

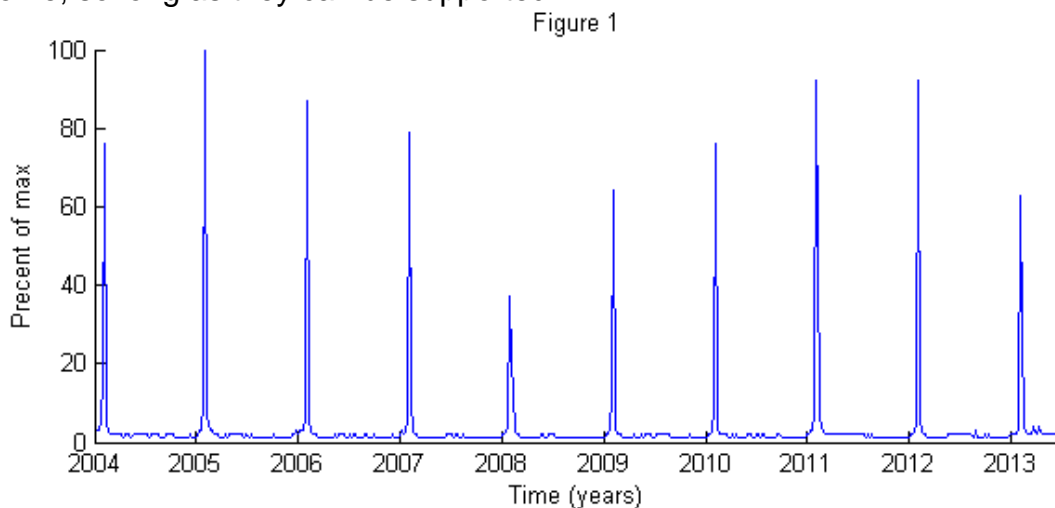
Using Google Trends to Demystify Climate Change Data

It is important for scientists to be able to understand patterns at multiple levels of scale in order to understand the world around us. This exercise will help you train your mind to see and interpret patterns in time series data. A time series is a set of data where measurements are made at intervals through time. An example would be measurements of temperature over a day or the height of a child measured each year.

Part 1: Identifying Patterns

Google Trends (www.google.com/trends) tracks how often certain words are searched for on Google. If you type in any term into the search engine it will create a graph of how often people search for that term through Google. For example, typing in the word "Oscars" creates a spike every year right around the time of the Academy Awards. Using graphs generated in this way, we'll practice identifying patterns and cycles in data.

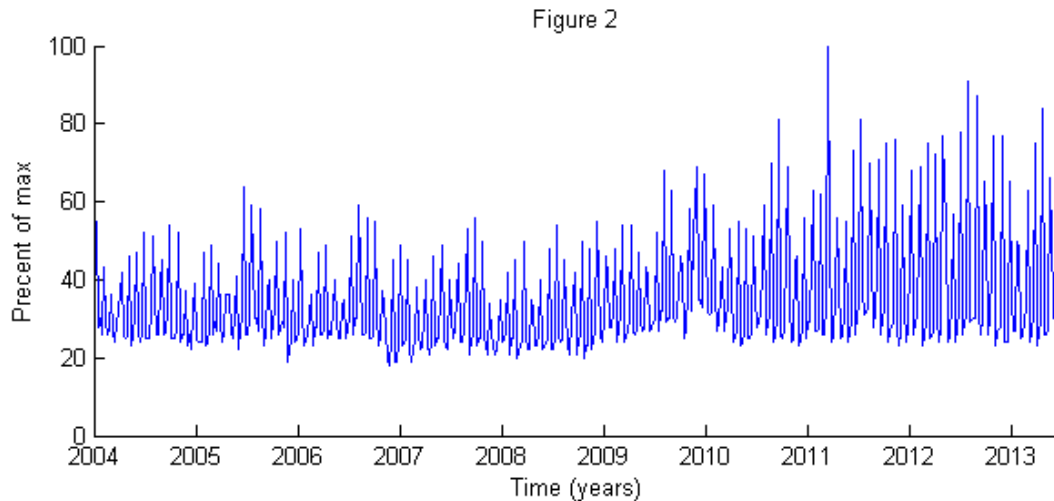
1. For each of the following graphs write down your best hypothesis for what people were searching for to create such a pattern and your rationale. It is unlikely that you will correctly identify the answers (hint: they get harder as you go), but what is important is that you can support your hypothesis with the data. Take some time to think about the shape of the lines as well as any patterns you might see. Creative answers are welcome, so long as they can be supported!



1a. Term Guess: *groundhog*

Support:

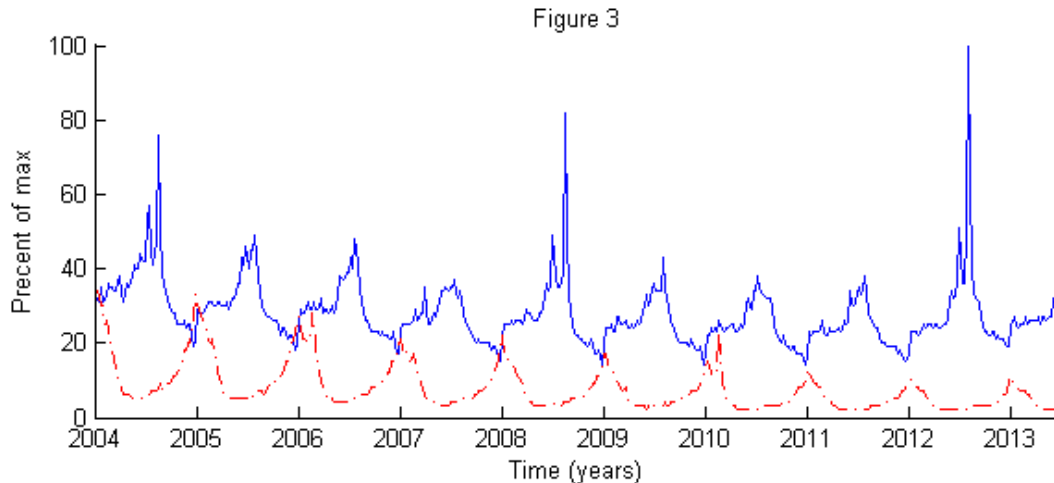
Support for the choice of groundhog could be along the lines of it peaks once a year in late winter, around the time of year groundhog day occurs. Other good guess would include, but are not limited to: MLK Day, Super bowl, etc.



1b. Term Guess: *Full Moon*

Support:

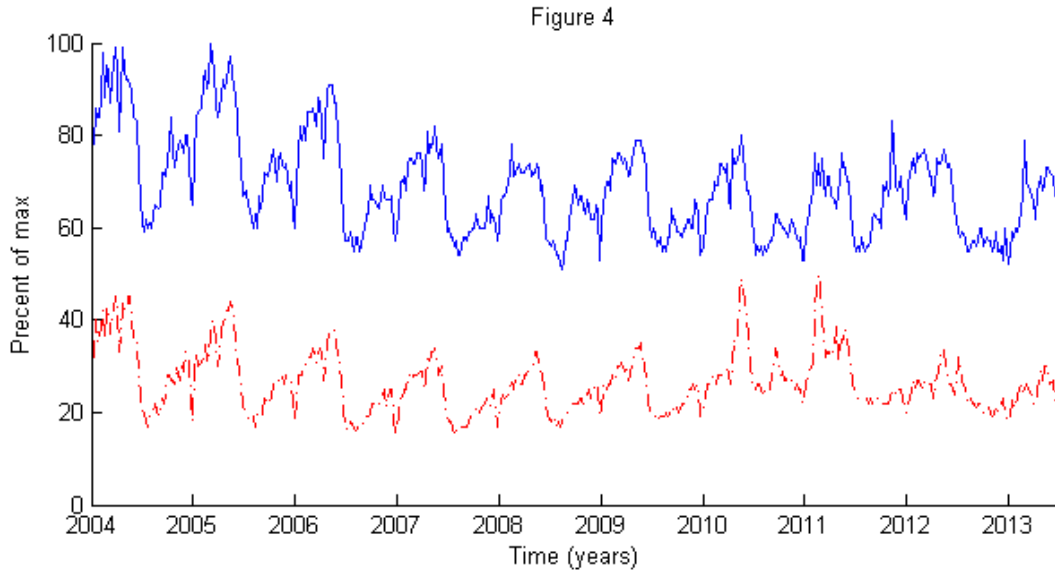
The correct answer is “full moon” because the pattern occurs approximately each month. For a fun, try typing “new moon” into google trends and you’ll see that the twilight book “new moon” ’s popularity changes that phrases trend.



1c. Blue Solid Term Guess: *Swimming*

Red Dashed Term Guess: *Skiing*

Support: *Students should notice that the trends are anti-phase with one being high each summer and the other is high in winter. Other good guesses would be ice cream and hot cocoa, sandcastle and snowman, etc.*



1d. This one is very tricky, just give your best shot:
Blue Solid Term Guess: *Romeo*

Red Dashed Term Guess: *Juliet*

Support: *Students should notice that these are both in phase with each other. Other strong guesses would be other duos such as Harold and Kumar or cat and mouse, but similar words would also be acceptable such as army and navy. Astute students will also notice that both are lower in summer than during the school year so academic guesses would be best such as Lewis and Clark or George Washington and first president.*

2. Look at graphs A and B. What is the most striking difference between them? What are these types of cycles called?

These two patterns have different periods, one cycling annually and one approximately monthly.

3. Describe the major difference between the patterns shown in Graphs C and D using the terms "phase" and "anti-phase."

Graph C has two lines that are in anti-phase meaning they have a similar pattern, but occur at opposite times. Graph D depicts two lines that are in phase or moving through time in synchrony.

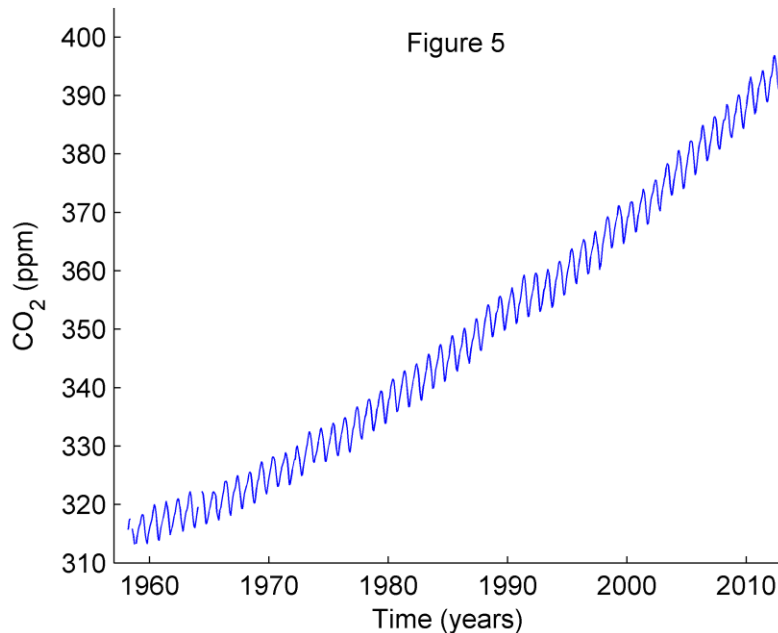
4. Many different types of scientists look at time series data like what you just saw. Give three examples of time-series data that scientists likely analyze.

Examples of time series data include: temperature, EKG (heart monitor), streamflow, brainwaves, bird song, etc., any data that is continuously sampled through time.

STOP. Wait for your teacher to discuss the answers with you before continuing.

Part 2: Interpreting Climate Data

The graph below is from the Mauna Loa Observatory in Hawaii. Scientists there have been tracking atmospheric carbon dioxide concentrations there for several decades.



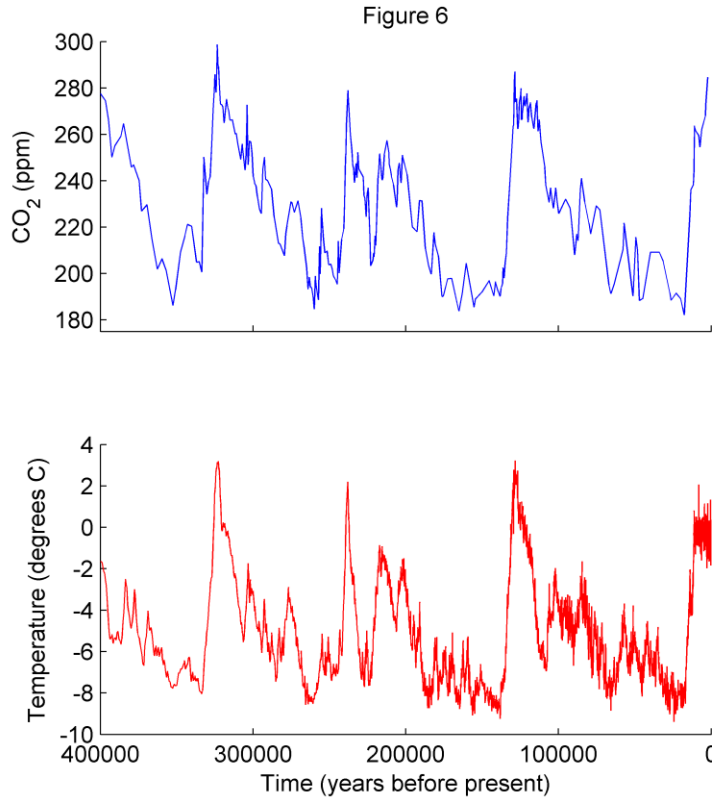
5. What are the x and y-axis labels and ranges for the above graph?
310-395 parts per million of CO₂ by the years 1955-2015

6. What general trend do you see in the data?
The data linearly increases through time. Also there is an annual increase and decrease averaging on this increasing line.

7. What do you think causes the annual cycle in this graph? (Hint- it has to do with plants in the Northern Hemisphere)
The Earth sort of takes a breath once a year. When plants grow leaves in the Northern hemisphere each Spring lots of CO₂ is taken up. Each fall, the plants lose their leaves and release CO₂. - Students might not think of this on their own, but it's important to point out so that they understand this key graph.

8. This graph is composed of an annual cycle with a strong trend. Do you think the increasing trend might also be part of a cycle? What would we need to look at to test this?
I think the increasing trend could be part of a cycle, but we need more data going farther back in time to be sure.

Scientists working in Antarctica have been able to reconstruct temperature and CO₂ over the past 450,000 years (see graph below). This should give us a long enough scale to see if there are any interesting patterns.



9. What are the x and y-axis labels and ranges for the above graphs?

Carbon dioxide in parts per million by years before 1950

Temperature Change in degrees Celsius by years before 1950

10. Are CO₂ and temperature in phase or anti-phase?

They are in phase or correlated.

11. About how long does each cycle last for CO₂ and temperature?

~100, 000 years

12. Is there a general trend in this data? Do CO₂ and temperature increase, decrease, or stay the same through time?

No, CO₂ and temperature cycle, but stay their average stays about the same through time.

13. This graph ends at zero, which is the year 1950, so the most recent years are missing. Look at the graph of CO₂ measured at Mauna Loa for the year 2010 (page 5). Place a dot on the graph for the CO₂ concentration in 2010 and draw the line to connect it to the rest of the graph.

14. Given the previous pattern, what do you expect temperature to do in response to the increase in CO₂ and why? Draw this on the graph above.

Given the synchrony between CO₂ and temperature over the past 400,000 years, we would expect that as CO₂ increases, there will be a corresponding increase in temperature due to the greenhouse effect.

15. Does the portion of the graph you just drew look different than you would expect given the last 450,000 years? Why or why not?

Yes, the unprecedentedly high CO₂ predicts unprecedentedly high temperature in the context of the past 450,000 yrs. This is clearly not part of the recent pattern.

16. Imagine you are the scientist that led the research on this ice core. How might you explain the pattern between CO₂ and temperature, both over the past 450,000 years and the recent increase?

The answer here is a sort of summary of the exercise meant to give fast students something to do if they get ahead. This question can also be used as a good activity debrief as a class discussion.