**Temperature Over Time - Investigation 1**

<http://www.ces.fau.edu/nasa/module-3/temperature-change-industrial/investigation-4.1.php>

**How Did Temperature Change Before the Industrial Revolution**

**Exploration 1: Antarctica Ice Cores and Temperature Over the 800,000 Years**

**Use the interactive, time-series graphing tool to answer the following questions.**

1. Look at the temperature anomaly data and describe the general pattern that you see over the past

 800,000 years.

2. Approximately how many glacial periods do you observe over the past 800,000?

3. What is the approximate time period between each glacial period?

4. The last ice age began about 2.75 million years ago, but according the time-series graph, approximately when did the last major glacial period begin?

5. Are we currently in a glacial or interglacial period? Approximately, when did this most recent period of climate begin?

6. Calculate the estimated rate of change for three sequential glacial-interglacial periods. To do this, zoom in on the time series graph to the glacial-interglacial periods listed in the table below. In the table you are given a one thousand year range to examine. You will look at all points in that thousand year period by running your cursor over the points. You will note the temperature anomaly for each point and then estimate the average for that range. Complete the table below by answering the following:

* + What is the range of years for each glacial-interglacial period listed?
	+ What is the temperature anomaly estimate for this glacial period?
	+ What is the temperature anomaly estimate for this interglacial period?
	+ Subtract your glacial period estimate from your interglacial period estimate and divide by the range.

**\_\_\_T2 – T1\_\_\_**

 **Year2 – Year1**

* + Determine the average rate of change per 100 years (century) for each glacial-interglacial period by multiplying your estimated rate of change per year by 100.

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| --- | --- | --- | --- | --- | --- |
| **Glacial-Interglacial****Periods** | **Years Ago**  | **Range of Years** (Between Glacial and Interglacial) | **Estimated Average****Temperature****Anomaly Readings** | **Estimated Rate of Change** (˚C/year) | **Average Rate of Change for Estimated Temperature Anomaly Readings**(˚C/100 years) |
| Glacial | 343,000-344,000 | **343,000-333,000=10,000** | **~-9˚C** | **3.5˚C – (-9˚C) / 10,000= 0.0013˚C/year** | **0.0013˚C/year \*** **100 years =** **0.13˚C/100 years** |
| Interglacial | 333,000-334,000 | **~3.5˚C** |
| Glacial | 252,000- |  |  |  |  |
| Interglacial | 242,000 |  |
| Glacial | 138,000 |  |  |  |  |
| Interglacial | 128,000 |  |

7. What is the average rate of change for the three glacial-interglacial periods analyzed in the table above?

**Exploration 2: Greenland Ice Cores and Temperature Between 50,000 and 10,000 Years Ago**

**Use the interactive, time-series graphing tool to answer the following questions.**

1. Look at the temperature anomaly data between 50,000 and 27,000 years ago. Describe the general pattern that you see.

2. Zoom in on the period of time between 30,000 years ago and the present. During what span of years was the temperature over 10°C colder than normal in Greenland?

3. Describe the temperature pattern that occurred from 13,040 to 11,560. This period was known as the Younger Dryas.

4. What general temperature trend do you observe between about 10,000 and 130 years ago? You will examine this in more detail in the next exploration.

5. Calculate the estimated rate of change for four sequential glacial-interglacial periods. To do this, zoom in on the time series graph to the glacial-interglacial periods listed in the table below. Complete the table below by answering the following:

* + What is the range of years for each glacial-interglacial period listed?
	+ What was the temperature anomaly for this glacial period?
	+ What was the temperature anomaly for this interglacial period?
	+ Subtract your glacial period estimate from your interglacial period estimate and divide by the range.

**\_\_\_T2 – T1\_\_\_**

 **Year2 – Year1**

* + Determine the average rate of change per 100 years (century) for each glacial-interglacial period by multiply your estimated rate of change per year by 100.

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| **Glacial-Interglacial****Periods** | **Years Ago**  | **Range of Years** (Between Glacial and Interglacial) | **Temperature****Anomaly Readings** | **Estimated Rate of Change** (˚C/year) | **Average Rate of Change for Estimated Temperature Anomaly Readings**(˚C/100 years) |
| Glacial | 35,810 | **35,810-35,190 = 620** | **-21.28 ˚C** | **-8.39-(-21.28)****/620 =** **0.021˚C /year** | **2.1˚C/** **100 years** |
| Interglacial | 35,190 | **-8.39 ˚C** |
| Glacial | 32,880 |  |  |  |  |
| Interglacial | 32,220 |  |
| Glacial | 29,740 |  |  |  |  |
| Interglacial | 28,980 |  |
| Glacial | 14,930 |  |  |  |  |
| Interglacial | 14,520 |  |

6. What was the average range of years between a glacial and interglacial period?

7. What was the average low temperature anomaly for the three periods? What was the average high?

8. How does the average rate of change of temperature anomaly during these glacial-interglacial periods from the Greenland core compare to that during the glacial-interglacial periods from the 800,000 Antarctica data?

**Exploration 3: Proxy Data and Temperature Before the Industrial Revolution**

**Use the interactive, time-series graphing tool to answer the following questions.**

1. What do you observe about the temperature anomaly between about 950 and 1250? Approximately, how many times was the anomaly around the norm (0°C)?
2. Zoom into the time interval between about 1250 and 1900. What do you observe about the temperature anomaly between about 1300 and 1850? How many times was the anomaly at or below ­­-0.65 °C?

3. What temperature pattern do you observe between the time interval of 1850 and 2006?