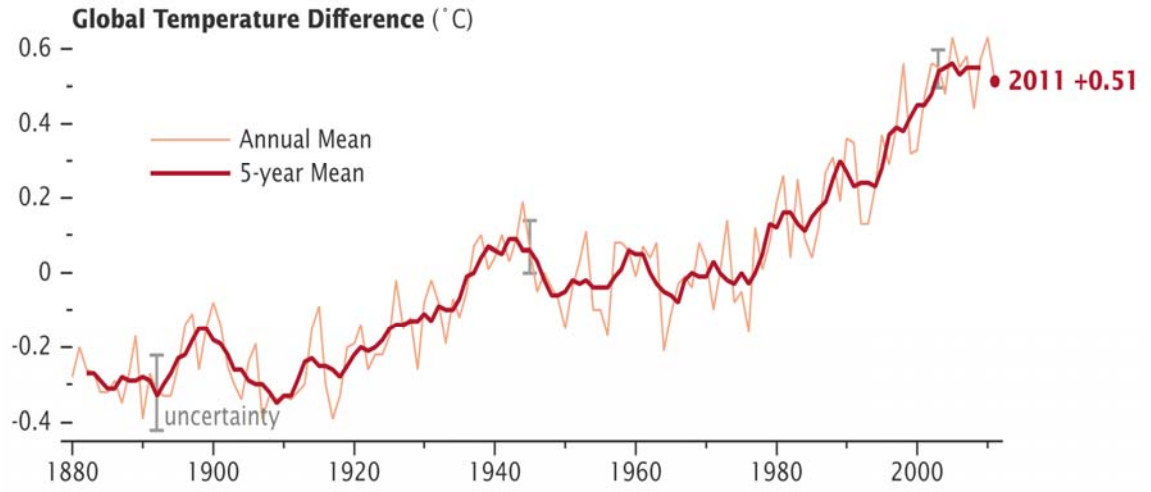

A new study by researchers at the NASA Goddard Institute for Space Studies determined that 2010 tied with 2005 as the warmest year on record, and was part of the warmest decade on record since the 1800s. The analysis used data from over 1000 stations around the world, satellite observations, and ocean and polar measurements to draw this conclusion.

The graph above gives the average 'temperature anomaly' for each year from 1900 to 2010. Climate scientists have defined the temperature anomaly as a measure of how much the global temperature differed from the average global temperature between 1951 to 1980. For example, on the graph, a $+1.0^{o}$C temperature anomaly in 2000 means that the world was $+1.0^{o}$ Celsius warmer in 2000 than the average global temperature between 1951-1980.

Problem 1 - Based on the graph, what is the slope of the major trend in temperature increase from 1960 to 2010 in degrees C per year?

Problem 2 - Compare the rates of temperature change during the three, 40-year intervals between 1880-1920, 1920-1960, and 1960-2000. Is the rate of temperature change constant, increasing in speed or decreasing in speed?

Problem 3 – If the temperature change continues at the rate measured between 1960-2000, what would you predict as the temperature anomaly, in Celsius and Fahrenheit, for the years 2050?

Problem 1 - Based on the graph, what is the slope of the major trend in temperature increase from 1960 to 2010 in degrees C per year?

Answer: Students can use a ruler to draw a straight line that matches the trend in the data. They can determine the slope of this line by reading-off the values on the vertical axis. An exact value using the 1960 and 2010 data points would yield a slope of about m = (y2-y1)/(x2-x1) = (+0.55 –(-0.05))/(2010-1960) = **+0.012^{o} C/year**.

Problem 2 - Compare the rates of temperature change during the three, 40-year intervals between 1880-1920, 1920-1960, and 1960-2000. Is the rate of temperature change constant, increasing in speed or decreasing in speed?

Answer: 1880-1920: Close to **0.0^{o} C/year**.
1920-1960: Close to (-0.05 – (-0.25)/(1960-1920) = **+0.005^{o} C/year**.
1960-2010: Close to **+0.012^{o} C/year**.

The slopes during each 40-year period are not the same so the temperature is not changing at a constant rate. The slopes are getting more positive, so that means that **the RATE of temperature increase each year is increasing 'in speed' as time goes by**.

Problem 3 - If the temperature change continues at the rate measured between 1960-2000, what would you predict as the temperature anomaly, in Celsius and Fahrenheit, for the years 2050.

Answer: Use a ruler to extend the line you drew in Problem 1 to the year 2050. Students should estimate a temperature anomaly close to +1.15^{o} C. Because 1 degree Fahrenheit is equal to 9/5 times the Celsius degree, the equivalent temperature increase is about **+2.1^{o} F** over the entire globe.

Note – Students should realize that because we did not account for the change in the rate found in Problem 2, using a straight line from 1960 to 2050 will underestimate the temperature in 2050 because of the accelerating INCREASE in the rate. You can estimate this by looking at the 40-year rates that were calculated of 0.0, +0.0075, +0.12 and estimate that between 2000-2040 the rate might be about +0.02^{o} C/year. Then starting at +0.55 in 2000 and adding 40x(0.02) we get T = 1.35^{o} C, or +2.4^{o} F.