climate*prediction*.net

Investigating Climate Model Output

For this exercise you will need to have the climate*prediction*.net model running on each of the classroom computers (go to http://www.climateprediction.net/download/index_ou.php)
And you will need to download the Student Visualisation Interface from http://www.climateprediction.net/client/help/vis2.php
Ideally, if you have had the model running on several computers over a long period of time, you will have your own, unique data sets to explore. If this is not possible, download 3 sets of data from a finished experiment (NB a very large download, 300Mbytes each) from

http://www.climateprediction.net/openu/experiment_sample/Expt files.zip
http://www.climateprediction.net/schools/data/Expt2.zip
http://www.climateprediction.net/schools/data/Expt3.zip

You should put each file in C:\Program Files\ Climate Prediction\archive on each computer and unzip it.

In this session you will have a look at the results of 3 climate models, each with pre-industrial carbon dioxide levels and then with doubled carbon dioxide levels to see what the effect of increasing carbon dioxide levels on the Greenhouse Effect is. No climate model is perfect, so, by comparing the pre-industrial modelled temperatures with what the average (mean) temperature really was, you can see how good each model is, and then adjust the predictions it makes for the future accordingly.

Before starting the exercise you may like to ask the class

- What is a climate model?

- What are the limitations of climate models?

- Why do we need to look at many climate models to get an idea of what might happen in the future?

Distribute the following list of locations to the students, working in pairs

London 0° 52°N pre-industrial temperature: **7.17°C**

New York -72 °W 42 °N pre-industrial temperature: **4.89°C**

Cape Town 18 °E -34 °S pre-industrial temperature: **15.96°C**

Buenos Aires -58 °W -34 °S pre-industrial temperature: **19.01°C**

Christchurch (New Zealand) 172 °E -43 °S pre-industrial temperature: **10.06°C**

Bombay 73 °E 19 °N pre-industrial temperature: **25.21 °C**

Moscow 37°E 56 °N pre-industrial temperature: **-0.41°C**

Shanghai 120 °E 32 °N pre-industrial temperature: **14.17°C**

Tokyo 140 °E 36° N pre-industrial temperature**: 8.39°C**

Honolulu -157 °W 22 °N pre-industrial temperature: **23.34°C**

Mexico City -99 °W 19 °N pre-industrial temperature: **15.74°C**

Vancouver -123 °W 50 °N pre-industrial temperature: **1.65°C**

Cairo 32 °E 30 °N pre-industrial temperature: **20.38°C**

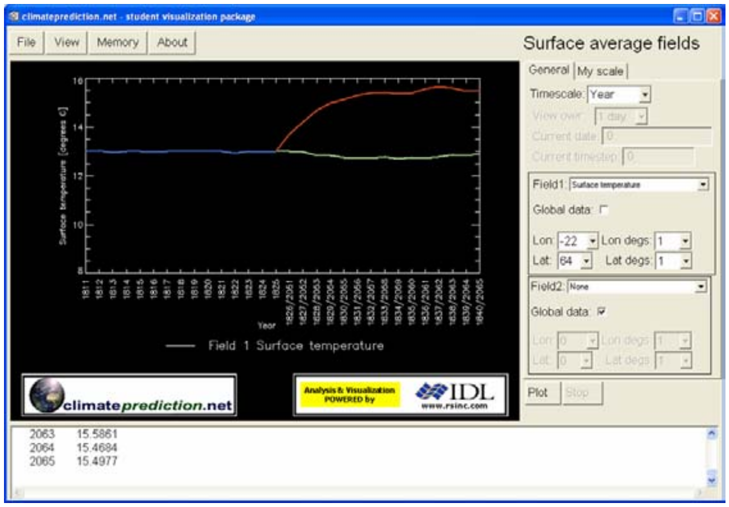
Timbuktu -3 °W 17 °N pre-industrial temperature: **25.89°C**

Reykjavik -22 °W 64 °N pre-industrial temperature: **2.86°C**

Rothero Research Station, Antarctica -68 °W -67 °S pre-industrial temperature: **-12.35°C**

The exercise is much quicker if done in Excel (using copy and paste) to find the mean values, but can be done with a pocket calculator.

- Double click on the 'SVI' icon
- Select 'change experiment' from the 'file' menu and choose one of the experiments
- Select 'surface average fields' from the 'view' menu
- Check that 'timescale' says 'year'
- Check that 'field 1' says 'surface temperature'



Click on ‘global data’ for field 1, and then enter the grid reference for your location in the world. ‘Lon degs’ and ‘Lat degs’ should stay as 1 degree.
Press ‘plot’.
The package will calculate the average surface temperature for each of the 45 years the model ran at your position in the world.
You need to calculate the average temperature between 1826 – 1840. Add up the 15 values for those years (you can use the scroll bar at the bottom to get to the right year, copy and paste the numbers into Excel and write an expression to calculate the average)

e.g. = (A$1 + A$2 + A$3 + A$4 + A$5+ A$6+ A$7+ A$8+ A$9+ A$10+ A$11+ A$12+ A$13+ A$14+ A$15)/15.

Or use Excel functions such as SUM or AVERAGE.

Record the value you get here:

To calculate the **absolute error** for this value, see which of the 15 values is most different to the average – to do this you need to subtract the average from each of the numbers in turn and see which has the greatest **residual**.
Record the greatest residual here:

absolute error

To calculate the **percentage error** for this value, divide the residual by the average and multiply by 100.

percentage error = absolute ⁄ average x 100

to get the **scaling factor** for this experiment, divide your value by the ‘real’ value for your city, which is in bold next to the city location on your piece of paper

scaling factor:
= value÷ real value

experiment name:

The scaling factor is how much you need to adjust the model answer by to get the real answer.
Now do the same for the other 2 experiments:
average temperature:

scaling factor:

experiment name:

average temperature:

scaling factor:

experiment name:
Now you need to do the same for future estimates:
calculate the average temperature in each model for the period 2051 – 2065 and divide this by the scaling factor for that model to get what the 'real' future temperature should be

model average temperature for 2051 – 2065 ÷ by scaling factor =scaled temperature:

model average temperature for 2051 – 2065 ÷ scaling factor =scaled temperature:

model average temperature for 2051 – 2065 ÷ scaling factor =scaled temperature

Now you need to calculate the average of these predictions for the future – add up the 3 scaled temperatures and divide by 3.

Average future temperature:

This is what the 3 models predict the annual average temperature at your location will be when carbon dioxide levels have doubled – some time this century.

Is it warmer or colder than it was in pre-industrial times?

Questions at the end of the lesson

- Find out where in the world warmed most and where warmed least/ cooled – discuss the fact that the climate does not change by the same amount everywhere. This model does not have a complete ocean, so the Gulf Stream can not slow down, but if it did, the effects would be very localised with not as much heat being transported from the tropics to the poles leading to warming of the tropics and cooling of the poles. Other effects can be much more localised – the British Antarctic Survey have found that some parts of Antarctica are cooling whilst other parts are warming.
- Find out where in the world had the most year-to-year variability (=error bars) and where had least. What does this variability mean in terms of weather – hot years followed by cold years etc.
- Ask why the temperature doesn't double everywhere when you double carbon dioxide. (feedback mechanisms – e.g. warmer, more cloud, more incoming solar radiation radiated back to space)

Possible extension

- do the same for precipitation