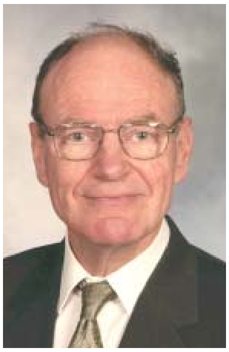

Donald Morton

Article

Climate Science and the Dilemma for Christians

Donald C. Morton

We hear from many sources that the most important environmental problem is global warming caused by carbon dioxide (CO_2) from the burning of fossil fuels. However, after a gradual rise of about 0.6 °C from 1978 to 1998, the global temperature, contrary to the predictions of climate models, has remained essentially constant for the past sixteen years while the atmospheric concentration of CO_2 has steadily increased. We do not know whether natural effects or anthropogenic CO_2 and similar gases are the primary cause of the recent increase in temperature. It could begin to rise again as we generate more CO_2, or it could fall as suggested by the present reduction in solar activity. This uncertain situation raises many questions about the usefulness of policies of mitigation and their unintended effects.

The Present State of Climate Science

Much current discussion of the environment centers on the predictions for our changing climate. Experts tell us that the warming of the earth by anthropogenic carbon dioxide (CO_2) is the most serious problem facing humanity so we must take action immediately. The difficulty with this view is that global temperatures stopped increasing after 1998 while the concentration of atmospheric CO_2 has continued its steady rise.

Figure 1 from the US National Oceanic and Atmospheric Administration shows how temperatures have not followed the rise in CO_2 as expected from all the model calculations. The recent paper by John Fyfe et al. provides further evidence of the deviation of climate models from the temperature observations.[1] Already in 2009, climatologists were concerned by the discrepancy and posed the rhetorical question, "Do global temperature trends over the last decade falsify climate predictions?" Their response was the following:

> Near-zero and even negative trends are common for intervals of a decade or less in the simulations, due to the model's internal climate variability. The simulations rule out (at the 95 % level) zero trends for intervals of 15 yr or more, suggesting that an observed absence of warming of this duration is needed to create a discrepancy with the expected present-day warming rate.[2]

Now we are beyond the fifteen-year test with no warming.

Government officials developing climate policies depend on the reports of the Intergovernmental Panel on Climate Change (IPCC). The 2013 Fifth Assessment Report (AR5)[3] includes figure 2, which shows the predicted temperatures rising steadily while the measurements follow the lower boundary of the models, even for these with only a modest increase in atmospheric CO_2. Clearly the global temperature is not following the expected increase from the rising CO_2 concentration. The models

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are failing the essential test of a scientific theory. It must make valid predictions. This criterion is especially important for climate models because the calculations depend on many adjustable parameters to represent physical effects too complicated to code explicitly. These are chosen to fit the observations so reproducing existing data is not an effective test.

As a consequence of the observed plateau, the AR5 Report broadened the range of the predicted temperature increase to 1.5 ºC to 4.5 ºC from the previous 2 ºC to 4.5 ºC for a doubling of the CO_2 concentration, thus allowing for a little less warming while retaining the alarming upper limit in spite of admitting that there may be a heating bias in some models. The report quickly passed over the change in slope of the temperature curve and a possible clue to some overlooked physics of climate change such as stable intervals between the chaotic shifts described below. Instead the report highlighted the conclusion,

> Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions in greenhouse gas emissions.[4]

Note that the growing of plants in glass houses actually depends on the plants and ground absorbing sunlight and heating the surrounding air, which is prevented from mixing with colder air outside. Atmospheric heating occurs through the tropospheric absorption of infrared radiation from the earth's surface in the molecular bands of the incorrectly named greenhouse gases. Besides CO_2 these are methane (CH_4), nitrous oxide (N_2O), ozone (O_3) and several chlorofluorocarbons (CFC's). In the IPCC reports, their effects are roughly cancelled by cooling attributed to albedo changes due to land use and aerosols including clouds, so the heating often is described in terms of just the CO_2 concentration, now about 400 parts per million. However, absorption by the highly variable concentration of water vapor dominates the effects of the other gases. Temperatures at night drop much more quickly in arid desert locations than where the humidity is high.

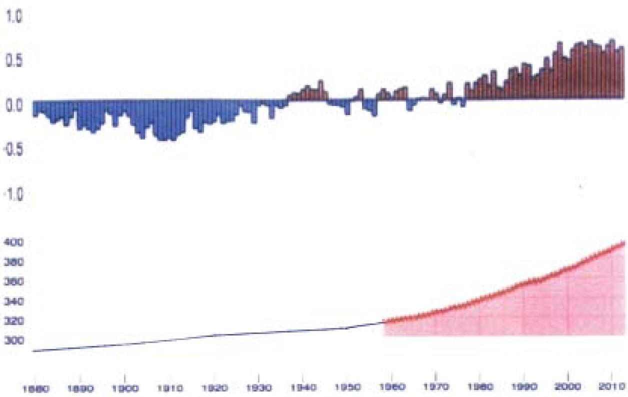

Figure 1. Global Average Temperature Anomaly (°C) upper, and CO_2 concentration (ppm) lower from http://www.climate.gov/maps-data by the US National Oceanic and Atmospheric Administration with ice-core data from the Antarctic Law Dome showing a gradual increase in the CO_2 concentration from 284 ppm in 1832 to 334 ppm in 1978. See ftp://ftp.ncdc.noaa.gov/pub/data/paleo/icecore/antarctica/law/law_co2.txt.

Concerns about Climate Models

There are many reasons to question the basic assumptions used in the models and the procedures for computing them, as described by Christopher Essex and Ross McKitrick in their very readable book.[5] Climate, like the weather, depends in part on the chaotic processes of convection and turbulence. Thus, very small changes in the initial conditions can result in very large differences in later states. Models of weather systems begin to diverge after a week or two, even though the models have been refined many times by comparing predictions with observations. The IPCC Report recognizes the problem with the statement, "There are fundamental limits to just how precisely annual temperatures can be projected because of the chaotic nature of the climate system."[6] However, it gives no time estimate and, without justification, plots graphs to 2100.

Furthermore, the model makers assumed that the recent temperature rise of about 0.6 ºC was caused primarily by anthropogenic generation of the absorbing gases, neglecting possible natural causes. Absorption of infrared radiation by these gases does

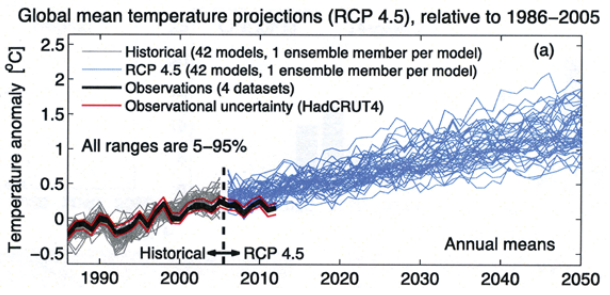

Figure 2. Model Predictions and Temperature Observations from IPCC Report 2013, p. 11–102. RCP 4.5 (Representative Concentration Pathway 4.5) labels a set of models for a modest rise in anthropogenic greenhouse gases corresponding to an increase of 4.5 Wm^{-2} (1.3 %) in total solar irradiance.

increase the air temperature and, hence, global sea and land surface temperatures, but the calculated backwarming is only about one-third to one-half the observed effect.[7] Consequently, the models included amplification by a positive feedback caused by hotter air holding more water vapor, which absorbs more radiation. The computer simulations approximated this feedback and many other effects by choosing parameters to match the observed temperature rise and produce a range of future scenarios. Essentially the feedback was calibrated by the past rise in temperature. If it is no longer rising, the estimated feedback is smaller and even could be negative due to the extra water vapor forming more clouds that reflect more sunlight. With less feedback, the increase in absorbing gases will warm the earth but possibly not enough for serious alarm.

We also need to recognize the uncertainties in the temperature statistic that attempts to calculate a single quantity to represent worldwide climate change with time. The usual plots, such as figures 1 and 2, show the temperature anomaly, the difference in centigrade degrees from a mean over many years (for example, 1961 to 1990) for each time and date at the site. Then climatologists average the anomalies over days, nights, seasons, continents, and oceans with extrapolations from other regions for missing data. Further corrections are necessary for changes in measuring practices, abandoned stations, extra heating in cities and the altitude of the station. Moreover, as emphasized by Essex and McKitrick, temperature is an intensive thermodynamic variable that has no physical meaning when averaged over different locations and times in a nonequilibrium system.[8] Nevertheless, this is the statistic adopted by the IPCC to represent global climate so it is reasonable to expect the predictions of the models used by the IPCC to be consistent with it.

For the purpose of this discussion, the divergence between the models and temperatures in figure 2 is sufficient reason to conclude that we do not yet understand climate. Susan Solomon, as reported by Jeff Tollefson, now is saying that fifty to one hundred years is needed to recognize a change in climate.[9] If so, the rise from 1978 to 1998 could be a short-term fluctuation not necessarily caused by CO_2. Kevin Cowtan and Robert Way have suggested a bias in the temperature record because of incomplete data on the recent Arctic warming.[10] However, Ed Hawkins has shown that this correction is insignificant.[11]

Many climatologists recognize the temperature plateau as a serious challenge to their predictions, so they are busy investigating many phenomena omitted from the present models. The hypotheses include

1. an overestimate of the effect of the absorbing gases in some models,[12]
2. inadequate inclusion of clouds that reflect sunlight,[13]
3. uncertainty in the contributions of other liquid and solid aerosols, some of which reflect and others absorb radiation,[14]
4. cooling by SO_2 aerosols from recent volcanoes,[15]
5. a decreasing concentration of stratospheric water vapor that slowed the rise in surface temperatures,[16]
6. a major South Pacific El Niño warming in 1998 so the plateau did not begin until 2001,[17]
7. a deep reservoir for the missing heat mainly in the Pacific Ocean[18] or the Atlantic Ocean,[19]
8. the Atlantic multidecadal oscillation,[20]
9. a multidecadal climate signal with many inputs propagating across the Northern Hemisphere like a stadium wave,[21]
10. reduced absorption by chlorofluorocarbons because their concentration has stopped rising following the Montreal Protocol,[22]
11. unpredictable climate due to chaos,[23] and
12. lower ultraviolet solar irradiance around 200 nm that reduces the formation of ozone and hence the absorption of solar energy between 240 and 320 nm in the stratosphere.[24]

Thus, there are many processes partially or completely omitted from the models that we were told were dependable for climate predictions. Several of these effects also could be natural contributions to the warming from 1978 to 1998. Consequently, we must wait for the development of new theories and new models to assess the importance of each item and how the predictions turn out as global temperatures evolve over the next decades—or longer, if we think fifty to one hundred years are needed to assess climate change. The testing of climate predictions takes time.

The simplest explanation for any variation in the global temperature would be a change in the total solar irradiance. However, we know from satellite observations beginning in 1978 that the luminosity of the sun integrated over all wavelengths varies by only 0.1 % over the 11-year sunspot cycle and has remained within that range during the present cycle.[25] The direct effect on temperature is only 0.1 ºC, but reduced solar activity also lowers the strength of the heliosphere magnetic shield permitting more cosmic rays to reach the earth and seed more clouds that then reflect more sunlight.[26] The solar wind also varies with solar activity, affecting cloud formation through interaction with global electric circuit.[27]

These are interesting possibilities because beginning about 2003, there was a major change in solar activity. The sunspot count in figure 3 shows an active sun from 1978 to 2003 followed by a broad minimum and a weak maximum just passed. Figure 4 shows that the previous occasions of weak activity were the Dalton Minimum from about 1800 to 1820 and the Maunder Minimum from 1645 to 1715. These events occurred during the Little Ice Age, a cold period that lasted from about 1430 to 1850 when glaciers in both the Northern and Southern Hemispheres advanced. We know from the cosmogenic nuclides ^{14}C in tree rings and ^{10}Be in ice cores that cosmic rays were stronger during these minima, confirming that the sun was less active. Gerard Bond et al. determined the history of North Atlantic sea temperatures for the past 12,000 years from the latitudes of sea-floor debris dropped by melting icebergs originating in Canada and Greenland.[28] They found a strong anti-correlation of temperature with the ^{14}C and ^{10}Be proxies for solar activity. Whether the lower temperatures resulted from a weaker total irradiance or some other solar influence we do not yet know, but solar activity does appear to affect climate. Similarly with a stalagmite taken from a cave in Oman, anti-correlation of $^{18}O/^{16}O$ with ^{14}C demonstrated the influence of solar activity on rainfall.[29]

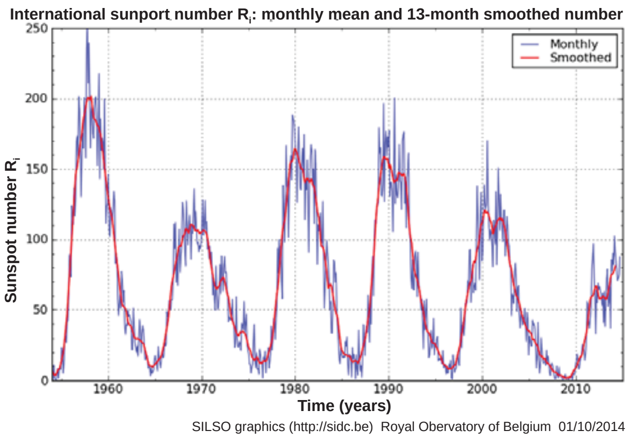

Figure 3. Monthly sunspot numbers for the past 60 years by the Royal Observatory of Belgium at http://sidc.oma.be/sunspot-index-graphics/sidc_graphics.php. The recent minimum was unusually broad with 820 spotless days compared with 230, 274, 275, and 310 days during the previous four.

Thus, temperatures could begin to rise again as we add more CO_2 to the atmosphere, or they could fall if the weak solar activity leads to a cooler earth. At present, some cooling process is providing a remarkable balance with the known global heating due to increasing concentrations of CO_2 and the other absorbing gases. While the present plateau lasts, we easily will match the proposed goal of limiting the temperature rise to 2 ºC since the industrial revolution. If temperatures rise again, we cannot say how much, if at all, we will need to constrain our CO_2 emissions because we do not know the fraction of the heating due to natural causes. In fact, a modest increase in temperature and CO_2 could have net benefits for crop yields. Operators of greenhouses often add CO_2 to stimulate plant growth.

The Dilemma for Christians

So this is the quandary for Christians and anyone else who cares for our planet. With these uncertainties about future temperatures and other aspects of our climate, should we still adopt the aggressive policies necessary for a significant reduction in the global CO_2 output or wait until we have a better understanding of the natural causes of a changing climate?

Specifically, here are some issues that deserve serious discussion.

1. As insurance against possible future warming, should we in the developed countries still make

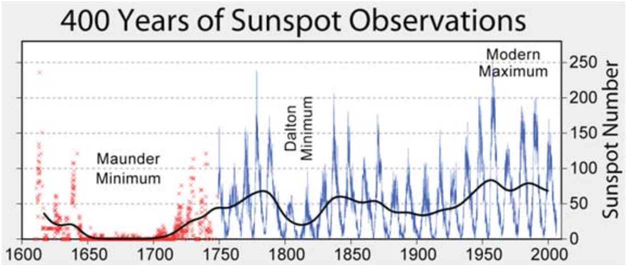

Figure 4. This plot from the US National Oceanic and Atmospheric Administration shows sunspot numbers since their first observation with telescopes in 1610. Systematic counting began soon after the discovery of the 11-year cycle in 1843. Later searching of old records provided the earlier numbers.

major reductions in our generation of the absorbing gases and accept the consequent economic pain? Small reductions with minimal economic impact are unlikely to be effective. The CO_2 curve in figure 1 shows the annual photosynthesis cycle but not the recession of 2008.

2. What will be the consequences of proposed policies for the poorest people in the developed countries and for all but the wealthiest in poor countries?

3. Are there other environmental issues equally or more important than the possible effects of CO_2? We do not have the resources to address all the problems.

4. Are all of the current efforts to reduce CO_2 emissions effective? Is subsidizing biofuels helpful? Why oppose pipelines for transporting petroleum products when shipping by railcar requires more energy and is more dangerous? Is it useful to construct large installations of windmills, solar cells, or mirrors if there is no way to store the energy? The excessive feed-in tariffs required to repay the investors add to everyone's electricity costs, and in the United States, windmills need special White House dispensation because they kill endangered birds such as bald eagles. A recent report in *The Economist* describes how unfavorable the real costs of wind and solar power are compared with hydro, nuclear, and gas sources.[30]

5. As developing countries such as China and India use more and more energy, they are becoming the major emitters of CO_2. Do we expect them to constrain their growth short of our standard of living? If not, how do we deal with all the extra CO_2?

6. Should we advocate and practice zero population growth to help limit global warming?

7. At the United Nations conference in Warsaw in November 2013, developing nations, with the support of China, demanded reparations from the developed countries for all the CO_2 they have added to the atmosphere since the industrial revolution and compensation for damage caused by hurricanes, typhoons, and spells of drought. How should we respond to such demands?

8. How serious are higher sea levels for island communities? According to the IPCC Report, the mean sea level is rising by 1.5 to 1.9 mm/yr, but the evidence for the expected acceleration is weak with a range of -0.002 to 0.019 mm/yr^2.[31] Data from the tide-gauge records show that rising sea level will not be a problem this century.[32] Except for a few places such as Manila in the Philippines, where the land is subsiding, the real threats may be human developments that hinder the natural reef-building processes that follow a rising sea level.[33]

9. The 2013 IPCC Report states that the pH over the open oceans ranges from 8.4 to 7.8, has decreased on the average by about 0.1 logarithmic units since the industrial revolution, and now is trending lower at 0.15 to 0.24 units per century.[34] Even if anthropogenic CO_2 is not causing serious global warming, is the decreasing alkalinity of the ocean sufficient reason to curtail the emission?

10. How much should we constrain travel? Should we use a train or bus in place of a one-hour aeroplane flight for a business meeting even if the longer duration surface travel requires being away an extra night or two? Should we take our vacations close to home? Should we travel to conferences in interesting places on other continents? Should we be using video conferencing instead?

What Should We Do?

It is my view that we should use this time of uncertainty in the predictions to pause in our actions and review the usefulness of the current and proposed projects. With whatever policies we choose, we must ask some basic questions. Will any of the mitigation schemes have a noticeable effect on the increasing atmospheric CO_2? Where is adaptation to be preferred? Could the available funds be spent better some other way? What are the unintended consequences? Also we should adopt a little humility and stop claiming that climate science is settled or that we understand climate well enough to be sure that we know how to control it.

Most importantly, we must eschew the notion of science by consensus and the denigration of skeptics. Even 90+ % of climatologists believing that anthropogenic CO_2 is warming the earth dangerously does not validate the hypothesis. There was consensus that anxiety or spicy food caused gastric ulcers until 1982 when two Australian researchers identified the bacterium *Helicobacter pylori*. Similarly, by consensus, the treatment of malaria once was to move the patient away from the "bad air."

Science progresses by the relentless questioning of every hypothesis, every theory, and every model and by comparing them with experiments and observations.

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