A Hitchhikers Guide to the Black Arts (of Earth system modelling)

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(Prof. Andy Ridgwell / University of Bristol & UC-Riverside / andy@seao2.org)

This workshop will give a brief introduction to and practical hands-on learning in Earth system modelling. It will provide a chance to explore the dynamics of the Earth's climate system as well as of global carbon cycling and the biogeochemical impacts of fossil fuel CO_2 emissions. The workshop will foster a critical appreciation of the nature and limitations of climate and Earth system models in trying to understand and predicting global change. But you will also see how numerical models can be utilized to address scientific questions, test hypotheses, and quantify the past and future relationship between global carbon cycling and climate and associated feedbacks. Blah blah blah.

In summary:

- You will have prescribed fun.
- You will lose all respect for climate (and other complex) models.
- But … you will also appreciate how essential models are as tools for testing hypotheses, quantifying impacts, and exploring the possible behaviours of climate and carbon cycling to (e.g. human) disruption, and generally: learning more about how the Earth system 'works'.

There are no 'pre-requisites' in terms of computer programming skills or knowledge.

The (ad-hoc / informal) outline of the day's itinerary is as follows:

- ***Session* #0 *(am)* – Getting started**
  Accessing the computing cluster; installing and compiling *c*GENIE; directory structure ('where everything is'). Command-line operation; how to submit jobs to a cluster queue. Use of 'restart' experiments and modelling methodologies. Visualization of model output.
- ***Session* #1 *(am)* – A 'real'(!) experiment**
  Setting up experiments: configuration files and setting parameter values.
  Exploring Earth system dynamics: 'Snowball Earth' and climate feedback.
- ***Session* #2 *(am)* – 'Poking the climate beast'**
  Applying perturbations and stability of the Atlantic meridional overturning circulation ('AMOC').
- ***Session* #3 *(pm)* – Poking the (short-term) carbon cycle**
  CO_2 emissions and the spatial patterns of ocean acidification.
- ***Session* #4 *(pm)* – Deep-sea sediments, weathering, and the long-term carbon cycle**
  Exploring the long-term controls on atmospheric pCO_2.

Ideally – please come to the workshop vaguely prepared (see overleaf) if you can.

Any questions – please email.

Andy (andy@seao2.org)

The course will be based around using and analysing the 'cGENIE' Earth system model (http://www.seao2.info/mycgenie.html). You will be accessing a computing cluster (deep in the basement at the University of Bristol) on which you will actually be running the model. You will hence need some means of accessing the remote computer. Unless you are some sort of wizard, I suggest bring your own laptop. You'll also need some specific software on it. The exact software will depend on your operating system, but everyone will need:

1. A terminal ('shell') window. This is no problem for linux and Mac users (you already have one built-in). For Windows, either download a simple (and old) SSH client (`ssh-client`) from my website (http://www.seao2.info//cgenie/software/ssh-client.exe) or you can get hold of e.g. `PuTTY` (http://www.putty.org/).
2. An sftp (secure file transfer) client for convenience (i.e. dragging and dropping files between local and remote computers, and opening files directly on the remote computer cluster). If you have installed `ssh-client` (Windows, above) then a sftp client is already included as part of this software. If using `PuTTY` (Windows) you might try downloading WinSCP (http://winscp.net/eng/index.php). For the Mac – I am told that `Cyberduck` is OK (there are bound to be many other alternatives). For linux, maybe `FileZilla`.
3. A viewer for netCDF format spatial data. A Java viewer called `Panoply` is provided by NCAR for all platforms – http://www.giss.nasa.gov/tools/panoply/
   (Note that you will need Java installed!)
4. A simple text editor, except not the rubbish default Windows one – you need one that can display unix ASCII text without screwing it up. Options for Windows users are:
   `notepad++` (https://notepad-plus-plus.org/)
   `SciTE` (http://prdownloads.sourceforge.net/scintilla/Sc355.exe)
   (linux and Mac users need no special/different editor compared with your standard editor – everything will display just fine).

One slight caveat with the written instructions that you will be given is that they assume that you will be running Windows and using `ssh-client` (and an old version of `Panoply`). So you'll need to translate the instructions a little depending on your operating system.

It is also possible to install and run the 'cGENIE' Earth system model directly on a linux box (e.g. Ubuntu) or a Mac. Sets of instructions ('Quick-Start Guide') are available on my website (under '`got muffin?`'): http://www.seao2.info/mycgenie.html

Actually, by some miracle, it is also possible to run the 'cGENIE' Earth system model directly on a Mac (PDF instructions can also be obtained from the list in the '`got muffin?`' box on the LH side of the webpage).

Note that it is not possible at this time to run cGENIE ('muffin' version) under Windows (at least, not without near infinite pain).

Also note that if you have trouble installing and running cGENIE on your own linux box or Mac, there may not be time to sort out the problem (and in any case, I have no clue at all about Apple hardware and software, and nor does the FBI by all accounts). If so, you'll have to access and run the model remotely. (There are also advantages to running on the remote cluster as you will see in due course.)

Summary: you can run the model (a) On a (remote) computer cluster account which is provided for you, and you provide a 'terminal'/mean of connecting (== easiest). (b) Install, the model on your own laptop if you prefer (/dare) (== hardest, but more 'fun'?).