2. Further ideas

2.0 Assessing the importance of emissions rate

By editing the flux and/or timing information you can control the CO_2 emissions trajectory and total fossil fuel burn. Explore different CO_2 release assumptions and note their impact on climate and ocean biogeochemistry. Much more realistic and appropriate to our current global experimenting is a lower rate (order of 10 or 20 PgC yr^{-1}) released over a longer interval (order 100 years) compared to the conceptual 1000 PgC near instantaneous pulse. Because the experiments are getting longer to run in real time … remember to make appropriate use of the cluster queuing facility – i.e. think about whether you want to sit around starting at the screen for 15 minutes waiting for a new line of numbers appear – if not: submit to the cluster queue. For instance, one might try and address the question: "For a given total release of CO_2, is it safer to burn it slower?" The answer is maybe not completely obvious, as burning carbon resources slower will result in a small global impact, but perhaps one that persists for longer. You could conceive of an ensemble (set) of model experiments, maybe one of 100 PgC yr^{-1} for 1 yr, one of 10 PgC yr^{-1} for 10 years, and one of 1 PgC yr^{-1} for 100 years, and run them all for e.g. 100 years. (As jobs submitted to the queue, all can be run simultaneously.) (Don't forget the control experiment!) But note that you should create 3 new *forcings* based on the original if you are editing the *forcing* and expecting to run different ones at the same time. Really, this is little from copying and renaming *user-config* files, except it involves entire directories in `genie-forcings`. Remember that the *forcing* is specified by the directory name assigned to `bg_par_forcing_name` (enclosed in `""`).

2.1 Determining thresholds of environmental impact

There are various concerns about the impacts of continuing fossil fuel CO_2 emissions and a number of proposed climatic (e.g. the 2 degree C global warming limit often mentioned in policy documents) and ecological 'tipping points'. You can assess the maximum allowable CO2 emissions to remain within particular global environmental limits in the model. For example:

What is the maximum total CO_2 release that can be made without inducing aragonite under-saturation at the ocean surface anywhere (or any season – see Section 5.2.3 in the User Manual for seasonal time-slice data saving)**? How important is the time-scale of emissions in determining this? For total emissions above this: where in the ocean does the surface first become under-saturated? How large would the emissions have to be in order to induce under-saturation at the surface in the tropics (home to socio-economically important reef systems).** These are questions that can be addressed with simple CO_2 release experiments in ocean carbon cycle models and everyone seems to get a GRL paper out of it each and every time!

How important are CO_2-cimate feedbacks in amplifying or diminishing future climate and ocean carbonate chemistry changes – e.g. is the same atmospheric pCO_2 value reached with and without climate feedback (and surface warming) – if not, why? You can investigate this by contrasting an experiment made including CO_2-climate feedback with one made without. The CO_2-climate feedback can be turned off by setting: **`ea_36=n`**.

Also: **How much CO_2 emission does it take to significantly 'collapse' the AMOC and over what time-scale? (Or alternatively: what is the atmospheric pCO_2 threshold for collapse?) If the AMOC weakens or collapses … why in the absence of a prescribed freshwater perturbation does this happen?** (Plotting appropriate ocean property anomalies between the CO_2 release experiment and a control experiment might help.)

Experiments could be hypothetical and consisting of CO_2 pulses or ramps (or exponentials) and run on directly from a pre-industrial spin-up, or more 'realistic' and run on from the end of a historical transient experiment (e.g. starting in year 2010).