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Activity Focus: In this case study, students learn about solar cycles that cause a change in the amount of solar radiation received by the Earth. Students are asked to analyze how these solar cycles might be contributing to global warming and climate change.

Major Concepts: Strong evidence exists that shows an accelerated rise in global temperatures over the past 30 years. In the media, much attention has been given to the increase in concentrations of the greenhouse gas, carbon dioxide. The central cause of this increase is being blamed on human activity, specifically the burning of fossil fuels. In addition to greenhouse gasses, however, sunspot cycles occur that relate to periods of increased solar activity (solar maximum) and decreased solar activity (solar minimum). This eleven-year cycle has been shown to have remarkable effects on global temperature. Sunspot cycles can be shown to have contributed to current warming, but cannot explain the persistence of current warming. During the current solar minimum (2008) global temperatures still appeared to be on the rise.

Objectives: After completing this activity, students will be able to:

- identify the relationship of sunspot cycles to Sun radiation output.
- relate the intensity of sunspot activity to global temperatures.
- recognize that cyclical conditions cannot explain the persistent change in global temperature increases.

Materials and Preparation: You will need to prepare the following materials before conducting this activity.

- Copy the Case Study (make 1 copy per student).
- Make a transparency or PowerPoint slide of diagrams and graphs (appendix) for use in the class discussion. (Providing a computer with the student copy opened works well as the students can see the color images in the context of the activity.)

Procedures: Students may work individually or in small groups to complete the activity.

1. Distribute the activity packet and ask students to read the introductory paragraph. Students can discuss this material in small groups or as a class.
2. If the case study is being done as a class activity, each chart and diagram can be displayed for the class to see and discuss. If being done in small groups, the charts and diagrams can be provided as color prints or made available as computer displays. (Providing a computer with the student copy opened works well as the students can see the color images in the context of the activity.)

3. Discuss the activity as a class, asking students to share their responses to the questions.


Assessments: The following assessments may be used as a pre/post activity or as part of a module assessment.

- Does sunspot activity cause the Sun to give off more or less solar radiation?
- How might increased radiation from the sun (sunspot cycle) affect the Earth’s temperature?
- Could the sunspot cycle explain the recent increase in global temperature? Explain your answer.
- Why would the increasing level of greenhouse gases in the atmosphere be a better explanation for global warming than the factors involved in the sunspot cycle?

Quiz: The following quiz may be used as a post-activity assessment.

Which statements are true? (Circle any that are correct)

- Increased sunspot activity causes decreased solar activity.
- Solar Maximum occurs about every eleven years.
- The Earth warms more during a solar maximum.
- When solar activity is low, the Earth cools.
- During solar minimum, more solar storm activity occurs.
Bibliography

NCDC mean annual global temperatures, 2007

NASA Earth Observatory Library http://eob.gsfc.nasa.gov/Library/

http://www.space.com/scienceastronomy/solarsystem/solar_max_sidebar_000131.html

NASA Explores www.nasaexplores.com


Sunspot image www.windows.ucar.edu

NOAA Earth System Research Laboratory, 2007
http://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html

Appendix: Data Masters

www.windows.ucar.edu www.nasaexplores.com
The Sunspot Cycle, 2007  
http://solarscience.msfc.nasa.gov/images/ssn_yearly.jpg

Source: data graphed from U.S. National Climate Data Center mean annual global temperatures 2007

Temperature (°C) deviated from normal 1880-2007

Source: data graphed from U.S. National Climate Data Center mean annual global temperatures 2007

Temperature Deviated from Normal 1985-2007

Source: data graphed from U.S. National Climate Data Center mean annual global temperatures 2007