The Keeling Curve

CONEX Read-ahead

Introduction

In 1958, scientist Charles Keeling began taking daily measurements of the concentration of carbon dioxide in the atmosphere. These measurements have continued since then and have come to be known as the "Keeling Curve", shown below.

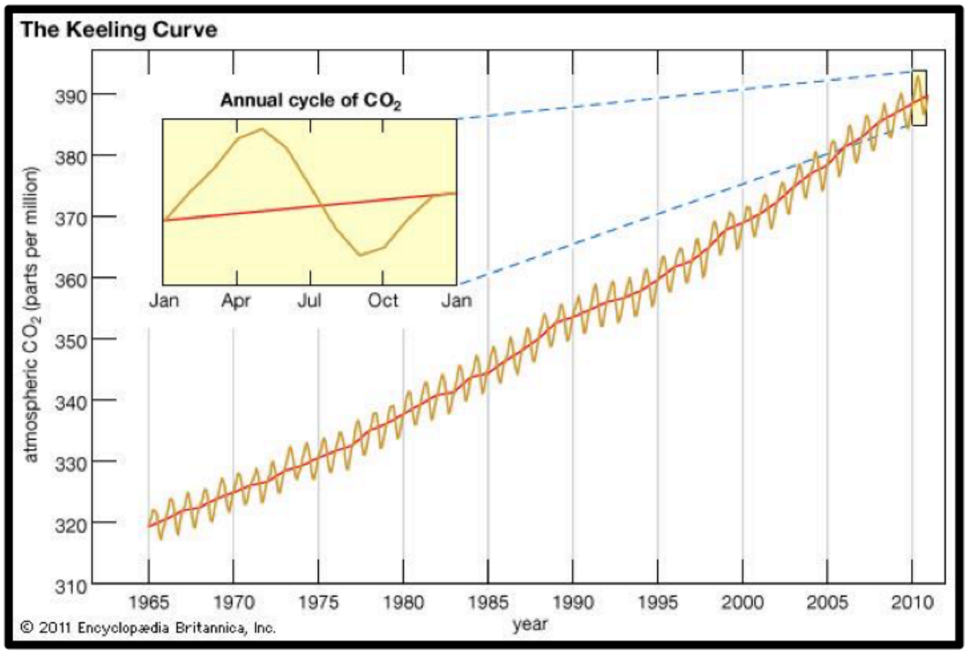

Figure 1: The Keeling Curve

In this application we explore how to model a real-world scenario using linear functions. Specifically, we will learn about the Keeling Curve, which plots the concentration of carbon dioxide in the Earth's atmosphere, and will represent this concentration as a function of time using a linear function.

Instructions

After reading through *The Keeling Curve* context and questions below, you should complete the application reflection in Canvas. Note: *you will have a chance to talk further with your coach before answering the questions below in detail.* The point of the read-ahead is to "prime the pump" for further conversations with your coaches.

The Keeling Curve

The Keeling Curve is important because it shows how the level of carbon dioxide in the atmosphere has been steadily increasing at an unprecedented rate for the past half-century. As the graph in Figure 2 below shows, CO_2 levels today are higher than they've been in the last 800,000 years.

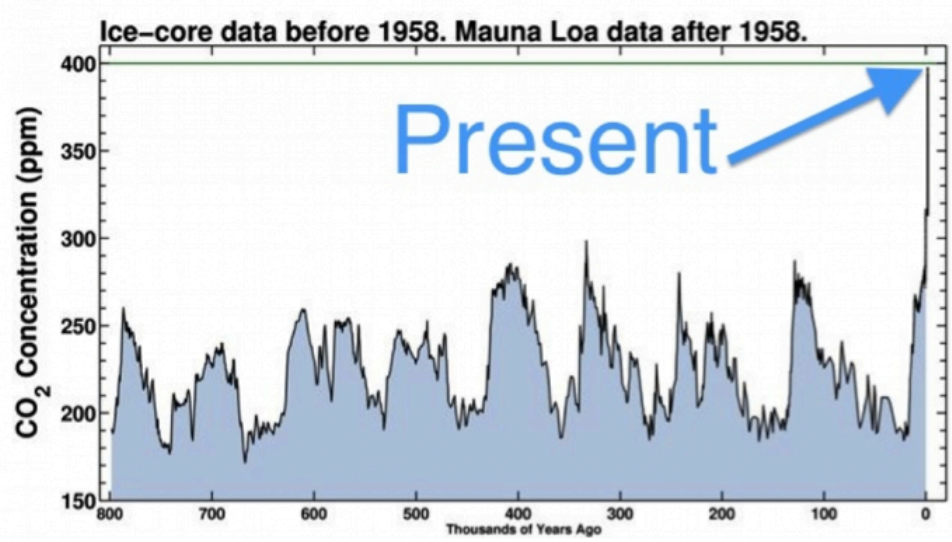

Figure 2: Atmospheric CO_2 levels

Carbon dioxide traps heat in our atmosphere and is the leading cause of anthropogenic global warming. The Keeling Curve has been partially credited for beginning discussions on curbing greenhouse gas emissions.

Questions

The following questions all refer to the graph of the Keeling Curve in Figure 1. Note that the actual CO_2 concentration, represented by the thin orange oscillating curve in the figure, varies slightly up and down every year. This is due to seasonal changes of CO_2 uptake. In the northern spring, levels of CO_2 begin to decline as new plant growth removes CO_2 through photosynthesis. When autumn comes, leaves drop and decay, and CO_2 levels rise again. **Since we are interested in the long-term trend, rather than seasonal variation, we will only consider the baseline concentration, which is represented by the thicker non-oscillating red curve.**

1. Suppose we let $C(t)$ represent the baseline atmospheric CO_2 concentration, measured in parts per million (ppm), at time t, where t is measured in years and $t = 0$ represents 1965. If we model $C(t)$ with a linear function, which of the following expressions makes the most sense as the slope of that function?

   (a) $C(2010) - C(1965)$

   (b) $C(45) - C(0)$

   (c) $\dfrac{C(2010) - C(1965)}{45}$

   (d) $\dfrac{C(45) - C(0)}{45}$

   (e) $\dfrac{C(0) + C(45)}{2}$

2. Find the equation of the linear function that goes through the points on the graph of $C(t)$ that correspond to the baseline CO_2 levels in 1965 and 2010, where again $t = 0$ represents 1965. Use the levels 320 ppm for 1965 and 388 ppm for 2010, and round the slope to two decimal places. Write your answer in slope-intercept form $L(t) = mt + b$.

3. If you were to draw the graph of your function $L(t)$ directly on top of Figure 1, would most of the baseline values on the Keeling curve lie above or below the graph of $L(t)$?
4. Use your function $L(t)$ to estimate the baseline CO_2 concentration in 1985. Round your answer to the nearest tenth.
5. Use your function $L(t)$ to estimate the baseline CO_2 concentration in 2025. Round your answer to the nearest tenth.
6. Which of the estimates you calculated in the previous two questions would you be most confident presenting to a group of policy-makers, and why?
7. Use your function $L(t)$ to estimate the year in which the baseline CO_2 concentration will surpass 450 ppm.
8. Find the equation of the linear function that goes through the points on the graph of $C(t)$ corresponding to the baseline CO_2 levels in 1985 and 2010. Use the levels 345 ppm for 1985, and 388 ppm for 2010. Write your answer in point-slope form $L(t) = L_0 + m(t - t_0)$.
9. (Graded for completeness only.) Which of the two linear functions you found above best fits the underlying function $C(t)$? Which do you think would do a better job of predicting the baseline CO_2 level in 2025? Can you think of another way to come up with a linear function to model this data?

Instructions, part deux

After reading and reflecting on these questions, complete the application reflection on Canvas. This will give your coach some insight on your thinking in order to best help you before you are required to formally answer these questions.