

Interactive comment on “Climate change imposed limitations on potential food production” by Philipp de Vrese et al.

Anonymous Referee #1

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This paper provides an interesting analysis of the maximum global extent of cropland area and maximum crop yields on such areas under conditions of future climate change, increasing CO₂ concentration, and some consideration of ecosystem conservation. Given that an advanced earth system model with an incorporated land surface scheme was applied, the analysis appears to be solid from the point of view of biophysical process representations. However I have some reservations about the framing, the manuscript structure, and the interpretation of some results. They are detailed in the following and should be critically reflected in a revision of the manuscript.

A main point of concern with the current manuscript is that it provides little information on the methods and scenario assumptions, unless one reads the Methods section. The Introduction ends with a short summary but then the Results immediately follow –

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more information is required at this point because it is crucial for readers' understanding and interpretation of the findings, and to make transparent the (partly strong) scenario assumptions. I suggest to at least add the following information at this place: what is the spatial/temporal resolution and the forcing of the model (incl. climate, CO₂, land use/protected areas); what are the environmental flow requirements about; how is area converted into (future) food supply; how is it possible that areas decline, what is the criterion for that. Furthermore, a clear research question should be formulated.

Related to that, parts of the Results section should be formulated more carefully. For example, on page 3 it is stated that “almost three quarters of all cultivable land could be farmed by the beginning of the next century”. Also on page 7 line 16: is a “vast increase in food imports” really the only way out, can such a claim be supported by other literature? Please make always sure that this is only in your very idealized simulation, which explores some upper potentials based on biophysical processes and land-climate feedbacks but not on socially (and technologically?) feasible potentials.

The Discussion is very short (with the two first paragraphs being only an extension of the Results) and rather weak. Here I would expect a critical reflection of scenario assumptions including more literature references on 1) how does the CO₂ effect in your model, which has such a very strong impact on the results (increasing K_{hum} by up to 12 billion!), relate to findings from other studies; 2) what are the crop management assumptions in your study, which is important relative to other studies which use specific increases in management which in turn affects the crop area

Minor / technical comments:

The title is quite general and does not well reflect that it is about a global modelling study of theoretical maximum potentials, thus I suggest to adapt it in this regard.

Abstract: Some more crucial information should be added, that is, which (climate) scenario runs you analyzed, why areas are to be abandoned in some of the simulations, and what are the “most optimistic assumptions” mentioned in the final words.

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The first paragraph of the results is partly Methods, partly self-evident, it could be deleted.

Does the CO2 fertilisation effect apply to both crops and natural vegetation?

Page 4 first paragraph: What do you mean, “without requiring any previous changes”?

Same paragraph and at other places: I think the term “sustainable” is not correctly used here, it is misleading; rather use “achievable”?

Page 4 third paragraph: It is unclear whether you here talk about global sums only or about regional patterns (i.e. is increased demand met globally or in the very regions); in any case more focus and examples on specific regions are needed.

Same page, next paragraph: I do not understand why “the results highlight the importance. . .”.

Page 5 first paragraph: 20% or 0.5K temperature increase is high – especially if that is a global value? What particular scenario does this relate to, i.e. how large an area is assumed to be irrigated and where? I also think it is not correct to express temperature changes in %.

Page 6 line 10: Please avoid such a statement if possible, as it appears to “recommend” RCP8.5 because it increases food production; this is also in contrast to many climate change impact studies that suggest strong declines in yields – which need to be cited here (or rather in an extended Discussion).

Same page lines 21-23: I do not understand this, safe climatic range for food. . .?

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