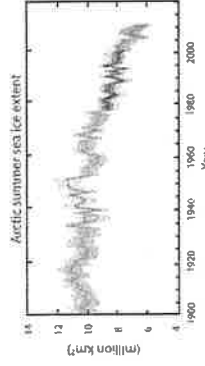
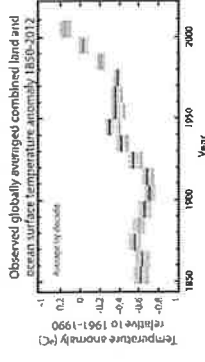
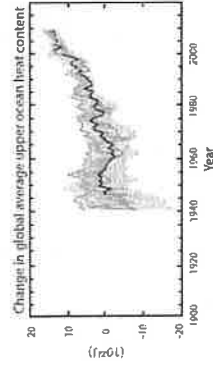
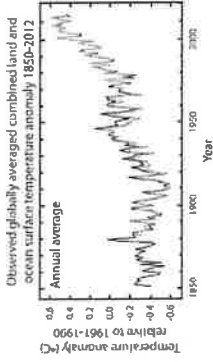
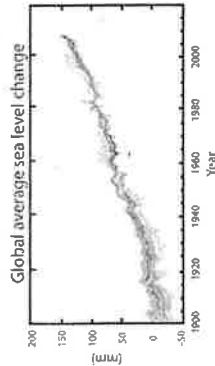
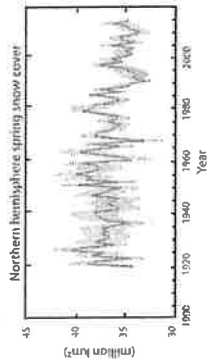
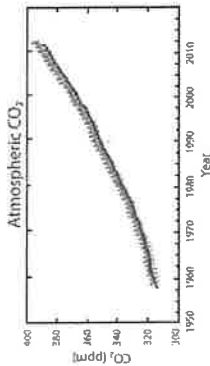


Climate Impact Graphs

Match the statement with the appropriate graph. Once your answers are confirmed, copy the statement beside its corresponding graph below.

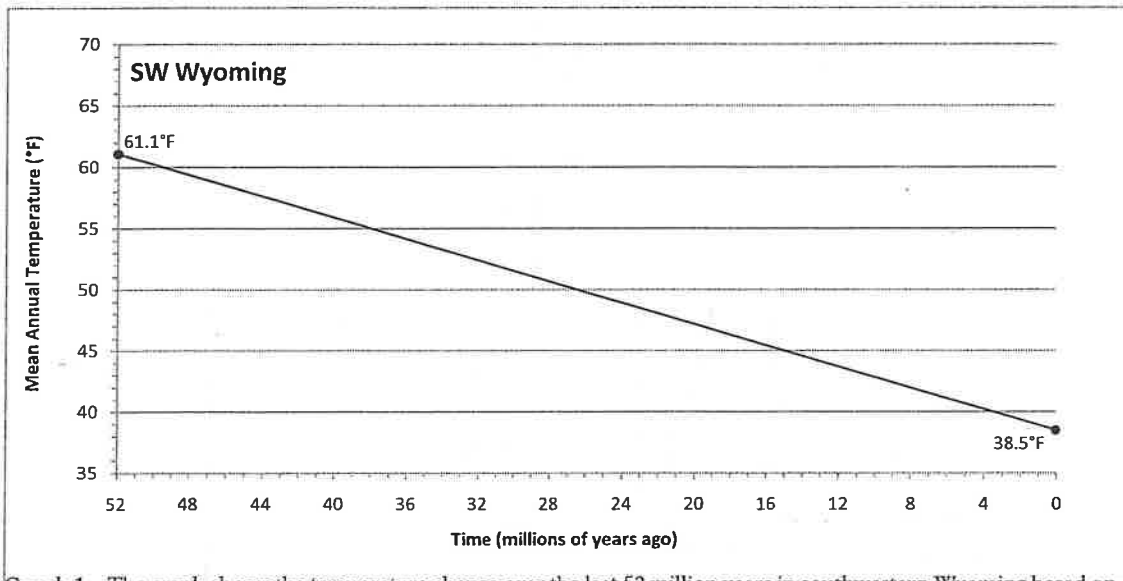
Name: _____



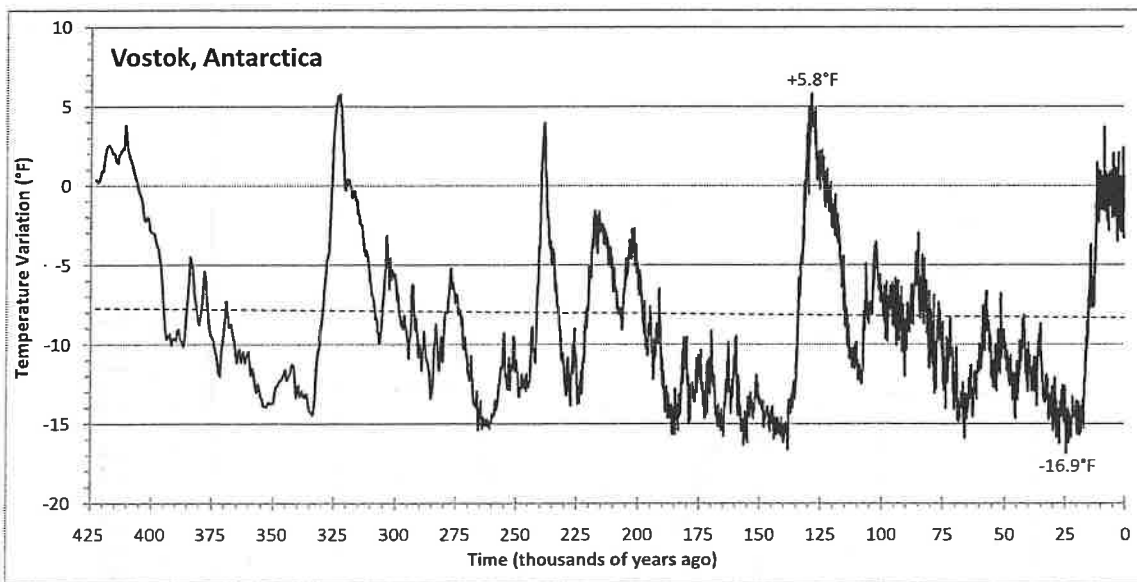
Graphs from "IPCC (2013) Climate Change 2013: The Physical Science Basis," Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Summary for Policy-makers, October 2013. Download the report at: <http://www.ipcc.ch/>

Climate Change Worksheet

1. Graphs 1 and 2 show how temperature has changed over geologic time. Read the captions, compare the graphs and list three differences. [Bonus: List one similarity.]

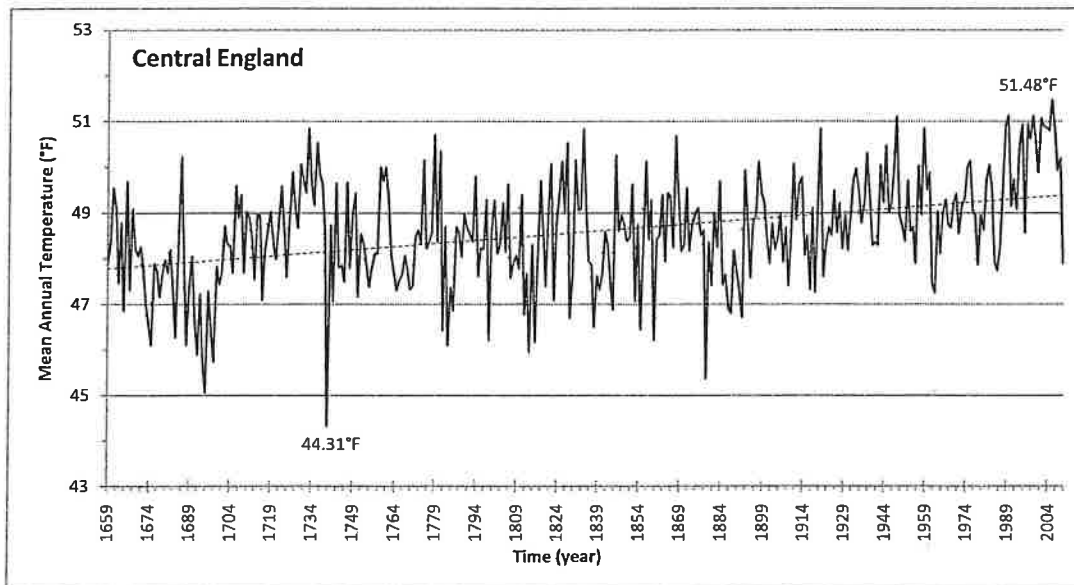


Graph 1—The graph shows the temperature change over the last 52 million years in southwestern Wyoming based on the analysis of fossil leaves (P. Kester and A. Aase, pers. com., 2011) and modern observational data. The mean annual temperature 52 million years ago was 61.1°F and today it is 38.5°F, a difference of 22.6°F.

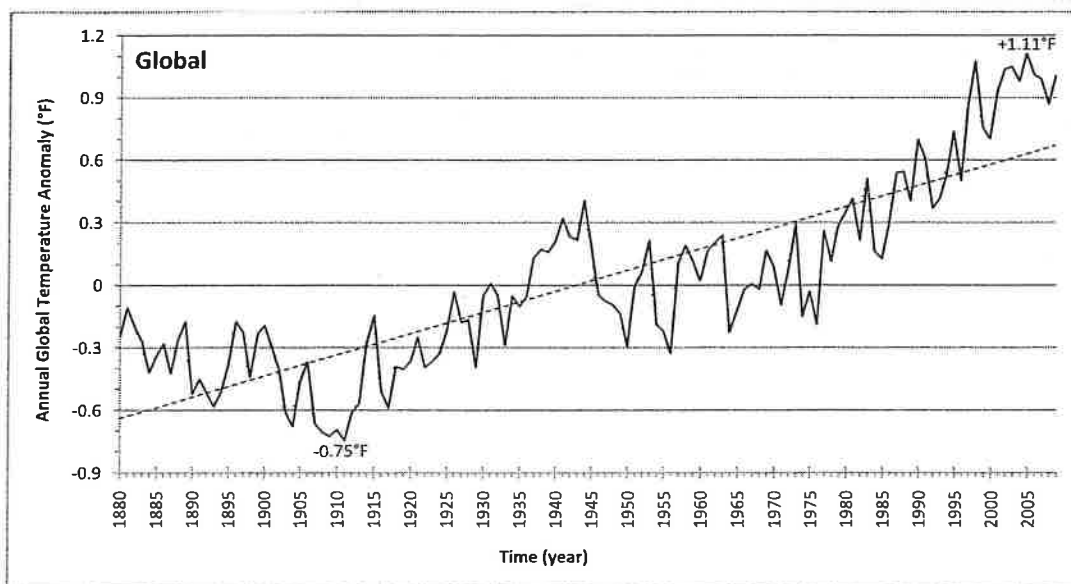


Graph 2—The graph (based on Petit, J.R. et al, 1999) shows the variation in temperature from the modern mean (-6.7°F) over the last 425,000 years at Vostok, Antarctica as determined by analyzing ice cores. The five tallest peaks represent short-lived warm periods that interrupted major glaciations. During the height of a warm period about 125,000 years ago, temperatures were 5.8°F warmer than today. At the last glacial extreme about 25,000 years ago they were 16.9°F cooler, a difference of 22.7°F.

2. Graphs 3 and 4 show how temperature has changed as advanced human civilization developed. Read the captions, compare the graphs and list three differences.



Graph 3—The graph (based on Parker, D.E. et al, 1992) shows mean annual temperature for Central England from 1659 to 2010. It is the longest continuous temperature record in existence. The lowest mean annual temperature over this period was 44.31°F in 1740 and the highest was 51.48°F in 2006, a difference of 7.17°F.



Graph 4—The graph (based on data from the National Climate Data Center) shows the annual global temperature anomaly for 1880-2009. A temperature anomaly is the difference between an observed temperature and a long-term average temperature. The largest negative anomaly over this period was -0.75°F in 1911 and the largest positive anomaly was 1.11°F in 2005, a difference of 1.86°F.

3. Why does Graph 1 look so different from the other three? [Hint: Give a pointed answer.]

4. Why is a global average, as opposed to data from a single location, a more meaningful measure of climate change?

5. The methods used to produce the graphs are different, but what do they all show? [Hint: Look to axes]

6. The dashed line in the last three graphs are linear trendlines. Trendlines smooth the peaks and valleys using an averaging technique to reveal the direction and magnitude of change over a period of time.

Step 1. Calculate the change in temperature, $\Delta T(^{\circ}\text{F})$, for Vostok, Antarctica, Central England and Global using data in the table below and the equation: $\Delta T(^{\circ}\text{F}) = t_{\text{min}} - t_{\text{max}}$. Show your work.

| | SW Wyoming | | Vostok, Antarctica | | Central England | | Global | |
|--------------------------|------------------|------------------|--------------------|------------------|------------------|------------------|------------------|------------------|
| | t_{min} | t_{max} | t_{min} | t_{max} | t_{min} | t_{max} | t_{min} | t_{max} |
| T ($^{\circ}\text{F}$) | 38.5 | 61.1 | -8.3358 | -7.7408 | 49.44 | 47.825 | 0.7688 | -0.547 |

Example (SW Wyoming):

from table, $t_{\text{min}} = 38.5^{\circ}\text{F}$

from table, $t_{\text{max}} = 61.1^{\circ}\text{F}$

$\Delta T(^{\circ}\text{F}) = 38.5^{\circ}\text{F} - 61.1^{\circ}\text{F}$

$= -22.6^{\circ}\text{F}$

Record your answers here.

| | SW Wyoming | Vostok, Antarctica | Central England | Global |
|------------------------------|------------|--------------------|-----------------|--------|
| $\Delta T(^{\circ}\text{F})$ | -22.6 | | | |

Step 2. Calculate the rate of temperature change per century, $\Delta T/t(^{\circ}\text{F}/100 \text{ yrs})$, for Vostok, Antarctica, Central England and Global using data from Step 1, the table below, and the following equation. Show your work and round answer to 5 decimal places.

$$\Delta T/t(^{\circ}\text{F}/100 \text{ yrs}) = \frac{\Delta T (^{\circ}\text{F})}{\Delta t (\text{yrs})} \times 100$$

| | | | | |
|------------------------|------------|--------------------|-----------------|--------|
| | SW Wyoming | Vostok, Antarctica | Central England | Global |
| $\Delta t(\text{yrs})$ | 52,000,000 | 425,000 | 352 | 130 |

Example (SW Wyoming):
 from Step 1, $\Delta T (^{\circ}\text{F}) = -22.6^{\circ}\text{F}$
 from table, $\Delta t (\text{yrs}) = 52,000,000 \text{ yrs}$

$$\begin{aligned} \Delta T/t (^{\circ}\text{F}/100 \text{ yrs}) &= \frac{-22.6^{\circ}\text{F}}{52,000,000 \text{ yrs}} \times 100 \\ &= -0.00005^{\circ}\text{F}/100\text{yrs} \end{aligned}$$

Record your answers here.

| | | | | |
|------------------------------------------------|------------|--------------------|-----------------|--------|
| | SW Wyoming | Vostok, Antarctica | Central England | Global |
| $\Delta T/t(^{\circ}\text{F}/100 \text{ yrs})$ | -0.00005 | | | |

7. Compare the rates of temperature change per century. The short-term records (Central England and Global) suggest Earth's surface temperature is _____ (cooling, or warming) significantly, while the long-term records (SW Wyoming and Vostok, Antarctica) suggest it has _____ (cooled, or warmed) albeit very slowly.

8. In your opinion, why does, or doesn't the evidence presented support a conclusion that modern climate change is being influenced by humans (anthropogenic climate change)?

9. Use the internet to investigate three factors (one anthropogenic and two natural) that influence Earth's climate. On separate index cards list each factor, what its influence is and how that varies over time. Be prepared to discuss the relative contribution of each factor to modern climate change in class.

