The Cyclical Sine Model Explanation for Climate Change

Dale Erwin Nierode (✉ dnierode@msn.com)
ExxonMobil Upstream Research Company

Research Article

Keywords: Climate Change, NASA greenhouse effect, Global Warming, Cyclical Sine Model.

Posted Date: November 1st, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-848733/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Climate Change due to excessive buildup of greenhouse gasses in the atmosphere from hydrocarbon combustion is one explanation (NASA greenhouse effect) for the Earth's temperature increase since 1850. If this is true, then eliminating fossil fuel use is the only way to preserve our planet. However, there is another explanation for Global Warming/Climate Change that leads to the opposite conclusion – hydrocarbon energy will be needed well into the future to cope with future, excessively hot and cold temperature cycles. This paper will show that the Global Warming/Climate Change underway on Earth today is a totally natural occurrence with solid scientific and historical support. The Earth is currently in the upswing part of its normal temperature cycle. Very warm (Medieval Warming) and very cold (Little Ice Age) cycles have been historically documented on Earth for at least the last 3,000 years. This cyclicity has a repeated period of about every 1,500 years (Singer 2008). This explanation for the Earth's temperature increases since 1850 is captured in a mathematical model called the Cyclical Sine Model. This model fits past climate cycles, measured temperatures since 1850, and correlates closely with the cyclicity of Bond Atlantic Drift Ice Cycles (Bond 1997), the Atlantic Multidecadal Oscillation (NASA AMO), and the Pacific Decadal Oscillation (NASA PDO). This model also quantitatively explains the time span 1945-1975 when an impending ice age was feared (Time Magazine 1974). The Cyclical Sine Model is the best explanation for the Earth's recent temperature increases.

1. Introduction

Since 1850 Earth average temperatures have been measured annually. Fig. 1 shows the Earth temperature data used in this study with the general upward trend of temperatures with values from 1850-2013 (HADcrut) and 2014-2020 (NOAA History). There is some scatter in the overall upward trend, but temperatures have increased about 1.3° C. since 1850. There were two time spans when temperatures leveled off for several years instead of continuously increasing. Hiatus #1 in Fig. 2 from about 1945 to 1975 led to fears of an impending ice age (Time 1974). Hiatus #2 from 1998 to 2014 led to the name change for increasing temperatures from Global Warming to Climate Change (Los Angeles Times 2017). The two hiatuses are significantly different in terms of their subsequent temperature increases. Hiatus #1 was followed by only a 0.13° C. average increase during the following ten years while Hiatus #2 was followed by a much larger increase of 0.36° C during just the next six years. The relatively large increase after Hiatus #2 is nearly three times greater than Hiatus #1 and accounts for over 28 percent of the total 1.3° C. increase since 1850.

The most difficult part of this study was to decide which of the many Earth temperature data sets (HADcrut, NOAA History, NASA giss, Berkeley Earth) to use. Fig. 3 shows the data used in this study compared to some alternatives. It was decided to use the HADcrut4 data that had been used for the United Nations Intergovernmental Panel on Climate Change (UNIPCC) model studies (UNIPCC 2014) coupled with recent NOAA data (NOAA History). The NOAA data were primarily selected because they are so readily available on a month-by-month basis. The HADcrut4 data are the solid black circles with the large open triangles as the NOAA recent data used from 2014 to 2020. The modified Karl (Karl 2015) data are shown as a solid line. Fig. 4 shows the same data comparison starting in 1980. It is seen that the NOAA and Hadcrut4 data are identical up to 2013. The NOAA data from 2014 to 2020 then seem to trend toward the Karl data modifications to 2016. Possibly NOAA is now analyzing future data using Karl's corrections for buoy-ship temperature differences and data trends. Data prior to 2013 have likely not yet been modified.

Using only the data in Fig. 1 (and Table 1) two different Cyclical Sine Models are presented with the first using only the data from 1850-2013 which were used in the UNIPCC latest modeling report (UNIPCC 2014). The second analysis used all data from 1850-2020, including the large increase since 2013.

Table 1
Earth Temperature Data

Year	T _{Earth} ° C.	Delta ° C.	Year	T _{Earth} ° C.	Delta ° C.	Year	T _{Earth} ° C.	Delta ° C.	Year	T _{Earth} ° C.	Delta ° C.
1850*	13.56	-0.35	1894	13.59	-0.31	1938	14.07	0.17	1982	13.99	0.09
1851	13.72	-0.19	1895	13.56	-0.34	1939	14.06	0.16	1983	14.18	0.28
1852	13.69	-0.21	1896	13.75	-0.15	1940	14.01	0.11	1984	13.98	0.08
1853	13.65	-0.25	1897	13.72	-0.18	1941	14.01	0.11	1985	13.97	0.07
1854	13.70	-0.20	1898	13.61	-0.29	1942	13.99	0.09	1986	14.03	0.13
1855	13.64	-0.26	1899	13.67	-0.23	1943	14.08	0.18	1987	14.13	0.23
1856	13.58	-0.32	1900	13.73	-0.17	1944	14.17	0.27	1988	14.18	0.28
1857	13.52	-0.38	1901	13.69	-0.21	1945	13.98	0.07	1989	14.15	0.24
1858	13.52	-0.38	1902	13.52	-0.38	1946	13.86	-0.04	1990	14.28	0.38
1859	13.66	-0.24	1903	13.51	-0.39	1947	13.85	-0.05	1991	14.23	0.32
1860	13.58	-0.32	1904	13.46	-0.44	1948	13.87	-0.03	1992	14.06	0.16
1861	13.58	-0.32	1905	13.58	-0.32	1949	13.85	-0.05	1993	14.11	0.21
1862	13.46	-0.44	1906	13.66	-0.24	1950	13.73	-0.17	1994	14.18	0.28
1863	13.72	-0.18	1907	13.46	-0.44	1951	13.87	-0.03	1995	14.30	0.40
1864	13.47	-0.43	1908	13.45	-0.45	1952	13.92	0.02	1996	14.13	0.23
1865	13.67	-0.23	1909	13.44	-0.46	1953	14.03	0.13	1997	14.32	0.42
1866	13.68	-0.22	1910	13.47	-0.43	1954	13.81	-0.09	1998	14.32	0.42
1867	13.60	-0.30	1911	13.43	-0.47	1955	13.78	-0.12	1999	14.31	0.41
1868	13.69	-0.21	1912	13.46	-0.44	1956	13.68	-0.22	2000	14.28	0.38
1869	13.68	-0.22	1913	13.51	-0.39	1957	13.94	0.04	2001	14.41	0.51
1870	13.67	-0.23	1914	13.68	-0.22	1958	13.99	0.09	2002	14.46	0.56
1871	13.61	-0.29	1915	13.74	-0.16	1959	13.95	0.05	2003	14.46	0.56
1872	13.74	-0.17	1916	13.56	-0.34	1960	13.91	0.01	2004	14.44	0.54
1873	13.67	-0.23	1917	13.49	-0.41	1961	13.99	0.09	2005	14.48	0.58
1874	13.63	-0.27	1918	13.59	-0.31	1962	14.02	0.12	2006	14.44	0.54
1875	13.57	-0.33	1919	13.60	-0.30	1963	14.01	0.11	2007	14.45	0.55

* Data from 1850-2013 HadCRUT4⁶, **2014-2020 NOAA

Year	T _{Earth} ° C.	Delta ° C.	Year	T _{Earth} ° C.	Delta ° C.	Year	T _{Earth} ° C.	Delta ° C.	Year	T _{Earth} ° C.	Delta ° C.
1876	13.62	-0.28	1920	13.68	-0.22	1964	13.72	-0.18	2008	14.39	0.49
1877	13.83	-0.07	1921	13.76	-0.14	1965	13.78	-0.12	2009	14.46	0.56
1878	13.98	0.08	1922	13.63	-0.27	1966	13.82	-0.08	2010	14.52	0.62
1879	13.73	-0.17	1923	13.67	-0.23	1967	13.91	0.01	2011	14.41	0.51
1880	13.75	-0.15	1924	13.66	-0.24	1968	13.85	-0.05	2012	14.47	0.57
1881	13.71	-0.19	1925	13.76	-0.14	1969	13.93	0.03	2013*	14.52	0.62
1882	13.75	-0.15	1926	13.83	-0.07	1970	13.92	0.02	2014**	14.59	0.69
1883	13.69	-0.21	1927	13.75	-0.15	1971	13.84	-0.06	2015	14.8	0.90
1884	13.63	-0.27	1928	13.76	-0.14	1972	13.89	-0.01	2016	14.84	0.94
1885	13.61	-0.29	1929	13.64	-0.26	1973	14.07	0.16	2017	14.74	0.84
1886	13.70	-0.20	1930	13.87	-0.03	1974	13.81	-0.09	2018	14.69	0.79
1887	13.63	-0.28	1931	13.89	-0.01	1975	13.89	-0.01	2019	14.85	0.95
1888	13.61	-0.29	1932	13.88	-0.02	1976	13.76	-0.14	2020	14.88	0.98
1889	13.77	-0.13	1933	13.71	-0.19	1977	14.02	0.12			
1890	13.59	-0.31	1934	13.90	0.00	1978	13.94	0.04			
1891	13.61	-0.29	1935	13.84	-0.06	1979	14.03	0.13			
1892	13.50	-0.40	1936	13.89	-0.02	1980	14.07	0.17			
1893	13.49	-0.41	1937	14.00	0.10	1981	14.16	0.26			
* Data from 1850-2013 HadCRUT4 ⁶ , **2014-2020 NOAA											

The Cyclical Sine Model for Earth temperature variations will be seen to explain what happened to Earth well *before* 1850, up to the present, and predict what will happen in the future. By this model Global Warming/Climate Change is occurring only in the sense that Earth temperatures are currently increasing.

2. The Cyclical Models

The temperature values in Fig. 1 are not the only information about Earth's past temperature behavior. The Earth has historically been experiencing regular temperature cycles. Table 2 summarizes the past five temperature epochs (Singer 2008 pp 51-59) in recorded history. Data summarized in that book show that many, diverse scientific studies have observed Earth temperatures cycling in about 1,500±500 year intervals. One ice core from the Vostok glacier in Antarctica observed 1,500 year temperature cycles (Lorius 1985) over more than 150,000 years. Other technical investigations like near shore sediment core analysis, studies of coral reefs, stalagmites, tree rings, iron filings, and fossilized pollen found the same 1,500 year temperature cycles (Singer

pp 61-69). These studies infer effective or “proxy temperatures” which are not actual measured values but are temperatures changes that explain the variations seen in their data analyses. The cause of these 1,500 year cycles is believed to be solar activity (Singer 2008 pp 18-20, Braun 2005). There are additional results from climatologists and oceanographers supporting the 1,500 year cycles. The Gleissberg and DeVries-Suess cycles have been combined to estimate a 1,470 year cycle (Braun 2005) attributed to the sun. In addition, the Bond cycles (Bond 1997, Obrochta 2014) will be seen to closely correlate with the Cyclical Sine Model.

Table 2
Historical Earth temperature cycles

Epoch	Start Date	End Date	Midpoint Date
Unnamed Cold Period	750 BC	200 BC	475 BC
Roman Warming	200 BC	400	100
Dark Ages Cold	440	900	670
Medieval Warming	900	1300	1100
Little Ice Age	1300	1850	1575

During about the next two centuries the Earth will continue to experience higher temperatures and unusual things will happen. Areas away from the equator will experience increased migration and food production will migrate to those areas also. We will experience many of the changes mankind lived through in a period known as the Medieval Warming. Then, this warm, inviting place called Greenland was discovered by the Vikings who grew crops there to feed their animals (Lamb 1995). After our current warming the Earth will cool and experience a very cold period like The Little Ice Age when the Thames River in London froze solid at least 23 times (Duell 2013) and has not done so again since 1814. Londoners held “Frost Fairs” on the solid ice with even an elephant walking across. The good news is that we now have huge amounts of energy for use during very warm and very cold periods.

A cyclical model should have its repeated period in the range of 1,000-2,000 years to be consistent with the proxy data. The initial strategy for cyclical modeling is to start with an assumed sine wave amplitude for a cyclical temperature model and see where that leads. Cyclical behavior has long been modeled by a simple sine wave function like Eqn. 1 that can be applied for temperature as a function of time.

$$T(t) = A \sin\left(\frac{2\pi t}{\lambda} + \phi\right)$$

1

To fit Earth temperature as a function of time to this sine wave we need the amplitude A, the period λ , and the phase ϕ . Amplitude is the height of the sine wave above and below a center line. Period is the length of the wave for a single increase and decrease cycle. Phase is the placement of the entire wave along the time axis. A computerized method called nonlinear regression finds these values by minimizing the differences between data and model. Nonlinear regression programs try various combinations of the variables in an organized way with the goal of making the deviations between data and model as small as possible. Data points can be given different weights depending on various factors. In this work all data points were given equal weights except the

final fit where data from 2014-2020 were given increased weights to bring them into better agreement. See Appendix 1 for more details about non-linear regression.

2.1 Single Sine Fit – 1850-2013 Data

We do not know how much average Earth temperature fell and rose from a mean value during the past five historical epochs. A base assumption is that it was the same for each past epoch and the present cycle. A first guess from the NOAA temperature for 2020 of 14.88° C. is that it may rise another 1° C. to a final value of 15.9° C. at the next maximum. The sine wave amplitude A would then be 2° C. to oscillate from a 13.9° C. standard baseline for the 20th century. For this case, the regression values would be only the period τ and phase ϕ . This first regression used only the temperature data through 2013 to be on a par with the UNIPCC study. The regression results are shown in Table 3 and Fig. 5.

Table 3
Single Sine Cyclical Model Parameters 1850-2013 – Fixed Amplitude

Period, years	1,126
Amplitude, deg C.	2.00
Phase, radians	177.7
Data point weights	1
Next Max Temperature	15.9° C. in 2220

With the amplitude fixed at 2° C. every 1,126 years this heating and cooling cycle repeats itself. It is seen that the last five climate change cycles in recorded history agree reasonably well in timing with this model. To the naked eye the fit to measured temperatures also looks reasonable. The fit to the Little Ice Age, Medieval Warming, and the three other epochs in historical documents gives confidence that current Earth behavior agrees with its own history. To include these historic cycles, it was assumed that at the midpoint of each epoch (Table 2) the respective maximum or minimum temperature was reached. The single large data point for each epoch is shown in Fig. 5. All these data together yield the Single Sine Cyclical Model with fixed amplitude shown in Fig. 5 where the next maximum temperature of 15.9° C. is expected about 200 years from now in the year 2220 after a further temperature increase of another 1.38° C. from the 2013 value of 14.52° C. Total increase since 1850 would be about 2.44° C.

If you look closely at the measured temperatures compared to this single sine wave curve fit in Fig. 6, it is apparent that there is another cyclical variant present. The experienced eye of a nonlinear modeler notices that the data in Fig. 6 exhibit an oscillation. This regular trend is a strong indication that even though the fit looks reasonable in Fig. 5, improvements to the model must be made. Another sine wave needs to be added to the primary one. This second sine wave would have been needed even if a constant wave amplitude had not been assumed for this first fit. The oscillation is inherent in the temperature data itself as shown in Fig. 7 and Table 4 where a 66.6 year cycle oscillates about just a linear trendline of the data.

Table 4
Temperature data cyclicity
about its trendline 1850-2013

Period, years	66.6
Amplitude, deg C.	.140
Phase, radians	107.8

2.2 Dual Sine Fit 1850-2013 Data

When a second sine wave is added to the first, the nonlinear regression results are shown in Fig. 8. For this fit *all* parameters for both sine waves were regression variables, the amplitudes, periods, and phases. A constant primary wave amplitude was not assumed. Only temperature data through 2013 were used. Table 5 shows the parameters for this fit where a primary period of 1,100 years was found.

Table 5
Dual Sine Cyclical Model Parameters 1850-2013

Two Sine Model	Sine 1	Sine 2
Period, years	1,100	68.4
Amplitude, deg C.	.875	.143
Phase, radians	102.	93.6
Data point weights	1	
Next Max Temperature	14.9° C. in 2210	

This dual sine model predicts that the Earth's temperature will increase only about another 0.38° C. which will be achieved in about 200 years in the year 2210 with a maximum temperature then of about 14.9° C. Total temperature increases since 1850 would be about 1.34° C. Note that the amplitude of the first sine wave was found to be 0.875° C., not the 2° C. of the first regression. Also, the period of 1,100 years is shorter though not greatly different from the 1,126 years found by the first fit. Fig. 9 shows that Earth temperature oscillations agree much better with the Dual Sine Cyclical Model than with the Single Sine Model. The second sine wave oscillation has a period of 68 years according to this fit.

2.2.1 Dual Sine Fit 1850-2013 Data – Climatological Comparison

The primary sine period of 1,100 years correlates closely with the Bond Atlantic Drift Ice cyclicity where the initial period was reported at 1,470 years (Bond 1997) and was later reduced (Obrochta 2014) to 1,000 years. The 68 year secondary sine cycle found within the temperature data correlates closely with the Atlantic Multidecadal Oscillation (AMO) and the Pacific Decadal Oscillation (PDO). Fig. 10 shows this close correlation with the AMO Index (NOAA AMO) which had a 73 year oscillation between 1926 and 1999! Not only does the AMO have a similar period, but it is also in close sync with the increases and decreases of the temperature

fluctuations. From Fig. 10 the expectation would be that there would be decreasing AMO index and cooling during the next 20 to 30 years. The PDO Index (NOAA PDO) also has a similar close correlation with the secondary temperature variations as shown in Fig. 11. The PDO period was about 62 years compared to the 68 years found in the secondary temperature oscillation. It also says that in the next 20 or 30 years cooling is expected.

When the Karl data in Fig. 3 from 1880-2016 (Karl 2016) are analyzed in this same way the results in Fig. 12 show that it too contains a temperature cycle of 71 years with further parameters in Table 6.

Table 6
Karl Data Dual Sine Cyclical Model Parameters
1880-2016

Two Sine Model	Sine 1	Sine 2
Period, years	1,076	71.3
Amplitude, deg C.	1.357	.115
Phase, radians	101.7	101.3
Data point weights	1	
Next Max Temperature	15.37° C. in 2220	

In summary, the 1,100 primary cycle period of the Dual Sine Cyclical Model is believed driven by solar activity and closely agrees with Bond Cycles, and the secondary temperature oscillations within the Earth temperature data agree with the AMO and PDO surface temperature oscillations. These conclusions were made possible by including both the five past historical temperature epochs and the measured Earth temperatures from 1850 to 2013. The final model fit next will include all data together from 1850-2020.

2.3 First Dual Sine Fit 1850-2020 Data

When the same analysis is done including the additional temperatures from 2014-2020, the nonlinear regression results are shown in Figs. 13 and 14. For this fit *all* parameters for both sine waves were again regression variables, the amplitudes, periods, and phases. Each temperature value was equally weighted. It is seen that the 2014-2020 data do not fit very well. There is a different characteristic in these data as already discussed about Fig. 2. Table 7 shows the resulting parameters for this fit.

Table 7
Dual Sine Cyclical Model Parameters 1850-
2020 Equal weights

Two Sine Model	Sine 1	Sine 2
Period, years	1,050	69.6
Amplitude, deg C.	.936	.162
Phase, radians	101.5	96.53
Data point weights	1	
Next Max Temperature	14.82° C. in 2200	

2.3.1 Final Dual Sine Fit 1850-2020 Data

To force the 2014-2020 data into this model, the weights for those years were increased to five compared to one for the rest of the data points. Weights from 2 to 10 were evaluated with the 5 weights judged to be the best compromise with deviations for the 2014-2020 data greatly reduced while deviations for all other data not greatly increased. Figs. 15 and 16 and Table 8 show the final best fit for all temperature data. This fit is the best one can do to include the unusual increase in reported temperatures since 2013. If more consistent temperature values are ultimately reported, a final fit may not need to give the 2014-2020 data increased weight.

Table 8
Dual Sine Cyclical Model Parameters 1850-
2020 weights=5 for 2014-2020

Two Sine Model	Sine 1	Sine 2
Period, years	1,060	76.1
Amplitude, deg C.	1.270	.243
Phase, radians	101.6	73.69
1850-2013 weights	1	
2014-2020 weights	5	
Next Max Temperature	15.4° C. in 2170	

2.3.2 Final Dual Sine Fit 1850-2020 Data – Climatological Comparison

The correlation for this final model fit is virtually the same as that already seen in Figs. 10 and 11. The primary sine period of 1,060 years correlates closely with the Bond Atlantic Drift Ice cyclicity where the initial period was reported at 1,470 years (Bond 1997) and was later reduced (Obrochta 2014) to 1,000 years. The 76 year secondary sine cycle found within the temperature data for this final fit correlates closely with the Atlantic Multidecadal Oscillation (AMO) and the Pacific Decadal Oscillation (PDO). Fig. 17 shows this close correlation with the AMO (NOAA AMO) which had a 73 year oscillation between 1926 and 1999! Not only does the AMO have essentially the same period, but it is also in close sync with the increases and decreases of the temperature fluctuations. From Fig. 17 the expectation would be that there would be decreasing AMO index and cooling during the next 20 to 30 years. The PDO Index (NOAA PDO) also has a reasonable correlation with the secondary temperature variations as shown in Fig. 18. The PDO period was about 62 years compared to the 76 years found in the secondary temperature oscillation. It also says that in the next 20 or 30 years cooling is expected.

In summary, the 1,060 primary cycle period of the Final Dual Sine Cyclical Model is believed driven by solar activity and closely agrees with Bond Cycles, and the secondary temperature oscillations within the Earth temperature data agree with the AMO and PDO surface temperature oscillations. These conclusions were made possible by including both the five past historical temperature epochs and the measured Earth temperatures from 1850 to 2020.

3. Future Earth Temperature Predictions

Figures 19 shows predictions beyond 2020 for the final Dual Sine Cyclical Model and the UNIPCC Model (UNIPCC 2014). The predictions are quite different. The major question is whether the Earth will continue to follow its historic 76 year temperature cycle shown in Fig. 16, or will temperatures essentially increase in a straight line.

3.1 Regular Downdip and Upswing Temperature Intervals

Each oscillation in the Dual Sine Cyclical Model cycles in Fig. 19 consists of two parts, a *downdip* followed by an *upswing*. With the primary sinewave temperature now increasing, temperature declines during a *downdip* are less than the temperature increases during an *upswing*. These differences are due to the increasing and decreasing contributions of the secondary sinewave cycle. The time interval between a local maximum and the next minimum is herein defined as a *downdip* while the interval between a local minimum and the next maximum is defined as an *upswing*.

Figure 20 shows the first *downdip* and *upswing* since 1850. The slope (derivative) of the dual sine wave curve shown in Figure 20 as the large-dashed line is used to locate the points of zero slope on the temperature curve. The vertical small-dashed lines designate the points of zero slope between the first maximum and the first minimum of the temperature curve and the second maximum showing downdip and upswing.

Figure 21 shows all four of the downdips and upswings between 1850 and the next overall maximum temperature predicted to be in 2170. Tables 9 and 10 contain the detailed values where downdips become longer as upswings become shorter. Fig. 22 shows the measured Earth temperature data with downdip interval temperatures shown as triangles and upswing intervals as circular data points. Downdips and upswings are clearly seen with upswings clearly demonstrating increased temperatures while the two downdips show more irregularity. Note that the period from 1945-1975 (Time 1974) when another ice age was feared fits almost exactly (1946-1976) with the 30 year Downdip 2 shown in the figure! There is also a prior Downdip 1 from 1870-1899 which did not receive notoriety as a non-increasing temperature interval. The final Dual Sinewave Cyclical Model predicts that we will be in Downdip 3 starting in 2022 and running until 2053.

Table 9
Predicted Earth Hiatus Intervals

Start Date	End Date	Interval, yrs	Type
1870	1899	29	Downdip 1
1946	1976	30	Downdip 2
2022	2053	31	Downdip 3
2097	2131	34	Downdip 4

Table 10
Predicted Earth Upswing Intervals

Start Date	End Date	Interval, yrs	Type
1899	1946	47	Upswinging 1
1976	2022	46	Upswinging 2
2053	2097	44	Upswinging 3
2131	2171	40	Upswinging 4

Table 11
NOAA Monthly and Annual Report Comparison

		2019	2019	2020	2020	2021	2021
Month	Monthly Avg	Reported Delta	Temperature	Reported Delta	Temperature	Reported Delta	Temperature
	20th century	deg. C	deg. C	deg. C	deg. C	deg. C	deg. C
January	12.00	0.88	12.88	1.14	13.14	0.80	12.80
February	12.10	0.79	12.89	1.17	13.27	0.65	12.75
March	12.70	1.06	13.76	1.16	13.86	0.85	13.55
April	13.70	0.93	14.63	1.06	14.76	0.79	14.49
May	14.80	0.85	15.65	0.95	15.75	0.81	15.61
June	15.50	0.95	16.45	0.92	16.42	0.88	16.38
July	15.80	0.95	16.75	0.87	16.67	0.93	16.73
August	15.60	0.92	16.52	0.94	16.54	0.90	16.50
September	15.00	0.95	15.95	0.97	15.97		
October	14.00	0.98	14.98	0.85	14.85		
November	12.90	0.92	13.82	0.97	13.87		
December	12.20	1.05	13.25	0.78	12.98		
Averages	13.86	0.94	14.79	0.98	14.84		
	NOAA	2019	2019	2020	2020	2021	2021
	Full Year	0.95	14.85	0.98	14.88		14.71*

* Estimated 2021 temperature through August if rest of 2021 is the same as 2020.

3.2 Final Near-term Temperature Predictions

Figure 23 shows the near-term part of Fig. 19. The large open circle is an early temperature estimate for 2021 with monthly data through August (see Appendix 2) with the assumption that the remainder of 2021 would be the same as 2020. Earth temperature for 2021 would be 14.71° C. (0.17° C. lower than 2020) by this estimate. So far 2021 has been cooler than 2020 for the same period, but of course the rest of 2021 could be warmer. The next four or five years should determine which model is the most accurate. The next maximum temperature for the Final Cyclical Sine Model should be about 15.4° C. in 2170.

4. Conclusions

The information presented in this paper has led the author to conclude the following:

1. The increasing temperature of the Earth since 1850 is part of the natural temperature cycle that has occurred on Earth for at least the last 3,000 years. The Dual Sine Cyclical Model fully explains both the distant past and current temperatures. Maximum Earth temperature of 15.4° C. should be reached in about 150 years.
2. The 1,060 year primary cyclicity of the Dual Sine Cyclical Model correlates closely with the Bond Atlantic Ice Drift cyclicity of about 1,000 years.
3. The observed secondary sine temperature fluctuations found within the Earth temperature data correlate closely with the Atlantic Multidecadal Oscillation and Pacific Decadal Oscillation.
4. The interval from 1945-1975 when an impending ice age was feared is explained as a downdip zone in the Dual Sine Cyclical Model.
5. The temperature fluctuations ahead for planet Earth will highly likely require abundant energy sources to maintain livable temperatures everywhere during very hot and very cold future cycles.

Abbreviations

A = amplitude of a sine wave, deg. C.

AMO = Atlantic Multidecadal Oscillation – systematic movement of water from the Caribbean to Labrador

Least Squares = sum of the squared R_i values at the regression end, dimensionless

ϕ = phase of sine wave, radians – movement on the time axis

R_i = residual of a data point, dimensionless (Eqn. B.2)

T = temperature, deg. C.

t = time, years

τ = period of a sine wave, years

W_i = weight factor, usually 1

$Y_{\text{Calculated},i}$ = calculated value of a temperature, deg. C.

$Y_{\text{Observed},i}$ = measured value of a temperature, deg. C.

Declarations

Funding – Not applicable

Conflicts of interest/Competing interests – Not applicable

Availability of data and material – Excel 365 non-linear regression files available if requested by reviewers

Code availability – Not applicable

Authors' contributions – I am the only author and have not published in life science journals

Ethics approval – Not applicable

Consent to participate – Not applicable

Consent for publication – Not applicable

References

1. Berkeley Earth <https://berkeleyearth.org>
2. Bond, Gerard, et. al., *A Persuasive Millennial-Scale Cycle in North Atlantic Holocene and Glacial Climates*, Science, Vol 278, November 14, 1997, 1257-1266.
3. Braun, Holger et. al., Possible solar origin of the 1,470 year glacial climate cycle demonstrated in a coupled model, Nature, 2005, 438, 7065, 208-211.
4. Duell, Mark, *Thrills of the frost fair: Fascinating paintings and memorabilia show how Londoners celebrated when the River Thames froze over*, Daily Mail, December 25, 2013.
5. HADcrut https://www.metoffice.gov.uk/hadobs/hadcrut4/data/current/time_series/HadCRUT.4.6.0.0.annual_ns_avg.txt
6. Karl, Thomas R., et. al., Science 26 Jun 2015, Vol 348, Issue 6242, pp. 1469-1472
7. Lamb, H. H., Climate, History and the Modern World, Psychology Press, 1995, 187-189
8. Lorius, C. et. al., A 150,000 Year Climate History from Ice Cores, Nature 316 1985, pp. 591-596.
9. Los Angeles Times, *Detailed look at the global warming 'hiatus' again confirms that humans are changing the climate*, May 3, 2017 Detailed look at the global warming 'hiatus' again confirms that humans are changing the climate - Los Angeles Times (latimes.com).
10. NASA <https://data.giss.nasa.gov/gistempv4>
11. NASA What is the greenhouse effect? – Climate Change: Vital Signs of the Planet (nasa.gov)
12. NOAA AMO SVS: Historical Atlantic Multidecadal Oscillation (AMO) (nasa.gov)
13. NOAA History of Earth's temperature since 1880 | NOAA Climate.gov
14. NOAA PDO <https://psl.noaa.gov/data/correlation/amon.us.long.data>

15. Obrochta, Stephen P, et. al., *Climate variability and ice-sheet dynamics during the last three glaciations*, Earth and Planetary Letters, vol 406, 2014, 198-212
16. Singer, S. Fred, and Avery, Dennis T., *Unstoppable Global Warming – Every 1,500 Years*, Rowland & Littlefield Publishers, Inc., 2008.
17. Singer, S. Fred, and Avery, Dennis T., *Unstoppable Global Warming – Every 1500 Years*, Rowland & Littlefield Publishers, Inc., 2008, pp. 51-59
18. Singer, S. Fred, and Avery, Dennis T., *Unstoppable Global Warming – Every 1500 Years*, Rowland & Littlefield Publishers, Inc., 2008, pp. 61-99
19. Singer, S. Fred, and Avery, Dennis T., *Unstoppable Global Warming – Every 1500 Years*, Rowland & Littlefield Publishers, Inc., 2008, pp. 18-20
20. Time Magazine, Another Ice Age? April 14, 1974, pp. 86.
21. UNIPCC <https://unfccc.int/topics/science/workstreams/cooperation-with-the-ipcc/the-fifth-assessment-report-of-of-the-ipcc>, 2014

Figures

Figure 1

Measured Earth Temperature Difference from the 20th Century Average of 13.90 C

Figure 2

Different Hiatus Responses

Figure 3

Comparison of some Earth temperature data bases

Figure 4

Deviation of Earth temperature data values since 2014

Figure 5

Single Sine Cyclical Model with Fixed Amplitude Fit to Data and Past Epochs

Figure 6

Deviation of Earth Temperatures from the Single Sine Fixed Amplitude Cyclical Model

Figure 7

Oscillation in Earth temperature data about its trendline

Figure 8

Dual Sine Cyclical Model Fit to Data and Past Epochs

Figure 9

Deviation of Earth Temperatures from the Dual Sine Cyclical Model

Figure 10

Dual Sin Cyclical Temperature Variations Compared to AMO

Figure 11

Dual Sine Cyclical Temperature Variations Compared to PDO

Figure 12

Deviation of Karl Temperatures from the Dual Sine Cyclical Model

Figure 13

Dual Sine Cyclical Model Fit to Data and Past Epochs- Data thru 2020

Figure 14

Deviation of Earth Temperatures from the Dual Sine Cyclical Model – Data thru 2020

Figure 15

Deviation of Earth Temperatures from the Dual Sine Cyclical Model – Data thru 2020 with wt. = 5

Figure 16

Deviation of Earth Temperatures from the Dual Sine Cyclical Model – Data thru 2020 with wt. = 5

Figure 17

Dual Sine Cyclical Temperature Variations Compared to AMO – Final Fit

Figure 18

Dual Sine Cyclical Temperature Variations Compared to PDO – Final Fit

Figure 19

Log-term Predictions of Future Temperatures Dual Sine vs. UNIPCC Models

Figure 20

Sequential zero slope points define a downdip and upswing

Figure 21

Predicted Temperature Downdips and Upswings Since 1850

Figure 22

Observed Temperature Downdips and Upswings Since 1850

Figure 23

Near-term Predictions of Future Temperatures Dual Sine vs. UNIPCC Models

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Appendix.docx](#)