

## ***Interactive comment on “Climate-driven expansion of blanket bogs in Britain during the Holocene” by A. V. Gallego-Sala et al.***

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We thank reviewer #2 for raising several interesting issues and questions, which we respond to here:

1. My main concern about this study is the restricted area targeted by this modeling exercise. The authors could broaden the impact of their study by emphasizing the potential role of the British blanket bogs as analogs for bogs worldwide.

The reason we focus solely on the British Isles is because the debate over the whether the initiation of blanket bogs is human induced or caused by climate change is basically limited to this area. Even when studies from other regions have raised (and usually dismissed) the possibility that humans caused blanket bog formation, they have cited

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papers about the UK as proof that this could be the case. The view that humans produced these landscapes continues to be influential in the UK and, in our experience of discussions involving local stakeholders, to cloud understanding of the overall control of blanket bog distribution and thus also understanding of the importance of considering climate change when planning conservation measures. However, we agree with the reviewer that the “unique” nature of the UK debate could have been better emphasised and we have therefore added two sentences in the introduction (beginning of the second paragraph) to make this clearer, as follows:

The global distribution of blanket bogs today is confined to cool, wet climates (Gallego-Sala and Prentice, 2013). The initiation of blanket bog formation during the Holocene is regionally asynchronous, and in most regional has been found to coincide with a shift towards cooler, wetter climates (Zaretskia et al., 2001, Dirksen et al, 2012). However, there has been considerable debate about the cause of Holocene blanket-bog initiation in the UK.

We have also added a sentence in the final section to emphasise this:

Climatic control of blanket-bog formation in the UK is consistent with evidence from other parts of the world that blanket-bog initiation occurred in response to climate change and that their current distribution is strongly controlled by climatic conditions.

2. Furthermore their role in a context of changing climate could be strengthened as well. This could be done in the introduction and conclusion. Our concern in this paper was to address a palaeoecological question that has not been satisfactorily answered in the literature, despite being a major focus for research for over 40 years. The role of blanket bogs in the context of a changing climate has been addressed in Gallego-Sala and Prentice, 2013. However, we agree that the survival of blanket bogs as an ecosystem will be affected by future climate changes and perhaps, by showing that by their past evolution can be satisfactorily explained by climate changes and does not require human intervention, our paper contributes to emphasising the climate sen-

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sitivity of these ecosystems. In view of this, we have added a final sentence to the manuscript to indicate why our findings might be relevant to the future climate impact debate around blanket bogs, following on from the existing text as follows:

Climatic control of blanket-bog formation in the UK is consistent with evidence from other parts of the world that blanket-bog initiation occurred in response to climate change and that their current distribution is strongly controlled by climatic conditions. It raises an important issue about the fate of this unique ecosystem under future climate change. Our work supports previous analyses that suggest they will require careful management given that their continued growth may be threatened by large-scale shifts in climate in some regions of the UK (Clark et al., 2010; House et al., 2010; Gallego-Sala et al., 2010) and worldwide (Gallego-Sala and Prentice, 2013).

3. If feasible, another option for broadening the impact of this study could be to use the PeatStash model to evaluate what would be the projected repartition of bogs in Britain and then worldwide for the next 100 years depending of the different climatic scenarios. The issue of what will happen to blanket bogs in the future has already been addressed in Gallego-Sala and Prentice, 2013. We have made this clearer in the text added in response to comment 2. Here we focus on the initiation of blanket bogs. 4. How the uncertainties associated with the MAT, MTWA, MAP pollen reconstructions are taken into account in the modeling experiments? How do they transfer into uncertainties in the blanket bog repartition? We use the pollen-based reconstructions as a “reality check” on the results obtained using the climate model simulations, in the sense that we have made sure that the simulated changes are consistent with the pollen-based reconstructions for those grid-cells where there are pollen-based reconstructions and in the sense that the simulation driven by the pollen-based reconstructions produces a similar result. We took this approach because, despite the apparent wealth of pollen data from the UK, the number of grid cells for which we have quantitative climate reconstructions is still limited and thus there is some interpolation involved in producing inputs for PeatSTASH. In contrast, the climate models provide “global” inputs. We rely

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on the ensemble of climate simulations to provide us with a measure of the probability of climate being suitable in any one location for blanket bog to occur. As we said in the paper, there are uncertainties quoted for the gridded pollen-based reconstructions: the average values of these are 0.04 for  $\alpha$ , 112 mm for mean annual rainfall and 1 °C for MTWA/MTCO. We did not run separate simulations using the range of uncertainties because these uncertainties are less than the inter-model differences between the simulations, and therefore our probability distribution already encompasses a larger range of uncertainty. We agree that it would be useful to clarify this point, as so we have expanded the text at the beginning of the methods section to clarify our approach as follows:

Pollen-based reconstructions provide an independent source of information. However, their distribution is not continuous across the whole of the UK and the necessity to interpolate between reconstructions at individual sites could introduce uncertainty (Bartlein et al., 2011). Nevertheless, this information provides a useful check of the reliability of the simulated climates at the location of the sites and an alternative scenario of climate change. We therefore used both the climate-model ensemble and the pollen-based reconstructions to obtain mid-Holocene climate estimates to drive PeatSTASH.

We have also added a sentence in section 2.3 as follows:

..... climatology (<http://www.cru.uea.ac.uk>). We do not account for reconstruction uncertainties in this application because they are smaller than the differences between the climate-model scenarios.

In our discussion, we already comment on the fact that the simulated climates are consistent with the pollen-based reconstructions (page 4819, line 15 et seq.).

5. Then, could the authors emphasize the novelty of this manuscript with that of the previous studies by the same authors: Gallego-Sala et al., 2010; Gallego-Sala and Prentice, 2013? The study by Gallego-Sala et al., 2010 shows that it is possible to explain the distribution of blanket bogs in the UK using climate information and docu-

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ments the model that is used here to simulate Holocene bog initiation. It also shows the likely impact of future climate changes on blanket bogs in the UK. The study by Gallego-Sala and Prentice, 2013 expands this analysis and modelling exercise to the world. Although these two papers use the same modelling tool as the current paper (PeatSTASH), this paper applies this tool to answer an entirely different question namely: was human invention required to cause blanket-bog initiation in the UK during the Holocene? This kind of application of the model is very worthwhile because it answers a longstanding debate which could be addressed in no other way.

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