Comment on gmd-2021-228
Anonymous Referee #1

Referee comment on "GOBLIN: A land-balance model to identify national agriculture and land use pathways to climate neutrality via backcasting" by Colm Duffy et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-228-RC1, 2021

Review of ‘Goblin: A land-balance model to identify national agriculture and land use pathways to climate neutrality via backcasting’ by Colm Duffy et al.

The paper provides a description and application of a model that attempts to capture the diverse range of land use emissions considerations to better investigate inherent tradeoffs in reaching carbon neutrality. The model has been developed in an Irish context and the description and analyses are very Irish-centric. The considerable work is seemingly scientifically sound and thus publishable. The work is overall well structured.

Principal concerns relate to broader applicability of the model itself or the underlying approach to other jurisdictions where in many cases the land-use considerations will differ quite widely from an Irish context. The validation is also inherently circular in nature in that validation is performed against the training dataset. This is therefore of questionable value and considerable attention is required to the validation aspects.

Major comments

- Although in the abstract billed as a model with potential global applicability many of the assumptions are highly tuned to an Irish context of a mid-latitude climate that is not moisture limited and where the principal agricultural production model is ruminant based. It would be worth perhaps being a little more circumspect about potential use in other contexts, at least without some pretty substantial modifications being undertaken to the model as it stands.
- It is implied that there is a hard wired condition in the model that neutrality must be reached in 2050? This is implied in several places and would constitute a major limitation for its universal application where different jurisdictions may wish to set earlier or later dates for a condition of neutrality in LULUCF to be reached consistent
with their NDCs
- For international applications it is unclear to what extent a number of the parameters in the model are specifically hardwired to the Irish context, whether these are ultimately tuneable or how a third party user would be able to find these values for their application. In terms of making the model generally applicable it would be useful to be explicit in this regard. It is fine to state the example parameters from the Irish example but in terms of this being a model that can ultimately be much more broadly used the authors need to be much more explicit how the model could be modified and what data would be required to do so.
- Some of the assumptions seem a little ad hoc. For example the fertiliser leaching is assumed to be 10% in line 378. Is it correct to infer this is a fixed assumption in the model? If so presumably the model is underdispersive? It would be important to note such limitations comprehensively. The authors may wish to tabulate fixed assumptions and at least provide an estimate of what the impact would be on the modelled dispersiveness.
- The land-use allocation module is highly optimised to an Irish context. For global applicability it would be required to apply numerous additional module features presumably?
- In all figures careful attention is required regarding the font size – in many figures the font is illegible in the printed copy owing to small font sizes.
- In the model validation piece the NIR numbers are taken as `truth` but in reality these are highly uncertain. What danger is there of overtuning having occurred whereby if the NIR numbers are wrong then so is the GOBLIN model output? Should the range in NIR numbers be given? I am not convinced that sufficient thought has been given to this model validation aspect in the present draft. It is two figures and a very brief discussion. I would expect more on validation and a more critical assessment of the suitability of NIR numbers for the task. The discussion then goes on to employ the model has been tuned to NIR in which case the validation is overtly circular in nature and cannot be considered an independent validation at all. Couching it as such is misleading to the casual reader.
- I would suggest giving the scenarios used in Figures 8-12 and associated text short names rather than using numerical identifiers for ease of reader comprehension.
- It is very clear from Figures 8-10 but particularly 8 and 9 that the GOBLIN model fails to capture real-world interannual variability yet this goes unremarked. This would raise concerns in readers minds as to the veracity of the model. If there are good reasons why this is so then these need to be stated explicitly in the text. I assume interannual variations in the historical record are driven by a combination of weather and market developments and that these are systemically omitted from the model, which is fine and understandable. But if so this needs to be made explicit when discussing these figures. I assume that some stochastic noise generator could be used to impute reasonable variations and this may be key if, mistakenly, policy is set to achieve targets in a given year.

**Minor comments**

- Line 90 mentions the need (to -> the)
- Line 103 also a net source
- Line 120 capitalise one of the n’s in in intensification for the acronym to make sense – probably the final one.
The sentence starting line 146 is an odd way to start a paragraph and also leaves open whether neutrality in 2050 is a hard-wired assumption in the model or something that can be varied. The final parentheses also make little logical sense. I would suggest completely redrafting this passage to provide a clearer entry to this paragraph.

- Line 203 makes no sense – upland and lowland were numbers – do you mean ewe numbers?
- The font size in figure 2 should be made larger for legibility
- The references in the forestry module entry in table 1 seem a little odd. Why in each case is the ‘author’ stated twice?
- Line 259 – will be? Surely this should instead be was?
- Table 2 caption should be clear that these are the values appropriate for an Irish application, surely?
- Figure 3 again would benefit from larger font size for legibility
- Line 355 is based upon a methane ...
- Figure 4 again the text font size needs to be larger for legibility.
- Line 458 issue of two sentences merged
- In Table 4 the last entry ‘name’ makes no logical sense
- Line 722 missing space between sentences
- Line 746 The novelty (the not then)