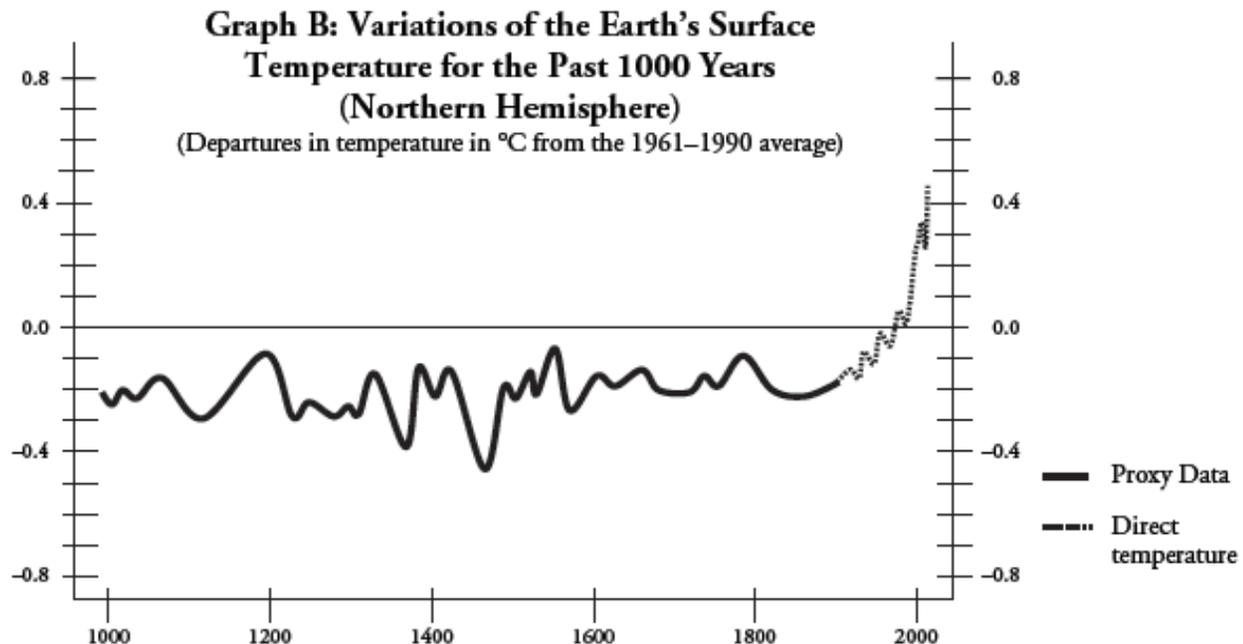
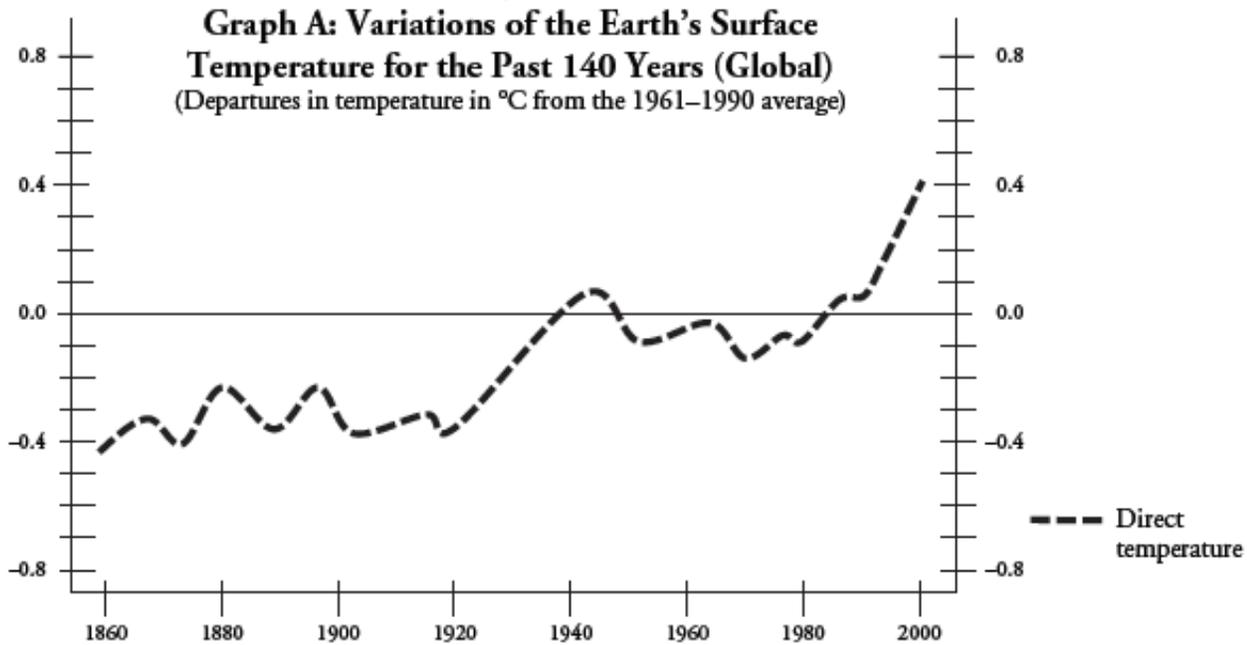


Global Climate Change - What evidence have scientists collected to support global climate change?

Obj/Module 63. Evidence of Global Warming

Why? Global climate change is a topic that is frequently discussed but often misunderstood due to the complexities of studying and predicting our earth's climate, the human impact on it, and the long-term effects of it. Making sense of complex graphs and data as well as discerning the validity of the data are important skills in climate literacy. This activity will explore the evidence that scientists have collected to support global climate change.

Model 1 – Earth's Surface Temperatures



Data adapted from the 2001 Climate Change Report, Intergovernmental Panel on Climate Change [IPCC]
<http://www.ipcc.ch/pdf/climate-changes-2001/synthesis-syr/english/question-1to9.pdf>

1. Consider the data in Model 1.
 - a. Do both graphs represent data from the same time periods? If no, specify the differences.

 - b. Do both graphs represent data from the same regions of the Earth? If no, specify the differences.

2. Consider the data in Model 1.
 - a. What is the source of the data?

 - b. What does IPCC stand for?

 - c. Take apart the word “intergovernmental.” What does this word mean?

3. The horizontal line at zero represents a baseline average temperature. From what years is this baseline temperature calculated?

4. When a data point is plotted below the horizontal line on either graph A or graph B, what does that indicate about the Earth’s average temperature that year?

5. What does the trend show in graph A? Explain your answer fully, citing specific information from the graph, including comparisons to the horizontal line at zero.

6. Compare the average annual temperature over the past 1000 years with the average annual temperature in the past 30 years.

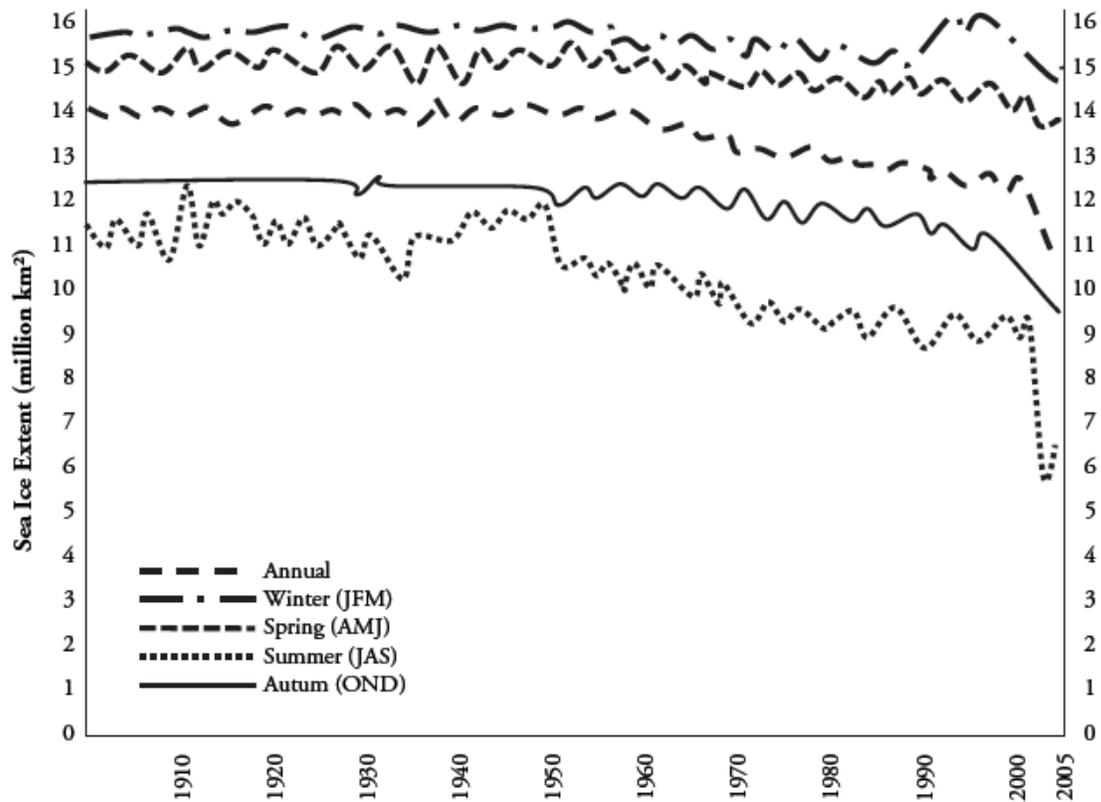
7. Is the change in temperature in graphs A and B correlated to the change in population on Earth? Justify your response.

Read This!

Some of the data for the graphs in Model 1 came from historical records. If you consider the dates on the graphs however, you will quickly realize that not all of the data could have been obtained by that method. Temperatures that are measured using thermometers and related devices are called **direct temperature** readings. The other data was deduced from tree rings, coral growth, and ice cores that were calibrated by modern time temperatures. These indirect temperature readings are called **proxy data**.

8. In graph B of Model 1, which line and time period(s) represent proxy data?
9. Tree rings vary in width from year to year, depending on the growing conditions. Which size rings would indicate good growing conditions, wide rings or narrow rings? Explain your reasoning.
10. The analysis used in the graphs has taken into account “data gaps, random instrument errors, uncertainties in ocean surface temperatures, and adjustments for urbanization over the land” (IPCC 2001 Climate Change—The Scientific Basis Report). Why do you think it is important for the scientists to take these uncertainties into account?
11. The IPCC is a multinational research effort directed under the United Nations. In its Fourth Assessment report, there was research by 450 primary scientists from 130 different countries with more than 800 contributing scientists and 2,500 experts providing over 90,000 review comments. What does this imply about the credibility of the climate change data in Model 1 from the IPCC?

Model 2 – Northern Hemisphere Sea Ice



Adapted from data supplied by Dr. William Chapman, University of Illinois. Used with permission from the author.
<http://arctic.atmos.uiuc.edu/cryosphere/>

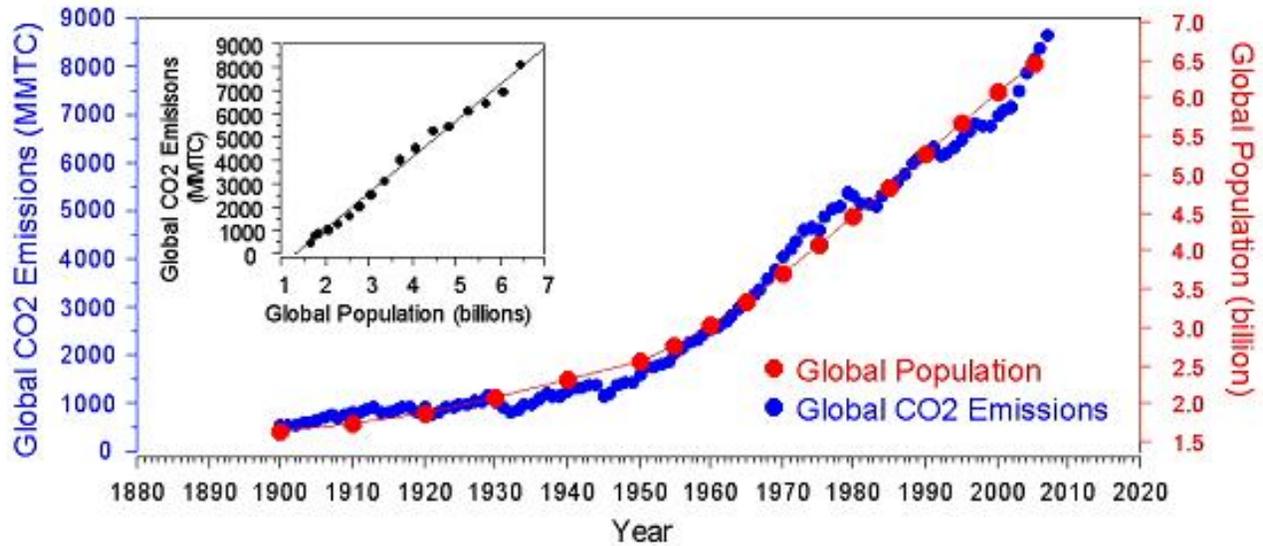
12. Consider the graph in Model 2.

- What is the dependent variable in the graph?
- What are the units for the dependent variable?
- How many years do the data represent?
- What area of the Earth is represented by the data?

13. Using the key, which line in the graph in Model 2 depicts the annual trend?

14. In which season(s) is the ice measurement greater than the annual average?
15. In which seasons is the ice measurement less than the annual average?
16. Using a complete sentence, describe the trend for the annual sea ice area over the period depicted in the graph in Model 2.
17. Using your knowledge from Model 1, propose an explanation for the change in annual sea ice area recently.
18. Melting glaciers and ice caps (polar ice at the North and South poles) provide one of the most visible signs of the effects of climate change. Why do you think this is so?
19. The glaciers and ice caps on the Earth help to reflect the sun's energy back into space. This is called the ice's **albedo**. How might the change in sea ice and the reduced albedo affect the Earth's temperature?
20. Early coal miners used canaries in cages as an early warning system to detect dangerous air conditions in mines. Arctic average temperatures have risen at almost twice the rate of the rest of the world. Some scientists are using the "canary in the coal mine" analogy to explain the importance of these data. Why do you think that conditions in the arctic are considered to be an early harbinger of climate change events?

Model 3 – Global Yearly CO₂ Emissions and Population Growth



21. What are the main sources of CO₂ for the time period shown?

22. What accounts for the dramatic change in CO₂ emissions shown in the graph?

23. What is the total rise in CO₂ emissions over the past 60 years? What is the percentage rise?

24. Refer to Model 1: Graph A. What is the total rise in temperature over the past 100 years? Calculate the rate of temperature change per year.

25. Some scientists predict a temperature rise of 1° to 3.5°C is enough to raise sea level an additional 15 to 95 cm (6 to 36 in). Using the rate you calculated in question 24, how long would it take the sea to rise this distance? (*Hint: time = distance/rate*)

26. What additional information would you want to have to understand these trends more fully?

27. List any other greenhouse gases that could contribute to global warming and climate change.

28. What additional data or proof would you need to establish human-generated CO_2 as the principle reason behind global warming?

29. What is the difference between the greenhouse effect and global warming?

