

USSP 2014:

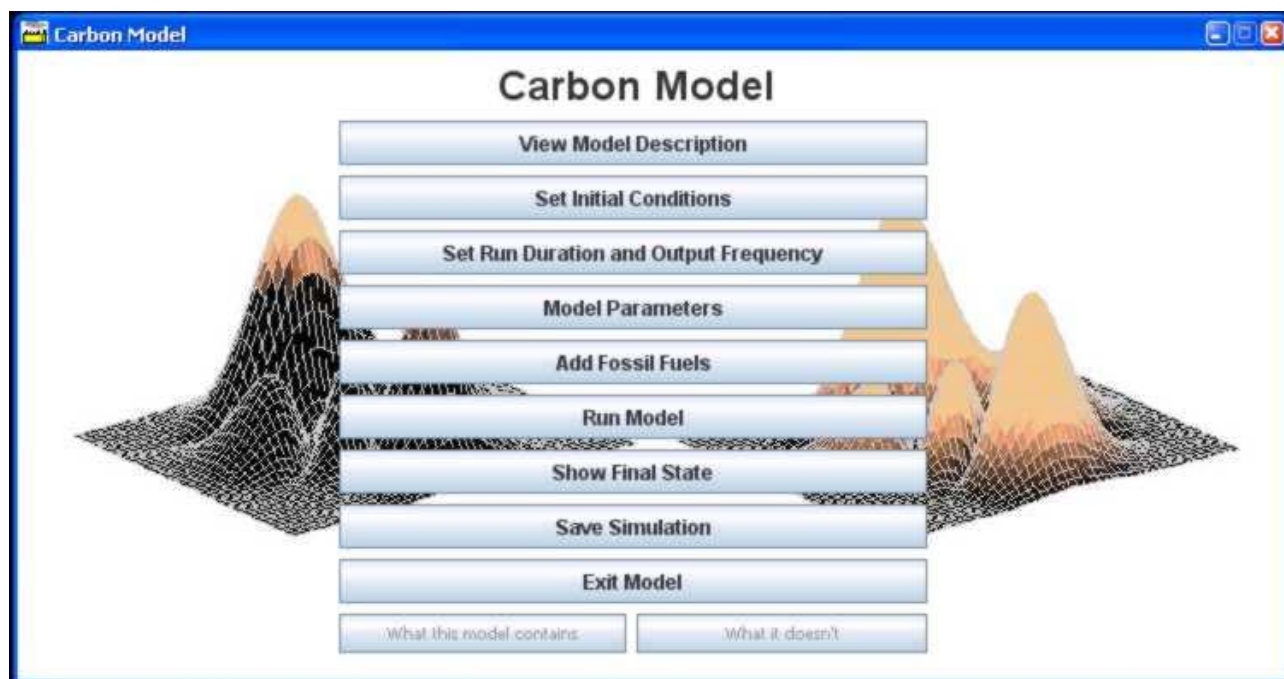
A brief guide to Toby Tyrrell's JAVA 'C Model'

- 0.1 For some of you, using numerical models of the climate system and/or global biogeochemical cycles might seem about as much fun as sticking your tongue in an electrical outlet ...

However, the model you are going to use has a relatively simple (maybe *too* simple!) to understand configuration and comes with a graphical interface for setting up experiments and viewing the results.

Run (e.g. double-click) on **C_Model.jar**.

You should now have the following (Carbon Model) window on your screen:



If not ... all is already lost ... ☹

- 0.2 Click on **View Model Description** button and read the brief description contained there (and look at the cartoon illustration).

The most important information you need about the model is encapsulated in the figure (RH side of the webpage) **Physical structure of the carbon model** (click on this to make it bigger). Basically, you are using a model that represents the entire global ocean as just 3 boxes – one for the surface, one for the intermediate depths, and one for the deep ocean. The only ‘circulation’ in the model is accomplished by mixing between the boxes. (There are also boxes for the atmosphere and the underlying sediments – again, globally averaged and lacking any spatial resolution.) Maybe this degree of spatial simplification might ‘matter’ (i.e., influence the predictions)?

- 0.3 This model includes many of the processes described in the lectures. Hence, by ‘playing’ with this model and changing some of the processes, one should be able to get a better feel for how biogeochemical cycles ‘work’ and how important they are (or not) to atmospheric $p\text{CO}_2$. This is one of the best uses of numerical models – improving your understanding of the Earth system (climate and global biogeochemical cycles). Numerical models are also a tool to answer ‘what if ...’ questions you might have (and some of the brief exercises will be doing just this).
- 0.4 Quickly familiarize yourselves with the relevant controls and outputs of the model and judge to what extent the model is capable of representing the ‘real World’.
- 0.5 First: without *changing anything* in the model: simply run it (click on the Run Model button in the main Carbon Model window). A pop-up window will open and show the model progress – it should take about 15 seconds or so to complete. (Note that the model does not solve all the equations in an instant – the solution is accomplished by taking little steps in time, one after another, and calculating the change in carbon cycle properties after each and every time step.)
When it finishes, a new Window (Carbon Model Plots) should appear containing 6 plots. There are in fact 3 pages of plots – you can move forward to the next page of plots via the Next button at the top of the screen, and back again (via Back).
- 0.6 First ... note that all the lines either go straight across or are almost straight – i.e., they don’t change with time (Time is on the x -axis and is in units of ky, i.e., thousands of years). This simply reflects that the initial values chosen for the various properties in the model (e.g., nutrient concentrations in the ocean boxes, atmospheric $p\text{CO}_2$) are about the same as the values reached after simulating thousands of years of nothing new happening, i.e., the model was already initial at (or close to) *steady state* (equilibrium). This is known as starting from a *spinup*. In the default setup of the model, it runs for 3000 years (i.e., the lines in the plots end at a value of 3.0 ky on the x -axis).
- 0.7 From the main Carbon Model control window – click on the Show Final State button. A window opens (called C_Model Final States) which provides a simple summary of some of the properties of the model reached at the end of the simulation. Again, there are several pages of values (contained in different ‘tabs’ – Summary, State Variables, and State Variables Cont).
- 0.8 You can alter the assumptions in the model via the Model Parameters button (in the main, Carbon Model window). You will see 7 different ‘tabs’, each with a different set of values you can change:
Physical, Rivers, Organic Carbon, Phosphorous, CaCO_3 , Biological, Isotopes.
When you have altered all the parameters you need:
Click on the **Apply and Close** button (NOT the Close one) to get your changes accepted.

0.9 For an example: to release (fossil fuel) CO₂ to the atmosphere:

Click on the **Add Fossil Fuels** button (Carbon Model window).

Click on the **On** icon (in the Fossil Fuels box), then the **Data** icon (in the Specified According To: box).

Under **Data Settings**, you have the option of choosing different ‘SRES’ Future Emissions 2000 – 2100 CO₂ scenarios. (The SRES CO₂ emissions scenarios represent ‘storylines’ of development up until the year 2100. They “... describe divergent futures that encompass a significant portion of the underlying uncertainties in the main driving forces [and] cover a wide range of key “future” characteristics such as demographic change, economic development, and technological change”.)

Keep the default selection of **A1B**.

Click on **Apply and Close**.

Before running the model, click on the **Set Run Duration and Output Frequency** button (main Carbon Model window). Set 2100 years as the **Duration of run** (so that the model finishes at year 2100 when the CO₂ emissions cease).

Click on **Apply and Close**.

Now run the model (**Run Model**).

1.0 You can restore all the default value in the model from the **C_Model Parameter** window by clicking on the **Default** button (it does not matter which ‘tab’ of parameter values is currently displaying) and **Apply and Close**. (To avoid confusion with previous experiments, it is advisable to close both the **Carbon Model Plots** and **C_Model Final States** windows.)