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Interactive comment on "Impact of droughts on the C-cycle in European vegetation: a probabilistic risk analysis using six vegetation models" *by* M. Van Oijen et al.

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We thank reviewer # 2 for the comments, for acknowledging the importance of ecological risk analysis and for qualifying our approach to this as interesting. The reviewer does suggest that our study may be hampered by insufficient quality of the models used, and by our results on future European carbon fluxes being in disagreement with "general foundations of biology" and by being inconsistent with "Darwin's evolution point of view". We shall discuss the seven points made by the reviewer in turn.

(1) The reviewer suggests that the six different models used in our study may not represent adaptation processes accurately. We agree with this criticism and refer to

our response to Referee 1, who made a similar comment.

(2) This is an inquiry about possible differences in model parameterisation for present and future time periods with respect to "plants, soils, phenology etc.". We should perhaps first clarify that in process-based models like ours there are no fixed values of soil composition, plant physiological processes or rates of phenological development. All these are processes that depend on the internal state of the system at any given time and how it interacts with the contemporary environment. The amount of soil organic matter changes over time and is not a fixed parameter. Rates of photosynthesis adapt to elevated atmospheric [CO2] (via stomatal closure), to temperature and atmospheric dryness, and soil moisture stress. Respiration responds to temperature but remains constrained by substrate availability, so again these processes respond to environmental change. There are no fixed days of the year associated with phenological stages in the models, instead temperature affects development rate. The parameters that underlie these dynamic processes, and constrain how they respond to the environment, are kept constant for the two time periods.

(3) Our simulations cover the whole of Europe as represented by more than 18000 grid cells (Table 1). The strength of our model evaluation using NDVI-data is that these data have a similar spatial extent and resolution. That allowed us to verify the spatial patterns simulated by the models, summarized by our main conclusions listed in section 5. A highly sparse set of eddy covariance towers (which also have footprints considerably smaller than the areas of grid cells) would not have afforded the same capability.

(4) The SPEI drought index indeed quantifies the environmental conditions, not the amount of drought stress experienced by the vegetation. Quantifying the latter is what the models were used for, and each model was run only for those grid cells for which it was able to represent the local vegetation, hence the different numbers of grid cells simulated by the different models (Table 1).

(5) It is always possible, as the reviewer does, to state about any given study that

"uncertainties may be much larger than the result" that was found. It is difficult for us to argue against unquantified uncertainties. We believe that such reasoning should not preclude us from giving the best possible risk estimates that we are currently capable of.

(6) Including P(H) explicitly in Table 2 would expand its size by 50% but not add any information. P(H) is equal to R/V (the ratio of risk and vulnerability) both of which are specified. We refer to Equation (3).

(7) The reviewer states that the species in southern Europe "should have a better chance to survive in dry conditions" according to "Darwin's evolution point of view". While we applaud the ambitious use of evolutionary theory by the reviewer in arguing against our predictions of risks to carbon fluxes a century hence, we feel that this is stretching the applicability of Darwin's theory. We suggest that there may be several misunderstandings here: âŮę Evolutionary theory applies to longer timescales than 100 years with annual and perennial plant species. âŮę Even over the past millennia, changes in vegetation composition in the Mediterranean have been dominated by human interference rather than by gradual evolution. âŮę Our paper is not about survival but about carbon fluxes. âŮę The severities of drought at the end of the century will increase. Hence they are not those experienced by vegetation today, so even if vegetation were very well adapted to present-day conditions (not at all a given if we consider that some desertification is being observed in southern Europe), that would not imply resilience against future droughts or allow for plant adaptation within the coming decades. âŮę "Dry conditions" in Southern Europe are not the same as "dry conditions" elsewhere. Of course Mediterranean vegetation can handle summer droughts that would be detrimental to vegetation elsewhere. That is exactly why we use the SPEI drought index. It is a local index, i.e. a SPEI value of zero represents the local average of water availability (precipitation minus potential evapotranspiration) in any grid cell, and drought stress to the degree of SPEI < -1 represents less water in already dry areas than in wet areas. The use of the SPEI thus ensures that drought hazard is

quantified relative to the average conditions experienced by the affected ecosystem in each location.

We like to conclude by thanking both reviewers again for their efforts.

Interactive comment on Biogeosciences Discuss., 11, 8325, 2014.