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Geoscientific Model Development Discussions

Interactive comment on "The Joint UK Land Environment Simulator (JULES), Model description – Part 2: Carbon fluxes and vegetation" *by* D. B. Clark et al.

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We thank the editor for her useful comments and we will make a number of changes to the manuscript, as outlined below.

1. "p3 l19-20: Why not name the MIP?"

The reference was to the C4MIP project and we will include that information in a revised manuscript.

2. "p5 l19-20 "The performance of JULES is assessed in Blyth et al. (2010)." Is this assessed version of JULES identical to that presented here? If not then differences

should be stated.”

Blyth et al. (2010) used JULES version 2.1.2 (unfortunately that information is not in that paper), which was the immediate predecessor to the version 2.2 that is described in our paper. Version 2.2 added âĂć the effects of ozone on leaf physiology âĂć the option to disable vegetation competition in the dynamic vegetation model (TRIFFID) âĂć further options for the calculation of canopy photosynthesis (options 4 and 5 in Table 2 in the manuscript) âĂć options for a more advanced treatment of urban areas, as discussed in Part 1 of the JULES description (Best et al., 2011, Geosci. Model Dev. Discuss., 4, 595–640)

Additionally there were various relatively minor bug fixes. We will include this information in a revised version of the manuscript.

3. “Section 2: Model description Should the title of this section be "Model Overview"? The entire paper is, after all, model description, in particular Section 3 onwards.”

We agree and will revise this title.

4. “This section needs to be expanded to include the context of the wider modelling community. Why was this way of constructing the model chosen, and what would have been the alternatives? For example, how does the choice of 5 PFTs compare with other state of the art models? Both the practical and scientific factors that come into making the basic decisions should be stated.”

We will attempt to address these issues in a revised manuscript. In brief, the 5 PFTs were chosen to be an optimal set to represent the variation in vegetation structure and function, suitable for inclusion in an Earth System Model. The number of PFTs defined in Dynamic Global Vegetation Models typically ranges from 2 to 10 [Brovkin et al. (1997), Sitch et al. (2003)], however there is no agreement as to the optimal number. PFT classification has been the focus of several international workshops and reviews (Lavorel et al., 2007). The number of PFTs depends on the ecological processes explicitly represented in the model (e.g. PFT traits in response to fire), and the availability of field data for parameter values, which is often incomplete (Lavorel et al., 2007). The latter is especially relevant to land surface models within Earth System Models, which require detailed information on both ecophysiological and physical parameters for a global domain. JULES represents one of the few land surface models (certainly in coupled modelling) that represent dynamic vegetation. In the C4MIP comparison (Friedlingstein et al., 2006), there were 11 climate-carbon cycle models (7 GCMs and 4 EMICs -intermediate complexity). Of the 7 GCMs, only 2 had dynamic vegetation: HadCM3LC (TRIFFID) and the model of the Lawrence Livermore National Laboratory. So, to reiterate, the 5 PFTs chosen for JULES/TRIFFID are a pragmatic choice balancing simplicity, comprehensiveness and data availability for explicit PFT characterisation in a global model.

Brovkin, V., A. Ganopolski, Y. Svirezhev, 1997: A continuous climate-vegetation classification for use in climate-biosphere studies. Ecological Modelling, 101, 251-261. Friedlingstein, P., et al., 2006: Climate–carbon cycle feedback analysis, results from the C4MIP model intercomparison, J. Climate,19, 3337–3353, doi:10.1175/JCLI3800.1.

Kattge, J., et al., 2011: TRY – a global database of plant traits. Global Change Biology. doi: 10.1111/j.1365-2486.2011.02451.x Lavorel, S., et al., 2007, Plant Functional Types: Are We Getting Any Closer to the Holy Grail?, Chapter 13 in Canadell J.G., D. Pataki, and L. Pitelka (eds), Terrestrial Ecosystems in a Changing World.The IGBP Series, Springer-Verlag, Berlin Heidelberg

Sitch, S. Et al., 2003: Evaluation of ecosystem dynamics, plant geography and terrestrial carbon cycling in the LPJ dynamic global vegetation model, Glob. Change Biol., 9, 161–185.

5. “On p16 a particular configuration is recommended because it is most realistic, but it "is likely to require specific parameterisations for each PFT". Perhaps you could explain why this is problematical. Is it a matter of the parameterisation being generally

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unknown, or a computational problem?"

Field data describing how nutrients and related physiological process vary through the canopy are available for relatively few vegetation types and locations. The existing description of such vertical variation in JULES is largely based on analysis of data for broadleaf trees in Amazonia [Carswell et al. (2000), as implemented in JULES by Mercado et al. (2007)]. Based on data from a variety of Amazon broadleaf trees, a recent study Lloyd et al. (2010) derived an equation describing the relationship between vertical gradients in photosynthetic capacity within tree canopies and the photosynthetic capacity of the upper leaves. We anticipate using this type of information in future development of JULES, although field studies of other vegetation types and in other regions are also required.

Carswell, F. E., Meir, P., Wandelli, E. V., Bonates, L. C. M.and Kruijt, B., Barbosa, E. M., Nobre, A. D., Grace, J., and Jarvis, P. G.: Photosynthetic capacity in a central Amazonian rain forest, Tree Physiol., 20, 179–186, 2000.

Lloyd, J. and Patiño, S. and Paiva, R. Q. and Nardoto, G. B. and Quesada, C. A. and Santos, A. J. B. and Baker, T. R. and Brand, W. A. and Hilke, I. and Gielmann, H. and Raessler, M. and Luizão, F. J. and Martinelli, L. A. and Mercado, L. M.: Optimisation of photosynthetic carbon gain and within canopy gradients of associated foliar traits for Amazon forest trees, Biogeosciences, 7, 1833–1859, doi:10.5194/bg-7-1833-2010, 2010.

Mercado, L. M., Huntingford, C., Gash, J. H. C., Cox, P. M., and Jogireddy, V.: Improving the representation of radiation interception and photosynthesis for climate model applications, Tellus B, 59,553–565, 2007.

6. "p25 l2 Is the TRIFFID code unchanged since 2001? If not, some explanation is required here."

TRIFFID is essentially unchanged since the description in 2001. The main change has been related to the replacement of a single soil carbon pool with the 4-pool RothC model, as described in the manuscript.

7. “p25 bottom. It is stated that TRIFFID may only use 5 PFTs. Is this likely to present a serious constraint on the usefulness of the model in the future?”

The description of vegetation in DGVMs is an active field of research, in the JULES community and for other models. More ecophysiological data are becoming available on global plant traits (Kattge et al., 2011). These can be used to refine parameterizations for an existing set of PFTs (as has been done here for JULES), used to define new sets of PFTs (e.g. Fyllas et al., in review), or used to define a more radical change, with a move away from PFTs to a more plant trait-based approach based on the continuum in trait space. However, the implication of such alternative representations of vegetation on the simulated evolution of the climate system is as yet unclear and needs to be explored. For the immediate future, we anticipate that JULES will continue to develop along the first two paths (e.g. addition of extra PFTs - technically it is not difficult to add PFTs to the model code) although we are also exploring the possibilities of using an alternative vegetation model (e.g. Fisher et al., 2010).

Fisher, R., McDowell, N., Purves, D., Moorcroft, P., Sitch, S., Cox, P., Huntingford, C., Meir, P., and Woodward, F. I.: Assessing uncertainties in a second-generation dynamic vegetation model caused by ecological scale limitations, New Phytol., 187, 666–681, doi:10.1111/j.1469-8137.2010.03340.x, 2010. Fyllas, N., J. Lloyd, and B. Quesada: Deriving plant functional types for Amazonian forests for use in vegetation dynamics models, in review for Perspectives in Plant Ecology and Systematics. Kattge, J., et al., 2011: TRY – a global database of plant traits, Global Change Biology. doi: 10.1111/j.1365-2486.2011.02451.

8. “The code was not included as supplementary information but does seem to be available to all researchers upon agreeing to the terms of the license.”

Unfortunately we cannot provide the code as supplementary information, as users have to agree to the terms of a licence agreement. As noted, the terms broadly mean that the code is freely available for non-commercial use.

9. “I see that version 3.0 is now the most recent version. Presumably version 2.2 will remain on the ftp server, but GMD would prefer the exact model version to be submitted as supplementary information. You are, however, welcome to submit a paper to GMDoutlining the changes to version 3, which can be linked to this paper through a Special Issue format. “

Yes, version 2.2 will remain on the ftp server. We will certainly consider submitting linked papers to describe changes for version 3.0 and future versions.

10. General comments on compilation

We are pleased that the reviewer was able to compile and use the model relatively easily. We test the building process and model results on a variety of platforms and compilers, although the list is relatively short and of course cannot by fully comprehensive.

11. “The user manual appears to be of a high standard. Please include this as supplementary information to the revised manuscript.

Yes, we will include this.

12. “What I found to be missing in the download is a README file. This should contain some orientation for the new user. Users need to know where to start, how to find the instructions for compiling and using the code, that there are test cases available, and information on how to get help should also be included.”

We are currently looking at how to improve various aspects of the documentation. A README file would be an obvious way to help new users in particular.

Interactive comment on Geosci. Model Dev. Discuss., 4, 641, 2011.