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Geoscientific Model Development Discussions

Interactive comment on "A vertical representation of soil carbon in the JULES land surface scheme with a focus on permafrost regions" *by* Eleanor J. Burke et al.

Anonymous Referee #2

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Review of gmd-2016-235: A vertical representation of soil carbon in the JULES land surface scheme with a focus on permafrost regions

The article presents a clear and well-structured description of a new addition to the JULES land surface model which includes a vertically resolved treatment of soil carbon stocks, transport and reactivity. Results are emphasized for the permafrost regions in comparison to the one-layer versions of the JULES model and existing observational datasets. The addition of vertical resolution in the soil zone generates overall larger estimates of soil carbon and a delay in the onset of respiration resulting from the propagation of temperature through the soil profile. These changes generally appear to result in closer agreement with observation, through they are heavily contingent upon

the parameterization necessary for both the ROTH and Q10 versions of the model.

The paper is generally well organized and clear. The description of vertical resolution (e.g. eq. 10 – 14) is critical to the novelty of the work and should be expanded to include a more thorough description of the diffusion coefficient, how it is parameterized and the nature of the depth dependence assigned to functions within eq. 14. In particular the transfer of respired C through the soil profile is not discussed, but this has direct implications for the use of the 'oldC' tracer.

Specific (in line) edits:

P1 L 11: 'not all of the processes relevant for the accumulation of permafrost carbon are included' – give more details for this statement

P4 Eq. 7 and 8 – flip order to agree with text

P4 L25: presumably both temperature functions are evaluated for a given choice of parameters for both soil moisture and vegetation. This assumes that the same relationship between choices of Ft would hold at a different choice of parameters for the other factors Fs and Fv – i.e. the relationship between Ft, Fs and Fv is linear. Is this the case?

P5 eq. 12-13: clarify is depth dependence assigned to Beta_ïĄćR or is the (z) assigned to the overall change in R_tot with depth? Is an explicit treatment of the depth dependent fraction of soil respiration emitted to the atmosphere necessary?

P5 L26: As written in eq. 10 – 13 D(z) is not a 'diffusion rate' it is a diffusion coefficient in units of L2/t

P6 L20: If the fraction of labelled C in the respiration flux is being used, then the earlier issue of how this C is allowed to move through the depth-resolved profile (e.g. Beta_R) needs to be clarified. It would seem that this parameter would become the fraction of respired C from each depth interval that reaches the interval above, and which should be added to respired C in that interval

P7 L5: define PFT

P7 L10: ‘are shown here’ – refer to a figure number or rephrase

P 7 L23: ‘soil carbon pools rescaled by relevant factors’ – clarify are these the same factors the diffusion coefficients and rate constants were scaled by?

P9 L15: why ‘and vice versa’?

P9 L25: Some comment could be made here to reconcile these results with the earlier statement (P2 L26) that ‘Without a vertical representation, decomposition rates are determined only by soil temperatures above the maximum summer thaw depth, so the very slow turnover of deep carbon in the permanently frozen soil is not represented’. This statement would seem to suggest that the vertically resolved model should predict a lower value, in contradiction with what’s shown here.

P9 L30: elaborate on this statement ‘soil carbon is not in equilibrium with the current climate’ – the model was initialized for the period prior to the current climate. . .

P11 L5: This is a nice result, though still would like more clarification on the treatment of respired C diffusion.

P12 L5: more discussion about implications for imposed difference in ïĄť resp between models on results would be helpful

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