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A global warning

Teaching tips

The student sheet, **A global warning. Is the Earth getting warmer ?** is intended to introduce the theme of global warming as a controversial scientific issue. Using an OHT of the sheet to initiate a class discussion, find out what the class already know about global warming and if they have any strong views on the subject. For example, do they see global warming as a controversial subject or, in their minds, is it all clear cut? Do they understand what global warming and the greenhouse effect mean? What are the problems associated with global warming? Why are so many governments concerned with it?

The sheet has been presented as a conversation between two young children. This is to try and get over the point that even though most people think that they understand global warming; the fact is that it is an extremely complex subject and many scientists disagree. The sheet aims to challenge existing ideas about global warming. This may cause cognitive conflict. The students should be encouraged to discuss their ideas before they go on to look at the data.

The newspaper headlines have been deliberately chosen to create an air of uncertainty relating to the scientific world and to introduce some of the vocabulary. For example, some students may wonder why there might be another ice age if the world is warming up. Through discussion with the class, highlight some of the scientific problems that face scientists *eg* data collection when there are so many variables, or the use of models to predict future temperatures and levels of greenhouse gases. Stress that all these factors and many more lead to scientists being uncertain about the future of global warming.

The purpose of the introduction is to highlight some of the areas of uncertainty and not to try and answer all the questions. After looking at climate data there will an opportunity for the students to formulate their own opinions on the subject and to debate any future steps that should be taken by scientists and governments.

For this activity to be successful it must be introduced through discussion otherwise the students will not appreciate the complexity of the problem, and they will not see the point of interpreting different types of data.

Key words from the newspaper articles that may need introducing:

- Greenhouse effect;
- Global warming;
- Modelling.

The greenhouse effect and global warming This sheet presents students with an opportunity to explore the greenhouse effect and global warming in more detail, through a 'cut and stick' approach. It should be used before going on to look at the data, if the class are unfamiliar with the greenhouse effect.

Climate models are computer programmes that are used to try and reproduce climatic data by feeding in lots of different variables such as wind speed and direction, rainfall, temperature, concentration of greenhouse gases etc. When the scientists believe that the model gives a good reproduction of what actually happens, they can use it to predict the future. For example, by feeding in different concentrations of greenhouse

gases they can predict by how much the earth surface temperature will rise. This information could then be used by international governments to set future greenhouse gas targets. (See note on Casino-21, page 4.)

Interpreting climatic data

This phase of the lesson involves the interpretation of real climatic data. The data is presented in the form of temperature – time graphs. Each graph is followed up by specific questions. Questions 1–20 are suitable to be used as individual class work or homework, as each question follows on from the last.

The International Panel of Climate Change (IPCC) temperature time data has been calculated and presented relative to the 1961–1990 average. When you look at the graphs, you will see that this average works out at zero. It is important to stress that it is not necessary to present absolute temperatures, because we are interested in looking at the temperature differences. The data file is found at **http://www.cru.uea.ac.uk/cru/data** (accessed April 2001).

Finally students should compare and discuss their graphs predicting the temperature change over the next twenty years.

The extension question could be discussed in groups. It may cause some difficulty as it is really intended to act as a thought provoker for the next session. There are two key ideas to stress here:

- In order to predict future temperature changes, a full picture of the past is required.
- Data collected by different methods can be very different, so where possible, scientists try to use data from more than one source. Which data set is the most accurate or reliable?

Acknowledgements for student worksheets

Newspaper headlines – © Times Newspaper Limited, (27/7/1989, 11/9/1994, 27/9/1995, 13/8/1998, 6/1/1999).

Data source for questions 1–10, Intergovernmental Panel on Climate Change.

Data source for questions 11–22, Central England Temperature data - Crown copyright, The Meteorological Office, Hadley Centre for Climate Prediction and Research.

Resources

- OHP
- Student worksheets:
  – A global warming – OHT Master for introductory discussion
  – The greenhouse effect and global warming
  – Looking at the data – Temperature changes over the past century
  – Looking at the data – Temperature changes over several centuries
  – Looking at the data – Extension sheet
  – Student information sheet – Collecting climatic data from ice and sediment cores
  – Looking at climatic data from the past
  – Student information sheet – Collecting climatic data that is millions of years old.

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Timing

Allow 1 hour. Some classes will need longer if they do **The greenhouse effect and global warming** sheet or if they get very involved in the discussions.

Adapting materials

Some teachers may feel that the questions are repetitive, in which case they could reduce the number of graphs that are analysed. However, care must be taken not to distort the overall aims of the material.

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Methods of collecting temperature data

Teaching Tips

In this section teachers are not expected to cover all the material, rather choose activities that are suitable for each class.

Introduce this lesson by discussing the answer to the extension question in the previous session. Try to get as many ideas as possible before introducing the methods that are actually used by scientists gives factual information about how ice and sediment cores are drilled in the field and later analysed.

Looking at real temperature and time data taken from North Atlantic sediment cores and ice cores in Greenland and Antarctica

This could be introduced by reminding the class that during the 20th century the Earth's average temperature has increased by approximately 0.5 °C. However, it is difficult to predict what will happen in the future when you are looking at a small time period, because every so often there are temperature fluctuations, such as in the 18th century, just after the little ice age.

In this lesson the students analyse temperature data going back 220,000 years and then look at the results of some temperature models that go back millions of years. By looking at levels of greenhouse gases, the students are asked to try and find patterns and links between the level of greenhouse gases and the Earth's temperature. This leads naturally into the final section, namely, man's influence on global warming. The question is posed 'what should we be doing about global warming?'

Life as a scientist working in Antarctica

This section aims to give an overview of life working in Antarctica.

The student sheets include an interview with Dr Jane Francis of Leeds University who has been part of past Antarctic expeditions. Some of the leaflets and videos listed in the resources section can also be used. The task at the end asks students to write an advert for expedition scientists. The advert should focus on the type of person required, the qualifications needed and should include something about the scientific work. This could be used in careers sessions.

Resources

- Student worksheet – Life as a scientist in Antarctica
- Internet access
- The British Antarctic Survey, BAS, website **http://www.Antarctica.ac.uk** (accessed April 2001). Contact Schools Liaison Officer, British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK. Telephone 01223-221400. Enquiries from schools and students: schools@bas.ac.uk
- The old BAS website still has information for schools **http://www.nerc-bas.ac.uk/nerc-bas.html** (accessed April 2001)
- Antarctica The White Laboratory – a 25 minute video available from BAS

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- Living & Working in Antarctica – an information leaflet available from BAS
- US Antarctic Resource Centre **http://usarc.usgs.gov/** (accessed April 2001)
- **http://www.antarcticanz.govt.nz/education/education.html** (accessed April 2001)

Timing

It is suggested that no more than 1 hour is spent on this section.

Opportunities for ICT

- Internet based research
- Writing a job advert

Opportunities for other key skills

- Communication – writing a job advert
- Application of number – working out percentages and using the results to determine temperatures from graphs.
- Working in groups

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Looking at the data – temperature changes over several centuries

1. Yes, it was cooler, the temperature change oscillated more.
2. 19th century.
3. Approximately 1699.
4. It took about 4 years to warm up by a degree.
5. Temperatures reach a similar maximum temperature and then in the late 1730s the temperature fell again.
6. Similar temperatures.
7. Again, stress that the 'correct' answer is unknown, accept any reasonable attempt.

8, 9, 10. Teachers may wish each group to report back.

Extension sheet

At this point it may be appropriate to summarise the results so far.

1. Conclusion– the evidence considered so far indicates that the surface temperature of the Earth has increased by about 0.5 °C during the 20th century, but the evidence is too limited to make firm predictions about future temperature changes.
2. In practice several different methods are used. Geologists look for fossilised / petrified plants and animals, in sediment cores from fresh water lakes and the seabed. Surface rocks can also be used to reveal clues. They use the temperatures that these animals lived in to determine the temperature. Ice cores are used to determine the temperature by looking at the ratio of oxygen isotopes. Air pockets are sampled to reveal CO_2 levels from past climates. Accept any reasonable answers.

Looking at climatic data from the past

1. There has been a small temperature decrease before stabilising out.
2. 16,000 and 50,000 years ago.
3. 12000, 22000, 36000 years ago.
4. The last time the temperature was similar to that today, it was followed by a gradual decrease over the next 10000 years. This could happen again.
5. It has not really varied but been stable.
6. Approx. 124–128000 years ago.
7. 5 °C lower than today.
8. 20–30000, 60–70000 and 140–150000 years ago.
9. 140–150000 years ago.
10. The temperature rose to reach the maximum recorded temperature (greater than today's temperature). Over the next 200 years the temperature rapidly dropped to today's temperature, where is stabilised out over the next 400 years before it continued to drop further.
11. Temperatures continued to drop until they reached a minimum.
12. It may follow the pattern of 130000–100000 years ago, plunging us into the next ice age.

13. Last 10000 years have seen a stable temperature.
14. Sediment cores show temperature changes of 10 °C, whereas the ice cores show changes of only 5 °C.
15. Yes, they follow the same general pattern.
16. Different methods of collection. Maybe harder to determine the timescale in sediments as they take longer to form.
17. Problems – Which set of data is correct? Should we only look at patterns and not actual numbers? Question – Why should the temperature vary so much? What causes the temperature trend to change direction?
18. a) Warmer that today.
    b) 3
    c) One every 100–200 million years.
19. Not really, but it does show that the Earth's climate has changed many times in the past and will change again.

Collecting climatic data that is millions of years old

1. The main problem is that the ecology may have evolved and the plants are different. The plants growing in the Southern hemisphere are not as well documented as the plants in the Northern hemisphere.
2. a) 40% smooth = 12 °C
   b) 70% smooth = 22 °C
   c) 20% smooth = 7 °C
   d) 90% smooth = 28 °C
   e) 30% smooth = 10 °C
   f) 50% smooth = 16 °C
3. a) Photograph A, the tree rings are wide indicating a lot of growth during the season. This tree grew very well under a greenhouse climate with plenty of water and warm temperatures. It is 100 million years old.
   b) Photograph B, some of the rings are closer together than others, indicating years when the tree did not grow much, due to lack of water.
   c) Photograph B shows the occasional drought, most of the time it grew well. Note the round holes were formed by boring worms when the tree was driftwood. The holes were then filled with sea floor sediment. The wood is now petrified.

Extension question – The answer should indicate some understanding that modern instruments are much more sensitive than they were even fifty years ago. Also the readings are now taken from all over the world, whilst early readings are limited geographically. Temperatures obtained from oxygen isotopes are measured using very sensitive equipment, but the method is built upon several assumptions. Temperatures collected by fossil methods are much less accurate because it is much harder to get large enough sample sizes and some temperatures are estimated using the nearest living relative! Exact measurements are not made.