CARBON DIOXIDE AND ATMOSPHERIC WARMING

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"No amount of experimentation can ever prove me right; a single experiment can prove me wrong."

Albert Einstein[1]

Carbon dioxide has been described as a "greenhouse" gas and is said to be a major factor in global warming and climate change.

It has been stated by some climate scientists that man's contribution to the amount of carbon dioxide in the atmosphere is leading to disastrous climate change and that the only counter is to reduce the emission of carbon dioxide into the atmosphere, primarily by reducing the combustion of fossil fuels.

It is true that carbon dioxide is a greenhouse gas: it absorbs infra-red energy and therefore must help to increase the temperature of the environment in which it exists. It is true that it, with other greenhouse gases in the atmosphere such as methane and water, has maintained the temperature of our world at levels commensurate with sustaining life on our planet. It is true that it constitutes a tiny fraction of the atmosphere and a small fraction of the gases which contribute to the greenhouse effect. And it is true that it is a significant factor in sustaining life on our planet being an important part of the carbon cycle through photosynthesis.

It is true that climate changes continuously, sometimes in a way that is beneficial to life, and sometimes in a way that is detrimental. Our planet has been through many cold and warm cycles, which we call "ice ages" and "inter-glacial periods" respectively. Currently the planet is approaching the end of an inter-glacial period known as the Holocene. A new ice age is imminent but no one can be certain when it will begin—tomorrow or a millennium hence.

The dilemma we face is where changes in climate will take us and what we can do about it should it be detrimental to life. The most prominent current hypothesis is that increasing concentrations of carbon dioxide in the atmosphere is the major cause of climate change and that it will lead to a detrimental increase in the surface temperature of the planet. The protagonists of this hypothesis conclude that the only possible solution is to reduce the emissions of carbon dioxide into the atmosphere and, if possible, reduce its concentration in the atmosphere. To this end a variety of taxes on the emission of carbon dioxide have been proposed and alternatives for the generation of electrical energy implemented to replace that generated by fossil fuels.

But, no one has proposed, let alone conducted, an experiment which definitively demonstrates the relationship between carbon dioxide and atmospheric temperature. Furthermore, no one has established an empirical explanation of the extent to which carbon dioxide contributes to atmospheric temperature. Figure 2 below confirms that New Zealand is similar to actual readings from elsewhere in the world: a small increase in the concentration of carbon dioxide in the atmosphere but no significant upward trend in temperature.

A number of investigators have proposed theories about the extent of the relationship and have suggested "forcings"—the effect of the contribution carbon dioxide makes to increasing temperature—which are incorporated in the many computer-based models which have been developed to project what may happen to climate in the near to longer-term future. Extensive applications have led to a variety of such projections but few, if any, have been properly validated and none have been able to satisfactorily explain global average temperature over the last two decades. It is fair to say that a model is only as good as its assumptions. It would appear that much work is required to establish satisfactory assumptions.

Several reasons have been expounded to explain the increase in global temperature over the last two centuries: that it is part of a natural cycle; that it is naturally recovering from the Little Ice Age; that it is a

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[1] http://www.quotes.net/quote/42043

result of carbon dioxide emitted into the atmosphere since the Industrial Revolution. Earlier periods of increases and decreases in the last few thousand years have been identified from a variety of geological and other records including eye witness accounts. The Roman Warm Period and the Mediæval Warm period are perhaps the best documented, but ice-core examinations provide information much further back in time.

Whether or not there is indeed a relationship between carbon dioxide and atmospheric temperature, while not experimentally established, can be examined by comparing more recent records.

I have considered the conditions in New Zealand over the last century by taking the temperature recorded as the Seven Station Series by the National Institute of Water and Atmospheric Research (NIWA)[2]. Although there is some dispute about the treatment and adjustment of the temperatures in this series[3] I have decided to use it because it appears to have de facto status and is used as a reference for public policy development.

Establishing the concentration of carbon dioxide in the atmosphere around New Zealand is difficult for at least two reasons: most recordings of carbon dioxide are spot readings taken at specific, isolated locations, one of which, until recently, was at Baring Head on the south coast of the North Island of New Zealand; and the atmosphere is not "well mixed", i.e., carbon dioxide is not uniformly distributed through the atmosphere. Unfortunately this latter condition appears to be assumed in the climate models but is not supported by recent satellite measurements[4].

To overcome the difficulty of ascertaining atmospheric carbon dioxide levels for New Zealand I have used the information collected from Baring Head[5], from Mauna Loa (Hawaii)(ibid) (Mauna Loa data can also be obtained from The Scripps Institute[6]), and from Antarctic ice core samples (Law Dome)[7]. The trans-Pacific measurements show a reasonable closeness, and are also close to the figures obtained from ice-core measurements. Figure 1 shows a plot of the three sets. For the purposes of looking at the temperature-carbon dioxide relationship for New Zealand I have used a composite of the three data sets. It should be reiterated that using this data series assumes that the carbon dioxide concentration is uniform over New Zealand which is certainly not the case but no finer resolution data is available. It is the best I can do under the circumstances.

Figure 2 shows the Seven Station Series temperature and carbon dioxide plotted from 1910 to 2010. Note that to keep the data on the same relative scale carbon dioxide concentration has been divided by 100 and that this tends to flatten the shape of the curve: it shows a steady rise in both temperature and carbon dioxide but it does not necessarily show that they are related—it does not establish a causal relationship

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[2] http://www.niwa.co.nz/our-science/climate/information-and-resources/nz-temp-record/seven-station-series-temperature-data

[3] http://nzclimatescience.net/index.php?option=com_content&task=view&id=769&Itemid=1

[4] http://photojournal.jpl.nasa.gov/catalog/PIA11194

[5] http://cdiac.ornl.gov/trends/co2/sio-keel.html

[6] http://scrippsco2.ucsd.edu/sites/default/files/data/in_situ_co2/monthly_mlo.csv

[7] https://www.ncdc.noaa.gov/cdo/f?p=519:1:::::P1_study_id:9959

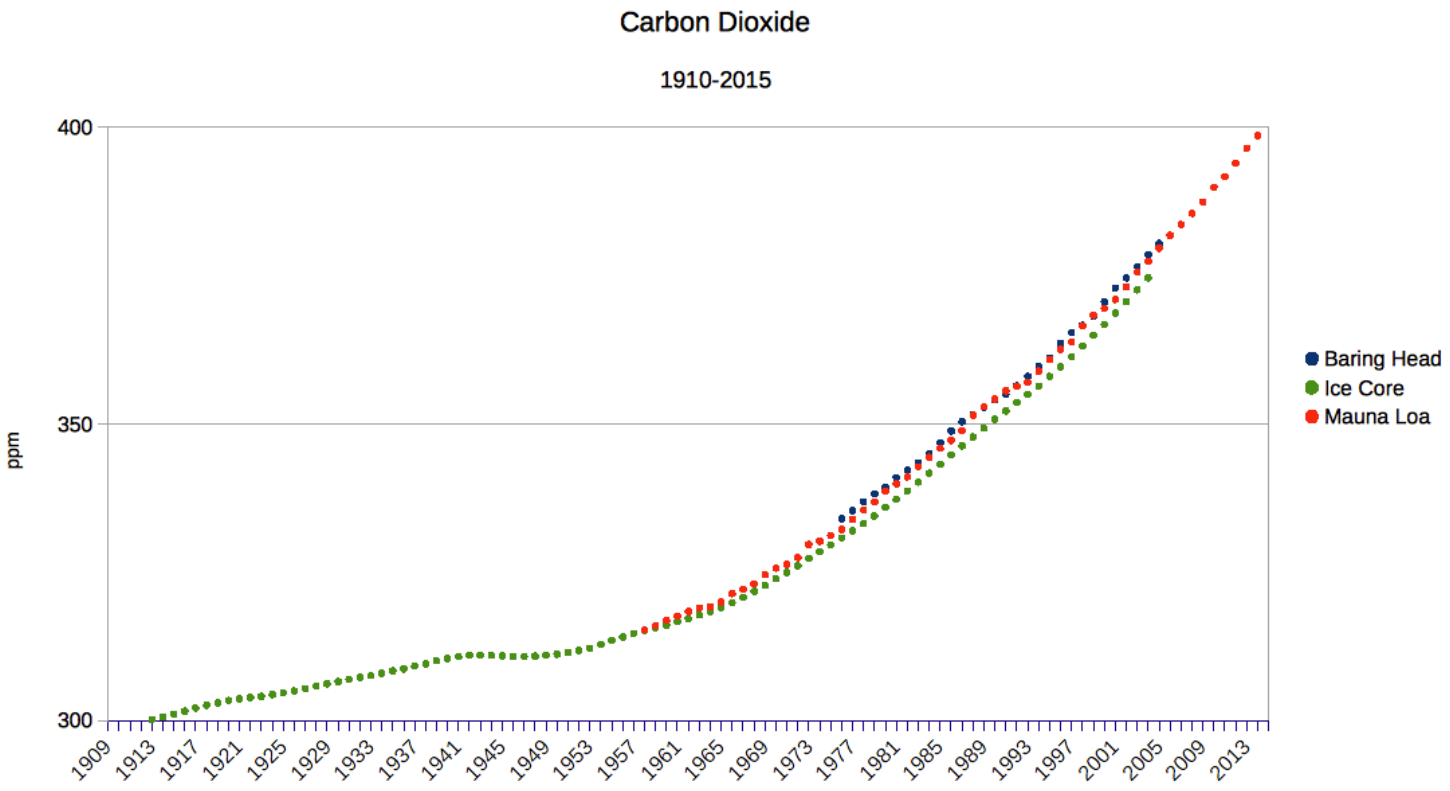

Figure 1: Atmospheric Carbon Dioxide Concentration

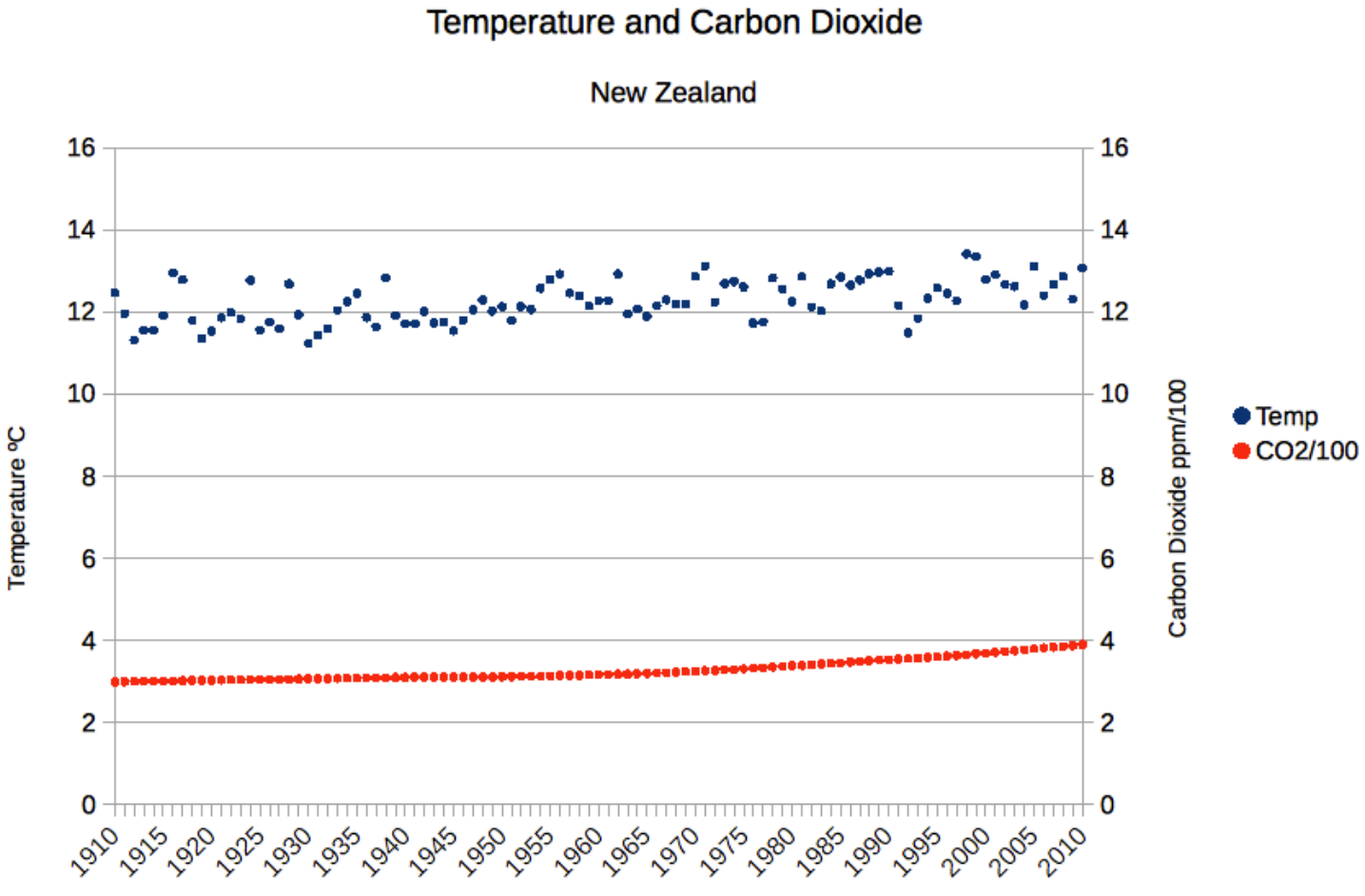

Figure 2: New Zealand Temperature and Carbon Dioxide Record

Whether there is a definite causal link between the two is disputed. One school of thought strongly believes there is. Another school suggests that carbon dioxide concentration lags temperature by several hundred years and several papers have revealed such. Fischer et al (1999)[8] shows that during the warming from an ice age carbon dioxide lags temperature by 600±400 years; Monnin et al. (2001)[9] concluded from studies of the Concordia Ice Dome that warming from the last ice age showed a lag of 800±400 years; Mudelsee (2001)[10], considering the full 420,000 year record for the Vostok Ice Dome history of carbon dioxide variations, showed a lag of 1,300±1000 years; and Caillon et al (2003)[11], also looking at the Vostok data, identified a lag of 800±200 years. Several explanations are given for this behaviour—the release of carbon dioxide from the oceans and other sources being considered significant.

The first school of thought attributes the increase in carbon dioxide to emissions from the combustion of fossil fuels. The second school of thought might suggest that the current rise in carbon dioxide is essentially due to the increase of temperature during the Mediæval Warm Period. What ever the case, Figure 2 should lead to a conclusion about the relationship between temperature and carbon dioxide and which leads which.

However, possibly because of the relatively small time-scale, Figure 2 does not allow such an analysis.

In an endeavour to more closely define a relationship, if one exists, a simple analysis might look at changes in temperature over a continuous span of years, and the change in concentration of carbon dioxide over the same time span. As an example of this approach I took the temperature and carbon dioxide data series described above over spans of 25 years, the results being plotted in Figure 3.

Figure 3 clearly shows that whilst the increase in carbon dioxide concentration over 25-year spans is continuous over the second half of the 20th century (there appears to be a minor decrease between the spans to 1940 and to 1950), temperature increases over those 25-year spans are by no means continuous. Indeed, the temperature changes are variable in magnitude and, in some cases, negative. That there is no significant trend in the relative changes is clearly indicated in Figure 4.

To reinforce the conclusion that there is no correlation between the 25-year changes the three following tables rank the changes into those that fall within temperature changes of 0º to 0.5ºC, 0.5º to 1.0ºC, and 1.0º to 2.0ºC.

These three tables show clearly that there is no obvious relationship between an increase in carbon dioxide in the atmosphere and a corresponding increase in temperature over New Zealand. The progression from top to bottom is chronological as indicated by the carbon dioxide values.

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[8] http://www.sciencemag.org/content/283/5408/1712.abstract

[9] http://www.sciencemag.org/content/291/5501/112.abstract

[10] http://www.manfredmudelsee.com/publ/pdf/The_phase_relations_among_atmospheric_CO2_content_temperature_and_global_ice_volume_over_the_past_420_ka.pdf

[11] http://icebubbles.ucsd.edu/Publications/CaillonTermIII.pdf

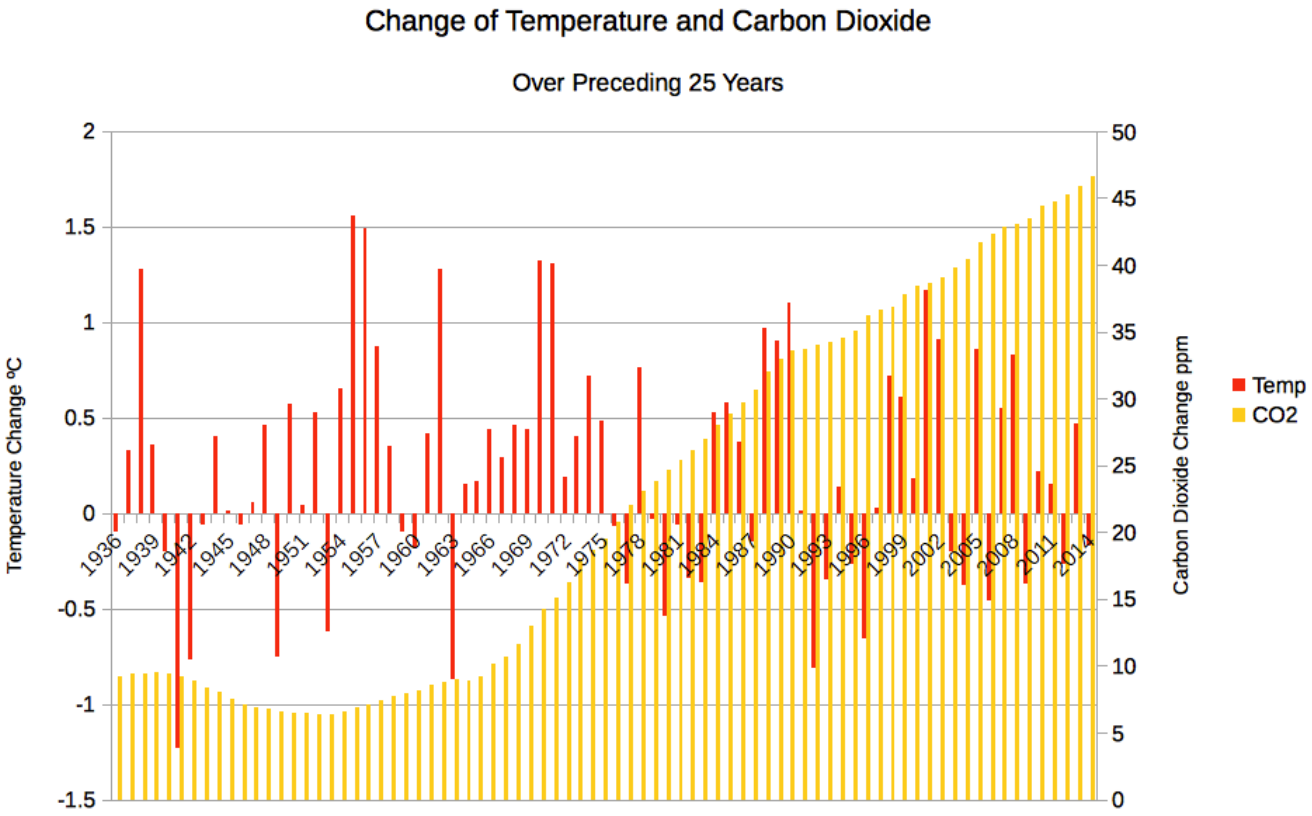

Figure 3: Temperature and Carbon Dioxide Changes Over 25-year Periods

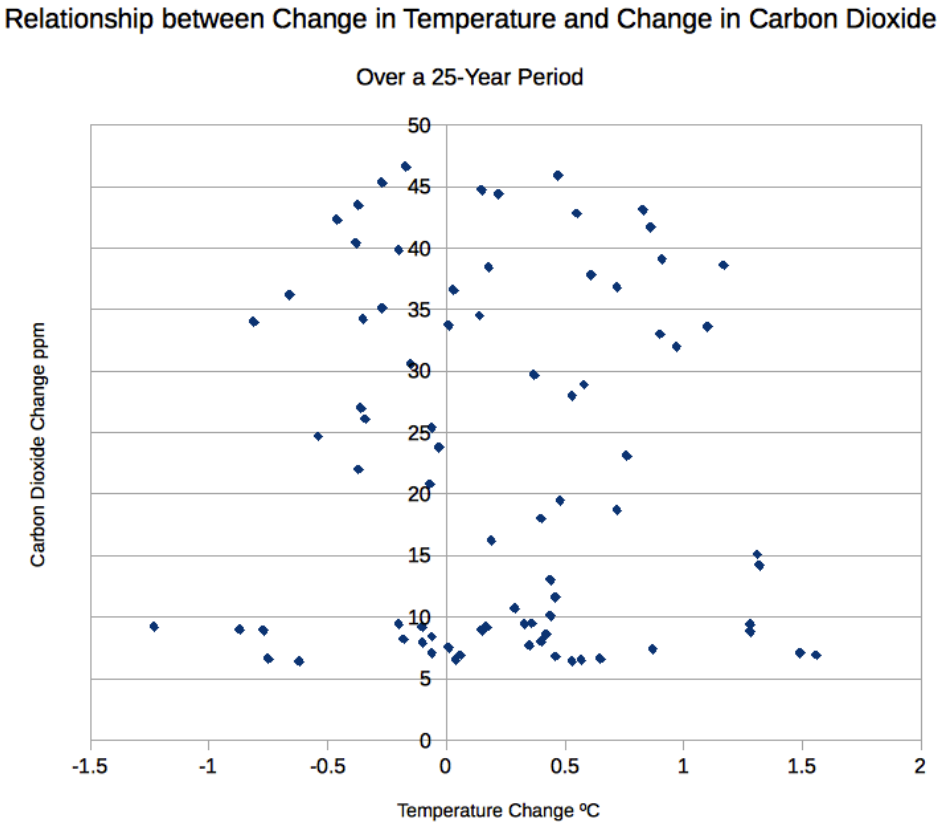

Figure 4: Temperature and Carbon Dioxide in New Zealand, 25-year Changes

For the range 0.0 to 0.5ºC

Temperature change ºC	CO_2 ppm
0.4	8.0
0.0	7.5
0.1	6.9
0.5	6.8
0.0	6.5
0.4	7.7
0.4	8.6
0.2	8.9
0.2	9.2
0.4	10.1
0.3	10.7
0.5	11.6
0.4	13.0
0.2	16.2
0.4	18.0
0.5	19.5
0.4	29.7
0.0	33.7
0.1	34.5
0.0	36.6
0.2	38.4
0.2	44.4
0.2	44.7
0.5	45.9

For the range 0.5 to 1.0ºC

Temperature change ºC	CO_2 ppm
0.7	18.7
0.8	23.1
0.5	28.0
0.6	28.9
1.0	32.0
0.9	33.0
0.7	36.8
0.6	37.8
0.9	39.1
0.9	41.7
0.6	42.8
0.8	43.1

For the range 1.0 to 2.0ºC

Temperature change ºC	CO_2 ppm
1.3	9.4
1.6	6.9
1.5	7.1
1.3	8.8
1.3	14.2
1.3	15.1
1.1	33.6
1.2	38.6

If there is a lag between an increase in temperature and an increase in carbon dioxide it is not evident in the relatively short time-scale of the data presented above. An increase in either temperature or carbon dioxide does not appear to cause an increase in the other variable. It is not unreasonable to conclude that an increase in carbon dioxide in the last century has not led to an increase in temperature over New Zealand. If the increase in carbon dioxide over New Zealand is a result of emissions from the combustion of fossil fuels it is reasonable to assume that the increase in temperature over New Zealand is not related to those emissions.

Remembering that the hypothesis of anthropogenic global warming (AGW) has never been established by experiment and that the extent of the effect has been projected only by computer models which rely on assuming AGW, the statement from Einstein at the start of this essay suggests that this simple analysis of the conditions over New Zealand indicates that it is not a valid hypothesis.

History will eventually reveal whether the hypothesis of AGW is valid and whether we should be devoting vast sums to prevent it. My enquiries regarding the highs and lows of temperature over the Holocene suggest that what is happening to temperature now is not unique, that its increase is not likely to be as disastrous as some would have us believe, and that the present warm period is not caused by the actions of mankind.

Perhaps, instead, we should be more concerned about the colder temperatures which will occur as the Holocene ends.

Gary Kerkin

June 2015