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Interactive comment on "A probabilistic risk assessment for the vulnerability of the European carbon cycle to extreme events: the ecosystem perspective" *by* S. Rolinski et al.

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General comments

We acknowledge the consideration and effort to evaluate our manuscript and give detailed responses to the concerns raised. From the references given by the referee, we cite already two but will include more in the discussion. Nevertheless, we have to mention here that we did not apply exactly the framework proposed by Van Oijen et al. (2013) but propose a different approach in which hazards are not defined meteorologically but ecologically. In other words, in our approach here, the ecological response is the basis for classifying an event as hazardous or not. This seems not to be written

clearly enough in the current manuscript and will be corrected accordingly.

Specific comments

Item 1:
Here we have to raise two arguments. First, our manuscript is not intended as a review of experimental results from the Carbo-Extreme project focusing on process behaviour during extreme events. These results were available and published after the analysis was performed. Here, Reichstein et al. 2013 (and Frank et al. in review in Global Change Biology) are a much better reference in this respect. Secondly, the distinction between ecosystem responses to single extremes and the long-term behaviour to climatic conditions including extremes has to be made clearer in a revised version of the manuscript. Although we accept the point that the model performance on climatic extremes has to be validated or justified, for the concept itself the reaction is of moderate importance. Concerning the model performance, we refer to Reichstein et al. 2007, GCB, where LPJmL anomalies are compared to those from satellite products for the European heat wave in 2003. This exercise shows that climatic anomalies result in modelled biological anomalies that are close to data derived from remote sensing. To compare the extensive data from experimental sites in the projects Carbo-Extreme and FUME to respective model results is surely an important task but would be beyond the scope of the manuscript.
The point on the distinction between short- and long-term responses on extreme events is more complex. Mostly (as in Van Oijen et al., 2013) meteorological extremes are considered and their impact on the biosphere is studied. Here, we define hazardous events as those after which the biosphere is a net emitter of carbon within the next 12 months. Then, we analyse the physical drivers connected to these source events. For the classification of a certain month as hazardous or not, the model performance is decisive but only the sign of the carbon balance and not the extent of the reaction. The magnitude of the vulnerability and risk values determined here, result from the average deviation of the meteorological variables. Thus, yes, it does play a role whether the

BGD
11, C5525–C5528, 2014

processes in the model include or react on feedbacks important in drought situations but no, the exact representation of the magnitude of the response does not play a role in our approach. This point has to be clarified in the revision.

Item 2:
We agree that the description of the input data needed more references. Climate data sets for both periods are described in detail in Beer et al. 2014 with information on the bias correction method for all variables which will be summarised in the revision of the manuscript. We acknowledge the concern about appropriate input data when using the fire module SPITFIRE and will add to the input data section that all variables are given daily including minimum and maximum temperature. The point that for the calculation of fire risks daily maximum temperature is necessary will be argued with reference to the analysis of Bedia et al. 2012.

Item 3:
The reviewer rightly points to the fact that components of the carbon balance should be evaluated. Since our calculation of the carbon balance is also based on the process-based fire-model SPITFIRE, a thorough analysis is demanded. We agree that the fire data situation in Europe allows in-depth evaluation of the fire model, especially with the latest publication on fire history, but also want to point out that this requires an in-depth analysis. We are aware of this and are involved in a joint analysis of vegetation-fire models which includes an evaluation of the embedded fire models using data from the GFED data base (Giglio et al. 2010 and van der Werf et al. 2010) and the EFFIS data. This manuscript is about to be submitted. We will add a paragraph to the discussion section of our manuscript to explain limitation of model processes including considerations on the fire module therein.

Concluding remarks:
Our approach is intended to relate physical drivers to ecosystem responses so that a better understanding of the functioning of and threats to ecosystems can be provided. Therefore, we welcome the recommendation to focus on process understanding under

BGD
11, C5525–C5528, 2014

extremes. Here, we propose a method that is suitable (in our view) to address and analyse system functioning and model performance but within the current manuscript we can only briefly consider this topic.

Technical corrections

Concerning misleading formulations and typos: Rewording and corrections of the given examples will be included in the revision.

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