3

Observations: Temperature Records

Introduction

The Intergovernmental Panel on Climate Change (IPCC) claims to have found evidence in paeloclimatic data that higher levels of atmospheric CO_2 can cause or amplify an increase in global temperatures (IPCC, 2007-I, Chapter 6). The IPCC further claims to have evidence of an anthropogenic effect on climate in the earth's temperature history during the past century (Chapters 3, 9), in the pattern (or "fingerprint") of more recent warming (Chapter 9, Section 9.4.1.4), in data from land-based temperature stations and satellites (Chapter 3), and in the temperature records of the Artic region and Antarctica where models predict anthropogenic global warming should be detected first (Chapter 11, Section 8). In this chapter, we critically examine the data used to support each of these claims, starting with the relationship between CO_2 and temperature in ancient climates.

References

IPCC. 2007-I. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller. (Eds.) Cambridge University Press, Cambridge, UK.

3.1. Paeloclimatic Data

Rothman (2002) derived a 500-million-year history of the air's CO_2 content based on considerations related to the chemical weathering of rocks, volcanic and metamorphic degassing, and the burial of organic carbon, along with considerations related to the isotopic content of organic carbon and strontium in marine sedimentary rocks. The results of this analysis suggest that over the majority of the half-billion-year record, earth's atmospheric CO_2 concentration fluctuated between values that were two to four times greater than those of today at a dominant period on the order of 100 million years. Over the last 175 million years, however, the data depict a long-term decline in the air's CO_2 content.

Rothman reports that the CO_2 history "exhibits no systematic correspondence with the geologic record of climatic variations at tectonic time scales." A visual examination of Rothman's plot of CO_2 and concomitant major cold and warm periods indicates the three most striking peaks in the air's CO_2 concentration occur either totally or partially within periods of time when earth's climate was relatively cool.

A more detailed look at the most recent 50 million years of earth's thermal and CO_2 history was prepared by Pagani *et al*. (2005). They found about 43 million years ago, the atmosphere's CO_2 concentration was approximately 1400 ppm and the oxygen isotope ratio (a proxy for temperature) was

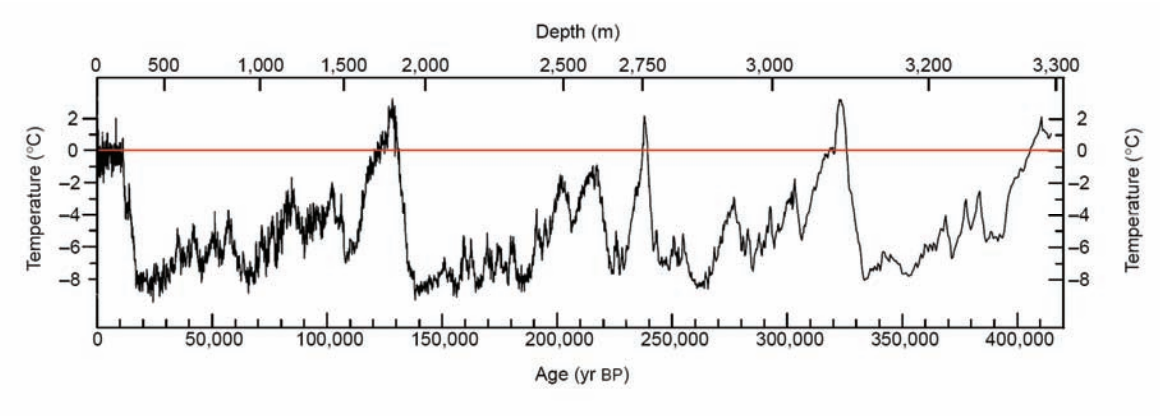

Figure 3.1. Temperature history derived by Petit *et al*. (1999) from an ice core extracted from the Russian Vostok drilling station in East Antarctica.

about 1.0 per mil. Then, over the next ten million years, the air's CO_2 concentration experienced three huge oscillations on the order of 1000 ppm from peak to valley. In the first two oscillations, temperature did not appear to respond at all to the change in CO_2, exhibiting an uninterrupted slow decline. Following the third rise in CO_2, however, temperatures seemed to respond, but in the direction opposite to what the greenhouse theory of global warming predicts, as the rise in CO_2 was followed by the sharpest drop in temperature of the entire record.

Following this large drop in temperature between 34 and 33 million years before present (Ma BP), the oxygen isotope ratio hovered around a value of 2.7 per mil from about 33 to 26 Ma BP, indicating little change in temperature over that period. The corresponding CO_2 concentration, on the other hand, experienced about a 500 ppm increase around 32 Ma BP, after which it dropped 1,000 ppm over the next two million years, only to rise again by a few hundred ppm, refuting – three times – the CO_2-induced global warming hypothesis. Next, around 26 Ma BP, the oxygen isotope ratio dropped to about 1.4 per mil (implying a significant *rise* in temperature), during which time the air's CO_2 content declined. From 24 Ma BP to the end of the record at 5 Ma BP, there were relatively small variations in atmospheric CO_2 content but relatively large variations in oxygen isotope values, both up and down. All of these many observations, according to Pagani *et al*. (2005), "argue for a decoupling between global climate and CO_2."

Moving closer to the modern era, Fischer *et al*. (1999) examined trends of atmospheric CO_2 and air temperature derived from Antarctic ice core data that extended back in time a quarter of a million years. Over this period, the three most dramatic warming events experienced on earth were the terminations of the last three ice ages; and for each of these climatic transitions, earth's air temperature always rose well in advance of the increase in atmospheric CO_2. In fact, the air's CO_2 content did not begin to rise until 400 to 1,000 years after the planet began to warm.

Another research team, Petit *et al*. (1999), studied the beginnings rather than the ends of glacial ages. They discovered that during all glacial inceptions of the past half million years, temperature always dropped well before the decline in the air's CO_2 concentration. They said their data indicate that "the CO_2 decrease lags the temperature decrease by several thousand years." Petit *et al*. also found the current interglacial is the coolest of the five most recent such periods. In fact, the peak temperatures of the four interglacials that preceded it were, on average, more than 2°C warmer than that of the one in which we currently live. (See Figure 3.1.)

Figure 3.1 tells us three things about the current warm period. First, temperatures of the last decades of the twentieth century were "unprecedented" or "unusual" only because they were *cooler* than during past interglacial peaks. Second, the current temperature of the globe cannot be taken as evidence of an anthropogenic effect since it was warmer during parts of all preceding interglacials for which we have good proxy temperature data. And third, the higher temperatures of the past four interglacials cannot be attributed to higher CO_2 concentrations caused by some non-human influence because atmospheric CO_2 concentrations during all four prior interglacials never rose above approximately 290 ppm, whereas the air's CO_2 concentration today stands at nearly 380 ppm.

Likewise, Mudelsee (2001) determined that variations in atmospheric CO_2 concentration lagged behind variations in air temperature by 1,300 to 5,000 years over the past 420,000 years. During certain climatic transitions characterized by rapid warmings of several degrees Centigrade, which were followed by slower coolings that returned the climate to essentially full glacial conditions, Staufer *et al*. (1998) observed the atmospheric CO_2 concentration derived from ice core records typically varied by less than 10 ppm. They, too, considered the CO_2 perturbations to have been caused by the changes in climate, rather than vice versa.

Other studies have also demonstrated this reverse coupling of atmospheric CO_2 and temperature (e.g., Cheddadi *et al*., 1998; Gagan *et al*., 1998; Raymo *et al*., 1998), where temperature is the independent variable that appears to induce changes in CO_2. Steig (1999) noted cases between 7,000 and 5,000 years ago when atmospheric CO_2 concentrations increased by just over 10 ppm at a time when temperatures in both hemispheres cooled.

Caillon *et al*. (2003) measured the isotopic composition of argon – specifically, δ^{40}Ar, which they argue "can be taken as a climate proxy, thus providing constraints about the timing of CO_2 and climate change" – in air bubbles in the Vostok ice core over the period that comprises what is called Glacial Termination III, which occurred about 240,000 years ago. The results of their tedious but meticulous analysis led them to conclude that "the CO_2 increase lagged Antarctic deglacial warming by 800 ± 200 years." This finding, in their words, "confirms that CO_2 is not the forcing that initially drives the climatic system during a deglaciation."

Indermuhle *et al*. (1999) determined that after the termination of the last great ice age, the CO_2 content of the air gradually rose by approximately 25 ppm in almost linear fashion between 8,200 and 1,200 years ago, over a period of time that saw a slow but steady *decline* in global air temperature. On the other hand, when working with a high-resolution temperature and atmospheric CO_2 record spanning the period 60 to 20 thousand years ago, Indermuhle et al. (2000) discovered four distinct periods when temperatures rose by approximately 2°C and CO_2 rose by about 20 ppm. However, one of the statistical tests they performed on the data suggested that the shifts in the air's CO_2 content during these intervals *followed* the shifts in air temperature by approximately 900 years; while a second statistical test yielded a mean CO_2 lag time of 1,200 years.

Another pertinent study is that of Siegenthaler *et al*. (2005), who analyzed CO_2 and proxy temperature (δD, the ratio of deuterium to hydrogen) data derived from an ice core in Antarctica. Results of their analysis revealed a coupling of Antarctic temperature and CO_2 in which they obtained the best correlation between CO_2 and temperature "for a lag of CO_2 of 1900 years." Specifically, over the course of glacial terminations V to VII, they indicate that "the highest correlation of CO_2 and deuterium, with use of a 20-ky window for each termination, yields a lag of CO_2 to deuterium of 800, 1600, and 2800 years, respectively." In addition, they note that "this value is consistent with estimates based on data from the past four glacial cycles," citing in this regard the work of Fischer *et al*. (1999), Monnin *et al*. (2001) and Caillon *et al*. (2003).

These observations seem to undermine the IPCC's claims that the CO_2 produced by the burning of fossil fuels will lead to catastrophic global warming. Nevertheless, Siegenthaler *et al*. stubbornly state that the new findings "do not cast doubt ... on the importance of CO_2 as a key amplification factor of the large observed temperature variations of glacial cycles." The previously cited Caillon *et al.* also avoid the seemingly clear implication of their own findings, that CO2 doesn't *cause* global warming. We find such disclaimers disingenuous.

When temperature is found to lead CO_2 by thousands of years, during both glacial terminations and inceptions (Genthon *et al*., 1987; Fischer *et al*., 1999; Petit *et al*., 1999; Indermuhle *et al*., 2000; Monnin *et al*., 2001; Mudelsee, 2001; Caillon *et al*., 2003), it is extremely likely that CO_2 plays only a minor role in enhancing temperature changes that are induced by something else. Compared with the mean conditions of the preceding four interglacials, there is currently 90 ppm more CO_2 in the air and yet it is currently more than 2°C colder than it was then. There is no way these real-world observations can be construed to suggest that a significant increase in atmospheric CO_2 would necessarily lead to *any* global warming, much less the catastrophic type that is predicted by the IPCC.

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3.2. Past 1,000 Years

The IPCC claims "average Northern Hemisphere temperatures during the second half of the 20th century were *very likely* higher than during any other 50-year period in the past 500 years and *likely* the highest in at least the past 1,300 years [italics in the original]" (IPCC, 2007-I, p. 9). Later in that report, the IPCC says "the warming observed after 1980 is unprecedented compared to the levels measured in the previous 280 years" (p. 466) and "it is likely that the 20th century was the warmest in at least the past 1.3 kyr. Considering the recent instrumental and longer proxy evidence together, it is very likely that average NH [Northern Hemisphere] temperatures during the second half of the 20th century were higher than for any other 50-year period in the last 500 years" (p. 474).