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Interactive Comment

Interactive comment on "A simple object-oriented and open source model for scientific and policy analyses of the global carbon cycle – Hector v0.1" *by* C. A. Hartin et al.

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General comments

Land carbon uptake in the model is represented by net primary production and not by gross primary production. This may have some conceptual and practical problems because, i) the autotrophic flux of carbon is not included in the calculations of the land-atmosphere C exchange, and ii) this land-atmosphere exchange can't be compared against many available data products. For example, soil respiration fluxes, which include both autotrophic and heterotrophic sources can't be compared with model predictions. Similarly, ecosystem level fluxes can't be compared with eddy-covariance derived fluxes or GPP estimates from satellite products. Can you explain why the autotrophic component of the land C cycle is not included in the model? Do you plan to include this in the future, or is there a particular reason why you believe this should not be included?

As the reviewer notes, we have chosen, in this 1.0 version, to implement the terrestrial-atmosphere C exchange as the difference between NPP and RH, rather than breaking out GPP and RA separately. This makes for a simpler model but, again as the reviewer correctly notes, limits our ability to compare to, for example, remotely-sensed GPP. This is a choice that could (and probably will) be changed in the future; we've logged it as an "issue" on the project repository at https://github.com/JGCRI/hector/issues/53. We have added the following to the manuscript under section 7.0: "For example, Hector does not currently simulate terrestrial gross primary production, a key metric of comparison to e.g. the FLUXNET database."

The documentation of the model in GitHub is incomplete and needs to be finished. In particular, the authors should describe better the steps for compiling and running the model in different OS. Given that this documentation is written in Markdown language, the authors should provide a step-by-step procedure for compiling and running a simulation using syntax highlighting. A demo on how to analyze the results using the R scripts would be also very useful.

All documentation of the model is now on Github wiki, including how to compile and run Hector in each OS, how to guides such as; add new components, unitvals, tseries and a demo of the R backend. All documentation is found at: https://github.com/JGCRI/hector/wiki

Figure 4 shows a very high sensitivity of Hector for predicting temperature anomalies. The slope after the 1960s is much larger in Hector than in the other models. Can you comment on this large sensitivity?

We have addressed and fixed the high temperature sensitivity after 1960 by includ-

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ing a variable ocean heat flux, as well as lagging the temperature effects from atmospheric [CO2]. There are numerous processes that are not simulated in Hector that buffer the temperature effects of increasing GHGs. Therefore, we take a simple approach in this current version and lag our temperature. We have addressed this in the manuscript section 4.1, “As global temperatures rise, the uptake capacity of the ocean thus diminishes, simulating both a saturation of heat in the surface and a slowdown in ocean circulation with increased temperatures. Finally, the temperature effects from atmospheric [CO2] are lagged in time, as there are numerous real-world processes not simulated in Hector buffering the temperature effects of increasing atmospheric [CO2].” See figures 4 and 8 for updated global temperature change.

Technical and other comments Page 7076, lines 22-23. I would say that fully coupled Earth system models (atmosphere-ocean-land) are at the complexity end, and not just AOGCMs.

The authors agree with the reviewer and have edited the title as suggested: “To accomplish this, a hierarchy of climate models with differing levels of complexity and resolution are used, ranging from purely statistical or empirical models, to simple energy balance models, to fully-coupled Earth System Models (ESMs) (Stocker, 2011).”

Page 7080, line 28. Change _ for d. The _ notation is commonly used for isotopes in C cycle models. Equation edited as suggested. “$dC/dt < \varepsilon$”

How do you calculate NPP0 and RH0? I think this formulation of RH is potentially dangerous because you may respire more C than what is available in the pools of equation (8) and (9).

In regards to NPP0 and RH: NPP0, the global preindustrial NPP flux, is specified a priori, not calculated. The use of RH0 in Equation 5 was a mistake, for which we apologize. At any point in time, model RH is always a function of the current carbon stocks in soil and litter.

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Equation (12). What is the last term Fi? It seems to me that this term violates mass balance. What additional flux, different from all inputs and outputs, can modify the net change?

The last term Fi is now the carbon flux to/from the atmosphere to/from the ocean. Equation 12 has been changed accordingly.

Page 7058, line 25. Replace 'model' for 'version'.

Model has been changed to version as suggested by the reviewer.

Equation (15). Why do you use a difference equation instead of a differential equation? Is this process discrete in time?

The reviewer brings up a good point. We updated equation 16 to reflect changes from a difference solution to an exact solution. Operating on a finite timescale introduces more error than an exact solution. $C(t) = C0 * \exp(-1/T) + E * T * (1 - \exp(-1/T))$

Interactive comment on Geosci. Model Dev. Discuss., 7, 7075, 2014.