Reply to anonymous referee #2

We would like to thank our referee for the very helpful comments which will improve our manuscript! If not stated otherwise, our references to pages, figures, etc. are based on the submitted, not the revised manuscript in order to match the references of the reviewers. In the following, we quote the referee's comments one by one, each followed by our reply in italic font.

1.
I ask the authors to elaborate somewhat in their Discussion on the challenges associated with applying this approach elsewhere. Please elaborate specifically on the technical challenges for applying it directly to a full model. Also, the vegetation model VECODE is quite simple, would they expect similar results with a more complex vegetation model?

Apart from the question of resolution we do not see any technical challenge to apply our approach elsewhere; the limitations rather arise from limits of the concept. Therefore, with a more complex vegetation model it would be more difficult to ensure the validity of this concept. We have added the following paragraphs to Sect. 6:
"The application of a hotspot detection scheme to other (potentially more complex) models therefore requires a thorough mechanistic understanding.
First, it must be established that a sudden transition results from a destabilization of an equilibrium due to internal feedbacks when the forcing is varied. This concept is in contrast to other possible reasons for sudden changes such as a discontinuous response function (not involving feedbacks) or chaotic dynamics like regime changes or intermittency that do not require any external parameter changes. The hotspot detection scheme therefore cannot dispose of the task to determine the most appropriate minimal model for explaining a sudden transition.
Second, the relation between the stability of an equilibrium and EWS is not a priori clear in a complex model. It must therefore be understood how the variability arises and how it affects the variable under consideration.

Third, the critical subsystem that is supposed to show slowing down must be identified so that an appropriate variable is chosen in the analysis.
The challenge for applying the hotspot detection scheme is therefore an investigative and intellectual challenge rather than a technical one. If the conditions for the applicability of EWS are met, the hotspot detection scheme is easy to apply as it is only a diagnostic tool and no changes to the model under analysis are required."

Also regarding the complexity of the vegetation model in relation to our regression approach we now write:
"However, the applicability of such an approach is very limited: 1. In PlaSim-VECODE, the variability is large enough to sufficiently sample large parts of the phase space. 2. The regression can only be done in a limited area or for low resolution, otherwise too many regression coefficients would need to be estimated. 3. We based our regression model on the knowledge of V(P). In case of a more complex vegetation model, many more variables would be involved and the relationships would be less clear."*

2.
Another issue is one of scale. Here, PlaSim-VECODE has been run at T21 resolution, are there challenges associated with applying this approach at higher

spatial resolution?

We have added the following paragraph to Sect. 6:
"Models with higher spatial resolution could pose a more difficult challenge if hotspots consist of many grid cells whose signal is hard to distinguish from others. The demand of long time series to increase the significance of the results would be particularly problematic regarding the computing time for such higher resolution models. However, large hotspots can still be detected if the system is divided into larger parts (determined by parameter n_max) which would slow down the hotspot detection algorithm. As the increase in computing time of the algorithm results from the large number of possible combinations of elements that are considered independently, parallel computing could be applied to speed up the hotspot detection algorithm to some extent."

(Also see our response no. 1 to referee 1.)

3.
Considering that ESD has no specific page limits or figure charges, I would suggest that the authors include a version of Figure 2 from Part 1 of this paper to make things easier for the reader.

We thank our referee for this suggestion. We have done so.

4.
Also, for the sake of clarity, please choose a set of terms and use them consistently throughout the paper. For example, I would consistently refer to the simpler model as the "regression model". Also, please decide between referring to multiple equilibria and multiple steady states. At the coupled climate system is inherently a non-equilibrium system, kept far from equilibrium by the flux of solar radiation, I would prefer references to states rather than equlibria. However, if the authors prefer to maintain consistency with other parts of the literature, that is their prerogative. I merely ask that they decide on one set of terminology or the other.

We now only refer to the "regression model".
We also agree that a steady state of the climate system is not an equilibrium in a thermodynamic sense. However, we refer to the solutions (fixed points) of the deterministic part of our models as equilibria in order to distinguish these from steady states which also depend on the noise in the system. We therefore argue that both terms (equilibrium and steady state) are needed. Nonetheless, we have made our terminology more consistent as suggested: we now always write "equilibrium" when refering to a deterministic solution, but we use the more general term "(steady) state" when we do not want to imply anything on the deterministic part of the system.