Predictions Of Global Mean Temperatures & IPCC Projections

Girma Orssengo, B. Tech, MASc, PhD
orssengo@lycos.com
April 2010

The Intergovernmental Panel on Climate Change (IPCC) claims that human emission of CO2 causes catastrophic global warming. When such extraordinary claim is made, every one with background in science has to look at the data and verify whether the claim is justified or not. In this article, a mathematical model was developed that agrees with observed Global Mean Temperature Anomaly (GMTA), and its prediction shows global cooling by about 0.42 deg C until 2030. Also, comparison of observed increase in human emission of CO2 with increase in GMTA during the 20th century shows no relationship between the two. As a result, the claim by the IPCC of climate catastrophe is not supported by the data.

Fossil fuels allowed man to live his life as a proud human, but the IPCC asserts its use causes catastrophic global warming. Fortunately, the global warming claim by the IPCC that "*For the next two decades, a warming of about 0.2°C per decade is projected for a range of SRES emission scenario"* [1] is not supported by observations as shown in Figure 1, which shows a plateau for the global mean temperature trend for the last decade.

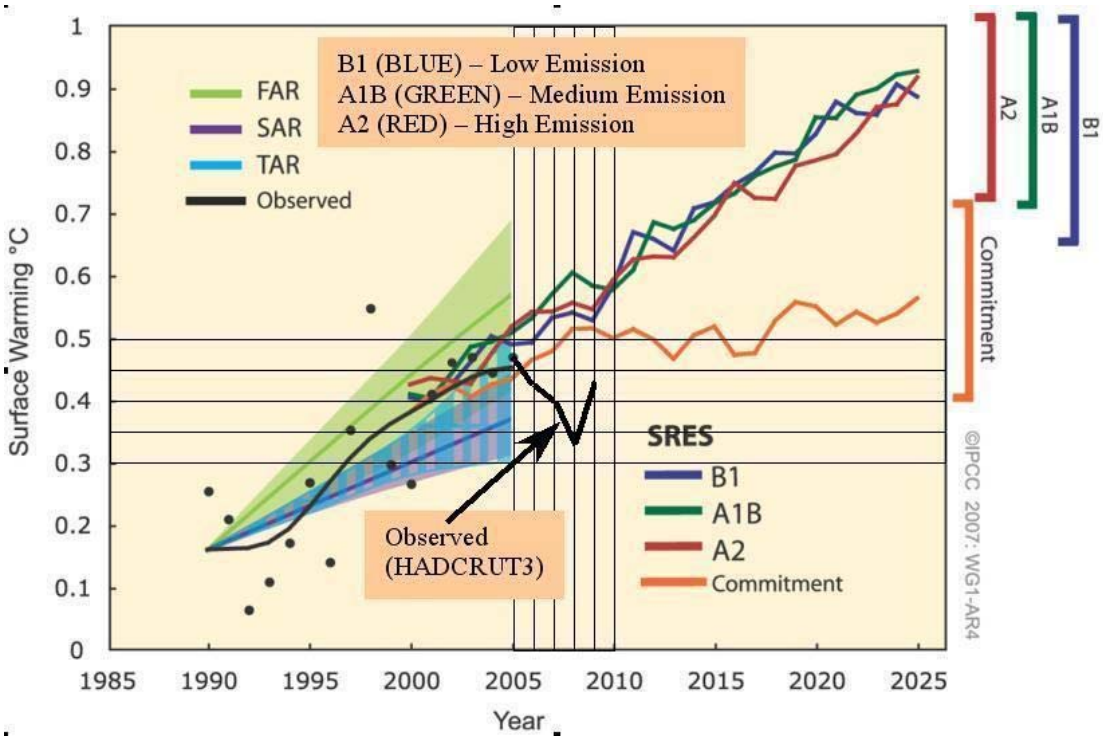

Figure 1. Observed temperatures are less than all IPCC projections. The observed temperatures are from the Climate Research Unit of the Hadley Center [2].

Figure 1 also shows that the observed temperatures are even less than the IPCC projections for emission held constant at the 2000 level.

As a result, the statement we often hear from authorities like UN Secretary-General Ban Ki-moon that "*climate change is accelerating at a much faster pace than was previously thought by scientists*" [3] is incorrect.

Thanks for the release of private emails of climate scientists, we can now learn from their own words whether global warming "*is accelerating at a much faster pace*" or not. In an email dated 3-Jan-2009, Mike MacCracken wrote to Phil Jones, Folland and Chris [4]:

I think we have been too readily explaining the slow changes over past decade as a result of variability--that explanation is wearing thin. I would just suggest, as a backup to your prediction, that you also do some checking on the sulfate issue, just so you might have a quantified explanation in case the prediction is wrong. Otherwise, the Skeptics will be all over us--the world is really cooling, the models are no good, etc. And all this just as the US is about ready to get serious on the issue.
...
We all, and you all in particular, need to be prepared.

Similarly, in an email dated 24-Oct-2008, Mick Kelly wrote to Phil Jones [5]:

Just updated my global temperature trend graphic for a public talk and noted that the level has really been quite stable since 2000 or so and 2008 doesn't look too hot.
...
Be awkward if we went through a early 1940s type swing!

The above statements from the climategate emails conclusively prove that the widely used phrase by authorities in public that global warming "*is accelerating at a much faster pace*" is supported neither by climate scientists in private nor by the observed data.

Thanks also goes to the Climate Research Unit (CRU) of the Hadley Center for daring to publish global mean temperature data that is "*quite stable since 2000*", which is contrary to IPCC projections of 0.2 deg C warming per decade. If the CRU had not done this, we would have been forced to swallow the extremely irrational concept that the gas CO2, a plant food, i.e. foundation of life, is a pollutant because it causes catastrophic global warming.

As IPCC's *"models are no good",* it is the objective of this article to develop a valid mathematical global mean temperature model based on observed temperature patterns.

Mathematical Model For The Global Mean Temperature Anomaly (GMTA) Based On Observed Temperature Patterns

The Global Mean Temperature Anomaly (GMTA) data from the Climate Research Unit (CRU) of the Hadley Center shown in Figure 2 will be used to develop the mathematical model. In this article, the observed GMTA data from the CRU are assumed to be valid.

Examination of Figure 2 shows that the globe is warming at a linear rate as shown by the least square trend central line given by the equation

$$\text{Linear anomaly in deg C} = 0.0059*(\text{Year}-1880) - 0.52 \qquad \text{Equation 1}$$

Figure 2 also shows that superimposed on this linear anomaly line there is an oscillating anomaly that gives the Global Mean Temperature Anomaly (GMTA) the characteristics summarized in Table 1.

Table 1. Characteristics of the observed Global Mean Temperature Anomaly (GMTA) shown in Figure 2.

From 1880s to 1910s	End of *warming*, plateau at –0.2 deg C & then *cooling* trend
From 1910s to 1940s	End of *cooling,* plateau at –0.6 deg C & then *warming* trend
From 1940s to 1970s	End of *warming,* plateau at 0.1 deg C & then *cooling* trend
From 1970s to 2000s	End of *cooling,* plateau at –0.3 deg C & then *warming* trend
From 2000s to 2030s	End of *warming,* plateau at 0.5 deg C & then ? trend

A mathematical model can be developed that satisfies the requirements listed in Table 1. If the model to be developed gives good approximation for the GMTA values at its turning points (plateaus) and the GMTA trends between its successive turning points as summarized in Table 1, the model may be used for prediction.

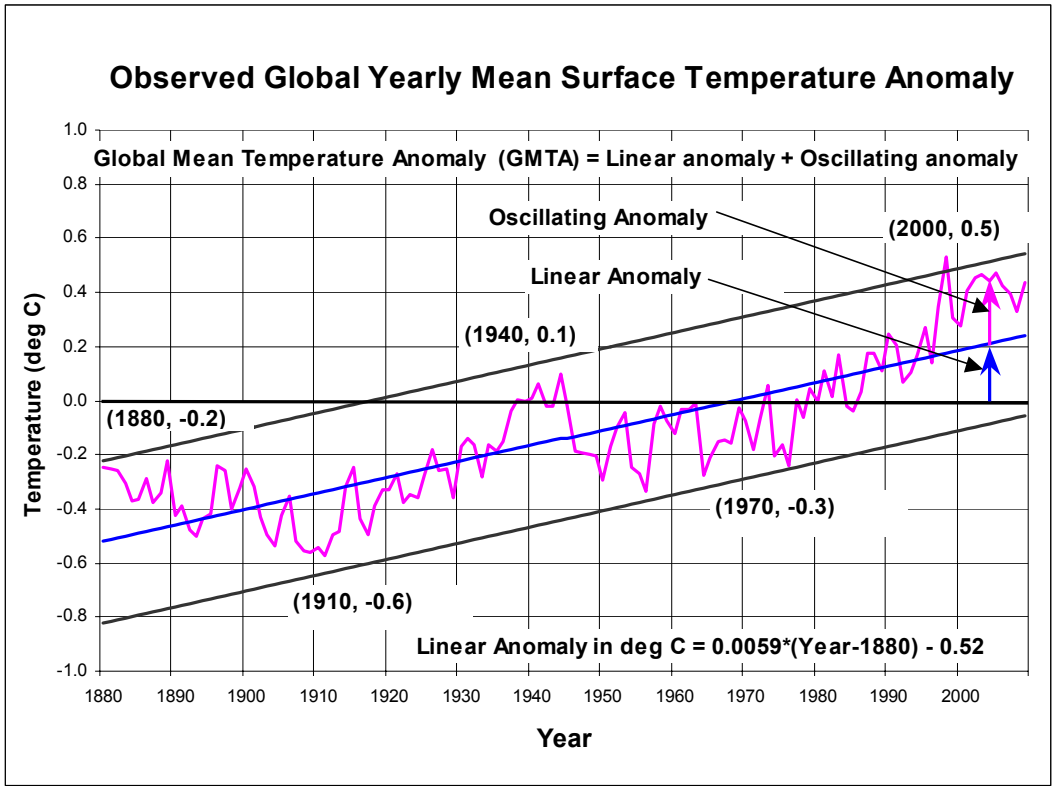

Figure 2. Observed Global Yearly Mean Temperature Anomaly (GMTA) from the Climate Research Unit (CRU) of the Hadley Centre [2].

For the oscillating anomaly, the sinusoidal function *cosine* meets the requirements listed in Table 1. From Figure 2, the amplitude of the oscillating anomaly is given by the vertical distance in deg C from the central linear anomaly line to either the top or bottom parallel lines, and it is about 0.3 deg C. From Figure 2, the oscillating anomaly was at its maximum in the 1880s, 1940s, & 2000s; it was at its minimum in the 1910s and 1970s. The years between successive maxima or minima of the oscillating anomaly is the period of the cosine function, and it is about 1940–1880=1970–1910=60 years. For the cosine function, once its amplitude of 0.3 deg C and its period of 60 years are determined, the mathematical equation for the oscillating anomaly, for the years starting from 1880, can be written as

*Oscillating anomaly in deg C = 0.3*Cos(((Year-1880)/60)*2*3.1416)* *Equation 2*

In the above equation, the factor 2*3.1416 is used to convert the argument of the cosine function to radians, which is required for computation in Microsoft Excel. If the angle required is in degrees, replace 2*3.1416 with 360.

Combining the linear anomaly given by Equation 1 and the oscillating anomaly given by Equation 2 gives the equation for the Global Mean Temperature Anomaly (GMTA) in deg C for the years since 1880 as

GMTA = 0.0059(Year-1880) - 0.52 + 0.3*Cos(((Year-1880)/60)*2*3.1416)* *Equation 3*

The validity of this model may be verified by comparing its estimate with observed values at the GMTA turning points as summarized in Table 2.

Table 2. Comparison of the model with observations for GMTA in deg C at its turning points.

Year	Observed (Table 1)	Model (Equation 3)
Warming plateau for the 1880s	-0.2	-0.22
Cooling plateau for the 1910s	-0.6	-0.64
Warming plateau for the 1940s	+0.1	+0.13
Cooling plateau for the 1970s	-0.3	-0.29
Warming plateau for the 2000s	+0.5	+0.48

Table 2 shows excellent agreement for the GMTA values between observation and mathematical model for all observed GMTA turning points.

A graph of the GMTA model given by Equation 3 is shown in Figure 3, which includes the observed GMTA and short-term IPCC projections for GMTA from 2000 to 2025. In addition to the verification shown in Table 2, Figure 3 shows good agreement for the GMTA trends throughout observed temperature records, so the model may be used for prediction. As a result, Figure 3 includes GMTA predictions until 2100, where the year and the corresponding GMTA values are given in parentheses for all the GMTA turning points.

As shown in Figure 3, a slight discrepancy exist between observed and model GMTA values at the end of the 1890s when the observed values were significantly warmer than the model pattern, and in the 1950s when the observed values were significantly colder than the model pattern.

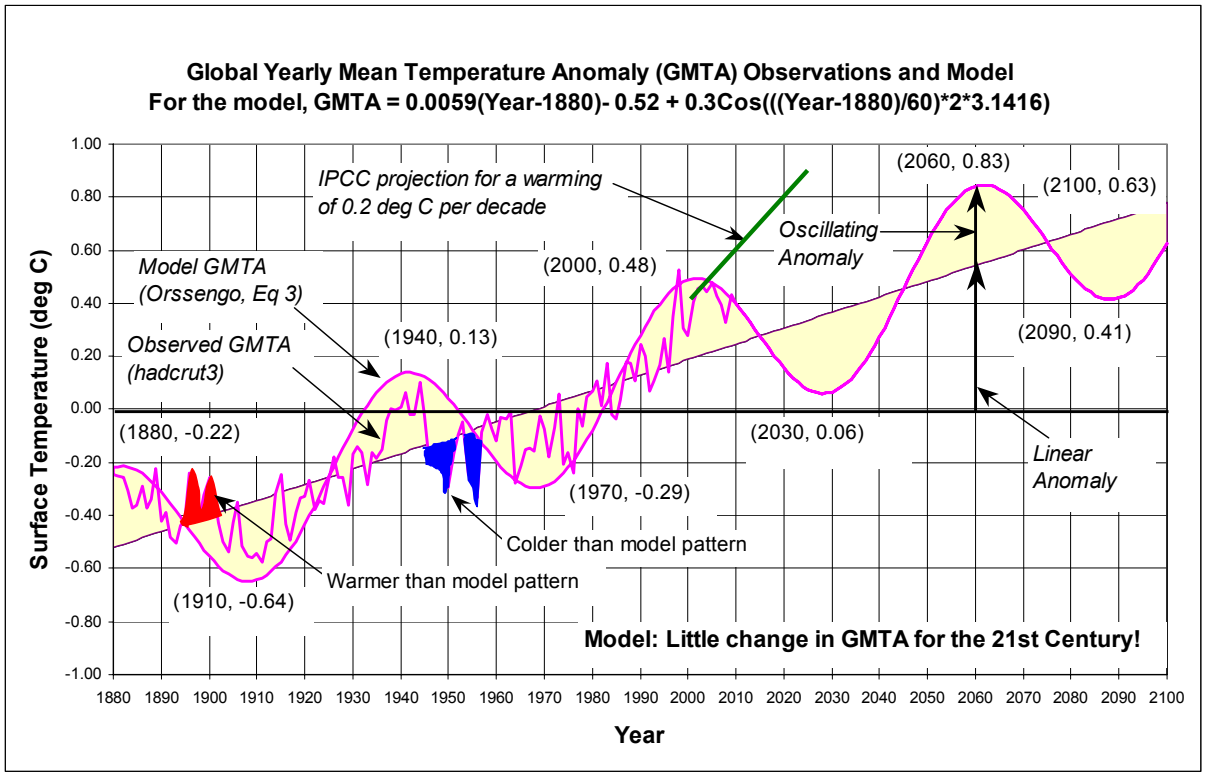

Figure 3. Comparison of observed Global Yearly Mean Temperature Anomaly (GMTA) with models.

From the model in Figure 3, during the observed temperature record, there were two global warming phases. The first was from 1910 to 1940 with a warming of 0.13+0.64=0.77 deg C in 30 years. The second was from 1970 to 2000 with a warming of 0.48+0.29=0.77 deg C in 30 years. Note that both warming phases have an identical increase in GMTA of 0.77 deg C in 30 years, which gives an average warming rate of (0.77/30)*10=0.26 deg C per decade.

From the model in Figure 3, during the observed temperature record, there were two global cooling phases. The first was from 1880 to 1910 with a cooling of 0.64-0.22=0.42 deg C in 30 years. The second was from 1940 to 1970 with a cooling of 0.13+0.29=0.42 deg C in 30 years. Note that both cooling phases have an identical decrease in GMTA of 0.42 deg C in 30 years, which gives an average cooling rate of (0.42/30)*10=0.14 deg C per decade.

The above results for the normal ranges of GMTA determined from the model can also be calculated using simple geometry in Figure 2. In this figure, almost all observed GMTA values are enveloped by the two parallel lines that are 0.6 deg C apart. Therefore, as a first approximation, the normal range of GMTA is 0.6 deg C. From Figure 2, the period for a global warming or cooling phase is about 30 years. Therefore, as a first approximation, the normal rate of global warming or cooling is (0.6/30)*10=0.2 deg C per decade.

The above approximation of 0.6 deg C for the normal range of GMTA should be refined by including the effect of the linear warming anomaly given by Equation 1 of 0.006 deg C per year, which is the slope of the two envelope parallel lines in Figure 2. As the oscillating anomaly changes by 0.6 deg C in 30 years between its turning points, the linear anomaly increases by 0.006*30=0.18 deg C. Due to this persistent warming, instead of the GMTA increasing or decreasing by the same 0.6 deg C, it increases by 0.6+0.18=0.78 deg C during its warming phase, and decreases by 0.6–0.18=0.42 deg C during its cooling phase. As a result, the refined normal ranges of GMTA are 0.77 deg C in 30 years during its warming phase, and 0.42 deg C in 30 years during its cooling phase. These results for the normal ranges of GMTA obtained using simple geometry in Figure 2 agree with those obtained from the model in Figure 3.

Correlation of Model and Observed Global Mean Temperature Anomaly (GMTA)

In Table 2, data points for only five years were used to verify the validity of Equation 3 to model the observed data. However, it is important to verify how well the observed GMTA is modeled for any year.

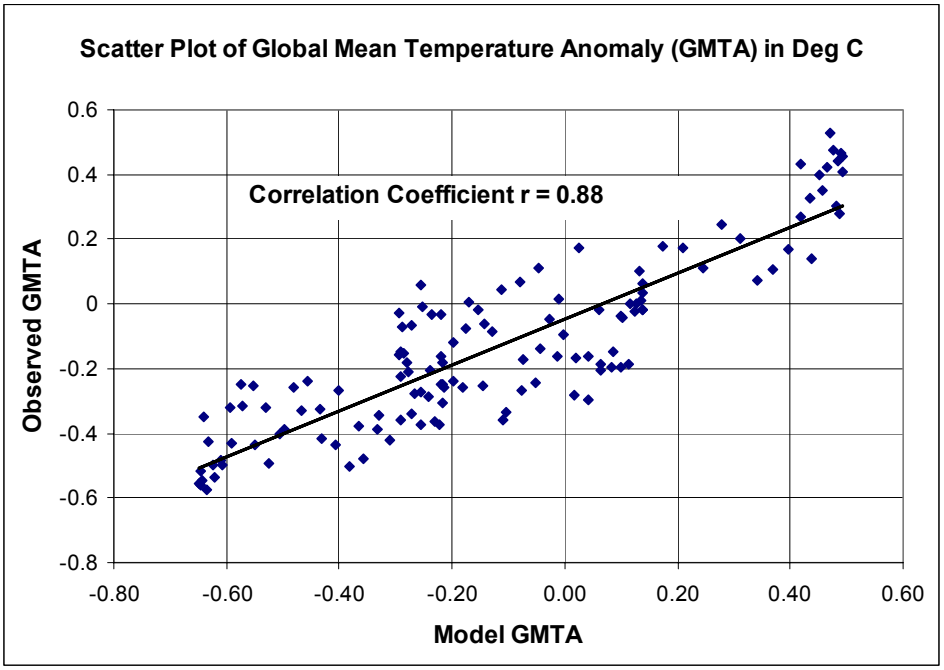

Figure 4. Correlation between model and observed GMTA values. The model GMTA values are from Equation 3, and the observed GMTA values are from the Climate Research Unit shown in Figure 2.

How well the observed data is modeled can be established from a scatter plot of the observed and model GMTA values as shown in Figure 4. For example, for year 1998, the observed GMTA was 0.53 deg C

and the model GMTA is 0.47 deg C. In Figure 4, for year 1998, the pair (0.47,0.53) is plotted as a dot. In a similar manner, all the paired data for model and observed GMTA values for years from 1880 to 2009 are plotted as shown in Figure 4.

Figure 4 shows a strong linear relationship (correlation coefficient, r=0.88) between the model and observed GMTA. With high correlation coefficient of 0.88, Figure 4 shows the important result that the observed GMTA can be modeled by a combination of a linear and sinusoidal pattern given by Equation 3. The positive slope of the trend line indicates a positive relationship between model and observed GMTA. That is, global cooling from the model indicates observed global cooling, and global warming from the model indicates observed global warming.

Global Mean Temperature Prediction Calculations

The following patterns may be inferred from the graph of the Global Mean Temperature Anomaly (GMTA) model shown in Figure 3 for the data from the Climate Research Unit of the Hadley Center [2]:

1. Year 1880 was the start of a cooling phase and had a GMTA of –0.22 deg C.
2. During the global cooling phase, the GMTA decreases by 0.42 deg C in 30 years.
3. Global cooling and warming phases alternate with each other.
4. During the global warming phase, the GMTA increases by 0.77 deg C in 30 years.

The patterns in the list above are sufficient to estimate the GMTA values at all of its turning points since 1880.

For example, as year 1880 with GMTA of –0.22 deg C was the start of a cooling phase of 0.42 deg C in 30 years, the next GMTA turning point was near 1880+30=1910 with GMTA of –0.22–0.42=-0.64 deg C. This GMTA value for 1910 is shown as (1910,-0.64) in Figure 3.

As year 1910 with GMTA of –0.64 deg C was the end of a global cooling phase, it is also the start of a global warming phase of 0.77 deg C in 30 years. As a result, the next GMTA turning point was near 1910+30=1940 with GMTA of 0.77–0.64=0.13 deg C. This GMTA value for 1940 is shown as (1940,0.13) in Figure 3.

As year 1940 with GMTA of 0.13 deg C was the end of a global warming phase, it is also the start of a global cooling phase of 0.42 deg C in 30 years. As a result, the next GMTA turning point was near 1940+30=1970 with GMTA of 0.13–0.42=-0.29 deg C. This GMTA value for 1970 is shown as (1970,-0.29) in Figure 3.

As year 1970 with GMTA of -0.29 deg C was the end of a global cooling phase, it is also the start of a global warming phase of 0.77 deg C in 30 years. As a result, the next GMTA turning point was near 1970+30=2000 with GMTA of 0.77–0.29=0.48 deg C. This GMTA value for 2000 is shown as (2000,0.48) in Figure 3.

As the GMTA values calculated above using the global temperature patterns listed at the beginning of this section give good approximation of observed GMTA values at all GMTA turning points (1880, 1910, 1940, 1970 & 2000), it is reasonable to assume that the patterns may also be used for prediction.

As a result, as year 2000 with GMTA of 0.48 deg C was the end of a global warming phase, it is also the start of a global cooling phase of 0.42 deg C in 30 years. As a result, the next GMTA turning point will be near 2000+30=2030 with GMTA of 0.48–0.42=0.06 deg C. This GMTA value for 2030 is shown as (2030,0.06) in Figure 3.

In a similar manner, the GMTA values for the remaining GMTA turning points for this century can be calculated, and the results are shown in Figure 3.

Figure 3 shows a very interesting result that for the 20th century, the global warming from 1910 to 2000 was 0.48+0.64=1.12 deg C. In contrast, for the 21st century, the change in GMTA from 2000 to 2090 will be only 0.41–0.48=-0.07 deg C. This means that there will be little change in the GMTA for the 21st century! Why?

Why Does The Same Model Give A Global Warming Of About 1 deg C For The 20th Century But Nearly None For The 21st Century?

According to the data shown in Figure 3, it is true that the global warming of the 20th century was unprecedented. As a result, it is true that the corresponding sea level rise, melting of sea ice or the corresponding climate change in general were unprecedented. However, this was because the century started when the oscillating anomaly was at its minimum near 1910 with GMTA of –0.64 deg C and ended when it was at its maximum near 2000 with GMTA of 0.48 deg C, giving a large global warming of 0.48+0.64=1.12 deg C. This large warming was due to the rare events of two global warming phases of 0.77 deg C each but only one cooling phase of 0.44 deg C occurring in the 20th century, giving a global warming of 2*0.77-0.42=1.12 deg C.

In contrast to the 20th century, from Figure 3, there will be nearly no change in GMTA in the 21st century. This is because the century started when the oscillating anomaly was at its maximum near 2000 with GMTA of 0.48 deg C and will end when it is at its minimum near 2090 with GMTA of 0.41 deg C, giving a negligible change in GMTA of 0.41-0.48=-0.07 deg C. This negligible change in GMTA is due to the rare events of two global cooling phases of 0.42 deg C each but only one warming phase of 0.77 deg C occurring in the 21st century, giving the negligible change in GMTA of 0.77-2*0.42=-0.07 deg C. Note that this little change in GMTA for the 21st century is identical to that from 1880 to 1970, which makes the global warming from 1970 to 2000 by 0.77 deg C appear to be abnormally high.

If the period for a century had been 120 years, we wouldn't have this conundrum of nearly 1 deg C warming in the 20th century but nearly none in the next!

Ocean Current Cycles

One of the most important variables that affect global mean surface temperature is ocean current cycles. The rising of cold water from the bottom of the sea to its surface results in colder global mean surface temperature; weakening of this movement results in warmer global mean surface temperature. Various ocean cycles have been identified. The most relevant to global mean temperature turning points is the 20 to 30 years long ocean cycle called Pacific Decadal Oscillation (PDO) [6]:

Several independent studies find evidence for just two full PDO cycles in the past century: "cool" PDO regimes prevailed from 1890-1924 and again from 1947-1976, while "warm" PDO regimes dominated from 1925-1946 and from 1977 through (at least) the mid-1990's (Mantua et al. 1997, Minobe 1997).

These cool and warm PDO regimes correlate well with the cooling and warming phases of GMTA shown in Figure 3.

The model in Figure 3 predicts global cooling until 2030. This result is also supported by shifts in PDO that occurred at the end of the last century, which is expected to result in global cooling until about 2030 [7].

Effect Of CO2 Emission On Global Mean Temperature

Examination of Figure 3 shows that the Global Mean Temperature Anomaly (GMTA) for 1940 of 0.13 deg C is greater than that for 1880 of –0.22 deg C. Also, the GMTA for 2000 of 0.48 deg C is greater than that for 1940 of 0.13 deg C. This means that the GMTA value, when the oscillating anomaly is at its maximum, increases in every new cycle. Is this global warming caused by human emission of CO2?

The data required to establish the effect of CO2 emission on global mean temperature already exist. The global mean temperature data are available from the Climate Research Unit of the Hadley Centre shown in Figure 3, and the CO2 emission data are available from the Carbon Dioxide Information Analysis Centre [8]. For the period from 1880 to 1940, the average emission of CO2 was about 0.8 G-ton, and the increase in the GMTA was 0.13+0.22=0.35 deg C. For the period from 1940 to 2000, the average emission of CO2 was about 4 G-ton, but the increase in GMTA was the same 0.48-0.13=0.35 deg C. This means that an increase in CO2 emission by 4/0.8=5-fold has no effect in the increase in the GMTA. This conclusively proves that the effect of 20th century human emission of CO2 on global mean temperature is nil.

Note that the increase in GMTA of 0.35 deg C from 1880 to 1940 (or from 1940 to 2000) in a 60 year period has a warming rate of 0.35/60=0.0058 deg per year, which is the slope of the linear anomaly given by Equation 1. As a result, the linear anomaly is not affected by CO2 emission. Obviously, as the oscillating anomaly is cyclic, it is not related to the 5-fold increase in human emission of CO2.

Figure 4, with high correlation coefficient of 0.88, shows the important result that the observed GMTA can be modeled by a combination of a linear and sinusoidal pattern given by Equation 3. This single GMTA pattern that was valid in the period from 1880 to 1940 was also valid in the period from 1940 to 2000 after about 5-fold increase in human emission of CO2. As a result, the effect of human emission of CO2 on GMTA is nil.

Further evidence for the non-existent relationship between CO2 and GMTA is IPCC's projection of a global warming of 0.2 deg C per decade, while the observed GMTA trend was "*quite stable since 2000"* [5]. The evidence will be "*unequivocal*" if global cooling by about 0.42 deg C starts soon and continues until about 2030, as shown by the model in Figure 3. The IPCC projection for the GMTA for 2020 is 0.8 deg C, while the prediction from the model for this value is 0.2 deg C, a large discrepancy of 0.6 deg C. If this global cooling is confirmed, it will then be time to bury the theory that *CO2, a plant food, causes catastrophic global warming*. Fortunately, we don't have to wait too long for the burial. Less than ten years. It will be *cheering news!*

IPCC Projections

According to the IPCC [1], "*For the next two decades, a warming of about 0.2°C per decade is projected for a range of SRES emission scenario."*

IPCC explains this projection as shown in Figure 5 where GMTA trend lines were drawn for four periods from 2005 to 1856, 1906, 1956 & 1981. These trend lines give increasing warming rate from a low value of 0.045 deg C per decade for the RED trend line for the first period from 1856 to 2005, to a greater value of 0.074 deg C per decade for the PURPLE trend line for the second period from 1906 to 2005, to a still greater value of 0.128 deg C per decade for the ORANGE trend line for the third period from 1956 to 2005, and to a maximum value of 0.177 deg C per decade for the YELLOW trend line for the fourth period from 1981 to 2005. IPCC then concludes, "*Note that for shorter recent periods, the slope is greater, indicating accelerated warming"* [9].

If this IPCC interpretation is correct, catastrophic global warming is imminent, and it is justified for the world to be griped by fear of global warming. However, is IPCC's "*accelerated warming*" conclusion shown in Figure 5 correct?

What the GMTA pattern in Figure 3 shows is that it has cooling and warming phases. As a result, in Figure 5, comparing the warming rate of one period that has only one warming phase with another period that has a combination of warming and cooling phases will obviously show the maximum warming rate for the first period. This is comparing apples to oranges.

Comparing apples to apples is to compare two periods that have the same number of cooling and/or warming phases.

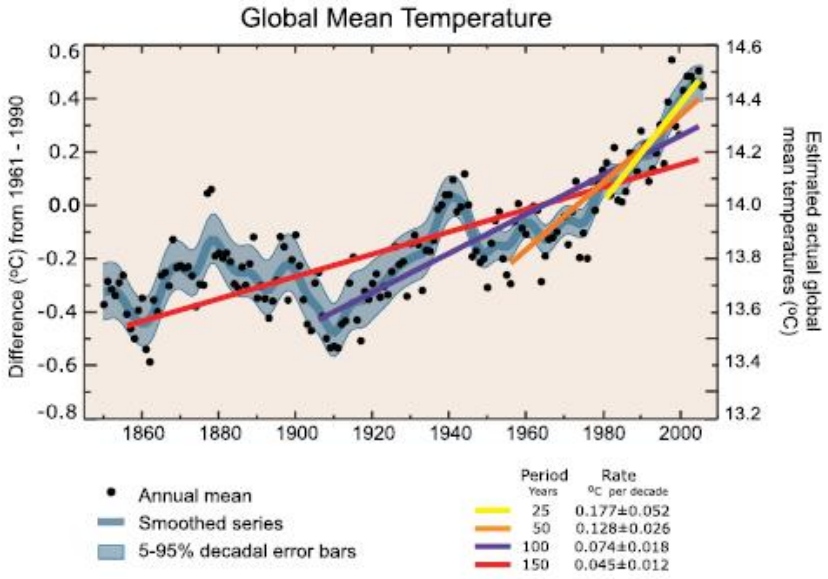

Figure 5. Accelerated global warming according to the IPCC [9].

One example of comparing apples to apples is to compare one period that has one warming phase with another that also has one warming phase. From Figure 3, two 30-year periods that have only one warming phase are the periods from 1910 to 1940 and from 1970 to 2000. For the period from 1910 to 1940, the increase in GMTA was 0.13+0.64=0.77 deg C, giving a warming rate of (0.77/30)*10=0.26 deg C per decade. Similarly, for the period from 1970 to 2000, the increase in GMTA was 0.48+0.29=0.77 deg C, giving an identical warming rate of 0.26 deg C per decade. Therefore, there is no "*accelerated warming*" in the period from 1970 to 2000 compared to the period from 1910 to 1940.

A second example of comparing apples to apples is to compare one period that has one cooling and warming phases with another that also has one cooling and warming phases. From Figure 3, two 60-year periods that have only one cooling and warming phases are the periods from 1880 to 1940 and from 1940 to 2000. For the period from 1880 to 1940, the increase in GMTA was 0.13+0.22=0.35 deg C, giving a warming rate of (0.35/60)*10=0.06 deg C per decade. Similarly, for the period from 1940 to 2000, the increase in GMTA was 0.48-0.13=0.35 deg C, giving an identical warming rate of 0.06 deg C per decade. Therefore, there is no "*accelerated warming*" in the period from 1940 to 2000 compared to the period from 1880 to 1940.

From the above analysis, IPCC's conclusion of "*accelerated warming*" is incorrect, and its graph shown in Figure 5 is an incorrect interpretation of the data.

Based on observed GMTA pattern shown in Figure 3, a global warming phase lasts for 30 years, and it is followed by global cooling. As a result, the recent global warming phase that started in the 1970s ended in the 2000s as shown by the current GMTA plateau, and global cooling should follow. Therefore, IPCC's projection for global warming of 0.2 deg C per decade for the next two decades is incorrect. Also, divergence between IPCC projections and observed values for the GMTA has started to be "*discernible*" since 2005 as shown in Figure 3.

According to the Occam's Razor principle, given a choice between two explanations, choose the simplest one that requires the fewest assumptions. Instead of applying the Occam's Razor principle by assuming the cause of GMTA turning points to be natural, the IPCC assumed the cause to be man-made [9]:

From about 1940 to 1970 the increasing industrialisation following World War II increased pollution in the Northern Hemisphere, contributing to cooling, and increases in carbon dioxide and other greenhouse gases dominate the observed warming after the mid-1970s.

Like in the 1880s & 1910s, what if the causes of the GMTA turning points in the 1940s and 1970s were also natural?

Figure 4, with high correlation coefficient of 0.88, shows the important result that the observed GMTA can be modeled by a combination of a linear and sinusoidal pattern given by Equation 3. This single GMTA pattern that was valid in the period from 1880 to 1940 was also valid in the period from 1940 to 2000 after about 5-fold increase in human emission of CO2. As a result, the effect of human emission of CO2 on GMTA is nil. Also, IPCC's conclusion of "*accelerated warming*" shown in Figure 5 is incorrect.

What is the cause of the GMTA turning point from warming to plateau in the 2000s? Here is the suggestion by Mike MacCracken [4]:

I think we have been too readily explaining the slow changes over past decade as a result of variability--that explanation is wearing thin. I would just suggest, as a backup to your prediction, that you also do some checking on the sulfate issue, just so you might have a quantified explanation in case the prediction is wrong.

According to the IPCC and the above suggestion, the 1940 GMTA turning point from global warming to cooling was caused by sulfates, the 1970 GMTA turning point from cooling to warming was caused by carbon dioxide, and the 2000 GMTA turning point from warming to plateau was caused by sulfates. It is interesting to note that sulfate and carbon dioxide gave the globe a 30-year alternate cooling and warming phases from 1940 to 2000. This is just absurd.

Instead of saying, "*Be awkward if we went through a early 1940s type swing!*" in private, but global warming "*is accelerating at a much faster pace*" in public, please release the world from the fear of climate catastrophe from use of fossil fuels, as this catastrophe is not supported by your own data. It is extremely callous not to do so.

Is the theory that "*human emission of CO2 causes catastrophic global warming"* one of the greatest blunders or something worse of "science"? We will find the unambiguous answer within the next ten years. Hope they don't succeed in calling the plant food a pollutant and tax us before then.

For any criticism, please contact me at orssengo@lycos.com

Girma J Orssengo
Bachelor of Technology in Mechanical Engineering, University of Calicut, Calicut, India
Master of Applied Science, University of British Columbia, Vancouver, Canada
Doctor of Philosophy, University of New South Wales, Sydney, Australia

REFERENCES

[1] IPCC Fourth Assessment Report: Climate Change 2007
"a warming of about 0.2°C per decade is projected"
http://www.ipcc.ch/publications_and_data/ar4/wg1/en/spmsspm-projections-of.html

[2] Observed Global Mean Surface Temperatures from the Climate Research Unit of the Hadley Center.
http://www.woodfortrees.org/plot/hadcrut3vgl/compress:12/from:1880/plot/hadcrut3vgl/from:1880/trend/plot/hadcrut3vgl/from:1880/trend/offset:0.3/plot/hadcrut3vgl/from:1880/trend/offset:-0.3

[3] Climate Change Science Compendium 2009
"is accelerating at a much faster pace"
http://www.unep.org/pdf/ccScienceCompendium2009/cc_ScienceCompendium2009_full_en.pdf

[4] Climategate Email from Mike MacCracken to Phil Jones, Folland and Chris
"that explanation is wearing thin"
http://www.eastangliaemails.com/emails.php?eid=947&filename=1231166089.txt

[5] Climategate Email from Mick Kelly to Phil Jones
"*Be awkward if we went through a early 1940s type swing!*"
http://www.eastangliaemails.com/emails.php?eid=927&filename=1225026120.txt

[6] The Pacific Decadal Oscillation (PDO)
http://jisao.washington.edu/pdo/

[7] Pacific Ocean Showing Signs of Major Shifts in the Climate
http://www.nytimes.com/library/national/science/012000sci-environ-climate.html

[8] Carbon Dioxide Information Analysis Center
Global CO2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring
http://cdiac.ornl.gov/ftp/ndp030/global.1751_2006.ems

[9] Climate Change 2007: Working Group I: The Physical Science Basis
How are Temperatures on Earth Changing?
http://www.ipcc.ch/publications_and_data/ar4/wg1/en/faq-3-1.html