Earth Syst. Dynam. Discuss.,
doi:10.5194/esd-2017-18-RC1, 2017

Earth System Dynamics Discussions

Interactive comment on "How to represent human behavior and decision making in Earth system models? A guide to techniques and approaches" *by* Finn Müller-Hansen et al.

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Received and published: 18 April 2017

How to represent human behavior and decision making in Earth system models? A guide to techniques and approaches

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Summary Apologies for the delay in responding.

This paper provides an overview of a broad range of representations of human behaviours that might be considered when attempting to 'people' Earth System Models (ESMs). I found the paper to be well researched and written on the whole and if the

aim was to inform the reader as to the range of options on offer in this space it did a relatively good job (with one or two notable exceptions which I detail below). However, the title suggests something more, with the stated aim to also offer some guidance over the way forward in this space. This is very much needed given the likely expansion of research this area will experience. Unfortunately, I found this aspect of the paper a little disappointing given it was rather passive, reserved or limited in any guidance it offered. This was not helped by the structure of the paper which separated out the extensive review of potential methods and the critique of these methods which was largely relegated to the Discussion. If the authors really want to be faithful to their title and stated aims I would suggest some editorial changes. I would start by offering a strong steer on the guiding principles of model framework selection in this space. I would then combine the description of the options with a more hard-hitting critique of the various options assessed against your guiding principles. My reading of the current paper suggest the author team would be more than able to achieve this and the product would be far more valuable than the largely descriptive review currently tabled. The alternative would be to dilute the title and aims to being those of a review of options as I believe this is what is currently being offered. I would like to encourage the former but providing the title and aims were adjusted the paper could go forward without this re-editing. I've ticked the 'major revisions' box but only because I couldn't simultaneously tick the 'minor revisions' box. This depends on which way you chose to jump.

Specific points (in no particular order) 1. I would like to see a full discussion over when ESM peopling might be useful, when it might not and when it might be actively discouraged. Given the huge uncertainties this activity can/will open up researchers need dissuading from the illegitimate and unnecessary hybridisation of social and natural systems models. This paper could offer some guiding principles. For example, although the chosen example of land surface/use parameterisation suggest a useful role for microscopic representations of people, ultimately we are only interested in the structural social dynamics when exploring Earth (i.e. global) scale feedbacks, even if these dynamics arise from the act of an individual. Therefore, at the ESM scale you would

have to have a really powerful justification of a highly disaggregated representation of people and there should always be a presumption in favour of the macroscopic representation. The fact that ESMs are spatially disaggregated and therefore we should naturally entertain representations of people at this scale is not sufficient in my view.

2. The opening text made a big play of the distinction between 'explicit decisions' and 'implicit behaviours'. Close inspection suggests this is a largely arbitrary distinction and some critique of this divide would be a useful addition. Is me typing this response an explicit decision or an implicit behaviour? I'm not sure.

3. Surely the most important distinction in normative framing involving any ESM is whether they adhere to the current socio-economic norm or they represent transitional/transformative dynamics. Everything else is simply detail. This is not developed at all and yet practically all applications of peopled ESMs will revolve around exploring and contrasting alternatives to business-as-usual. This review is very constrained in this regard, and hardly mentions alternative (and potentially indispensable) economic framings required when investigating, for example, implementation of the Paris Agreement.

4. Other than discussion of flow consistent approaches, this review makes little or no mention of (bio)physical frameworks as covered in say ecological economics. I appreciate they are not mainstream but I think this is a critical omission because perhaps the most consistent scheme for peopling of ESMs is where both the Earth and social systems are both on a sympathetic '(bio)physical' footing. This could be nicely contrasted against the fact that the standard marcoeconomic framings are flow/physically inconsistent. Perhaps it's time for the natural sciences to call the macroeconomic emperor on their lack of physically defensible clothing and peopling ESMs appears to be a great place to start. ESD has been central to getting these alternatives into the literature and it is anomolous that they are not considered here.

5. Much of the problem space that peopled ESMs would explore would be around pre-

cautionary Command and Control type policy such as that offered in the Paris Agreement. Here a formal control representation of 'people' is much more appropriate given it is about compliance or non-compliance with a stated environmental objective such as keeping below 2 K. I would like to see some discussion of this.

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