Ozone hole

Activity description

In this activity students suggest types of function to model ozone hole data (given in a table and also a graph) before using a graphic calculator or spreadsheet to find at least two particular models. They then consider how well their functions model the data and what they predict for the future.

No answers or reflection questions are provided. This is so that this activity can be used as an assignment for assessment without the danger of students finding model answers here.

Suitability and time

Advanced (Level 3); 1–4 hours depending on the methods used

Resources

Student information sheet and worksheet
Optional: Slideshow

Equipment

Graphic calculators or computers (with Excel) or graph paper
Optional: internet access

Key mathematical language

Functions, models, percentage errors

Notes on the activity

If students have not had much prior experience of modelling, they may need a lot of help. For example, you might need to remind them of the typical shapes of the graphs of different types of functions (such as linear, quadratic, cubic, exponential, logarithmic, trigonometric).

You may prefer to tell students which type of functions to use and/or to split the data into sections and ask them to use different functions for each section.

However, if students already have experience of modelling data from other real contexts, you might expect them to decide what to do for themselves and in this case you could use this activity as an assignment.

During the activity

The models and real data can be compared using percentage errors and/or graphs drawn on graph paper, graphic calculators or computers. A graphic calculator or spreadsheet will enable students to investigate models quickly and easily. If you use graph paper, split the work between groups of students and pool results.

Points for discussion

- Whether it is better to use a single function to model the whole dataset or to use different functions for different subsets of the data.
- What types of function could be used as models.
- The dangers of using a model to extrapolate/predict future changes.

Extensions

Students could read more about this topic on the internet, or search for new data and consider whether or not their functions are still good models.

Montreal Protocol http://www.atm.ch.cam.ac.uk/tour/glossary.html#m

The Montreal Protocol was signed in 1987 by many countries with the aim of reducing the use of CFCs (chlorofluorocarbons) which had been responsible for damage to the ozone layer. Since then, further amendments to the protocol have imposed even greater restrictions. Students could be asked to look for any evidence indicating that the Montreal Protocol has been successful.

A progress report 'Achievements in Stratospheric Ozone Protection' published in 2007 said that 'The ozone layer has not grown thinner since 1998 over most of the world, and it appears to be recovering because of reduced emissions of ozone-depleting substances. Antarctic ozone is projected to return to pre-1980 levels by 2060 to 2075'.
http://www.epa.gov/ozone/2007stratozoneprogressreport.html#poster

Based on the work they have done, do students agree with this statement?

Further information about ozone can be found at the following websites:

NASA
http://ozonewatch.gsfc.nasa.gov The Ozone Hole Watch gives up-to-date data and animations.

http://ozonewatch.gsfc.nasa.gov/education/index.html for further teaching resources and activities.

University of Cambridge Centre for Atmospheric Studies
http://www.atm.ch.cam.ac.uk/tour for 'The Ozone Hole Tour'.

US Environmental Protection Agency
http://www.epa.gov/ozone/basicinfo.html for basic information about ozone depletion.
http://www.epa.gov/ozone/intpol/mpagreement.html for information on international developments.
http://www.epa.gov/ozone/intpol/pograph.html for a graph showing planned reductions in HCFC (hydrofluorocarbon) emissions.

http://www.epa.gov/ozone/strathome.html for the ozone depletion web area which has many weblinks to other information.