

# The Cyclical Sine Model Explanation for Climate Change

Dale Erwin Nierode (✉ [dnierode@msn.com](mailto:dnierode@msn.com))

ExxonMobil Upstream Research Company



---

## Research Article

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

**Posted Date:** December 16th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-848733/v2>

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

---

# Abstract

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 approximately every 1,500 years [1]. The 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 thousand year cyclicity of solar activity from  $^{14}\text{C}/^{12}\text{C}$  ratio studies [2], and Bond [3] Atlantic drift ice cycles. This model also agrees with sunspot history, the Atlantic Multidecadal Oscillation, and the Pacific Decadal Oscillation. In addition, this model quantitatively explains the time span 1945-1975 when an impending ice age was feared [4]. Earth temperatures are controlled by three solar cycles of approximately 1,000, 70, and 11 years. The Cyclical Sine Model is the best explanation for the Earth's recent temperature increases.

## 1. Introduction

The world today is gripped by the threat of existential climate change. It is said that the increase of greenhouse gasses in the atmosphere from burning hydrocarbons has caused increasing Earth temperature close to the point of extinction. **Fig. 1** shows reported annual Earth temperatures since 1850 from various sources [5-7]. Temperatures values are virtually identical until about 2000 but diverge significantly thereafter. Temperature data used for the UNIPCC model 5 fit [5] are the lowest curve with the other profiles tending toward the model 5 predictions shown as the large-dashed line. **Fig. 2** shows a closer look after 2000. This paper will use the UNIPCC T data [5] and HadCRUT5 [7] to bracket the range of reported temperature profiles. I consider the original UNIPCC T data [5] from 1850 to 2013 to be the most trustworthy.

The United Nations Intergovernmental Panel on Climate Change (UNIPCC) has been working since 1985 to model Earth temperatures by including every climate event that happened since 1850 in a model of the whole Earth and its atmosphere. The model breaks the Earth surface and atmosphere into 3-D volumes with each element experiencing its own history. Then the results are summed each year to yield a calculated Earth temperature to be compared with the measured value. The last UNIPCC modeling results were published [5] in 2014 with the comparison to Earth temperatures shown in **Fig. 3**. It is seen that the agreement between data and model is not very exact. The two intervals highlighted by circles show that the model significantly overpredicts measured temperatures. The most alarming one is the interval from 1998-2014 when temperatures leveled off [8] instead of increasing as the model predicted. This was when the term *global warming* was deemphasized in favor of *climate change* because the Earth did not warm as expected. Nonlinear modeling is discussed in detail in Appendix 1 where a result like **Fig. 3** requires resolution of inconsistencies before any prediction into the future is credible. To the untrained eye agreement between model and data in **Fig. 3** may seem good enough but it is not. To date the UNIPCC has not yet issued an improved model.

The approach in this paper is to model the two measured Earth temperature profiles and include past Earth history. After the model is complete it will be compared to climatological data such as solar cycles and other climatological correlations. It will be seen that when all this information is considered a much better explanation for Earth temperature history results where predicted future temperatures are believable.

## 2. Additional Earth Data

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 1 summarizes the past five temperature epochs [9] in recorded history. Data summarized in that book show that many diverse scientific studies have observed Earth temperature cycling in approximately  $1,500 \pm 500$  year intervals. One ice core from the Vostok glacier in Antarctica observed 1,500 year temperature cycles [10] over more than 150,000 years. Other technical investigations, such as 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 [1]. These studies infer effective or "proxy temperatures", which are not actual measured values but are temperature changes that explain the variations seen in their data analyses. The cause of these 1,500-year cycles is believed to be solar activity [2, 11, 12]. 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 [12] attributed to the sun. In addition, the Bond cycles [3] will be seen to closely correlate with the cyclical sine model.

The historical epochs in relation to measured Earth temperature values since 1850 tie together in a way pictured in **Fig. 4** as a simple sine wave. This is the definition of the Cyclical Sine Model. The only assumption is that the Earth has behaved repetitively in past historical epochs reaching the same extremes in temperature.

## 3. The Cyclical Models

Cyclical behavior has long been modeled by a simple sine wave function such as Eqn. 1 that can be applied for temperature as a function of time.

$$T(t) = A \sin \left( \frac{2\pi t}{T} + \varphi \right) \quad (1)$$

To fit Earth temperature as a function of time to this sine wave, we need amplitude  $A$ , period  $T$ , and phase  $\varphi$ . Amplitude is the height of the sine wave above and below a centerline. 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 the 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 nonlinear regression.

### 3.1 Single Sine Fit – 1850-2013 Data

A single sine wave was fit to the measured Earth temperatures and the past five temperature epochs of Table 1. Regression was done for the amplitude, the period and phase. This first regression used only the temperature data through 2013 to be on par with the UNIPCC study [5]. The regression results are shown in Table 2 and **Fig. 5**.

Every 1,036 years this heating and cooling cycle repeats itself. 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 1), 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 shown in **Fig. 5** where the next maximum temperature of  $14.83^{\circ}\text{C}$ . is expected about 200 years from now in the year 2220 after a further temperature increase of another  $0.24^{\circ}\text{C}$ . from the 2013 value of  $14.59^{\circ}\text{C}$ . Total increase since 1850 would be about  $1.27^{\circ}\text{C}$ .

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 wave.

### 3.2 Dual Sine Fit 1850-2013 Data

When a second sine wave is added to the first, the nonlinear regression results are shown in **Fig. 7**. Only the original temperature data through 2013 [7] were used. Table 3 shows the parameters for this fit where a primary period of 1,100 years was found.

This dual sine model predicts that the Earth's temperature will increase only about another 0.34° C. which will be achieved in about 190 years in the year 2210 with a maximum temperature then of about 14.93° C. Total temperature increases since 1850 would be about 1.37° C. Additionally, the period of 1,100 years is longer, though not greatly different from the 1,036 years found by the first fit. **Fig. 8** 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.

### 3.3 First Dual Sine Fit 1850-2020 Data

When the same analysis is done including the additional temperatures [7] from 2014-2020, the nonlinear regression results are shown in **Figs. 9 and 10**. Each temperature value was equally weighted. The 2014-2020 data do not fit very well. There are different characteristics in these data, as already discussed in **Fig. 3**. Table 6 shows the resulting parameters for this fit.

### 3.4 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. This gives extra importance to recent data assuming it is valid. 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. 11 and 12** and Table 7 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.

#### 3.4.1 Regular Downtip and Upswing Temperature Intervals

Each oscillation of the dual sine cyclical model cycles in **Figs. 7, 9, and 11** consists of two parts: a *downtip* followed by an *upswing*. With the primary sinewave temperature increasing, the temperature declines during a *downtip* 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 *downtip*, while the interval between a local minimum and the next maximum is defined as an *upswing*. **Fig. 13** shows the first *downtip* and *upswing* since 1850. The slope (derivative) of the dual sine wave curve shown in **Fig. 13** 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 showing *downtip* and *upswing*.

**Fig. 14** shows all five *downtips* and *upswings* between 1850 and the next overall maximum temperature predicted to be in 2232. Tables 8 and 9 contain the detailed values where *downtips* become longer as

upswings become shorter. **Fig. 15** shows the measured Earth temperature data with downdip interval temperatures shown as open circles and upswing intervals as solid circles. Downdips and upswings are clearly seen, with upswings demonstrating increased temperatures, while the two downdips show more irregularity. Note that the period from 1945-1975 when another ice age was feared [4] possibly due to aerosols in the atmosphere fits closely (1947-1976) with the 29-year Downdip 2 shown in the figure. There is also a prior Downdip 1 from 1875-1903 that did not receive notoriety as a nonincreasing temperature interval. The final dual sinewave cyclical model predicts that we will be in Downdip 3 from 2019 until 2049.

At this point all results presented were generated only from Earth temperature data since 1850 and the midpoint dates for the last five historical epochs. The only assumption was that the current and past five epochs reached the same high and low temperatures. Nonlinear regression alone determined the model parameters to make model and measured temperatures fit best. The next step is to compare the final model (**Fig. 11**) with various solar and climatological correlations.

### 3.4.2 Model Comparison to Solar Cycles

The primary cycle of 1,071 years found in the final dual sine model is supported by  $^{14}\text{C}/^{12}\text{C}$  results using wavelet analyses where a 1,000 year solar cycle [2] was found. Additional support is given from Atlantic drift ice cycles found to exhibit 1,470 Earth temperature cycles [3]. All the other proxy data [1] having found cycles between 1,000 and 2,000 years also are consistent with 1,071 years.

The final dual sine cyclical model correlates closely with solar sunspot history [13]. **Fig. 16** shows that downdips occur during sunspot minima while upswings occur during maxima. This agreement affirms the counterintuitive observation that "Irradiance is greatest during sunspot maxima and lowest during sunspot minima" [14]. **Fig. 17** shows that the 24 sunspot data tops from 1749-2019 exhibit an approximate secondary cyclicity of 71 years in addition to the primary Schwabe 11 year cycles. The 71 year cycle is nearly equal to the 73 year cyclicity within the Earth's temperature data itself. It is apparent that sunspots with their effect on solar irradiance are the direct cause for the Earth secondary temperature cycles.

Future sunspot behavior that would be consistent with the final dual sine cyclical model is shown in **Fig 18**. Tables 8 and 9 contain the specific timing predictions for future sunspot activity. Current sunspot 25 is predicted to be "feeble" just like 24 with a value of 115 in 2025 [15]. The future sunspot maxima values shown are very approximate with total sunspot numbers increasing until 2232 and afterward decreasing. Such behavior would be consistent with slightly increasing solar irradiance followed by reductions after the next maximum Earth temperature in 2232. Sunspots should be minimum for cycles 25-26 during the next downdip from 2019-2049. **Fig. 19** is a plot like **Fig. 18** using temperature data only from 1850-2013. It is

seen that the agreement here is slightly better with solar cycle 24 just at the beginning of the downdip whereas in **Fig. 18** it is slightly before the end of an upswing. This sheds a little bit of doubt on the Earth temperature data from 2014-2020.

In summary, the 1,071 year primary cycle period of the final dual sine cyclical model is believed to be driven by solar activity [2] and is consistent with proxy results [1].

### 3.4.3 Model Comparison with Climatological Correlations

The 73-year secondary sine cycle found within the temperature data also correlates closely with the Atlantic Multidecadal Oscillation (AMO) and the Pacific Decadal Oscillation (PDO). **Fig. 20** shows this close correlation with the AMO [16], with a 69-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. 20** the expectation is that there would be a decreasing AMO index and cooling during the next 20 to 30 years. The PDO index [17] also has a good correlation with the secondary temperature variations, as shown in **Fig. 21**. The PDO period was approximately 65 years compared to the 73 years found in the secondary temperature oscillation. It also says that in the next 20 or 30 years, cooling is expected.

In summary, the secondary temperature oscillations within the Earth temperature data agree with the AMO and PDO surface temperature oscillations and all three are caused by sunspot cycles.

## 4. Future Earth Temperature Predictions

**Figs. 22** shows predictions beyond 2020 for the final dual sine cyclical model and the UNIPCC model [7]. The predictions are quite different. The major question is whether the Earth will continue to follow its historic 73-year temperature cycle shown in **Fig. 15** or will temperatures essentially increase in a straight line.

**Fig. 23** shows the near-term part of **Fig. 22**. The large open circle is an early temperature estimate for 2021 [6]. Earth temperature for 2021 would be 14.73°C (0.19°C. lower than 2020) by this estimate. To date, 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 cyclic sine model should be approximately 15.39°C in 2232.

During approximately 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. 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 [18]. After our current warming, the Earth will cool and experience a very cold period, such as The Little Ice Age, when the Thames River in London froze solid at least 23 times [19] and has not done so again since 1814. Londoners held “Frost Fairs” on 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.

## 5. Conclusions

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

1. Solar cycles fully explain Earth temperature increases since 1850. The primary 1,071 year cycle is supported by  $^{14}\text{C}/^{12}\text{C}$  ratio wavelet studies and Bond Atlantic ice drift measurements. Sunspot dual cyclicity of approximately 73 and 11 years accounts for the Atlantic Multidecadal Oscillation, and the Pacific Decadal Oscillation measurements. The final dual sine cyclical model gives very close support for these three solar cycles.
2. The Earth will experience sunspot minima for the next two 11 year cycles causing cooling (non-increasing) temperatures during that time interval.
3. The next maximum Earth temperature of  $15.39^{\circ}\text{C}$  should be reached in approximately 211 years.
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.

## Appendix 1

Scientists and engineers often have data in need of interpretation for basic understanding of what the data mean, and to ultimately extrapolate the meaning into the future. Mathematical modeling plays the main role in quantifying the information in an organized manner. The obvious requirements to do modeling are:

1. You must have data before constructing a mathematical model.
2. Your model must very closely quantify the data.

In the absence of either one, you do not have an adequate model.

Nonlinear regression of data started in the early 1950's when computers became fast enough to perform the many thousands of iterations necessary to arrive at the final answer. Early programs were entered by IBM



paper cards and required a liquid nitrogen cooled Cray computer to complete the calculations. Today the same calculations can be done on a laptop computer using a regression program such as Solver in MS Excel.

Nonlinear regression is NOT able to give an answer that the user desires. The data itself contains a story that is revealed by nonlinear regression. It is not possible to select a set of parameters for real world data as John von Neumann famously said, "With four parameters and I can fit an elephant, and with five and I can make him wiggle his trunk" [20]. I expect that von Neumann would agree that his muse is not correct for real data analysis. The data speaks for itself.

### Non-Linear Mathematical Models

Nonlinear models are difficult to successfully apply to complex data sets. Most of the behaviors of Earth systems are nonlinear, as are physical phenomena such as the failure of structures. Nonlinear modeling is now a well-established, mathematical activity.

Models can be any type of algebraic or computer equation with dependent and independent variables to describe the data. For example, one might have Earth average, annual temperature values as the dependent variable with cloud cover, CO<sub>2</sub> concentration in the atmosphere, and rainfall as independent variables, among others. The UNIPCC modeling effort is to quantify all the phenomena occurring everywhere on the surface of the Earth from 1850 to the present time. The hope is that if you correctly model all the many pieces, when you put them together you will replicate the Earth's temperature history. Their models are so complex and costly to run that they are unable to do any fitting of individual block information using the nonlinear regression method explained next.

### Non-Linear Regression

**Nonlinear regression** is a computerized method by which observed data are fitted to a nonlinear function that has some parametric values that are not closely known. The data are fitted by one of several methods of successive approximations to find the best value of the parameters, the regression parameters. If the model has sufficient capability to completely reproduce the character of the data, the result is a best fit, which often confidently predicts behavior beyond the range of the data.

Several regression methods are termed Gauss-Newton, Gradient Descent, and Levenberg-Marquardt, among others. Each starts with a user supplied estimate of the regression parameters and makes successive changes to the parametric values, leading to a least squares final fit. A least-squares fit minimizes the sum

of the squares of the residuals in eqn. 1.1. When the sum of squares is minimized, differences between the model and data are the best possible fit for that model.

$$\text{Least squares} = \sum_1^n W_i (R_i^2) \quad (1.1)$$

Where,

$$R_i = (Y_{\text{Calculated},i} - Y_{\text{Observed},i}) / Y_{\text{Observed},i} \quad (1.2)$$

$R_i$  is called the residual of a data point. It is the fractional difference between calculated and observed values as a fraction of the observed value.  $W_i$  is a weight factor that can be assigned to give more credence to certain points. For example, more accurate values are based on improved measurement methods. The residuals are squared in the sum of squares to be minimized by nonlinear regression so that positive and negative residuals are treated equally. If not squared, a large negative residual and a large positive residual would merely cancel each other out, giving a misleading result. With most data being measured in some way, there are always measurement errors termed random errors. Measuring equipment or personal observations of some events always introduces some uncertainty. The nonlinear regression program used in this work was the Solver in MS Excel 365.

## Nomenclature

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

$\phi$  = 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

$\tau$  = 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.

# Compliance With Ethical Standards

I believe I have followed ethical standards. My work experiences in oil industry research have not skewed my work in climate change modeling. My high school physics teacher Mr. Bates taught me that scientists follow Socrates' dictum to "follow the data wherever it may lead" rather than intentionally cherry picking information to yield a desired result. I worked for Exxon Production Research Company for 32 years and retired before the ExxonMobil merger. I have not had any direct contact with ExxonMobil since retirement. I financed this work myself. My oil field research mainly involved hydraulic fracturing which is an anathema to the greenhouse gas climate community. Wells have been fraced (note no k) since 1948 without any adverse results. Fracing simply accelerates the recovery of hydrocarbons making the production operation more economical at lower cost to the consumer. Wells can be drained in 10 years rather than 40 years typically. I was a coauthor and coeditor of the Society of Petroleum Engineer's Monograph on Hydraulic Fracturing if anyone wants more truth on the matter.

Due to my work background a journal editor, peer reviewer, or eventual reader could do a thought experiment and conclude that my oil industry involvement caused my manuscript to be unethically produced to favor my biases. It could be concluded without direct evidence that I am immoral and unethical. In my scientific experience that means that any doubters are ethically bound to show where what I have done is biased and/or technically flawed.

The SNAP journal and other Springer journals require a specified affiliation. I did so, but do not want that affiliation shown on a final paper if accepted. ExxonMobil has not seen or financed this work, and I cannot ethically show any connection to them without their prior approval.

## References

1. Singer, S. Fred, and Avery, Dennis T., *Unstoppable Global Warming – Every 1500 Years*, Rowland & Littlefield Publishers, Inc., 2008, pp. 61-68
2. Ma, L. H., Thousand-Year Cycle Signals in Solar Activity, *Solar Phys*, 245, 2007, pp.411-414.
3. Bond, Gerard, et. al., *A Persuasive Millennial-Scale Cycle in North Atlantic Holocene and Glacial Climates*, *Science*, Vol 278, November 14, 1997,1257-1266.
4. Time Magazine, Another Ice Age? April 14, 1974, pp. 86.
5. UNIPCC <https://unfccc.int/topics/science/workstreams/cooperation-with-the-ipcc/the-fifth-assessment-report-of-of-the-ipcc>, 2014
6. HadCRUT4 [https://www.metoffice.gov.uk/hadobs/hadcrut4/data/current/time\\_series/HadCRUT.4.6.0.0.annual\\_ns\\_avg.txt](https://www.metoffice.gov.uk/hadobs/hadcrut4/data/current/time_series/HadCRUT.4.6.0.0.annual_ns_avg.txt)
7. HadCRUT5 <https://www.metoffice.gov.uk/hadobs/hadcrut5/data/current/download.html>
8. Los Angeles *Times*, *Detailed look at the global warming 'hiatus' again confirms that humans are changing the climate*, May 3, 2017
9. Singer, S. Fred, and Avery, Dennis T., *Unstoppable Global Warming – Every 1500 Years*, Rowland & Littlefield Publishers, Inc., 2008, pp. 39-59

10. Lorius, C. et. al., A 150,000 Year Climate History from Ice Cores, *Nature* 316 1985, pp. 591-596.
11. Singer, S. Fred, and Avery, Dennis T., *Unstoppable Global Warming – Every 1500 Years*, Rowland & Littlefield Publishers, Inc., 2008, pp. 29-38
12. 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.
13. Sunspots, <https://ngdc.noaa.gov/stp/solar/ssndata.html>
14. USGS, The Sun and Climate, fs-0095-00.pdf (usgs.gov)
15. NASA What will solar cycle 25 look like? <http://www.nasa.gov/sun>
16. NOAA AMO SVS: Historical Atlantic Multidecadal Oscillation (AMO) (nasa.gov)
17. NOAA PDO <https://psl.noaa.gov/data/correlation/amon.us.long.data>
18. Lamb, H. H., *Climate, History and the Modern World*, Psychology Press, 1995, 187-189
19. 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.
20. Dyson, Freeman, *A Meeting with Enrico Fermi*, *Nature* 427, 297 (2004)

## Statements And Declarations

**Author** – Dale Nierode

**Funding** – Not applicable

**Conflicts of interest/Competing interests** – Not applicable

**Availability of data and material** – Excel 365 nonlinear 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

## Tables

Table 1 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

Table 2 Single Sine Cyclical Model Parameters 1850-2013

<b>Period, years</b>	1036
<b>Amplitude, deg C.</b>	0.830
<b>Phase, radians</b>	176.5
<b>Data point weights</b>	1
<b>Next Max Temperature</b>	14.83° C. in 2220

Table 3 Dual Sine Cyclical Model Parameters 1850-2013

<b>Two Sine Model</b>	<b>Sine 1</b>	<b>Sine 2</b>
<b>Period, years</b>	1,100	68.4
<b>Amplitude, deg C.</b>	.875	.143
<b>Phase, radians</b>	102.	93.6
<b>Data point weights</b>	1	
<b>Next Max Temperature</b>	14.93° C. in 2210	

Table 4 Dual Sine Cyclical Model Parameters 1850-2020 Equal weights

<b>Two Sine Model</b>	<b>Sine 1</b>	<b>Sine 2</b>
<b>Period, years</b>	1050	71.7
<b>Amplitude, deg C.</b>	.970	.162
<b>Phase, radians</b>	101.4	101.7
<b>Data point weights</b>	1	
<b>Next Max Temperature</b>	15.03° C. in 2225	

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

<b>Two Sine Model</b>	<b>Sine 1</b>	<b>Sine 2</b>
<b>Period, years</b>	1,071	72.7
<b>Amplitude, deg C.</b>	1.264	.233
<b>Phase, radians</b>	1017	103.9
<b>1850-2013 weights</b>	1	
<b>2014-2020 weights</b>	5	
<b>Next Max Temperature</b>	15.39° C. in 2232	

Table 6 Predicted Earth Temperature Downdips and Sunspot Activity

<b>Start Date</b>	<b>End Date</b>	<b>Interval, years</b>	<b>Type</b>	<b>Sunspot Activity</b>
1875	1903	28	Downdip 1	Minima*
1947	1976	29	Downdip 2	Minima*
2019	2049	30	Downdip 3	Minima
2091	2122	31	Downdip 4	Minima
2166	2195	35	Downdip 5	Minima

\* As observed

Table 7 Predicted Temperature Upswings and Sunspot Activity

Start Date	End Date	Interval, years	Type	Sunspot Activity
1903	1947	44	Upswing 1	Maxima*
1976	2019	43	Upswing 2	Maxima*
2049	2091	42	Upswing 3	Maxima
2122	2160	38	Upswing 4	Maxima
2195	2232	37	Upswing 5	Maxima

\* As observed

## Figures

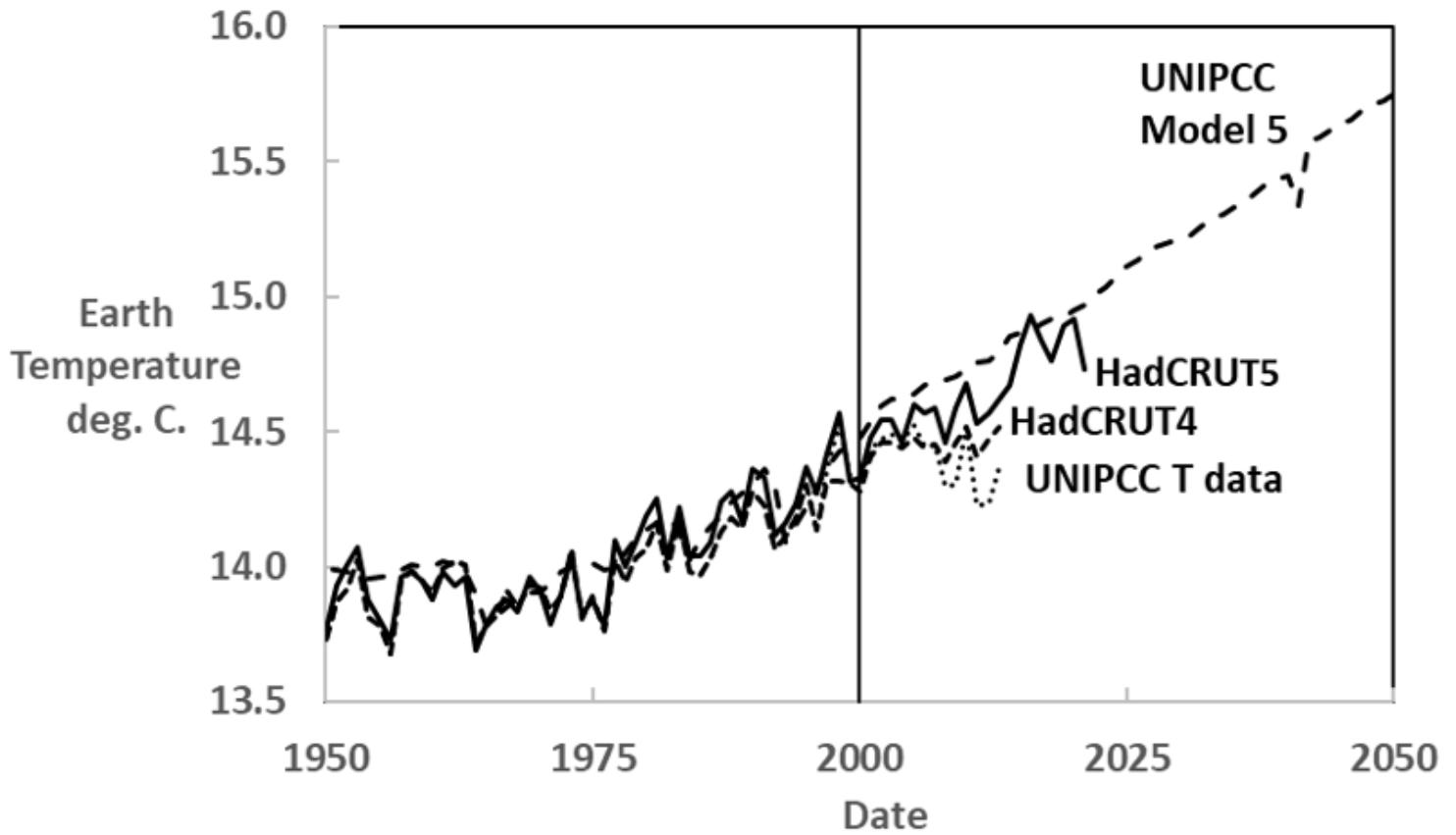


Figure 1

Reported Average Annual Earth Temperatures Since 1850

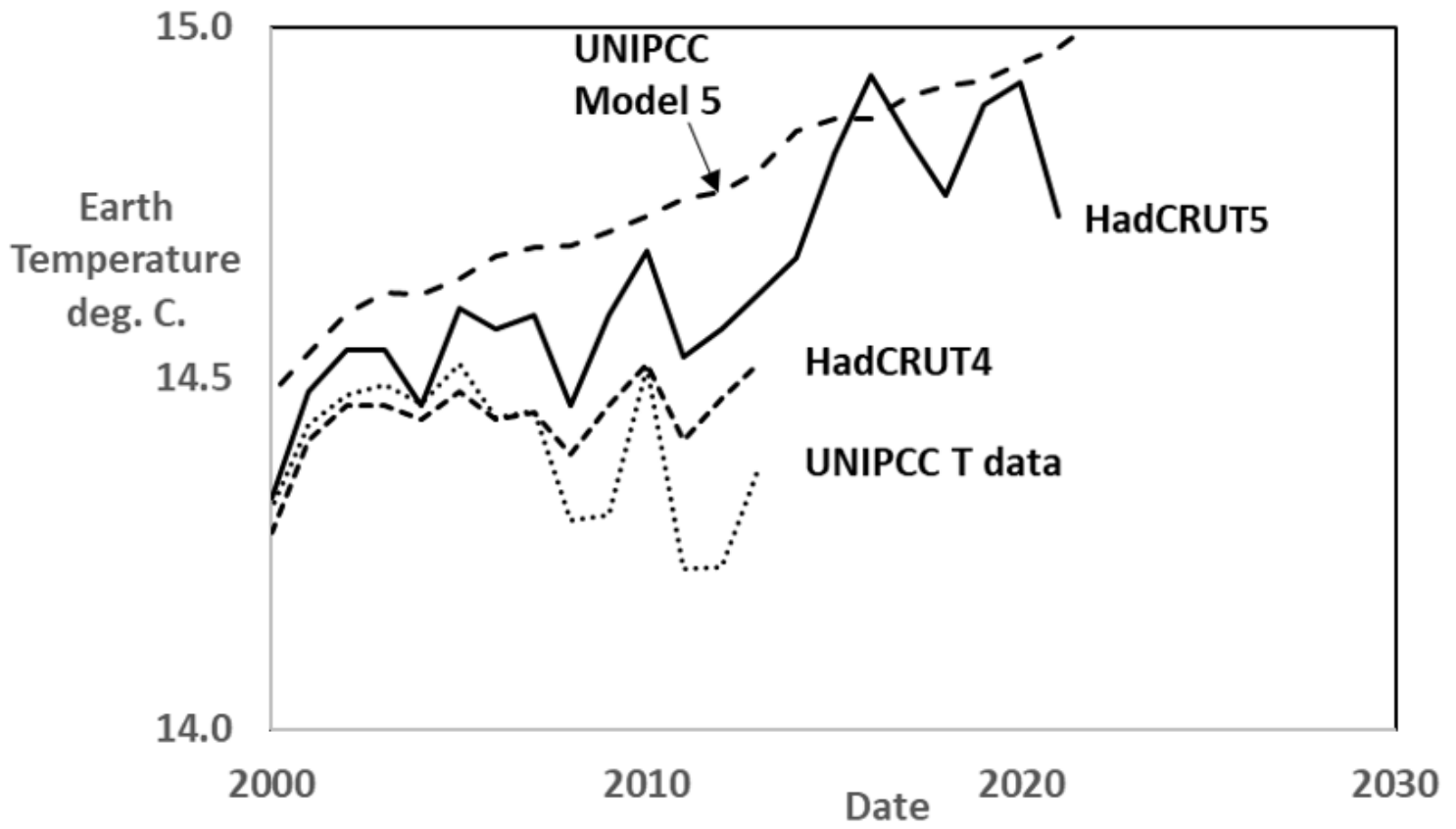


Figure 2

Reported Average Annual Earth Temperature Deviations Since 2020

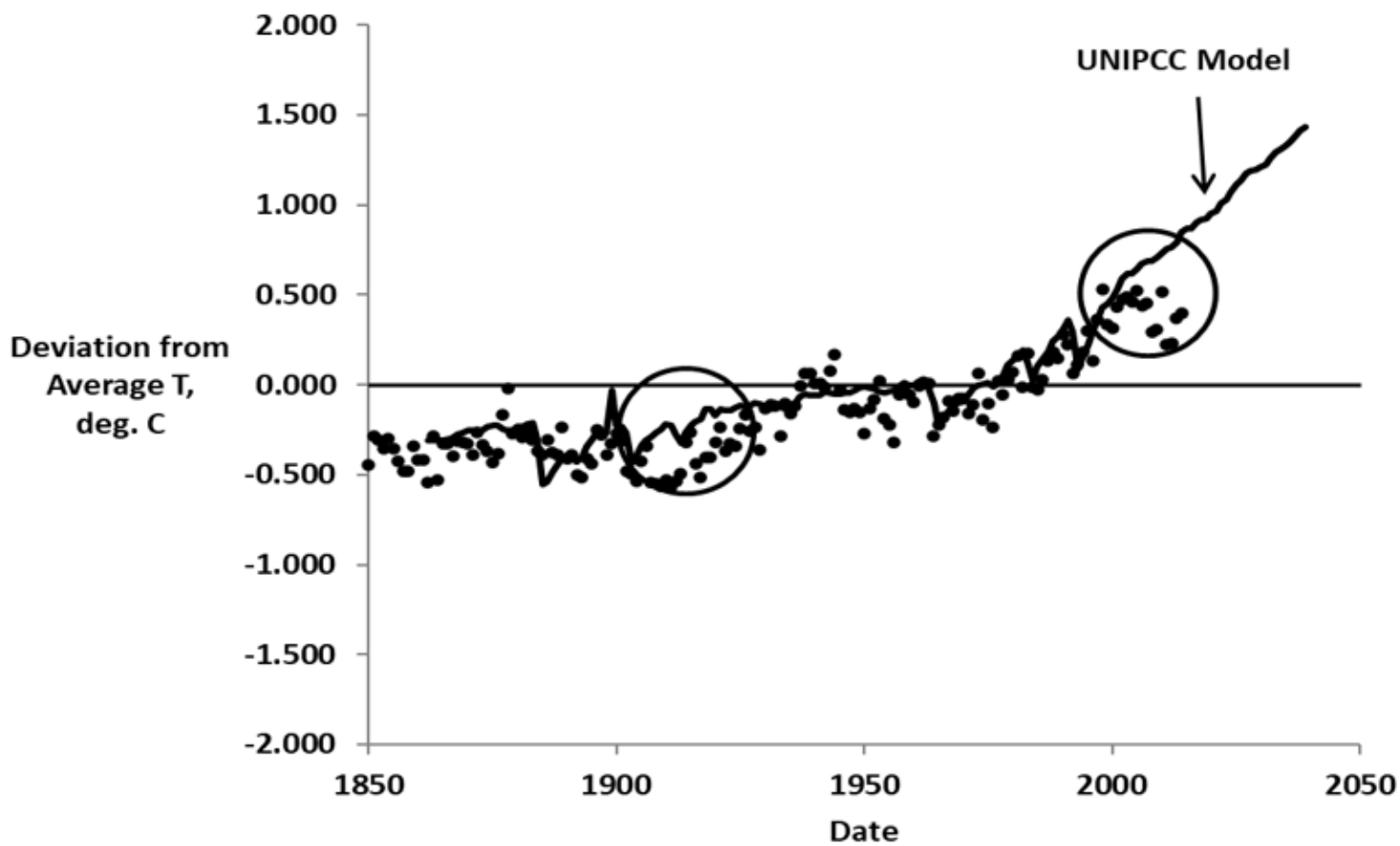


Figure 3

UNIPCC Model 5 Results



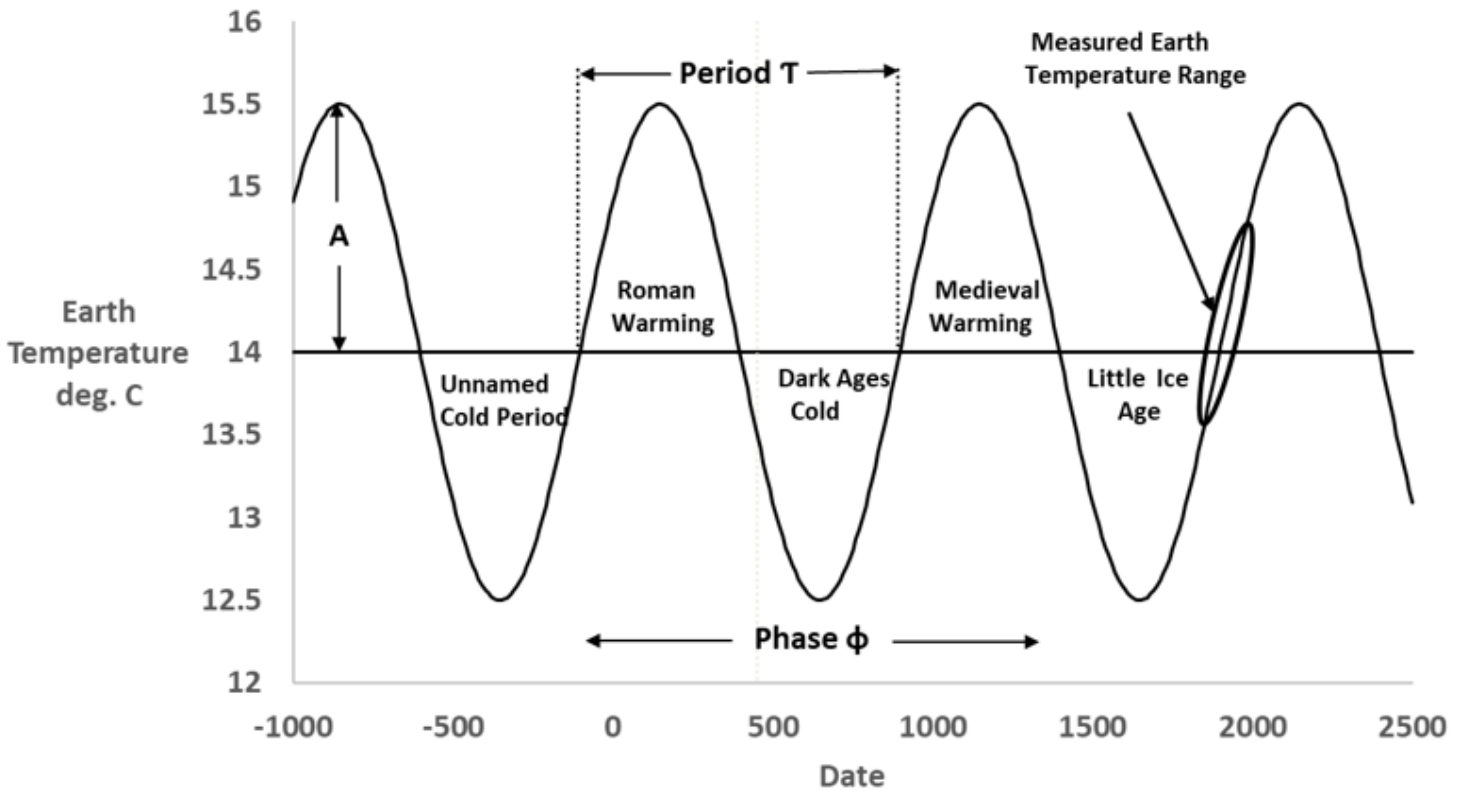


Figure 4

Possible Sinusoidal Earth Temperature Model

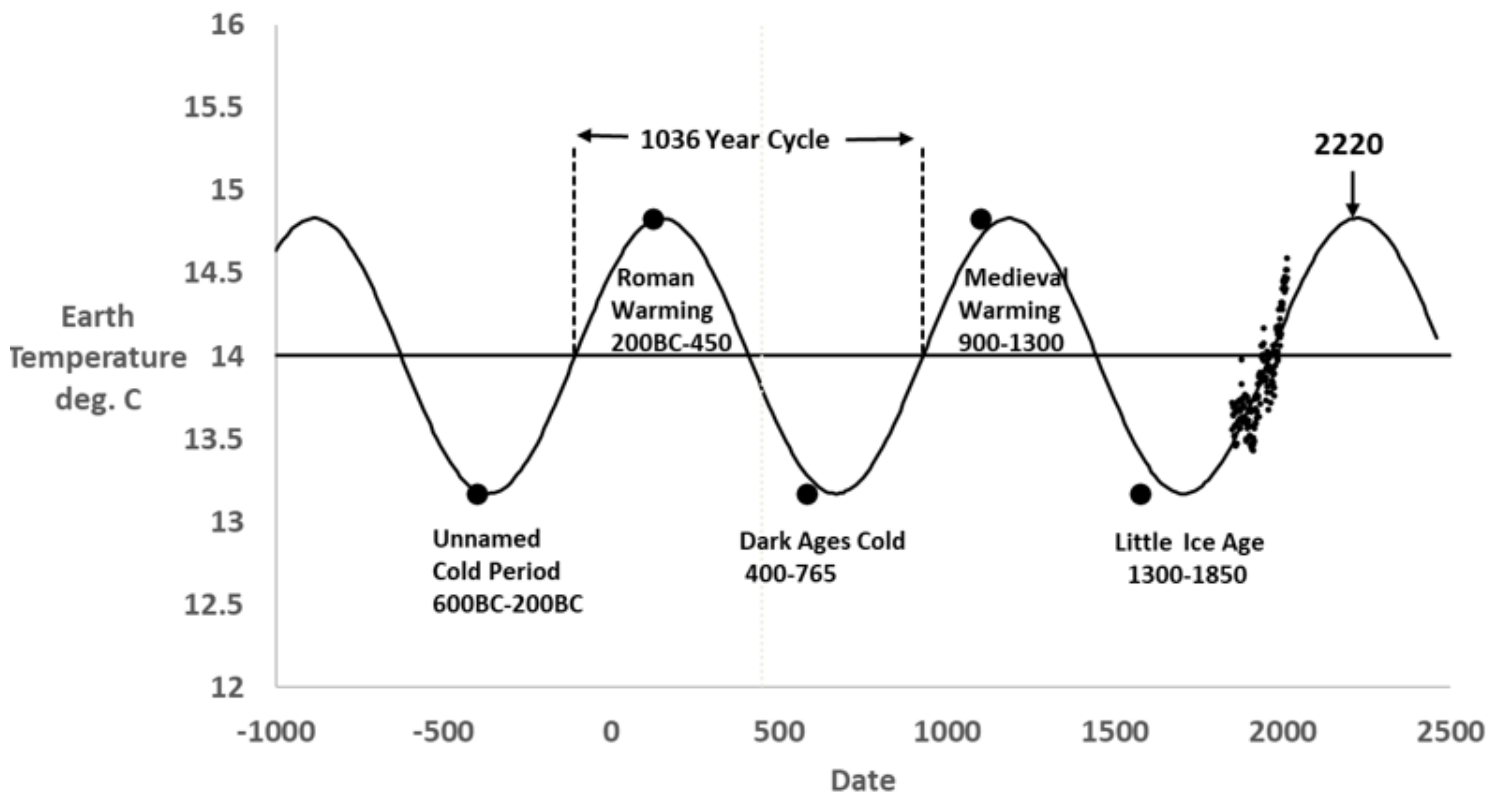


Figure 5

Single Sine Fit to Earth temperature data (UNIPCC, 2014) to 2013

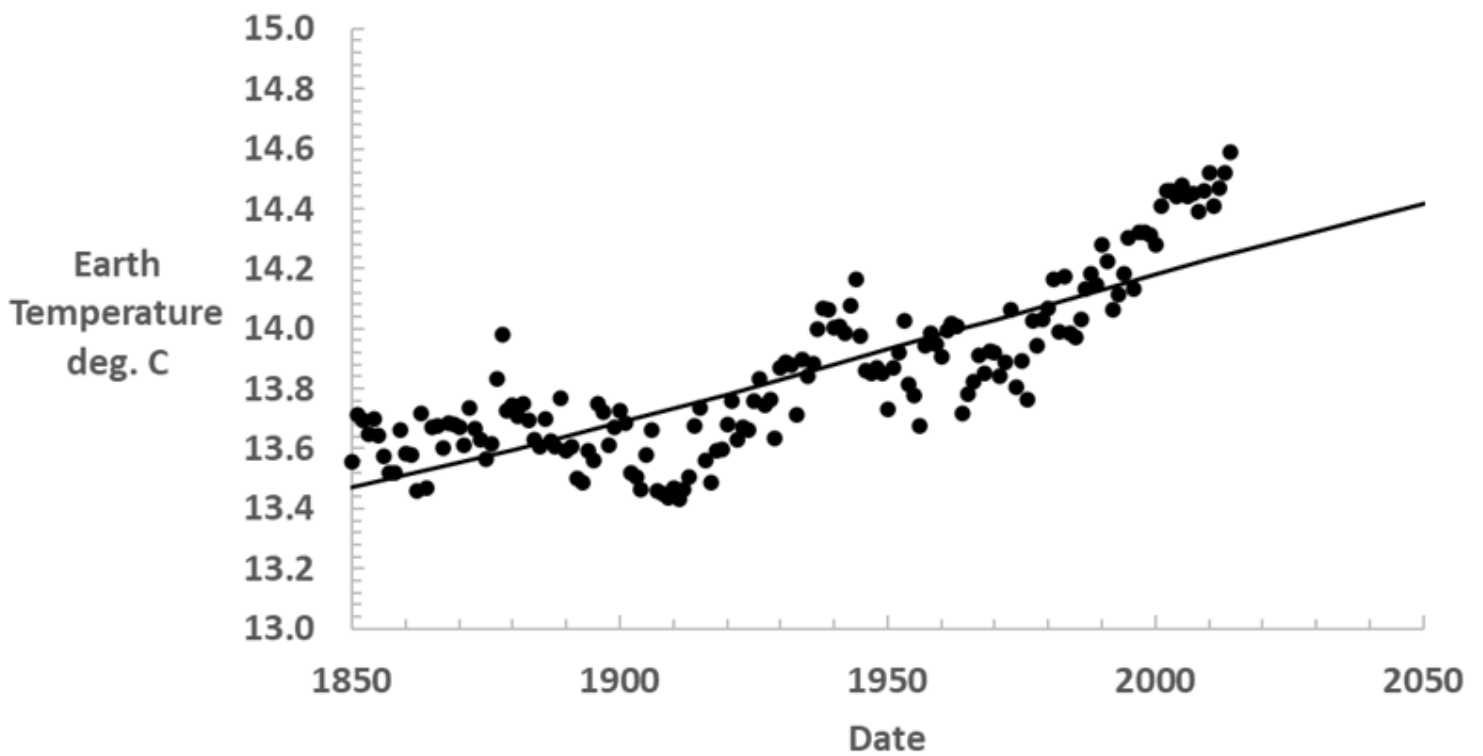


Figure 6

Deviation of Single Sine Fit to Earth temperature data (UNIPCC, 2014) values to 2013

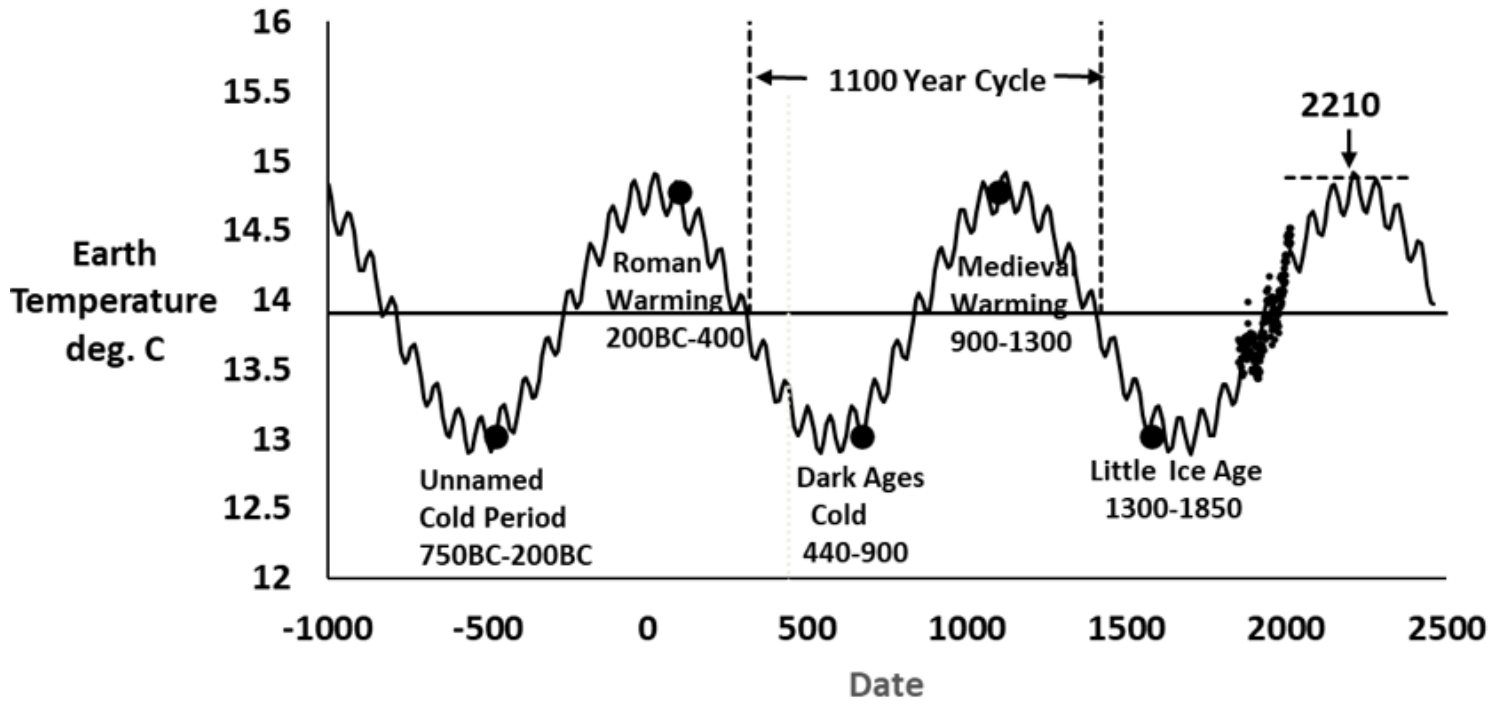


Figure 7

Dual Sine Fit to Earth temperature data (UNIPCC, 2014) values to 2013

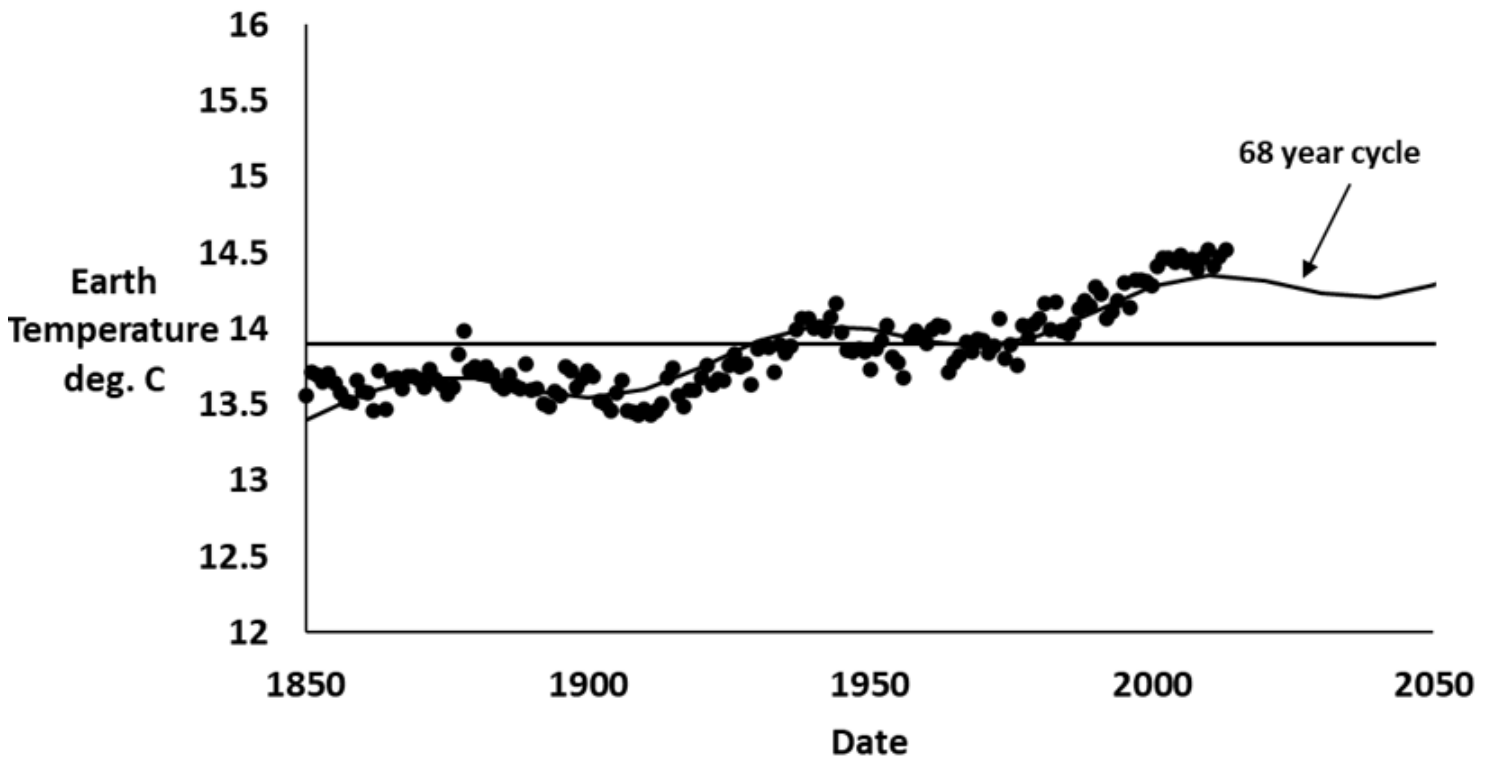


Figure 8

Deviation of Dual Sine Fit to Earth temperature data (UNIPCC, 2014) values to 2013

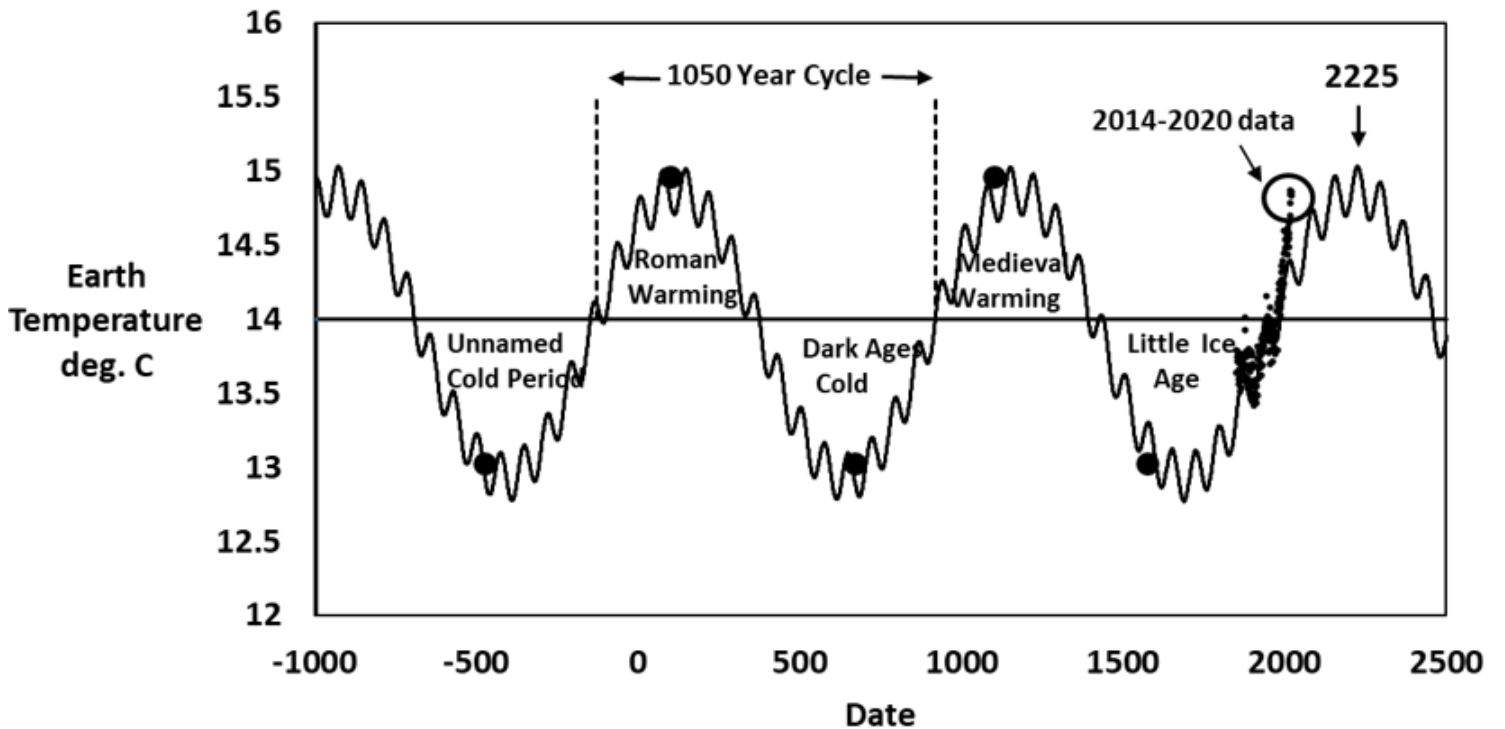


Figure 9

Dual Sine Cyclical Model Fit to Data and Past Epochs- Data (HadCRUT5) through 2020

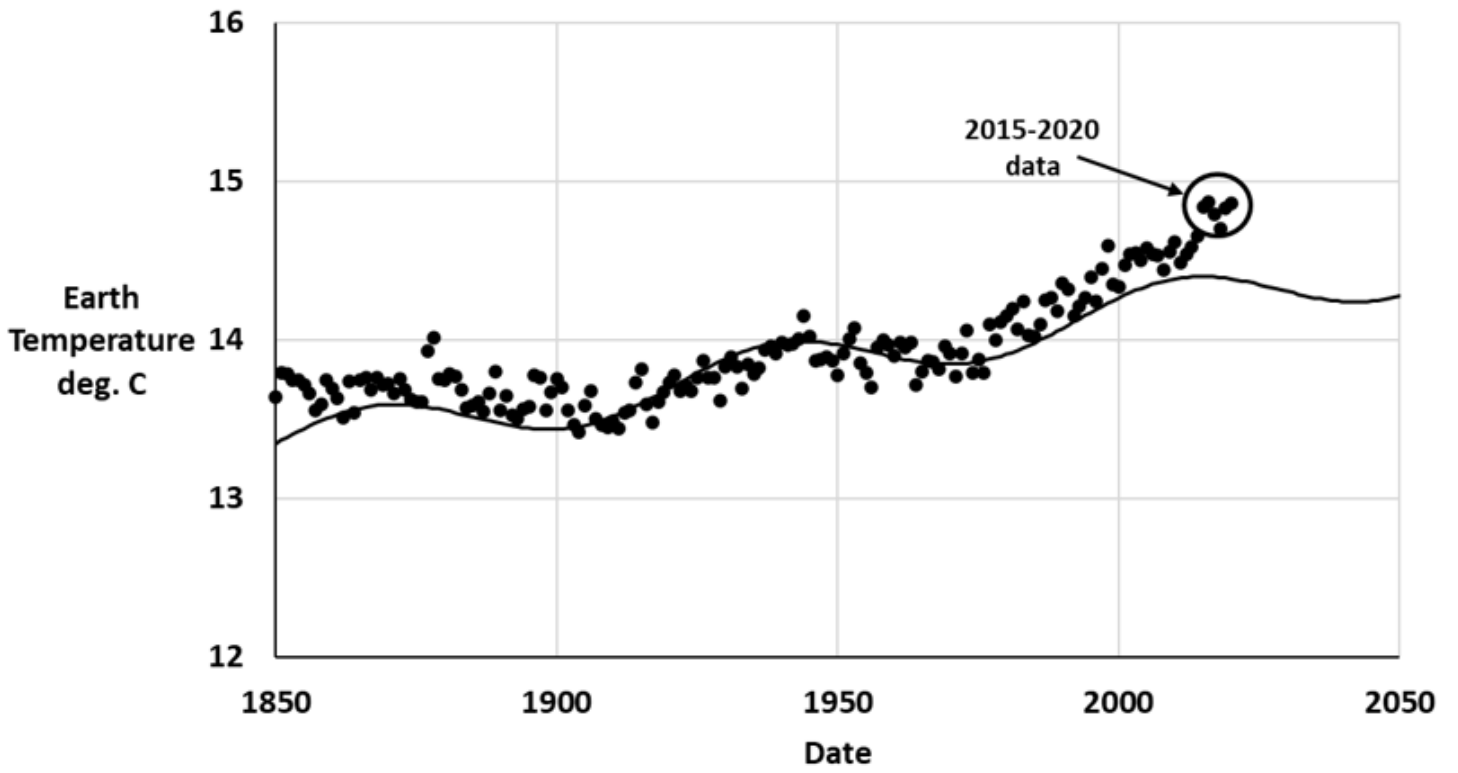


Figure 10

Deviation of Dual Sine Fit to Earth temperature data (HadCRUT5) values to 2020

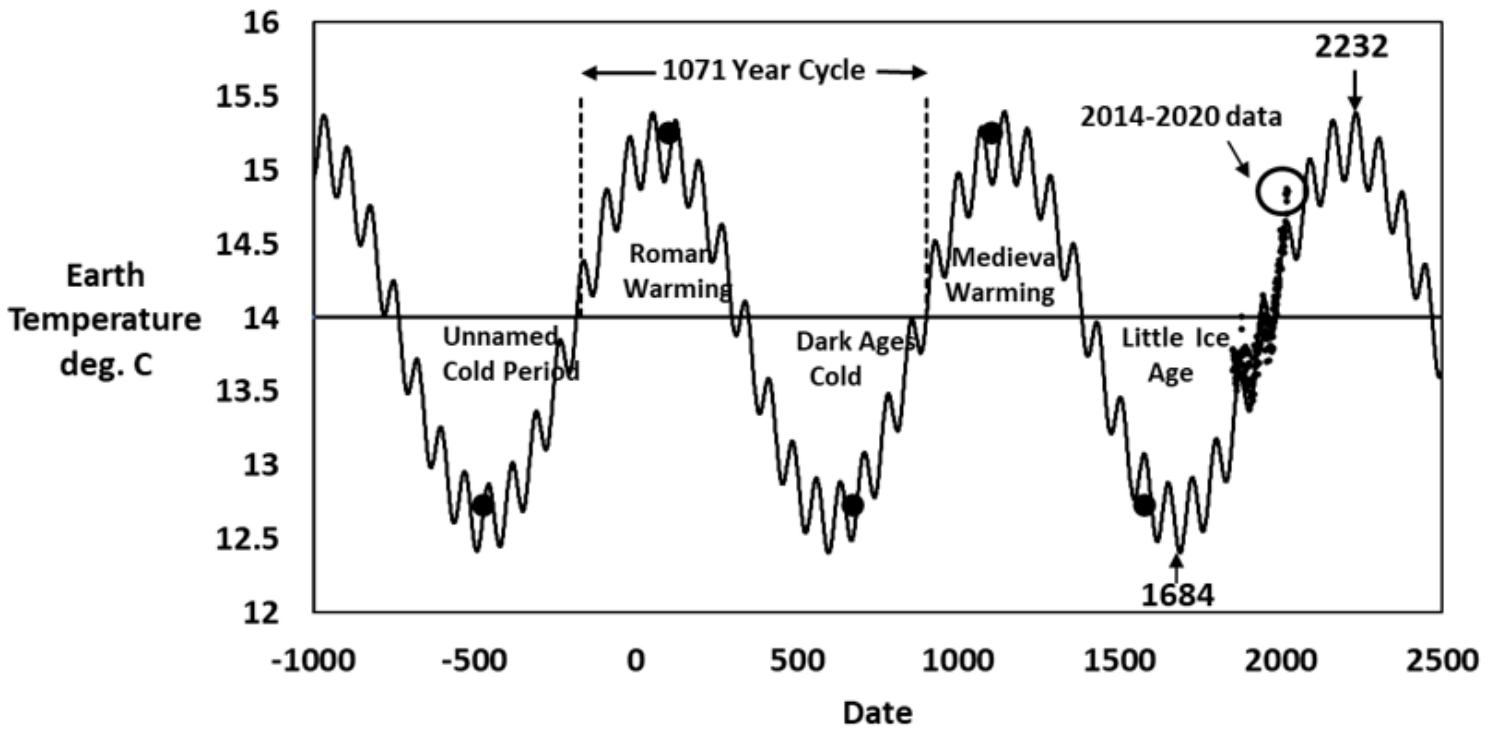


Figure 11

Dual Sine Cyclical Model Fit to Data and Past Epochs- Data (HadCRUT5) 2014-2020 Wt.=5

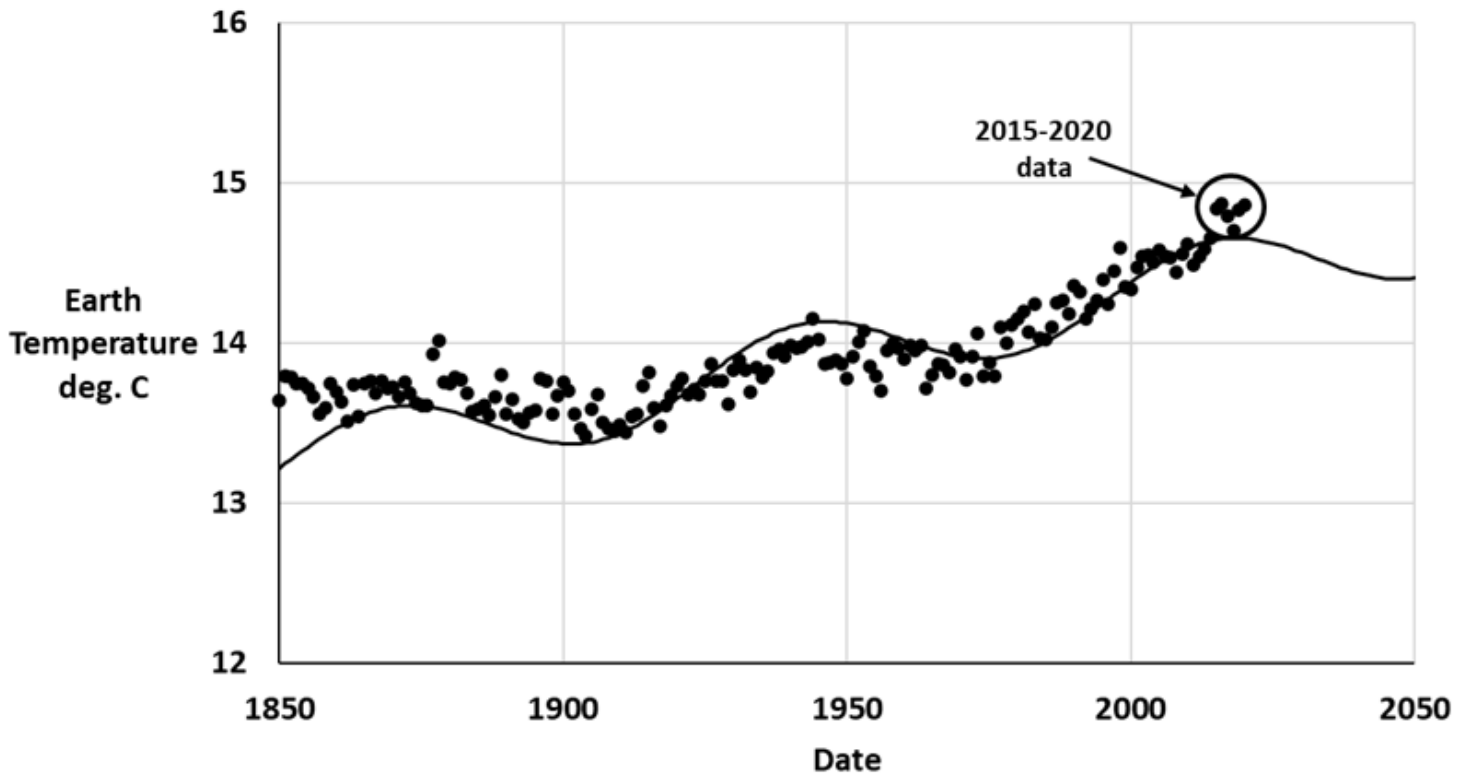


Figure 12

Deviation of Dual Sine Fit to Earth temperature data (HadCRUT5) 2014-2020 Wt.=5

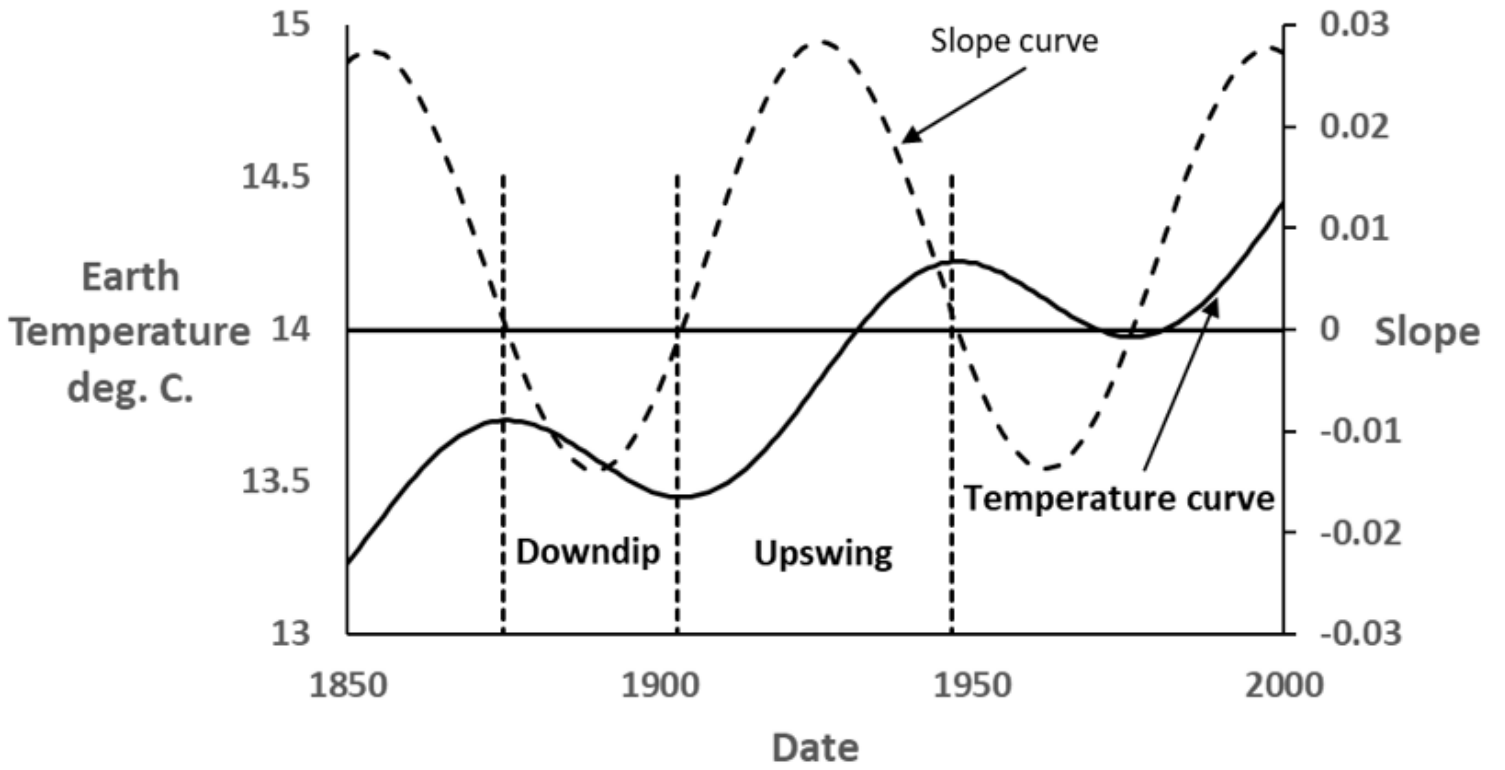


Figure 13

Sequential Zero Slope Points Define a Downdip and Upswing

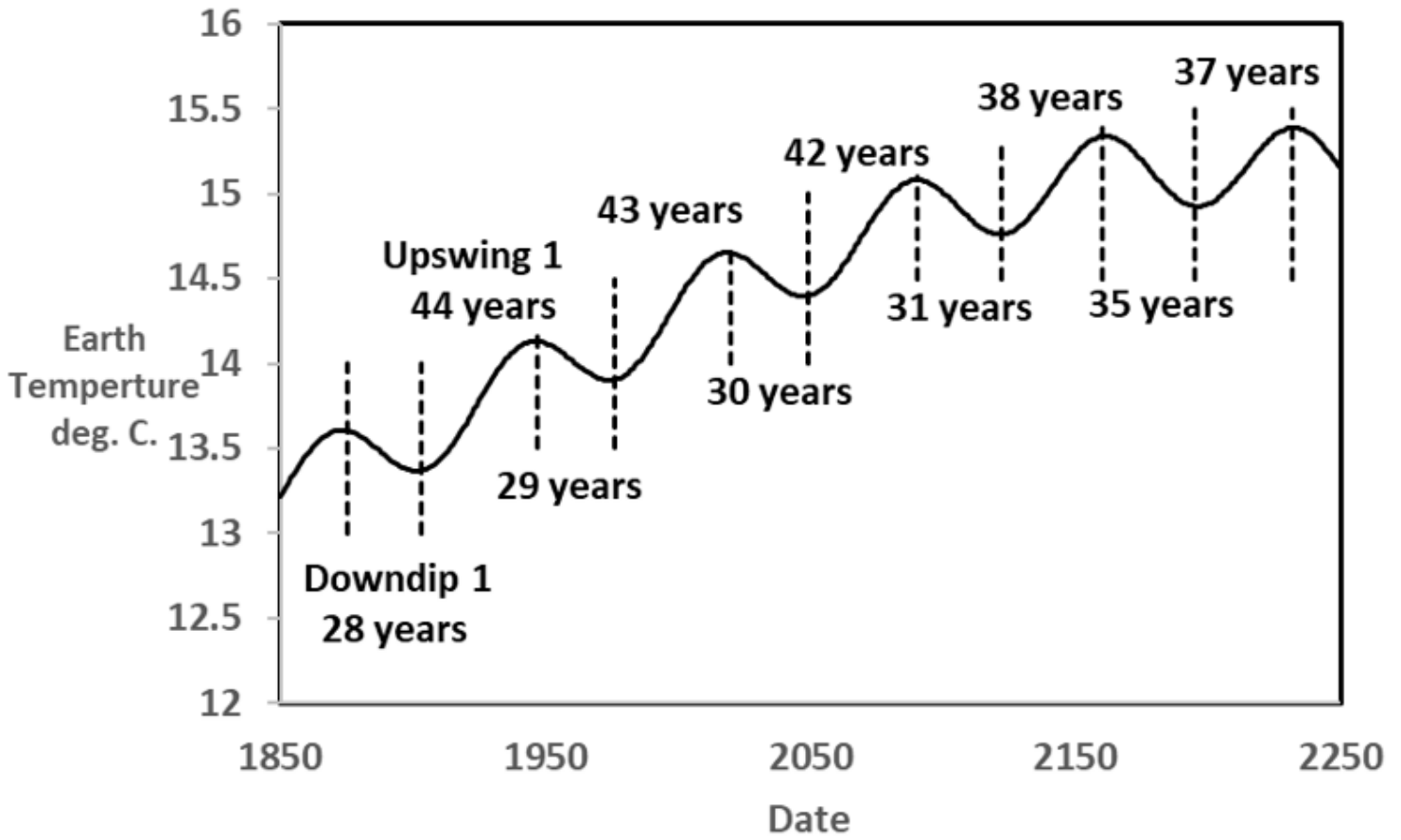


Figure 14

Predicted Temperature Downdips and Upswings Since 1850



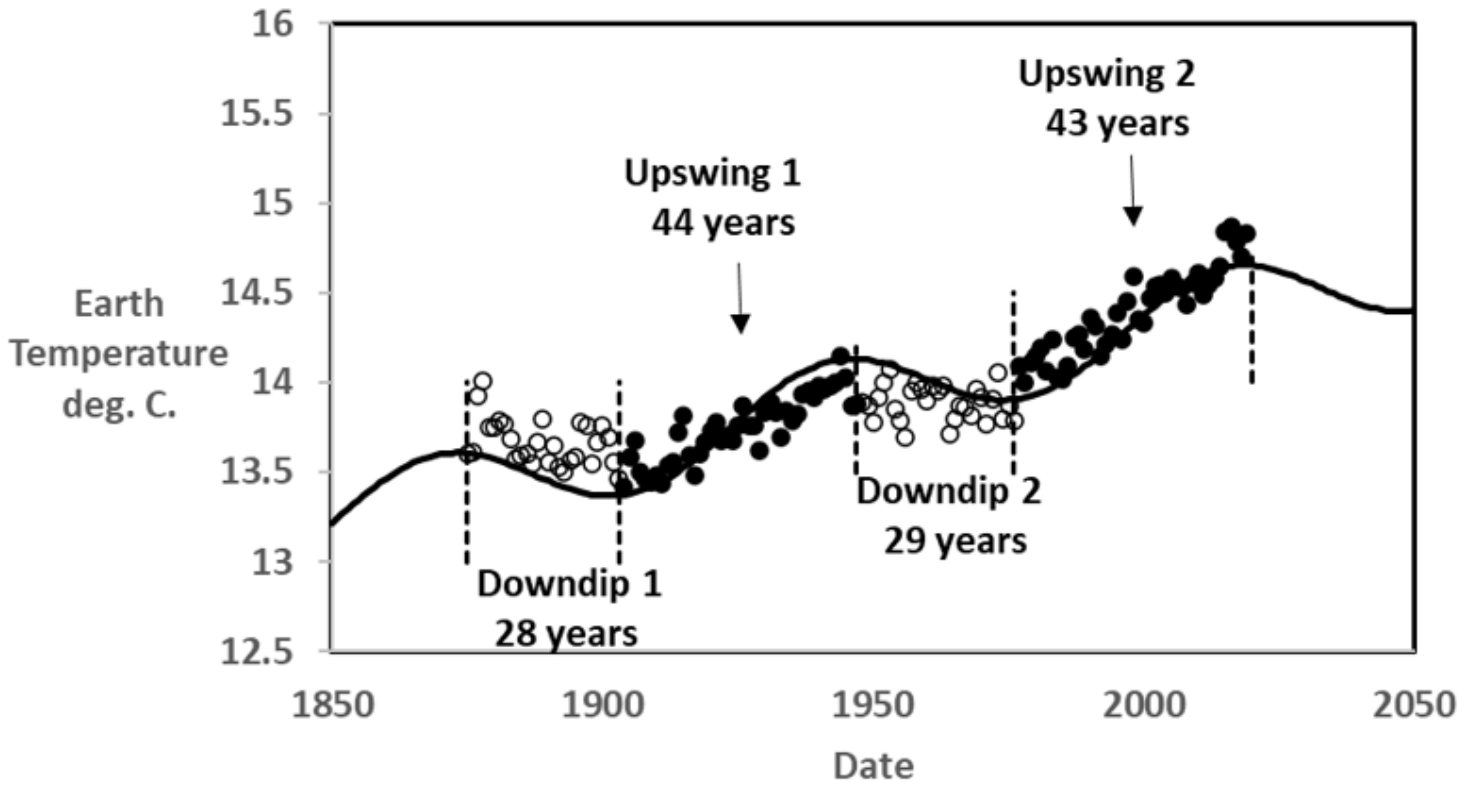


Figure 15

Observed Temperature Downdips and Upswings Since 1850

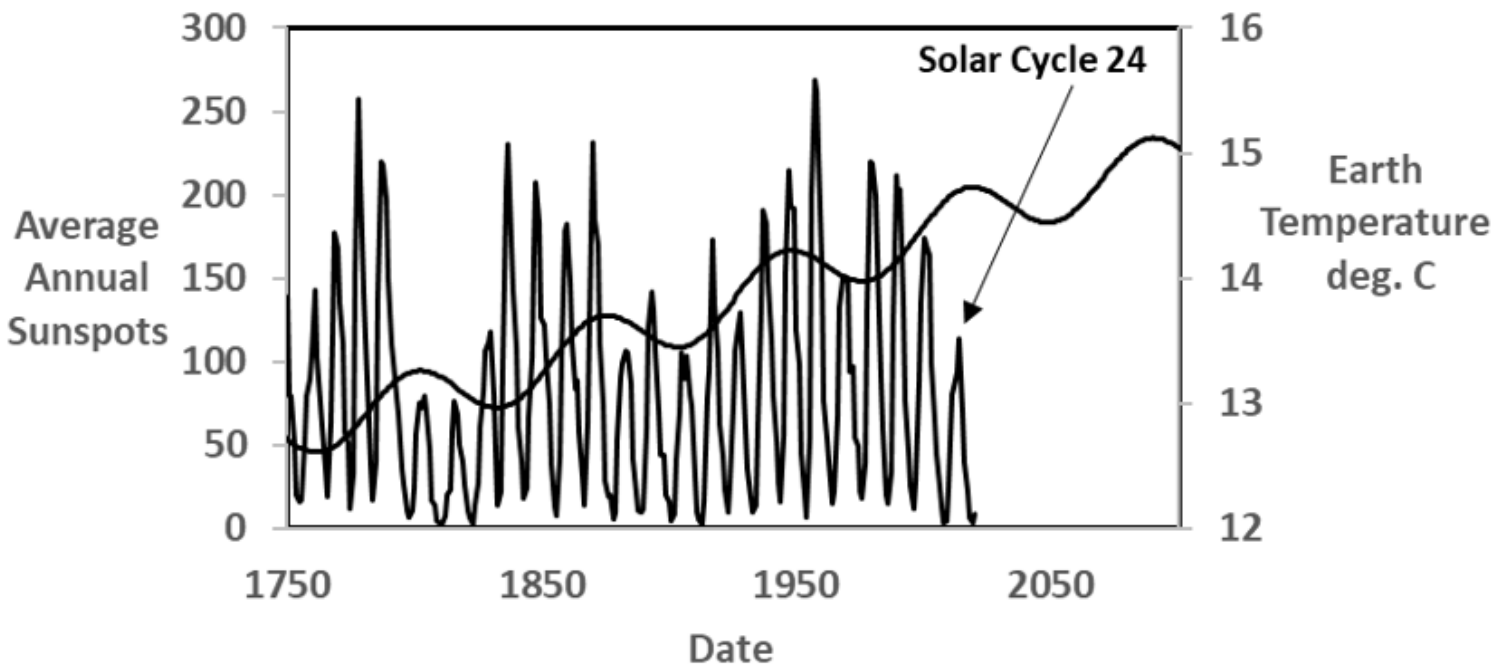


Figure 16

Comparison of Sunspot Data to the Final Dual Sine Cyclical Model (1850-2020 data)

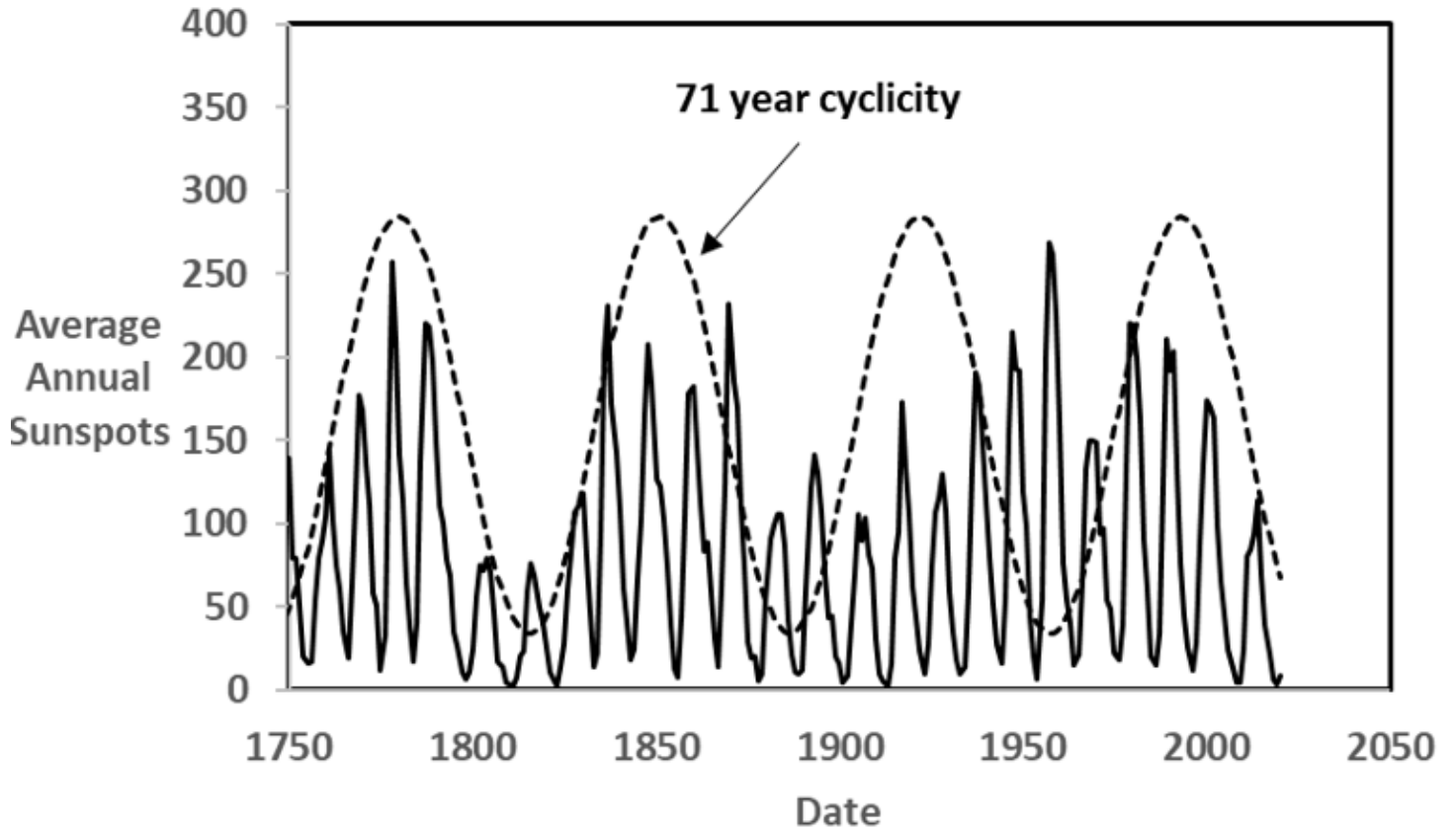


Figure 17

Regression Fit of the 24 Solar Cycle Tops

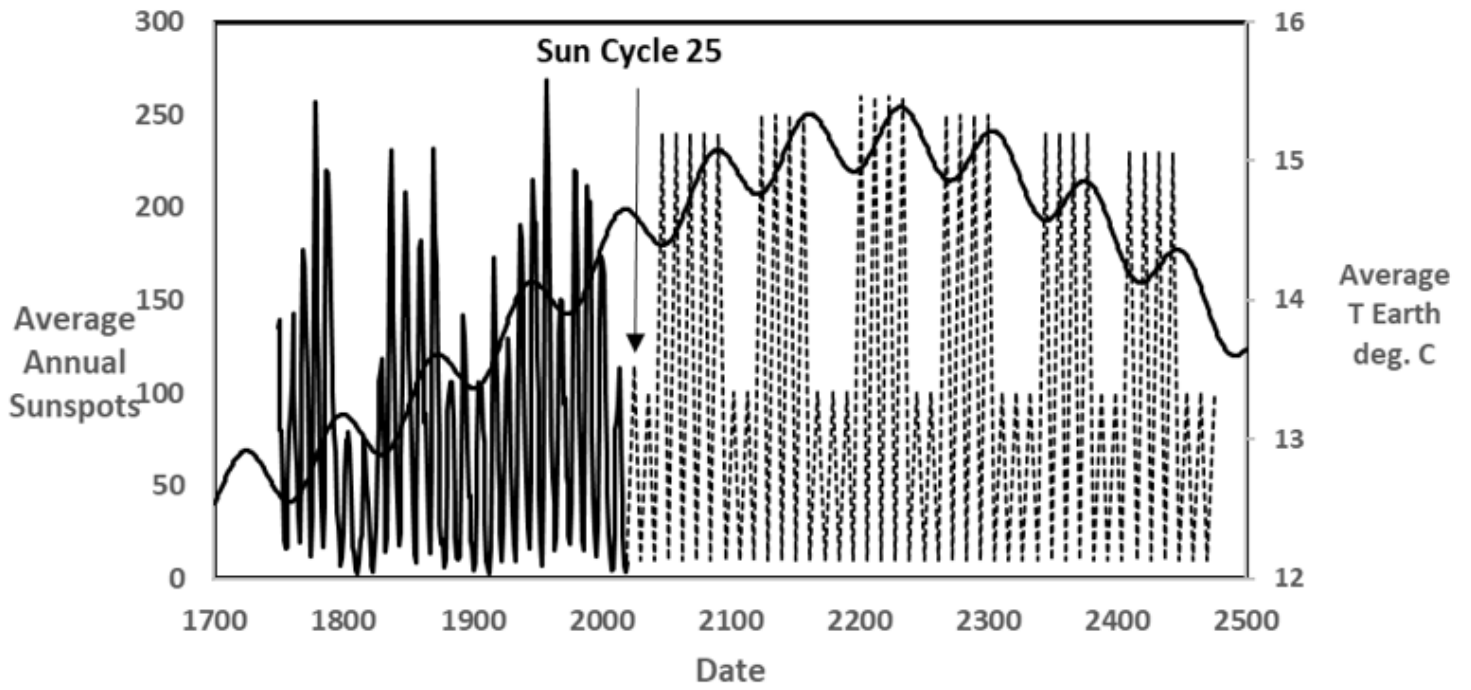


Figure 18

Comparison of Sunspot Data to the Final Dual Sine Cyclical Model (1850-2020 data)

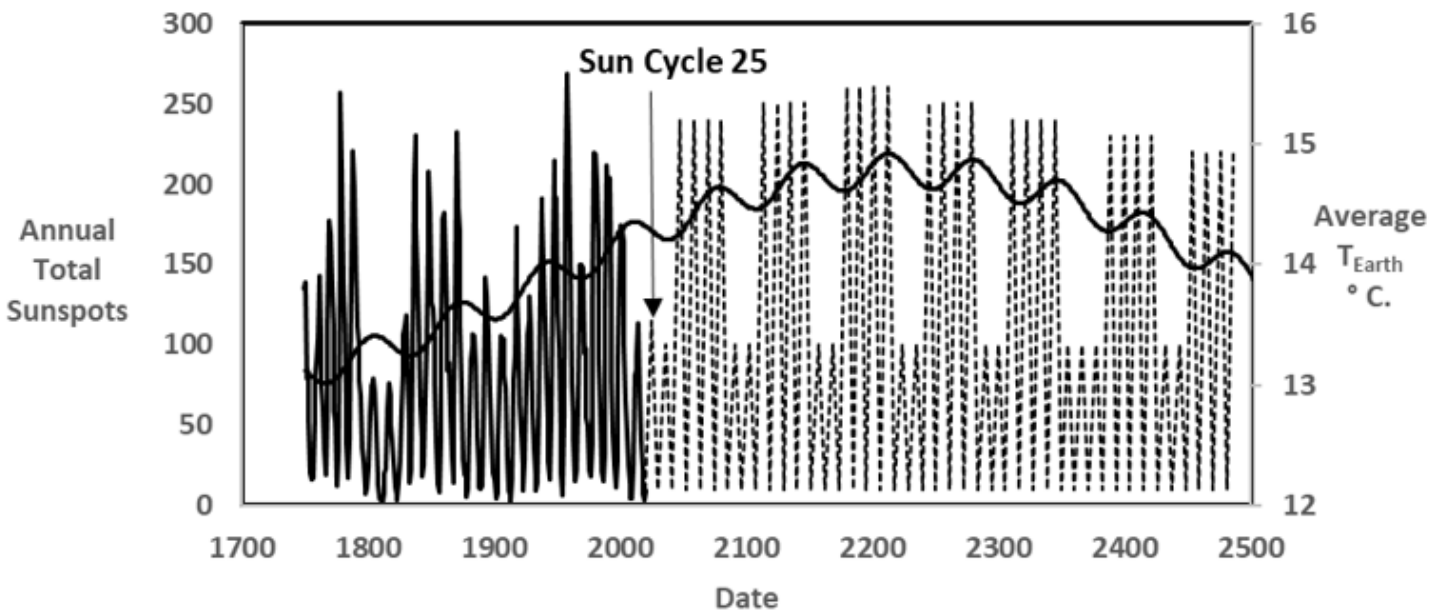


Figure 19

Comparison of Sunspot Data to the Dual Sine Cyclical Model (1850-2013 data)

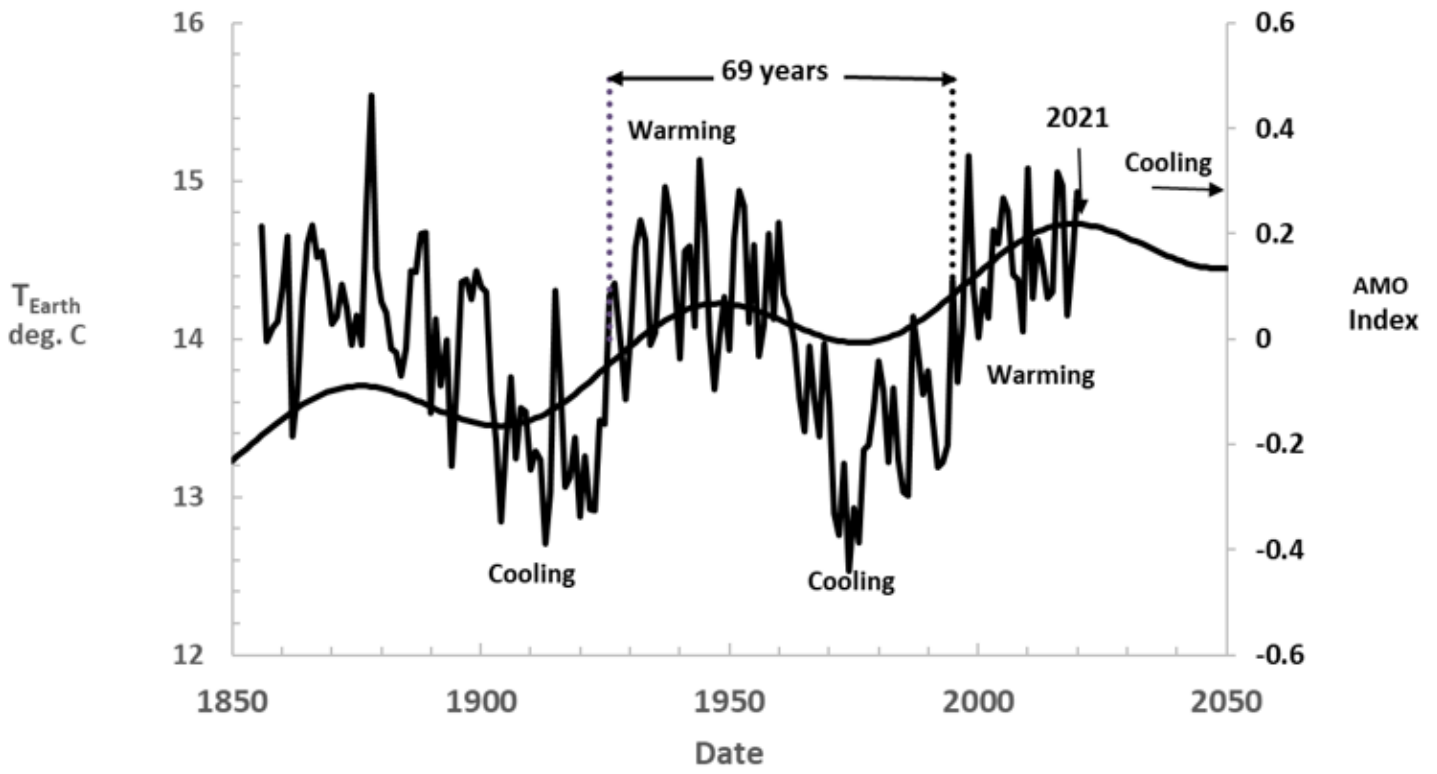


Figure 20

Dual Sine Cyclical Temperature Variations Compared to AMO

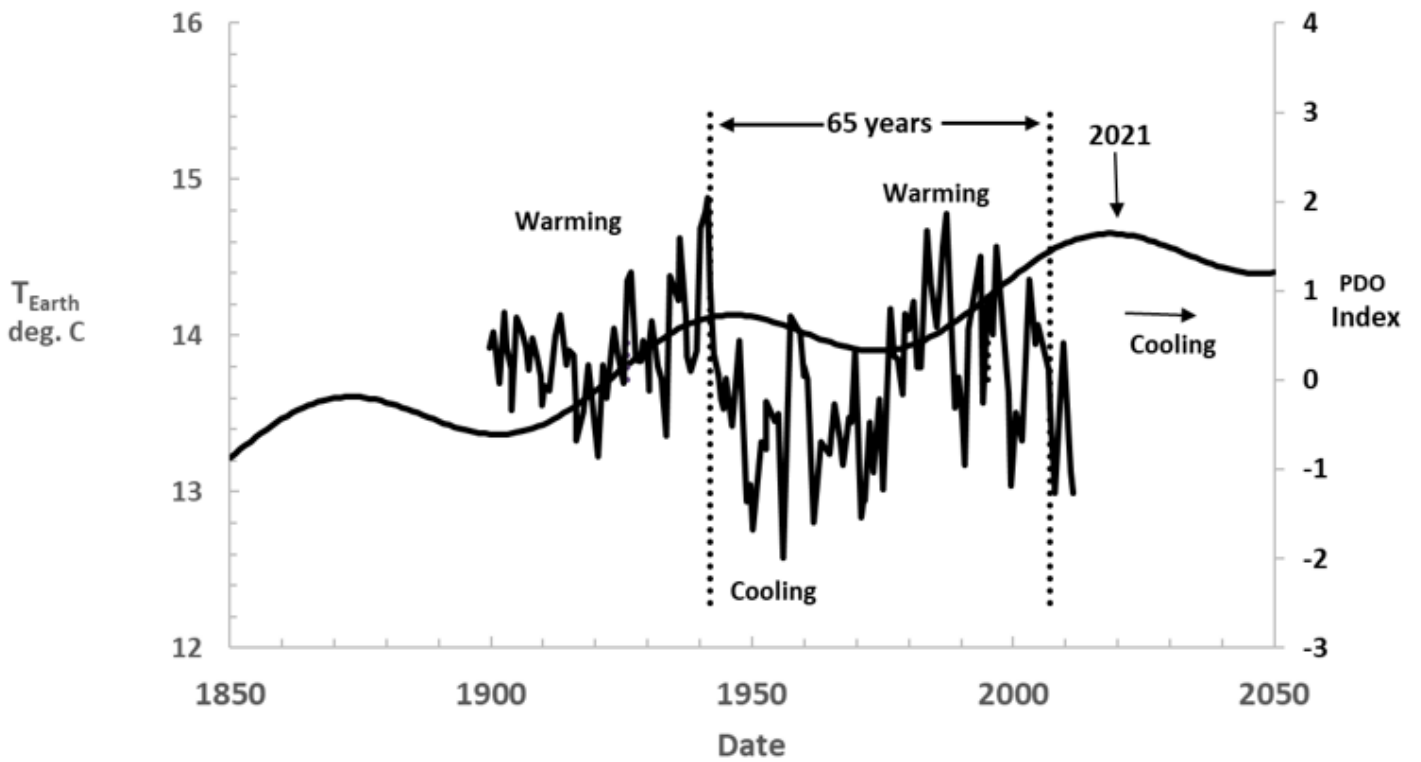


Figure 21

Dual Sine Cyclical Temperature Variations Compared to PDO

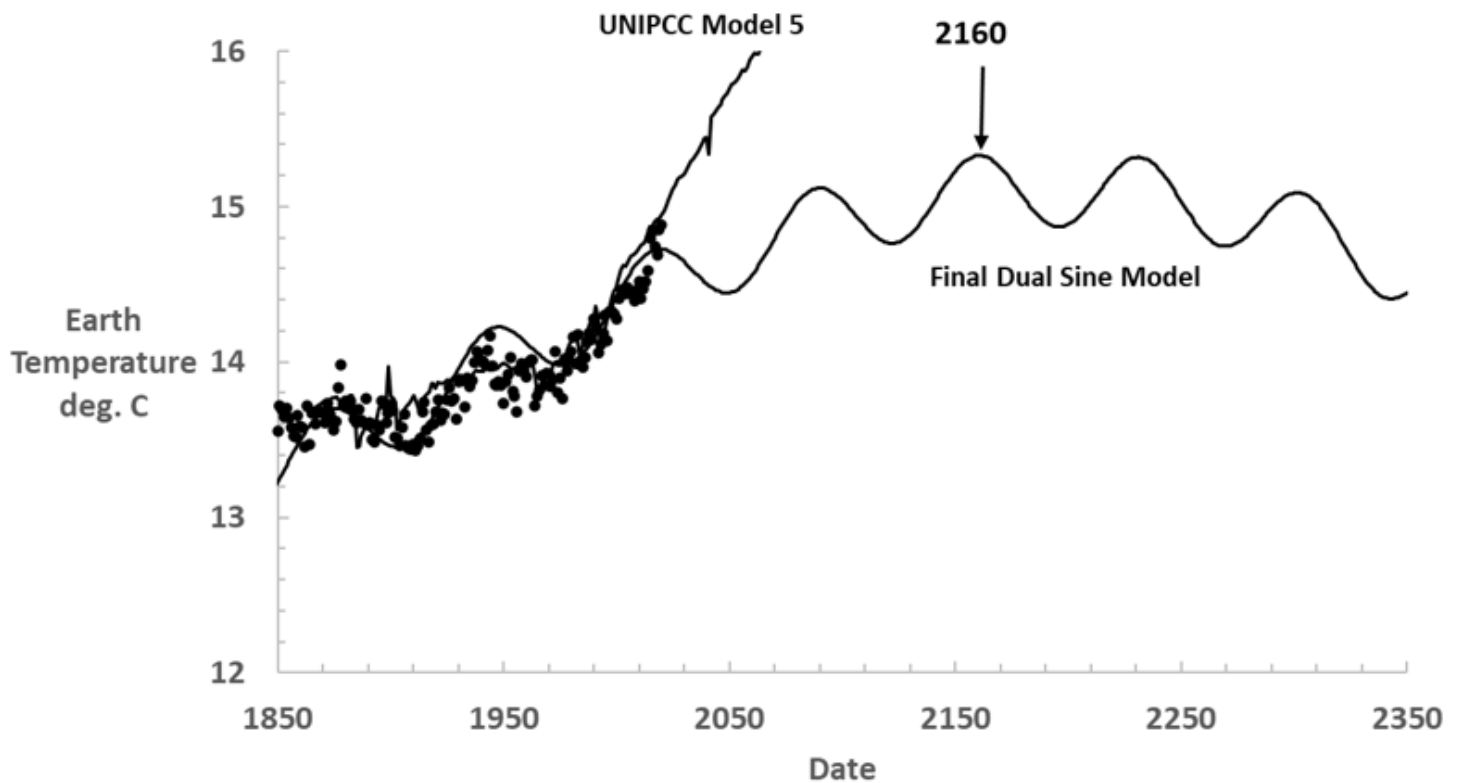


Figure 22

Log-term Predictions of Future Temperatures Dual Sine vs. UNIPCC Model 5

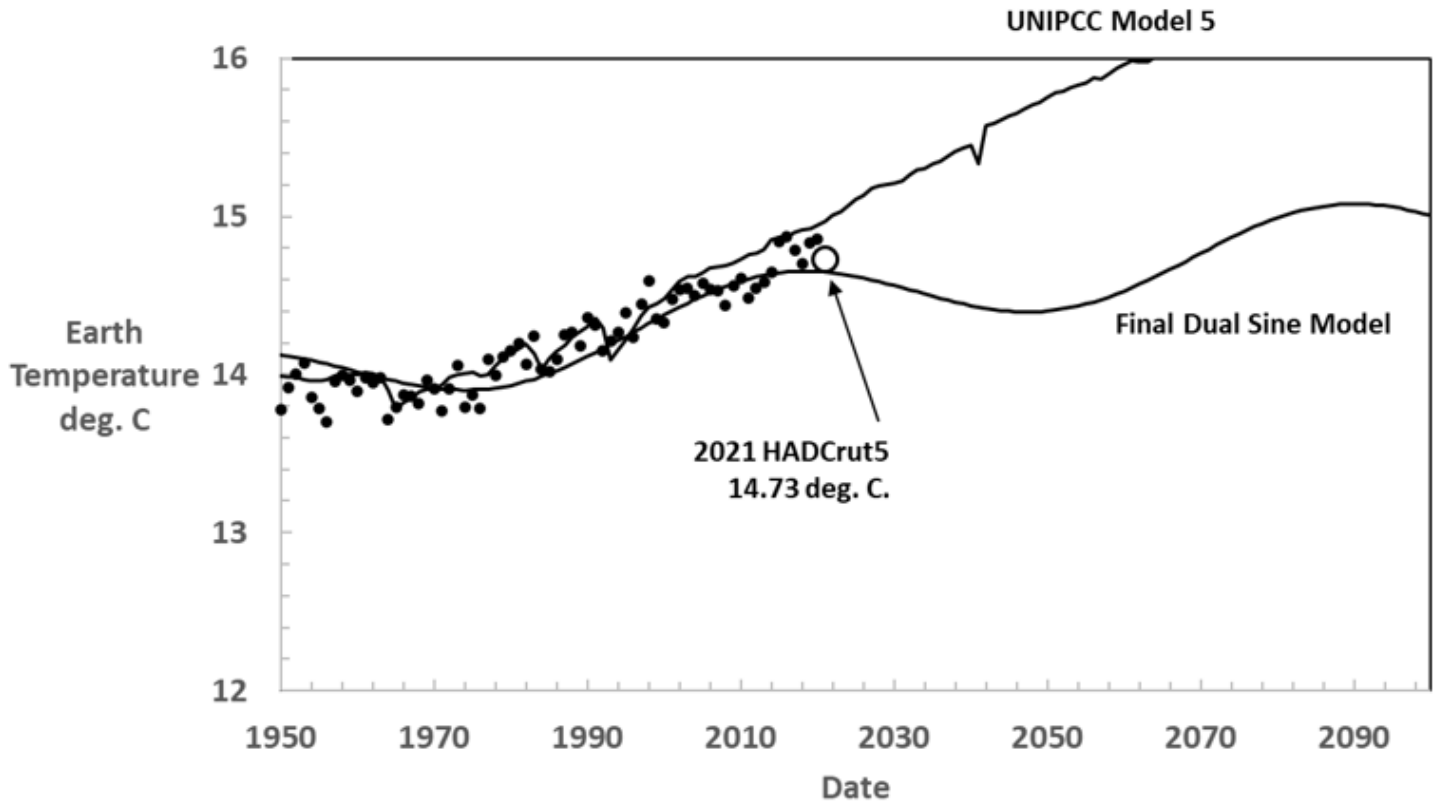


Figure 23

Near-term Predictions of Future Temperatures Dual Sine vs. UNIPCC Model 5