

Interactive comment on “Constraining a land surface model with multiple observations by application of the MPI-Carbon Cycle Data Assimilation System” by G. J. Schürmann et al.

Anonymous Referee #1

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General comments:

G.J. Schürmann et al., in their manuscript "Constraining a land surface model with multiple observations by application of the MPI-Carbon Cycle Data Assimilation System", describe the MPI-CCDAS system, and a parameter optimization/state estimation experiment with it. The authors optimize various parameters of the JSBACH land surface model, utilizing remote sensed FAPAR data and CO₂ flux measurement data from around the globe. They also analyze, how each dataset constrains carbon-related model variables, and what parameter values the MPI-CCDAS system optimizes the model to.

The topic at hand is important, since estimating the terrestrial carbon fluxes is difficult,

and uncertainties in carbon stocks and fluxes are still large. Tuning a process based model makes it possible in principle to improve forecasts of how the terrestrial carbon stocks develop in the future.

There are several good things to say about the research at hand. For instance, the MPI-CCDAS is a new and seemingly useful tool for these kinds of experiments, and valuable in itself as a further development of the CCDAS system. The case study done with the system and presented in the manuscript is reasonable and the results generally seem to be good. The authors also nicely discuss and analyze why the results look as they do.

However, the manuscript needs to be refined, expanded and clarified in some ways. These are listed in the Specific comments section

Specific comments:

According to already the first sentence of the abstract, the paper is supposed to describe the MPI-CCDAS system. However, the description of the system is unclear and there seems to be text missing between pages 2 and 3. Currently the section is written to vaguely describe that there is some data assimilation and some generic likelihood function being minimized. It would be important to include more specifics about the CCDAS method. What algorithm, how the data is used to update the state, when new parameter vectors are drawn etc. I'd enjoy explanations with formulas when needed. It would be also good to describe how the error covariance matrix for the likelihood function is constructed.

The differences of the parameter values obtained in Table 6 is large. They are discussed in the text, but there is no compact description of different error sources and their relative importances (like initial states, observation error, model bias, land cover type parametrization errors etc.). I understand that it was not the objective of this research to quantify uncertainties in the parameter and carbon stock values. Anyway, discussing the topic a bit more would be appreciated.

The language of the manuscript is not particularly good. Some sections are better than others. Very carefully checking grammar, breaking up too long sentences, checking capitalization rules etc. needs to be done. Some corrections are listed below, but they also could be wrong as I'm not a native speaker.

There is a maybe a bit too much discussion-related content in "results", and some of it could go to the discussion part.

It is stated that the "prognostic capabilities of the model have been largely improved" (section 4.3) ... which is deduced from the two-year validation period. I'd like to believe that, but two years is not much. Could you please discuss this a bit further in the discussion part.

Technical corrections

section 1 / line 63: "certain processes..." is too unspecific. Please clarify.

s. 2.1 title: Phenology-module => The phenology module, or something

s. 2.2 / l. 61: what is "smoothly averaged temperature with a "memory"-time scale of 30 days"? There must be a more precise way of saying this.

sections 2.2-2.2.4 These sections are a bit long or unstructured somehow, as they describe just standard JSBACH model physics. Particularly when compared to sections 2.2.5 and 2.1. More conciseness and clarity are needed.

equation 5: Please state the mean and standard deviation of ψ in the explanation, even though it looks obvious. As it reads, ψ could be a distr with funny values.

l. 75: "memory time-scale" (compare to "memory"-time scale earlier)... please be consistent and choose as comprehensible expression as possible

s. 2.2.2 / l 13: multiplication sign is not usually a star when printed. Use something like latex `\times` instead. Repeated many times in formulas, fix them all, please

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l. 18 should it not be exemplified "by" instead of "for"?

l. 20 ", gas" => ", and gas"

sentence spanning the lines 29-39: restructure for readability

equations 13,14,16: exp and min are not normally italicized in formulas

s. 2.2.4/l.15 turns over to => turns to

s. 2.2.5/l.36- please clarify where "these" transport matrices refers to. The "responses" or what? I would not mind if this section was a bit expanded as well.

2.3/51 why not say just "the assumed prior Gaussian uncertainty"?... and ...the posterior values from the assimilation experiments.

Funny spacing in equations 20 & 21

page 7, l. 15 "uncertainties...are based on expert knowledge" is quite subjective and ad-hoc. It's probably tricky, but I'd appreciate being more specific here. The expert knowledge has to be based on something, anyway. Please consider working on it.

l. 55 reference to EDGAR could go to references

s.4.1 / l. 69-72 the conclusion drawn is not immediately obvious to me, especially when "consistency" is not defined. I understand the basic idea here, but still, please clarify and explain.

s. 4.1 /l. 85 norm of the gradient, but it's missing of what? costfunction? with respect to what? Please be more explicit here. It's possible to guess what you mean, but that should not be needed.

4.2/27 what is "magnitude of the phenological seasonal cycle"?

l.39 "For the other"... slightly odd sentence, please check

p.12 l.14 f_photo => f_photos - usage not systematic in the text throughout it

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4.4.1/38 I read it as "an FAPAR" constant instead of "a"

4.4.2/157 C uptake , better maybe carbon uptake?

4.4.2/last sentence could be better formulated

5.1/l.80 ranging from 111-151 => ranging from 111 to 151

p. 15/l.1 References are quite old. Are there any newer ones available?

p.18/l.26 Northern extra-tropic => northern extra-tropical.

Last paragraph of conclusions: first sentence quite long, please consider restructuring

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