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Geoscientific Model Development Discussions

Interactive comment on "Towards an advanced atmospheric chemistry-enabled ESM with dynamic land surface processes: Part I - Linking LPJ-GUESS (v4.0) with EMAC modelling system (v2.53)" *by* Matthew Forrest et al.

Anonymous Referee #1

Received and published: 9 October 2018

In the text of my last submission all line breaks were missing. Here the same text but in corrected format. Hope this is better.

Review of the article "Towards an advanced atmospheric chemistry-enabled ESM with dynamic land surface processes: Part I - Linking LPJ-GUESS (v4.0) with EMAC modelling system (v2.53) by Forrest et al.

General comments

The article describes a one-way coupling of the vegetation model LPJ-GUESS with

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the ECHAM5 atmospheric model that is implemented in the modelling system EMAC. Several aspects of the resulting simulated vegetation are displayed and evaluated to be in good agreement with observations. Additionally, it is pointed out that this is a first important step on the way to build an Earth System Model (ESM) including both atmospheric chemistry as well as dynamic vegetation.

I appreciate this initiative as this ESM will be a very helpful tool to approach many important scientific questions like those listed in the abstract and the introduction. In view of the large effort it takes to construct such an ESM it is also appropriate to report already the first development steps to the modelling community. Also the text is well written. There are only two aspects, which (in my opinion) should be improved in the manuscript before publication.

First, it should be clear from the title and the abstract that no detailed plan to construct an ESM nor any results based on an ESM are presented and that the only content of the article is the coupling of LPJ-GUESS to EMAC and the evaluation of the resulting vegetation. The reader is confused by the structure of the abstract. At the beginning of the abstract ESMs are explained, then it's mentioned that the coupling of LPJ-GUESS to EMAC is presented, then the development of ESMs is motivated that include dynamic vegetation and atmospheric chemistry, to finish with a sentence that simulated vegetation patterns are in agreement with observations. It would be much more straightforward to describe the contents of the paper first and then to motivate this work or the other way around, but not to mix both aspects in the abstract.

Second, the description of the coupling is incomplete in some aspects.

LPJ-GUESS has a daily time step. This should be mentioned in section 2.2 and not only in the appendix. As the atmosphere model resolves the daily cycle, I guess, EMAC is building daily averages at the end of the simulation day and then passing it to LPJ-GUESS. Please describe this. What does it mean in terms of photosynthesis and stomatal conductance? These variables have a strong daily cycle, depend on

each other, and also depend on the daily cycle in atmospheric conditions, but they are calculated by LPJ-GUESS on a daily basis.

What variables are passed from EMAC to LPJ-GUESS? Precipitation, snow, solar insolation (split in visible and NIR?), wind?, temperature (surface temperature, 2m temperature, temperature of the lowest atmosphere level?), atmospheric humidity?, etc. A list of variables could easily be added to section 2.3 and would give the reader much more insight, what coupling of LPJ-GUESS to an atmosphere model means.

The paper shows results for a one-way coupling. No information from LPJ-GUESS are used in the calculations within EMAC during the simulation. That means, that the atmosphere model still needs the old land surface representation (in particular for the surface energy balance calculation). Please mention this. Generally, I think, a diagram illustrating the data flow between EMAC and LPJ-GUESS (also in terms of output) would be very helpful.

Specific comments

Please omit "advanced" in the title. It is not explained in the article in what manner the atmosphere chemistry model is advanced.

Replace in the title "land surface processes" by "vegetation". The article is only concerned with vegetation. Many other dynamic land surface processes that are relevant in Earth System modelling (as lakes/wetlands, permafrost, erosion, hydrological discharge) are not mentioned.

page 1 line 10: please skip "fully". I don't believe that really everything in your surface description is computed porgnostically and nothing is prescribed (e.g. hydrological soil properties etc.).

page 5 line 10: What is the chemical input from EMAC to the vegetation model? Constant CO2, constant N deposition? Perhaps it's better to specify it as the atmospheric chemistry model in EMAC is not used for this study.

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page 5 line 12: What is SMIL?

page 6 line 2: Why do you kill the vegetation in the spin-up run? What does this mean?

page 6 line 26: It would be nice to have some more information about NME scores.

page 7 line 12: Here it is speculated that a bias in vegetation is caused by a precipitation bias in EMAC. Please mention, how large this precipitation bias in EMAC is (with respect to the bias corrected CRUNCEP data).

page 7 line 30: Here it is speculated that imperfect process representation in LPJ-GUESS is responsible for a bias in tree cover over North Africa. Please, mention again, if there is also a precipitation bias of EMAC in this region.

page 9 line 2: Again speculation. Here about N limitation in the tropics causing a bias in biomass. Do you have a nitrogen limitation factor? Is it possible to prove the N limitation in your model output?

page 13 line 19: I'm very sceptical about a reduction of climate biases by vegetation dynamics. In most cases/regions there seems to be a positive feedback between climate and vegetation. That means, that climate biases will be enhanced by switching on vegetation dynamics.

Technical corrections

page 1 line 9/10: "Then it" instead of "At this point, the full model" to shorten the abstract

page 2 line 32: "a fully" instead of "an fully"

page 3 line 4: "resulting damage" instead of "resulting to damage"

page 5 line 11: "not affect the climate" instead of "not effect the climate"

page 7 line 27" "are the climate" instead of "is the climate"

page 8 line 9: "to ensure" instead of "to be ensure"

page 11 line 12: "crown area of trees at 50 m2 in LPJ-GUESS" instead of "crown area of trees LPJ-GUESS is 50 m2"

page 11 line 28: "affect" instead of "effect"

page 13 caption of Tab.1: "the vegetation simulated" instead of "the vegetated simulated"

page 13 line 10: "that in this" instead of "that this"

page 13 line 10: What is the meaning of PNV?

page 13 line 13: "utilising the recently" instead of "utilising a the recently"

page 13 line 25: "bidirectionally" instead of "bi-bidirectionally"

page 14 line 28: "Creation of three" instead of "Creation of a three"

page 16 line 23: "biomass due to" instead of "biomass to"

page 16 line 27: "was defined by the following classes in the Globcover 2009 dataset" instead of "was defined as classes"

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