Geosci. Model Dev. Discuss., referee comment RC2
https://doi.org/10.5194/gmd-2021-169-RC2, 2021

Comment on gmd-2021-169

Anonymous Referee #2

Referee comment on "C-LLAMA 1.0: a traceable model for food, agriculture, and land use" by Thomas S. Ball et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-169-RC2, 2021

Review of gmd-2021-169:

C-LLAMA v1.0: a traceable model for food, agriculture and land-use

Summary

The authors present an empirical system for extrapolating global historical land use data into the future under user-defined scenario conditions, at the national level. The model appears to mostly capture historical trends and behaves as expected to variations in yield, industrialization, diet, and efficiency. The results are comparable to a global model with a similar structure.

Overall response

I like the potential application of this model both for data analysis and scenario exploration, but this paper is incomplete in multiple respects. Considerable clarification is needed, including with respect to the knowledge gap that this system aims to fill. My main concerns are summarized here, with specifics following.

1) Framing and introduction need clarification of why this model is important: what knowledge gap does this fill? One useful aspect is how it summarizes current data and trends. The main aim appears to be able to explore different food demand and supply scenarios and how they may affect land use, in a straightforward manner. This is of importance to the food systems field, especially once the model includes bioenergy crops and afforestation. As it is, it still has value in its simplicity, but I suggest reading and incorporating more food systems literature in order to clarify this model's contribution. The juxtaposition with cmip-style models does not show how this model is a benefit (e.g., why are iams not "traceable?" they have hundreds if not thousands of outputs. how does this model make it easier to understand land change?). It is also unclear what the point of the comparison with Falafel is.

2) Significant clarification of the data and model processes is needed. In many cases I think I understand what you mean because the model needs to work a certain way to achieve your goals, but the description is not sufficient.

3) There appears to be an inconsistency between food "supply" and calculation of food energy requirement, with respect to whether losses are included and subtracted properly. This may simply be a clarity issue, but it is important to make sure that the operations are consistent with the data represent.

4) The anchor or baseline scenario should reflect historical trends or conditions so that it can be used for model evaluation, with appropriate sensitivity analyses. It appears that it represents recent historical trends, except in its target calorie requirement, and then some constants are applied or some industrial limits changed for sensitivity. The increase in calories should not be in the anchor and should be a diet change scenario. Further sensitivity analyses are warranted, particularly for the parameters in table B1, and could also be done for the values in tables A3a and A3b.

5) Demonstrating the model's usefulness is important, in line with the reframing indicated above. The increase in target calorie scenario is one example, and I suggest you also add a couple of extreme examples such as full change to vegetal diet and full change to dairy diet. There are some examples in the literature that this model can be compared to.

Specific suggestions:

Abstract

Introduction

line 28:

Do you mean that the difficulty of interpretation makes it is unclear how different drivers affect land?

lines 34-47:

How is this related to IAMs and DGVMs? What is the knowledge gap that needs to be filled? Are there advantages of cllama/falafel type models over others? How do cllama and falael help achieve understanding of land projection and climate targets in addition to other models? Is cllama an extension of falafel? What does the comparison of cllama and falafel tell us?

Model overview

Need a data section and probably a table that describes all of the data used, including the years. Later you refer to 2017 data but here you state the data are from 1961-2013.

Be clear that the model starts in 2018, assuming that the last year of data used is 2013

lines 74-78:

Here you state that there are 162 countries in the database, but figure 3 shows that 174 countries are included and 21 are not included, which sums to 195 countries. These numbers are not consistent.

Model components

line 107:

more detail is needed for the input data. e.g., this food supply does not include the post-production waste? then is it really food supply or food consumed? It seems more like food demand, either as consumed or consumed+post-production loss.

Later you base food energy requirement on the "food supply", which seems to have post-production loss included, then subtract three losses: processing, transport, and post-production. Make sure that your F and E and r their FAO source are consistent with each other. For example, FAO data may implicitly exclude all of these losses, which would mean that you are underestimating E and subsequently r because you are adding only post-production loss and then subtracting all three losses. Furthermore, your additional 28% for F appears to be valid only for the developed countries and is too high for subsistence countries (see table 2).

Check with section 3.3.1.

lines 109-117:

why is this the default? it seems that the model should use the baseline food "supply" and

that a scenario would be to increase this as described.

line 125:

what same process? the relative proportion of each commodity within each group?

lines 155-156:

How does GDP reflect income equality and a high efficiency parameter? How would high GDP represent a majority subsistence agriculture country?

lines 162-166:

If high industrialized countries should have a value >1, why is Xa scaled to 0-1?

For what year are the results 0.5-1.2?

Why is Ftarget multiplied by 0.7 in equation 5?

line 167:

If equation 5 is a function of year, how is this projected forward linearly?

lines 178-181:

Are there three version of equation 6, for processing, distribution, and post-production, respectively? Based on later descriptions, this factor does not seem to apply to the harvest loss, as this is implicitly captured in the historical trend analysis for crop yield.

Later it sounds like this equation is also used for forage and non-forage, which should also be explained here.

All factors using this equation should be stated here. waste feed factors also.

line 215 and 220:

section 3.1?

line 236:

what years of data are used?

line 249:

possibly agricultural greenhouse gas emissions, not global greenhouse gas emissions.

lines 265-266:

this is confusing because mu is already used, but not in this context.

And there is no z in this context, but it is used differently later.

lines 270 and 271:

capital Q and year n

line 287:

does other waste include processing and distribution? be clear here, as above distribution waste is not included in the list. and does this include harvest residue also since it is included as one G in eq 11?

lines 290-291:

what about forage demand? you mention it earlier, but here livestock feed comes only from waste and fodder. What are z? feed source ratios or waste stream proportions? this isn't clear.

line 322:

section 3.3

line 337:

section 3.4; and some of the livestock land requirement is based on fodder crop area, so this statement is not true.

lines 339-340:

shouldn't this already be taken care of by mu-forage and mu-nonforage for pigs and chickens?

line 344:

what pasture land area data are used? What years of data are used overall in this calculation?

line 347:

what is z? z seems to be used for a lot of different things but is not explained or defined clearly in each case. Maybe different variables are needed instead of all of them being z.

lines 350 to 352:

combine to calculate the pasture area?

the trajectory of what? the historical pasture yield Y or the pasture area?

If the yield is scaled, then does pasture area remain constant? Or is the scaling done just at the initial date, and this scaling value stays constant while area changes with changing demand?

lines 353-353:

see comments for appendix c

line 353:

section 4

Model output

Be clear that the model starts in 2014, assuming the last year of data used is 2013.

I suggest that the anchor scenario be defined to best represent the historical trends in the data, including population and food supply. Then analyses can start from there. SSP2 population may or may not be sufficient for this, and the food supply shouldn't be based on the recent data and not an increase to an idealized amount. Presumably the other middle of the road parameters are based on recent trends. This would present a good empirical analysis of the current state/trajectory based on data, which can then be a basis for other scenarios.

lines 371-372:

why? if these are extrapolations of historical trends, which they mostly are, then land use trends should not reverse. even the ssp 2 population projections do not diverge that much from recent history over this period.

Does this have to do with increasing calories to meet idealized food supply? but this wouldn't apply to europe.

line 385:

this is inconsistent with the pasture area increase

section 4.1.1

what is the point of this comparison? why are the initial areas different?

Discussion

line 459:

or simple linear extrapolation of historical trends of allocation

lines 474-475:

include some example scenarios in this study

Appendix C

Did you try calculating a scaling factor only once at the initial year, then using this same value throughout? This effectively calibrates the pasture yield to be consistent with history, while allowing pasture area to change independently. scaling through out conflates pasture yield change and area change. it may make more sense to allow for a separate pasture yield factor that can be set as desired, even by using a trend of historical pasture yield.