



This is the print version of the [Skeptical Science](http://sks.to/pre1940) article '[It warmed before 1940 when CO2 was low](http://sks.to/pre1940)', which can be found at <http://sks.to/pre1940>.

What caused early 20th Century warming?

What The Science Says:

Early 20th century warming is due to several causes, including rising CO₂.

Climate Myth: It warmed before 1940 when CO2 was low

"Of the rise in temperature during the 20th century, the bulk occurred from 1900 to 1940. It was followed by the aforementioned cooling trend from 1940 to around 1975. Yet the concentration of greenhouse gases was measurably higher in that later period than in the former. That drop in temperature came after what was described in the National Geographic as 'six decades of abnormal warmth'." ([James Schlesinger](#))

At a glance

The Twentieth Century climate was a veritable Smorgasbord of natural and manmade factors. They vied with or against one another, driving temperatures in various directions at different times. Conditions were on the cool side up until the 1920s. That was followed by a sustained warming through to the late 1940s. From then until the late 1970s, periods of warmer and cooler conditions alternated. Thereafter, we saw the erratic but one-way climb of temperatures that has persisted through to the present day.

This was also the period during which CO₂ emissions from use of fossil fuels really took off, from **1.5 billion** tonnes a year in **1900**, through **6 billion** tonnes in **1950**, **25 billion** by **2000** and **44 billion** now. How well do those figures correlate with what was going on in Earth's climate system at the time?

Planetary climate is affected by a number of factors. Examples include solar variability, the amount of volcanic activity, fluctuating ocean currents, cyclic variations in Earth's orbit, the strength of the Greenhouse Effect and the amount of sunlight reflected by Earth's surface. Some are forcings - factors that dictate and change the total energy within the climate system. Others are feedbacks - they respond in various ways to those changes.

Both forcings and feedbacks operate on a variable timescales - from years to millennia. That variability means they may sometimes reinforce one another and at other times cancel each other out. To assess why the climate behaved in a certain way at a certain time, all must be examined.

In the case of the 1920-1940 period, the increase in global temperature is thought to have been largely caused by three of the above factors. The amount of solar energy reaching the top of Earth's atmosphere rose steadily from 1920-1940. Although the amount of change was small, it was certainly not negligible. Volcanic activity produces atmospheric aerosols that can have a cooling effect by partly blocking out the sun. Lower than normal volcanic activity, as was the case in the 1920-1940 period, would result in less of those airborne coolants. Our early, albeit relatively low greenhouse gas emissions also contributed to the warming. Regional factors played a role in increasing temperatures in some parts of the world, too. Most notably, changes in ocean currents led to warmer-than-normal sea temperatures in the North Atlantic.

Anyone who has been around for long enough to recall the chemical smogs of the 1950s and early 1960s will know that pollution can be deadly. In one smog, in London in December 1952, between 4,000 and 12,000 people died, victims of severe respiratory disease. Governments responded. Over the next two decades numerous Clean Air Acts were passed. Pollution levels fell accordingly. But such pollutants, just like volcanic gases, are aerosols that have that same cooling effect. Clearing them away removed that effect and tore off the mask behind which CO₂ emissions had been hiding - and off we went on our warming journey.

Further details

It is a widespread misconception that anthropogenic global warming has been the dominant factor driving climate during all periods of the twentieth century. It is clear that anthropogenic carbon emissions are the reason we are warmer today than we were in the mid-1800s. But here we are considering the whole 20th century. As has obviously been done with respect to the more recent, post 1970s warming, to examine the evolution of climate through the whole 20th Century it is necessary to investigate all potential causes of climate forcing and establish how they have interacted. In addition to greenhouse gas emissions, other key variables to consider include:

- solar variability
- volcanic activity
- aerosol concentrations - both natural and anthropogenic
- changes in albedo
- fluctuations in oceanic currents
- orbital factors (Milankovitch cycles)

These factors operate on various timescales and interact variably with one another, but despite such complexities, climate science has drilled down into the pre-1940s period and has identified the key reasons for the warming at the time.

In the early 20th century, while CO₂ levels were much smaller, they were rising despite emissions being a fraction of what they are today. Solar activity was on the rise throughout this period, amounting to a change in incoming radiation of approximately a watt per square metre.

Also, after a burst of volcanic activity in the late 19th century (think Krakatoa etc), there was a relatively quiet volcanic period in the early 20th century. These were two dominant factors in the warming from 1900 to 1940 (fig. 1).

However, those factors have played little to no part in the warming since 1975. Solar activity has declined since that time whereas temperatures have continued climbing. Volcanoes have been relatively frequent in the last few decades and if anything, have exerted a cooling effect that has somewhat masked the CO₂ warming effect. The 1991 eruption of Mt Pinatubo is an example.

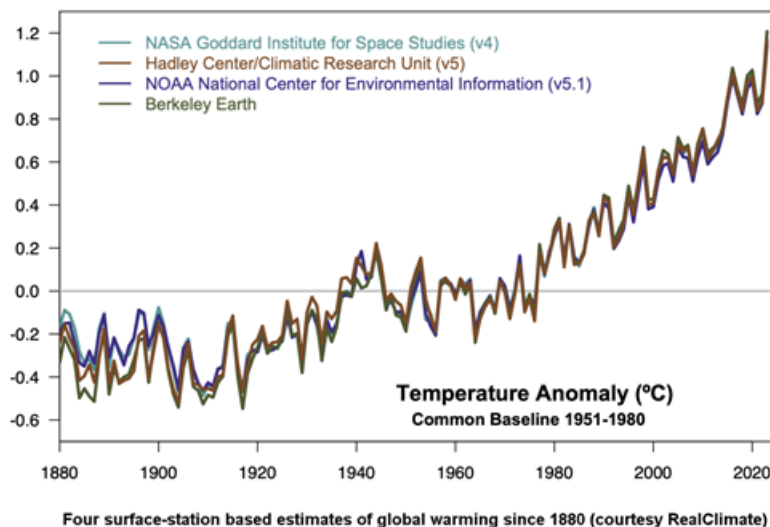


Figure 1: Multiple independent global surface temperature products show a very coherent pattern of temperature change over the 1880-2023 period. While there is overlap in the weather station inputs and ocean data, the methods for correcting for missing data, inhomogeneities, spatial sampling etc. are independent. Graphic: [Realclimate](#).

Papers studying climate change over the early 20th century

In, "Estimation of natural and anthropogenic contributions to twentieth century temperature change" ([Tett et al. 2002](#)), the authors commented: "During 1907–57 we found that there was negligible net anthropogenic warming with the effect of greenhouse gases largely being balanced by other anthropogenic forcings. Therefore, in this period, the warming was largely naturally caused. The late century warming was largely explained by greenhouse gases offset by the effect of volcanic aerosol and the indirect effect of anthropogenic aerosols. Over the entire century natural forcings make no net contribution as they warm early in the century and cool from the 1960s on."

In the paper, "Solar Forcing of Global Climate Change Since The Mid-17th Century" ([Reid 1997](#)), the author found a link between solar variability and early 20th Century climate change, concluding that "solar forcing and anthropogenic greenhouse-gas forcing made roughly equal contributions to the rise in global temperature that took place between 1900 and 1955".

More recently, in an important review paper ([Hegerl et al. 2019](#)), the causes of observed climate variations were discussed in the period from 1750 to the present day. Interestingly, a synthesis of results from attribution studies showed how greenhouse gases began to cause a warming trend that was attributable to greenhouse gases by 1900 in proxy-based temperature reconstructions.

Hegerl et al. found that the influence of greenhouse gases unsurprisingly increased over time, dominating recent trends. However, other forcings caused substantial deviations from this emerging greenhouse warming trend. Intense periods of volcanicity caused strong cooling in the early 19th century. Warming occurred during periods of low volcanic activity, such as in the early-to-mid 20th century. Anthropogenic aerosol forcing most likely masked some anthropogenic global warming over the 20th century. That was particularly the case in the period since the accelerated increase in sulphate aerosol emissions starting around 1950, thereby explaining the overall cooler conditions in the post-1940s period. This paper is open-access.

Of course, that sulphate aerosol pollution was a bit different to CO₂ - you could see it and taste it. The [London Smogs](#) are just one example. Such appalling air quality led to measures in various countries to limit such pollutants, such as the UK government passing the Clean Air Acts of 1956 and 1968. With this negative forcing mechanism strongly reduced, the modern anthropogenic warming signal emerged a few years later.



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