The Cryosphere Discuss., 6, C672–C674, 2012
www.the-cryosphere-discuss.net/6/C672/2012/

The Cryosphere Discussions

Interactive comment on "Uncertainties in the global temperature change caused by carbon release from permafrost thawing" *by* E. J. Burke et al.

Anonymous Referee #2

Received and published: 31 May 2012

This paper presents a series of simulations of the permafrost carbon feedback with HadGEM2-ES using relative simple setups that allow to evaluate uncertainties/sensitivities related to total quantity, vertical distribution, quality and decomposability (aerobic and anaerobic pathways) of soil organic matter (SOM) following permafrost thawing (active layer deepening and talik formation). The authors also acknowledge other mechanisms for carbon burial (cryoturbation) and remobilization (thermokarst, fire, coastal and river erosion, possibly decomposition heat), as well as deep carbon pools (e.g. Yedoma), that are not included in this model exercise. As most of these would result in more rapid SOM remobilization it can be stated that the permafrost carbon feedback in this paper is probably under-estimated. It would have been par-

ticularly interesting if thermokarst formation, expansion and drainage could have been simulated by 'prescribing' a transient increase in lake area, which would have exposed more carbon to talik formation and have increased the proportion of SOM decomposed anaerobically (methane emissions). However, this is probably much more complex to implement in a model environment. The paper has good structure and is excellently written, with a clear presentation of the results and acknowledging some of the remaining uncertainties (as discussed above). It represents a valuable contribution to the ever-increasing work on the permafrost carbon feedback and I recommend that it is accepted following minor revisions.

GENERAL COMMENTS The authors appropriately indicate that the modeled extent of the current permafrost region and the total soil C pool for the upper 3m compare reasonably well with observations (Zhang et al., 2003; Tarnocai et al., 2009). My only main concern with the paper is that the authors do not address sufficiently the error resulting from an overestimation of the present-day active layer in the HadGEM2-ES model. There is only a vague reference to this issue in the final conclusions section (page 1388, lines 1-2). This implies that too much soil C is already in the active layer and, therefore, less will become available for future decomposition as permafrost thaws. There is likely a double bias here, because it is often the most organic-rich soils (peat deposits) that have the shallowest active layers. The authors should make an effort to compare the modeled depth of the active layer with observations (e.g. the CALM network), and quantify the amount/proportion of soil C that presently resides in their modeled active layer. This will provide a good indication of the extra amount of soil C that actually is perennially frozen under current conditions compared to model results.

SPECIFIC COMMENTS page1372-line4: check sentence, snow is definitely part of the climate system p1373-l6: modeled active layer depths across latitude in fig. 2 (p1396) seem to be exaggerated compared to observations (see also p1381-l1-2), and would probably only apply to well-drained upland soils with thin top organic layers. For instance, Histels near the southern limit of permafrost distribution can have active lay-

ers of only 50-60 cm. The specific thermal properties of different soil types are not considered in the model setup. p1376-l13. Turbels p1385-l21: Thermokarst terrain is widespread at higher latitudes (in the whole permafrost region) p1385-l22-24: Observations suggest that lateral erosion and ground subsidence increase thaw lakes area and number in continuous permafrost regions and drainage decreases them in discontinuous regions ... p1386-l12: after cryoturbation; add 'coastal and river erosion' p1387-l14: after cryoturbation; add 'coastal and river erosion' page 1388, lines 1-2: provide an estimate for these uncertainties; calculate proportion of soil C in the modeled active layer under current conditions which can be compared to the estimates in Tarnocai et al. (2009) and regional studies

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Interactive comment on The Cryosphere Discuss., 6, 1367, 2012.