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Interactive comment on "Plant phenology evaluation of CRESCENDO land surface models – Part I: start and end of growing season" *by* Daniele Peano et al.

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Dear authors,

Many thanks for your interesting evaluation of phenology in the CRESCENDO model ensemble. Please excuse the delay in my referee report.

In my view, your study has some methodological issues (see below) that need to be resolved before I can recommend publication of the manuscript. In addition, your analysis and model-data comparisons could benefit from considering some other publications that benchmarked land surface models for phenology or that parametrized phenology

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modules in DGVMs with satellite observations (Forkel et al., 2015; Jolly et al., 2005; Kelley et al., 2013; Knorr et al., 2010; MacBean et al., 2015; Schaphoff et al., 2018; Stöckli et al., 2011).

Good luck with the revisions and I'm looking forward to read a revised version.

Yours sincerely, Matthias Forkel

1 Naming of LAI datasets

The name "SENTINEL LAI" is completely misleading. Sentinels are various satellites and some of them allow to retrieve LAI (Sentinel-2 MSI and Sentinel-3 OLCI). However as far as I know, there is no operational LAI datasets from the Sentinels. The text writes that the data comes from SPOT and Proba-V and there is indeed a LAI datasets available from these sensors through the Copernicus Global Land Service. However, this dataset is harmonized from observations from the SPOT and Proba-V sensors but does not include data from any Sentinels. You need to be accurate and specific about the used dataset. If the used dataset does not include Sentinel data, it should not be named "SENTINEL". A similar issue is with the "MODIS" dataset. You need to be specific which dataset and version was used. The most recent MODIS LAI/fPAR dataset is "MOD15A2H" – is this the used dataset? Was the GIMMS LAI3g or a more recent version used?

2 Regridding of LAI and model datasets

The section about the regridding of the LAI datasets needs some more details: How were data gaps/missing values considered during regriddng? How were different land cover type considered? Did you separate the LAI of different land covers for each 0.25° grid cell?

3 Propagation of differences between datasets in the analysis

What is the reasoning behind using MODIS as the reference (L 304-306)? From your analysis, you cannot provide any evidence that the MODIS dataset would be "better"

than the other two. It would be better to propagate the differences between the satellite datasets in the entire analysis. For example, the maps could also show the agreement of the “multi-data ensemble”.

4 Chapter 3.5 and Figures 6 and 7

I find the biome-averaged(?) GSS and GSE values misleading, especially for PFTs that grow on both hemispheres. How were values from both hemispheres computed? I hope you did not just use the average! Also given the fact that GSS usually delays polewards, I think biome-averaged GSS and GSE dates are not meaningful. Better would be to show distributions of GSS and GSE (e.g. boxplots or violin plots and separated for the northern and southern hemisphere). In addition, I wonder how differences in the spatial distribution of PFTs were considered in this data-model comparison. Was the comparison only done for grid cells where both ESA CCI and the models have the same PFT? Howe were the different PFT schemes of the models made consistent with the PFTs from the ESA CCI land cover map? If differences in PFT distribution are not considered, there might be the risk that differences in GSS and GSE are actually not related to the phenology module but to the model components that affect the spatial distribution of vegetation (e.g. establishment, mortality, disturbance). This might be especially an issue for models with dynamic (not prescribed) vegetation such as LPJ-GUESS.

Specific comments

Many sentences are long and rather difficult to read. I suggest to revise the text specifically to shorten some sentences.

L 16-19: The first sentence is very difficult to read (very long, 4 times interrupted with references). I suggest to split this into 2-3 sentences.

L 59-60: It is necessary to also shortly describe what the 4GST method actually is and how it differs from other approaches for evaluating phenology.

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L 74-76: Please provide the correct link to the used dataset and not just to the Copernicus programme.

L 94-98: How were these PFTs compared to the models that might use other terminologies for PFTs?

L 156: “mostly according to the common CRESCENDO protocol”: I which aspects did the model run differ from the protocol?

L 267-268: Describe how the model results were disaggregated to 0.5° resolution if their native resolution was coarser.

L 275-278: It would be helpful if a simplified version of Supp. Fig. 1 would be in the main text to immediately understand the methodology without the need to go to the supplement or previous paper.

L 283: But how was the timing of GSS and GSE defined? How did you obtain these phenophase dates from the linear regression fitted to the LAI data?

L 285-287: If the precision of the method is only 1 month, how can you report biases of 0.5 months for GSE and 0.6 months for GSS in the abstract?

L 321-323: I rather think that there is a different reason for not detecting evergreen phenology in northern forests in the LAI datasets: In the northern needle-leaf evergreen forests, tree cover is only between 40% and 60% at the used resolution of 0.5°. Hence a large part of the LAI seasonality in this regions comes either from the understory, from gaps or grasslands which indeed show a seasonality.

Figure 5: By looking at the large variability of the satellite datasets at below 40°S, I’m wondering it the same grid cells were used fro all datasets and models. How were the latitudinal gradients averaged over regions where one dataset or model shows EVG phenology (hence no GSS and GSE dates) but the others did. Was the same land/sea mask and no data mask used for all datasets and models? I assume that major differences between datasets and models originate also from the choice of the

grid cells that were included in averaging.

L 453: The maximum LAI value is also affected by the spatial resolution of the aggregated dataset because high values are increasingly averaged towards lower values.

L 481: Please avoid paragraphs that consist only of one line/sentence.

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