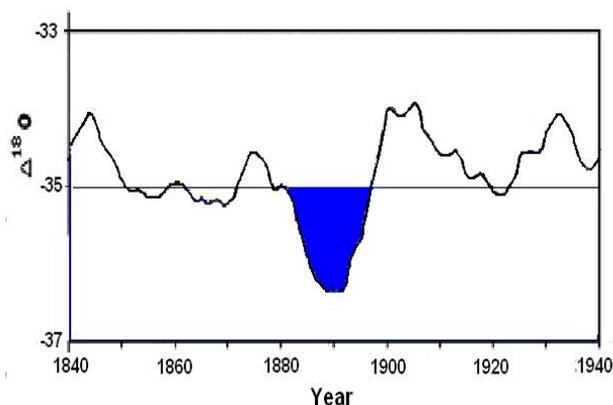


Figure 3. GISP2 oxygen isotope record of the 1880-1915 cool period.

1915 to 1945 warm period could not be caused by atmospheric CO₂. Global temperatures rose steadily in the 1920s, 1930s, and early 1940s. By the mid 1940s, global temperatures were about 0.5 °C (0.9° F) warmer than they had been at the turn of the century (Figure 1). More high temperature records for the century were recorded in the 1930s than in any other decade of the 20th century (Fig. 2).

Glaciers during this period retreated and, in general, followed the warming climate pattern. All of this occurred before CO₂ emissions began to soar after 1945 (Fig. 3), so at least half of the warming of the past century cannot have been caused by manmade CO₂.

Temperatures in the 1930s in the Arctic and Greenland were warmer than at present and rates of warming were higher, warming 4°C (7° F) in two decades. Greenland temperatures generally followed the global temperature pattern, warming in the 1920s, 1930s, and early 1940s, cooling until about 1977, and then rising again until the turn of the century. The average rate of warming from 1920 to 1930 was considerably higher than from 1980–2005, despite the fact that the 1920-1930 warming occurred before CO₂ could have been the cause. Temperatures in Greenland during the Medieval Warm Period (900-1300 AD) were generally warmer than today.

1945 to 1977 cool period with soaring CO₂ emissions. Global temperatures began to cool in the mid-1940's at the point when CO₂ emissions began to soar (Fig. 4). Global temperatures in the Northern Hemisphere dropped about 0.5° C (0.9° F) from the mid-1940s until 1977 and temperatures globally cooled about 0.2° C (0.4° F) (Fig. 1). Many of the world's glaciers advanced during this time and recovered a good deal of the ice lost during the 1915–1945 warm period. However, cooling during this period was not as deep as in the preceding cool period (1880 to 1915). Many examples of glacial recession during the past century cited in the news media show contrasting terminal positions beginning with the maximum extent at the end of a ~30 year cool period (1915 or 1977) and ending with the minimum extent of the recent 20 year warm period (1998). A much better gauge of the effect of climate on glaciers would be to compare glacier terminal positions between the ends of successive cool periods or the ends of successive warm periods.

Figure 4 shows CO₂ that even though emissions from 1945 to 1977 soared, global temperature dropped during that 30-year period. If CO₂ causes global warming, temperature should have risen, rather than declined, strongly suggesting that rising CO₂ did not cause significant global warming.

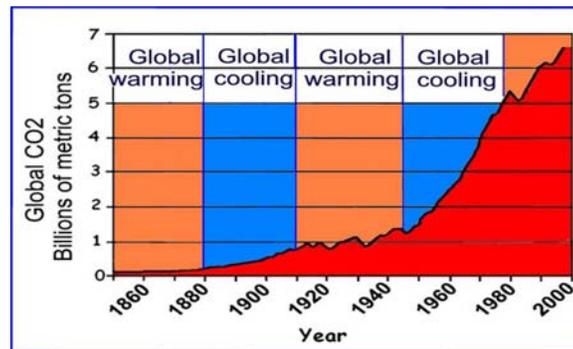
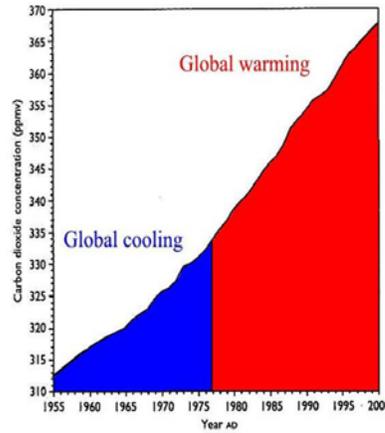
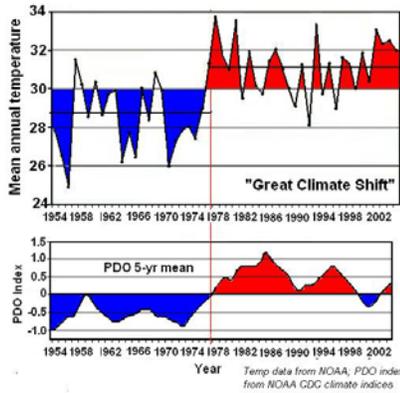


Figure 4. CO₂ emissions from 1850 to 2000. Note that CO₂ emissions were low during the global warming from 1850 to 1880 and rose slowly during the deep global cooling from 1880 to about 1915. Emissions were fairly constant during the strong global warming from 1915 to 1945. While emissions were soaring from 1945 to 1977, the global climate cooled, rather than warmed as it should have if CO₂ was the cause of global warming.

1977 to 1998 global warming The global cooling that prevailed from ~1945 to 1977 ended abruptly in 1977 when the Pacific Ocean shifted from its cool mode to its warm mode in a single year and global temperatures began to rise, initiating two decades of global warming (Fig. 1). This sudden reversal of climate in 1977 has been called the “Great Pacific Climate Shift” (Fig. 5) because it happened so abruptly. During this warm period, alpine glaciers retreated, Arctic sea ice diminished, melting of the Greenland Ice Sheet accelerated, and other changes occurred.



A.

B.

Figure 5A Mean annual temperatures for Anchorage, Fairbanks, and Nome (upper graph) and Pacific Decadal Oscillation (PDO) (lower graph) reflecting Pacific sea surface temperatures. The sudden switch from cool to warm PDO caused the “Great Climate Shift” in 1977 that initiated the latest global warming period. **Figure 5B.** Atmospheric CO₂ from 1955 to 2000. Note that CO₂ rose smoothly across the ‘Great Pacific Climate shift’ from cool to warm in 1977 without any sign of unusual increase.

The abruptness of the shift in Pacific sea surface temperatures and corresponding change from global cooling to global warming in 1977 is highly significant and strongly suggests a cause-and-effect relationship. The rise of atmospheric CO₂, which accelerated after 1945 shows no sudden change that could account for the “Great Pacific Climate Shift” (Fig. 5B).

During the 1977–1998, atmospheric CO₂ continued to rise, the only period in the past four centuries when global warming and atmospheric CO₂ have risen together. However, this doesn’t prove a cause–and–effect relationship—just because two things happen together doesn’t prove that one is the cause of the other.

The global warming from 1977 to 1998 has received much attention in the news media and represents the period now popularly called “global warming”. Previously, warming during the entire 20th century was referred to as the time of “global warming” but when it became apparent that increasing atmospheric CO₂ could not explain warming and cooling prior to 1977, advocates of CO₂ as the cause of the warming restricted what is now labeled as “global warming” to the post-1977 warming.

Global cooling from 1999 to 2009. No global warming has occurred above the 1998 level. In 1998, the PDO was in its warm mode. In 1999, the PDO flipped from its warm mode into its cool mode and satellite imagery confirms that the cool mode has become firmly entrenched since then and global cooling has deepened significantly in the past few years.