

## ***Interactive comment on “CARBON-DISC 1.0 – A coupled, process-based model of global in-stream carbon biogeochemistry” by Wim Joost van Hoek et al.***

### **Anonymous Referee #2**

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The authors present a model development to simulate the concentrations, transformation and transfer fluxes of dissolved inorganic carbon (DIC), dissolved organic carbon (DOC) and terrestrial and autochthonous particulate organic carbon (POC) from headwaters to river mouth, and which is supposed to be useful for global simulations and future scenarios. I find the manuscript is poorly written, files in supporting documents are corrupted and results are not convincing, neither for model validation nor its potential global application. Therefore, I do not find that this work would merit publication.

Major comments:

- Abstract: there is no reported value of globally estimated in-stream fluxes which is

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not consistent with their claimed global model title.

- Introduction: is very weakly written and mostly written after Cole et al 2007 paper. There is definitely a lack of discussion over the freshwater carbon cycle processes and need for further references. Furthermore, the authors need to discuss the existing models and any sufficiently striking advance over past publications.

- Throughout the text, almost all equations need to be revised and written more clearly with better abbreviations and definitions. The text is very unorganised.

- Results and validations: In general I do not find results convincing for the validation of model. For instance processing data from your supporting document csv for Figure 6 shows all your model simulations for the latitude of 47-50 and longitude of 7-8 is overestimated. Keeping the simulations from only this lat-lon will lower your  $r^2$  to 0.18. This is the same trend in your TOC and DIC results, just the model has underestimated at all points. You need to better calibrate your parameters. Another issue is that the model is not capable of capturing any seasonality of measured data of any kind (e.g. Figure 7). As mentioned above, you need to calibrate your model parameters better.

- Source codes: 1) I tried to run the model but when I execute the commands for abiotic, respiration or biology I get the error: "ModuleNotFoundError" is not defined." Check the files you uploaded and try to include all necessary files for the model. I believe this is due to missing/not properly linked mocsy module. 2) I took a look at your source code/carbon/code/reactions.py: Firstly: What is your model time step? Considering Line126 in text I believed it is 1 month. But apparently in your reaction routine all you values are daily and you use 365 to convert to yearly. What is the case? Also what is  $tT$ ? temperature controlling effect on reactions? If so it needs to be explained more. What is sigma and temperature correction parameter? Line 508-522 of code: why are your codes representing respiration, mortality and excretion identical? Am I missing something here?

- Model exports (Netcdf files): As a test I just analysed the raw output data and took a

look at DOC and DIC concentration randomly. Why do you have a negative value for DOC concentration in model? And why do you have a value of 7589.186 mg L<sup>-1</sup> for DOC concentration? Why are there some very high values such as 37316.32 as DIC concentration? Why didn't you elaborate on the abnormal model results, as you are aiming to have a global version of your model and these extreme or negative values will affect your future possible global estimation? This shows there may be some errors in your model that you have not fixed and it may be giving nonsense outputs for some cases.

- Table 1. Where did you find 1% fraction of DOC from total soil carbon ? I have never seen this fraction in any study. The DOC fraction is estimated between (20-40%) (Meybeck, 1982). Moreover, DOC transport from soil to river system is not only through surface runoff but also through subsurface runoff and drainage.

Other comments:

L41- Wrong reference. I could not find any statement regarding the terrestrial or aquatic sources

L42- Again, Wrong reference. Exactly which part of Cole et al, 2007 paper is referring to POC as a form of delivered C to surface waters?

L44- Give a reference for the mentioned processes

L50- Name some of these perturbations which are in line with your context?

L54- what do you mean by "informed projections"?

L58-60- Indeed we need a model which includes all these missing compartments. But your model does not include any of these. Then what is the striking advance in your model compared to the existing models?

L60- You need to include in your introduction more detail on existing models and what the improvement is in your model. e.g. compared to RIVERSTRAHLER, ORCHILEAK,

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DLEM, etc..

L64- What do you mean by designed for global application? You have neither tested your model at the global scale nor presented any global results. The only evaluation which I can find is based on the Rhine basin .

L72- what do you mean by the period 1900-2000? models can simulate C, N and P depending on the forcing data period.

L73- biogeochemistry \*processes

L76- Only air temperature is taken from CRU?

L77- What is the reason for focusing on monthly scale?

L79-81: These line are not clear. Need a revision. I do not see the link between IMAGE and soil organic carbon in Fig.1.

L81- Add more information of the hydrology parameterisation.

L85- Add these fluxes to arrows from IMAGE and SOC to CARBON-DISC box on Fig.1.

Figure1. Confusing. You need to revise this figure. Make it consistent with the explanation from L79 to 87.

L90- The whole definition of IMAGE and IMAGE-DGNM is very confusing and not clear. After several times back and forth I could understand the model structure. You need to revise this whole section. Moreover, the SPM is missing on the arrow from SOC to surface runoff. All the particle forms that you are discussing from L90 to 96 should be also in Fig.1 to make it easier to understand.

L99- You missed mentioning the temperature and radiation when explaining PCR-GLOBWB.

L99- Change solar irradiance to radiation to be consistent with Fig.1

L100-104- poorly written. needs revision.

L104- Which equations?

L106- missing “,” after environments

L116- What is the rationale to compare the monthly simulations with bi-weekly measurements?

Figure 2. caption: add what the yellow circles are

L125-129- Needs revision. You need to change the abbreviations for C. It is confusing as it is now. For instance, you can change the Ci to Ctot, Chyd and so on.

L130- I do not see the description of bgc.

L135- This has to come before the description of total C species definitions.

L137-138- Unclear. Is this referring to eq.1? Which hydrological model data?

L155- Here and for all the equations after this one definitions should be much shorter and better written. Use proper abbreviations.

L210- As an example I am pointing this out. You are bringing SEDOC here (eq11) and then I need to scroll down to eq21a and b to understand it. Very poorly written and needs better flow through the text. Bring the explanation of processes involved in each equation to appear right after it. Until further revision of the methods, I skip the rest of the method and equations.

L331- What do you mean by scheme?

L344- What was the rationale to do 750 model spin-ups? Was that enough to reach equilibrium? The presentation of your model mass balance is missing. You need to add it as well.

L335- Need further explanation of the rationale for these two set-ups.

L340- I did not find any “scheme” in your supplementary material files.

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