TEACHER PAGE - *Trial Version*

** After completion of the lesson, please take a moment to fill out the feedback form on our web site (https://www.cresis.ku.edu/education/k-12/online-data-portal)**

Lesson Title: Data Series – A Look at Global Temperature Anomalies
Grade: 7-12

Question: How has global temperature changed over time? How does the type or amount of data affect the outcome or trends experienced by a member of the public?

Time:
Two 45 minute class periods plus additional time for instruction on Excel if necessary. Lesson can be structured to 20-30 minute segments or as stand-alone activities.

Scope of the Lesson:
Given sets of data the student will show that various viewpoints can be supported depending on how data is presented and interpreted. These may or may not be accurate or relevant representations of data results over time.

This lesson contains basic graphing components, interpretation of information and communication to others of findings depicted on their graph. You may choose to use either the total lesson or bits and pieces depending on student abilities and time constraints. The lesson is also designed so that it can be expanded for advanced students and used as an enrichment activity or a remedial activity.

Use of Microsoft Excel or another computerized graphing program will speed the activity and allow for more than one set of data to be examined. Graph paper and calculator can also be used by the students to get the same results.

If groups are given different data sets, the graphs can be printed or displayed so that the entire class or several groups can merge their information to come up with findings.

Objectives:
Given a set of data students will be able to:

- Create, using Microsoft Excel or another graphing program, an appropriate graph.
- Determine the mean, median, mode and range of the data.
- Using the graph they construct, be able to answer questions related to the data.
- Interpret the information found on the graph, and present their findings either orally or in a written format.

Standards:

- National 9-12: A2, 3; B1; E1; F2; G4, 5, 6; H1, 2, 3

Vocabulary:

- anomaly: a deviation from the common rule, type, arrangement, mean, or form
- deviation: departure from a standard or norm
- global warming: an increase in the earth's average atmospheric temperature that causes corresponding changes in climate and that may result from the greenhouse effect

- climate change: any long-term significant change in the weather patterns of an area

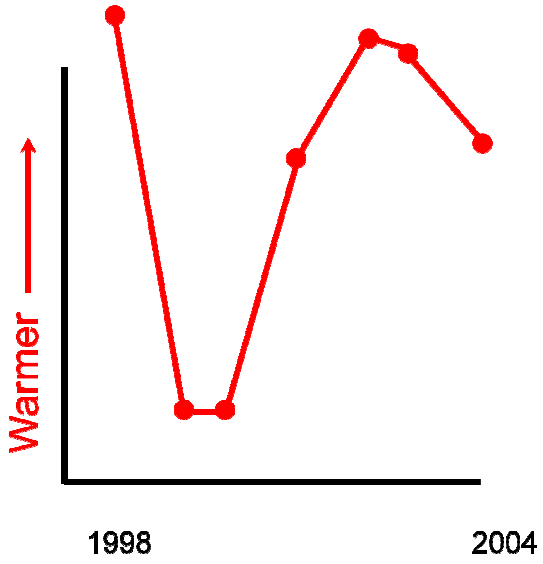
Background:
Temperature has great importance to all organisms. Each species has a maximum and minimum temperature beyond which survival is impossible. It is likely that humans have kept temperature "records" even in prehistoric times, communicating with regard to hot and cold seasons and years. Currently debate exists about the occurrence of climate change and its severity across the globe. The number of recording stations from both land and sea has increased greatly in the last century with over 3,000 presently in place. Using data from P.D. Jones *et al* and information from the Climate Research Unit (CRU) we will be looking at temperature fluctuations over time. The data begins with readings from 1850 through 2009 and is listing the temperature anomalies, or deviations from a mean. In this case, the mean is coming from the 30-year period 1961-1990. The data is then measured against whether the temperature increased or decreased from that mean and listed as the departure from the mean.

Example: If the mean yearly temperature for the 30-year period 1961-1990 was 65 degrees, the mean from 1850 will be measured against that. If the temperature were lower than the 1961-1990 mean you will get a negative anomaly (negative number), if it is warmer you will see a positive anomaly.

Materials:

- Computer w/Microsoft Excel (or other graphing software)
- Data Set – Global Monthly and Annual Temperature Anomalies (1850-2010)
  - http://cdiac.ornl.gov/trends/temp/jonescru/data.html
- Student Worksheet

Engage:



Q1) From Figure 1, describe the overall changes you see in temperature from 1998 to 2004. What evidence does this graph show in the case for or against global warming?

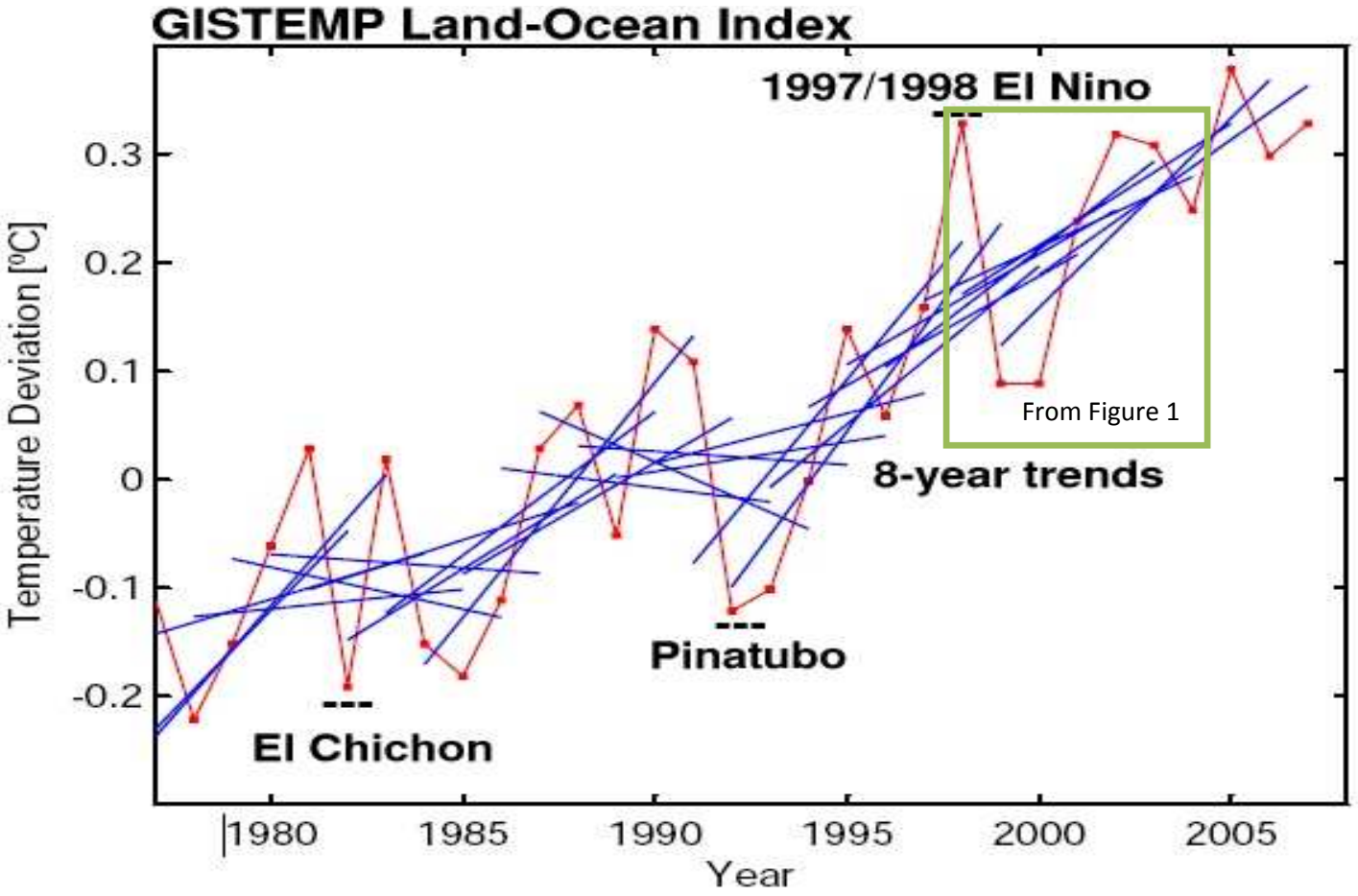


Figure 1 – Source: Gavin Schmidt – NASA GISS (http://www.realclimate.org/index.php/archives/2008/01/uncertainty-noise-and-the-art-of-model-data-comparison/#more-523)

Q2) From Figure 2, describe the overall changes you see in temperature from 1980 to 2005. What evidence does this graph show in the case for or against global warming?

Explore:

- Download the data set (see materials section).
- Choose any 30-year period from 1850-2010 and construct a graph of the annual temperature anomaly versus the year.
- Add a trend line to this data. Observe the trend displayed by the trend line.
- Make a new graph to look at the entire data set (1850-2010). Be sure to plot a trend line on this graph as well.

Q3) Find the following statistical information from your 30-year period. Mean? Median? Mode?

Q4) Describe the temperature trend in both of the graphs.

Q5) From the second graph, if temperatures were to continue in this manner, what might you predict for the following 30 years?

Q6) Plan a short presentation (2-3 minutes) of your data results, your conclusion(s) regarding this data, and your position supporting a claim that your data represents true historical trends in global temperature.

Explore:

- Use the following graphs to answer the questions below:

Q7) Which graph has the lowest recorded temperature anomaly?

Q8) Which graph shows the lowest overall temperature anomalies?

Q9) Which graph demonstrates a 30-year prediction into the future?

Q10) Which graph shows the largest overall annual temperature increase over a 30-year period?

Q11) Which graph shows the longest record of data?

Elaborate:

- Let's take a closer look at Graph D. You are now going to see how the same set of data can be manipulated to express different points of view.

Q12) How many years worth of data are used to calculate the trend line on Graph D?

Q13) How many years into the future is the trend line used to predict?

Q14) What appears to be the temperature trend from 1941-2000?

Q15) Does this make sense with the media reports over the last several years?

Q16) If you were going to create a presentation around this set of data, what types of comments would you make regarding the evidence for global warming?

- Now take a look at Graph E. We are going to fill in the missing data from 1971 to 2000. Notice the changes!

Q17) How many years worth of data are used to calculate the trend line on Graph E?

Q18) What appears to be the temperature trend from 1941-2000?

Q19) Does this make sense with the media reports over the last several years?

Q20) Extend this trend line another 30 years into the future (2030). What conclusions can be made from this graph?

Q21) If you were going to create a presentation around this set of data, what types of comments would you make regarding the evidence for global warming?

Evaluate:

Q22) Write a short description of the activity you have just completed. Consider the following topics in your discussion:

- What are some ideas to consider when using trend lines to present data?
- What about missing data?
- What about shifting data just a few points to the right or left?

Q23) Using the data provided from the Excel file, see if you can make an argument for global cooling? Produce a graph to support this position.

Resources:

- Jones, P.D., D.E. Parker, T.J. Osborn, and K.R. Briffa. 2006. Global and hemispheric temperature anomalies--land and marine instrumental records. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.

STUDENT PAGE

Lesson Title: Investigation – A Look at Global Temperature Anomalies

Question: How does the type or amount of data affect the outcome or trends experienced by a member of the public?

Objectives:
Given a set of data students will be able to:

- Create, using Microsoft Excel or another graphing program, an appropriate graph.
- Determine the mean, median, mode and range of the data.
- Using the graph they construct, be able to answer questions related to the data.
- Interpret the information found on the graph, and present their findings either orally or in a written format.

Vocabulary:

- anomaly: _____
- deviation: _____
- global warming: _____
- climate change: _____

Background:
Temperature has great importance to all organisms. Each species has a maximum and minimum temperature beyond which survival is impossible. It is likely that humans have kept temperature "records" even in prehistoric times, communicating with regard to hot and cold seasons and years. Currently debate exists about the occurrence of climate change and its severity across the globe. The number of recording stations from both land and sea has increased greatly in the last century with over 3,000 presently in place. Using data from P.D. Jones *et al* and information from the Climate Research Unit (CRU) we will be looking at temperature fluctuations over time. The data begins with readings from 1850 through 2009 and is listing the temperature anomalies, or deviations from a mean. In this case, the mean is coming from the 30-year period 1961-1990. The data is then measured against whether the temperature increased or decreased from that mean and listed as the departure from the mean.

Example: If the mean yearly temperature for the 30-year period 1961-1990 was 65 degrees, the mean from 1850 will be measured against that. If the temperature were lower than the 1961-1990 mean you will get a negative anomaly (negative number), if it is warmer you will see a positive anomaly.

Materials:

- Computer w/Microsoft Excel (or other graphing software)
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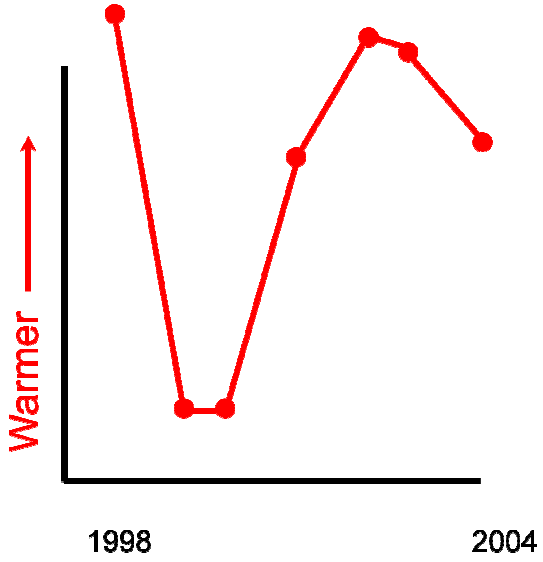

Q1) From Figure 1, describe the overall changes you see in temperature from 1998 to 2004. What evidence does this graph show in the case for or against global warming?

Figure 1

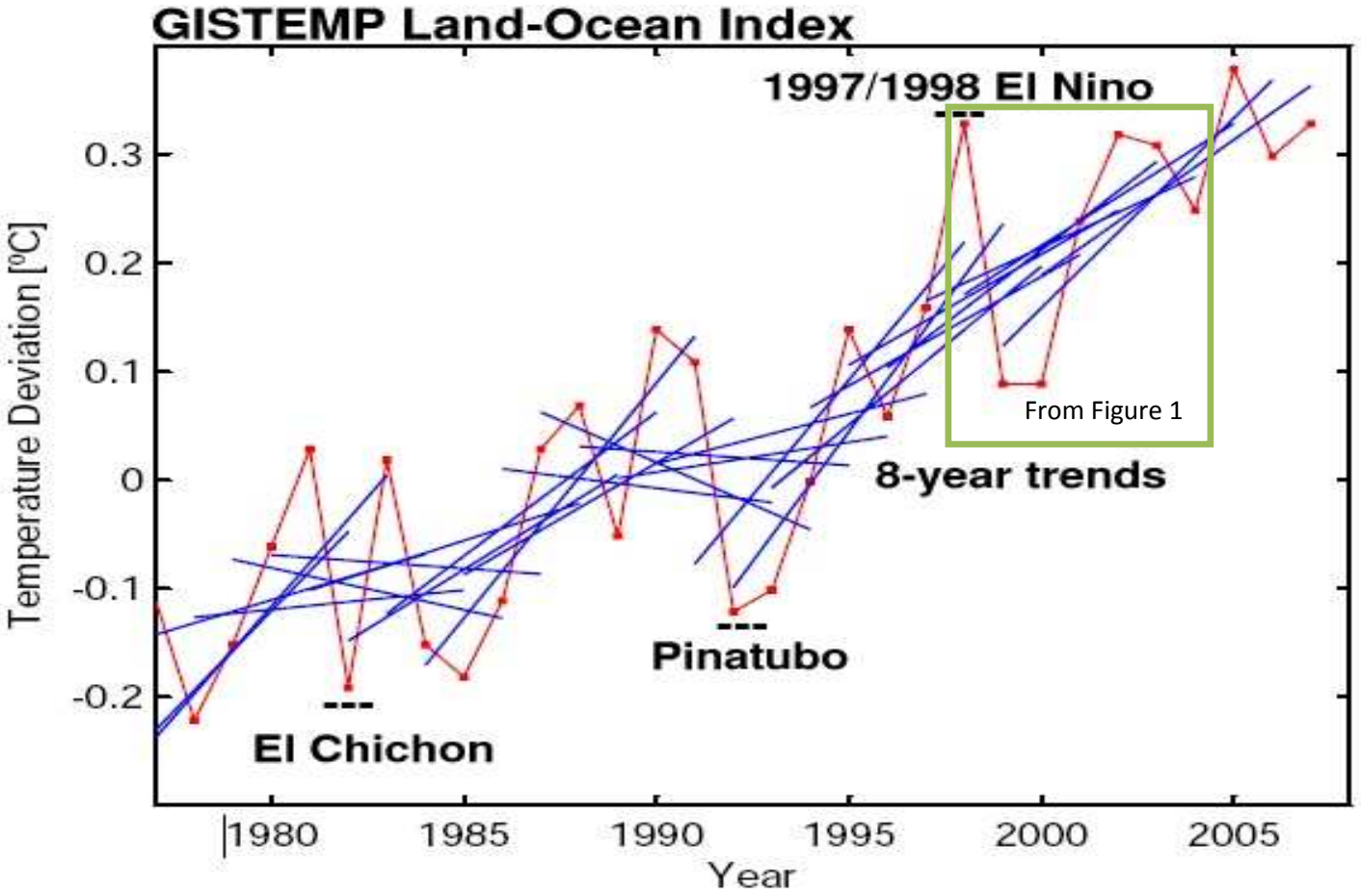

Figure 2 – Source: Gavin Schmidt – NASA GISS (http://www.realclimate.org/index.php/archives/2008/01/uncertainty-noise-and-the-art-of-model-data-comparison/#more-523)

Q2) From Figure 2, describe the overall changes you see in temperature from 1980 to 2005. What evidence does this graph show in the case for or against global warming?

Explore:

- Download the data set (see materials section).
- Choose any 30-year period from 1850-2010 and construct a graph of the annual temperature anomaly versus the year.
- Add a trend line to this data. Observe the trend displayed by the trend line.
- Make a new graph to look at the entire data set (1850-2010). Be sure to plot a trend line on this graph as well.

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Q4) Describe the temperature trend in both of the graphs.

Q5) From the second graph, if temperatures were to continue in this manner, what might you predict for the following 30 years? Explain.

Q6) Plan a short presentation (2-3 minutes) of your data results, your conclusion(s) regarding this data, and your position supporting a claim that your data represents true historical trends in global temperature.

Explore:

- Use the following graphs (A-H) to answer the questions below:

Q7) Which graph has the lowest recorded temperature anomaly?

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Q9) Which graph demonstrates a 30-year prediction into the future?

Q10) Which graph shows the largest overall annual temperature increase over a 30-year period?

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Elaborate:

- Let's take a closer look at Graph D. You are now going to see how the same set of data can be manipulated to express different points of view.

Q12) How many years worth of data are used to calculate the trend line on Graph D?

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Q14) What appears to be the temperature trend from 1941-2000?

Q15) Does this make sense with the media reports over the last several years?

Q16) If you were going to create a presentation around this set of data, what types of comments could you make regarding the evidence for global warming?

- Now take a look at Graph E. We are going to fill in the missing data from 1971 to 2000. Notice the changes!

Q17) How many years worth of data are used to calculate the trend line on Graph E?

Q18) What appears to be the temperature trend from 1941-2000?

Q19) Does this make sense with the media reports over the last several years?

Q20) Extend this trend line another 30 years into the future (2030). What conclusions can be made from this graph?

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Evaluate:

Q22) Write a short description of the activity you have just completed. Consider the following topics in your discussion:

- What are some ideas to consider when using trend lines to present data?
- What about missing data?
- What about shifting data just a few points to the right or left?

Q23) Using the data provided from the Excel file, see if you can make an argument for global cooling? Produce a graph to support this position.

Resources:

- Jones, P.D., D.E. Parker, T.J. Osborn, and K.R. Briffa. 2006. Global and hemispheric temperature anomalies--land and marine instrumental records. In Trends: A Compendium of Data on Global Change. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A.

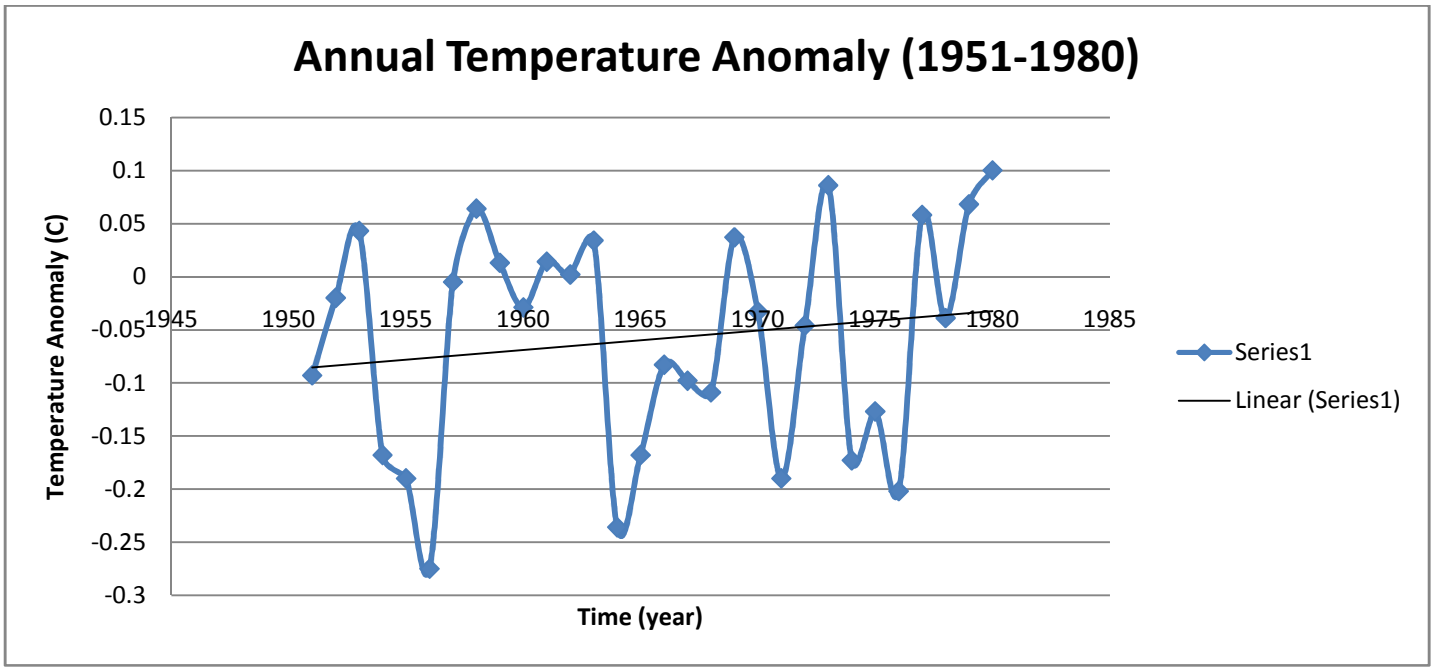
ANSWER KEY (answers based on the 30-year period from 1951-1980)

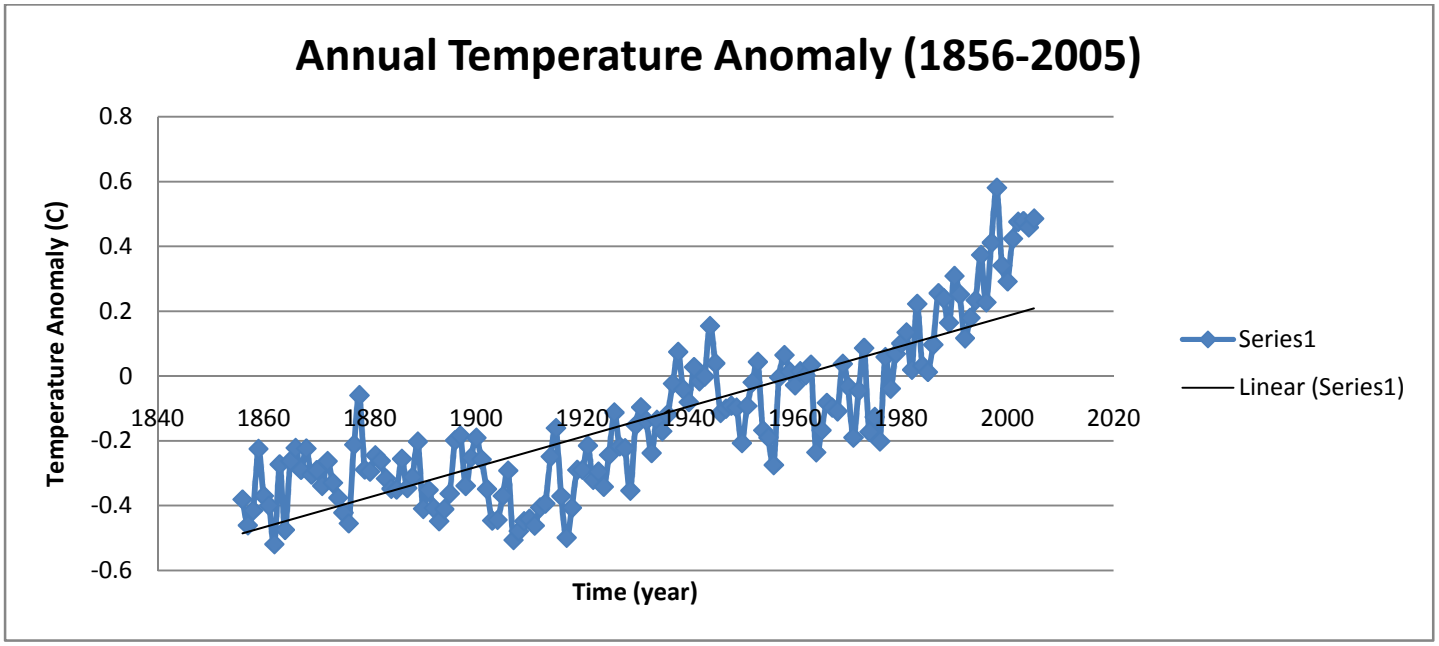
Q1) There is a sharp drop in temperature after 1998, then a somewhat rapid increase again. In 2004 the temperature dropped back down again. This graph does not show a clear indication of increasing or decreasing temperatures, though a trendline might indicate steady to a slight downward trend in temperature during this time.

Q2) The overall trend looks as though the temperature is increasing. With the blue lines representing 8-year trends, it should be clear that short term trends are variable; sometimes small, sometimes large, sometimes negative – depending on which year you start with. From this short period of observations, the graph does appear to show some evidence of global warming.

Q3) Mean: -0.138; Median: -0.191; Mode: -0.29

Q4) There is a general upward trend in the 30-year graph (1951-1980) and with the graph of the entire dataset (1859-2005). The trend is steeper for the entire dataset with a slope of 0.004 than for the 30-year period with a slope of 0.001.





Q5) The temperature appears to be increasing more dramatically in recent years. This trend could be expected to accelerate into the future if the concentration of greenhouse gases continues to increase as well.

Q6) EXAMPLE: In the beginning of my set of years, temperatures were about -.2 degrees in their anomaly. By 2005, temperatures were about +.5. This is a significant change and the graphs show that temperatures are gradually increasing. Each time temperatures rescind a little, they hit higher records ultimately showing the warming temperatures.

Q7) Graph A

Q8) Graph A

Q9) Graph D

Q10) Graph G

Q11) Graph E

Q12) 30 years

Q13) 30 years

Q14) There is a decreasing temperature trend.

Q15) Most of the recent media reports indicate an increasing temperature trend.

Q16) Despite global warming, some trends seem to show a decrease in temperatures. However, this is only a prediction so there is room for error and this trend could be incorrect.

Q17) 60 years

Q18) The trend is increasing temperatures.

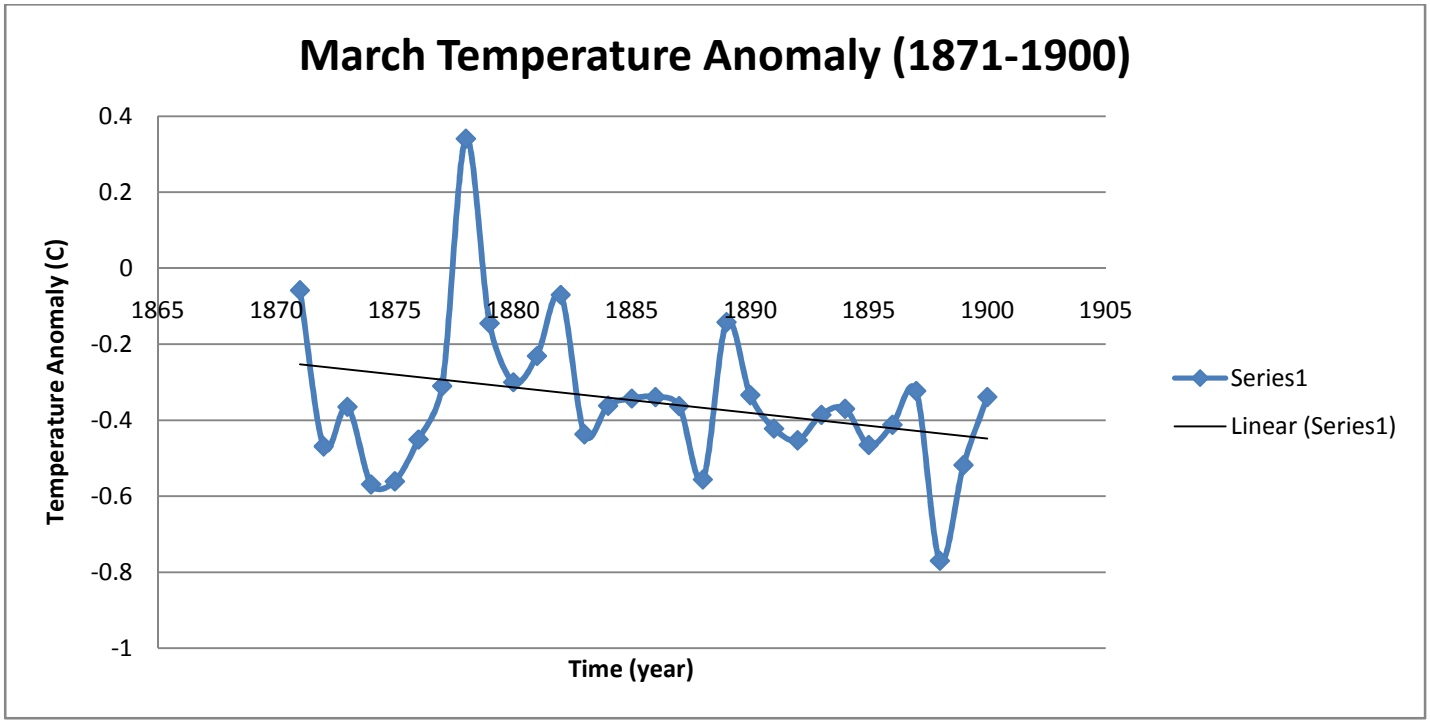
Q19) Yes.

Q20) The temperatures will continue to increase.

Q21) This graph supports the continuing increase in temperatures.

Q22) You have to have data to add a trend line, however, you can manipulate the data in a way that when adding the trend line it supports what you are trying to prove. Missing data can be accounted for by making predictions around it. These predictions are not always accurate but that is how you can get around missing data. Shifting points left or right can cause it to either support or go against what you are trying to prove. It only takes one number to completely change a graph.

Q23) It is possible to use the data and prove global cooling but it depends on what data you use. You can prove anything you want to with a graph. This makes it so you can't totally trust all graphs to be completely accurate. Yet, on the other side, it isn't very hard to get people to believe your "not-so-true" graph. The graph below uses the temperature anomalies from March 1870 – March 1900.


March Temperature Anomaly (1871-1900)
Temperature Anomaly (C)
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
1865
1870
1875
1880
1885
1890
1895
1900
1905
Time (year)
Series1
Linear (Series1)