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Interactive comment on "Land surface phenological response to decadal climate variability across Australia using satellite remote sensing" *by* M. Broich et al.

Anonymous Referee #2

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General Comments

The manuscript presents a geographically comprehensive analysis of vegetation land surface phenology variability over Australia using MODIS EVI data, with TRMM precipitation and the Southern Oscillation Index as climatic drivers. The manuscript is well written, advances the current understanding of vegetation phenology over this continent, and provides clear figures illustrating the results. Clarification regarding the methods and a few minor changes are needed however.

The implementation of the 7-parameter double logistic model needs to be clarified. The authors show in Figure 1 the 36 sites used for "algorithm development and calibration"

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but it is not clear how these sites were used in this regard. Stating they were calibration sites implies that they were used to either provide initial estimates of the parameters, to constrain the parameters prior to applying the model across all pixels, or perhaps to help identify the width of the smoothing filter and moving window for defining seasonal minimums. And if so, were these estimations or constraints specific to land cover types and therefore applied based on each pixels land cover? or perhaps regionally to determine areas that may exhibit dual seasonality? I suspect the sites were used simply as test cases to ensure the model produced expected results, correct? If this is the case then I don't believe using the term calibration is correct. My second concern in regard to these sites, is that only a single site is presented as an example of how well the model works (and I agree it works fairly well in this location, aside from missing a second season in 2010; see below). I would highly suggest including more plots (like those found in Figure 2) that encompass the range of land cover types and/or climate zones. They need not be as detailed as Figure 2, simply displaying the raw EVI and fitted curves would suffice. This would highlight the robustness of the model and/or the areas where the model had trouble, allowing researchers to determine whether applying this model would benefit future specific analyses.

The second point regarding the model fits is that of dual seasonality within a year. The authors state a moving window was used to identify minimum points and hence the extent of the phenological cycle, and that the model was then fit to each of these phenological cycles. First, if this method identifies seasonal cycles without regard to fixed yearly intervals then why is it necessary to fit "a second 7-parameter double logistic curve" when a second phenological cycle was identified within a given year? Second, how large was the moving window and how wide was the smoothing Savitsky-Golay moving filter? The width of each of these would greatly effect whether a "second" season was detected or not. This is very apparent in Figure 2. The EVI data points display what appears to be two seasons in 2010, but the smoothing filter dampens the second season, minimums are not identified, and the second season is not detected in the curve fit.

The dual seasonality problem could also be clarified by including a map showing which pixels displayed two cycles within a year and how often this occurred. This would also help to clarify the peak dates shown in Figure 4. Do these dates signify the timing of the first or second peak? Do many of the areas without a peak in a given year contain two peaks the following year (i.e. the season started late in year 1 and peaked in year 2, yet the pixel also displayed a second season in year 2). I realize that it may seem I am belaboring the dual season problem, but this can be a very common characteristic of highly variable rainfall-driven vegetation phenology and should not be overlooked. If a very low percentage of the land area does not display dual seasonality, then I would concede this point, but at this point it in unclear to what extent this occurs throughout the continent. Dual peaks within a year also can affect the results displayed in Figure 6B; lead time of SOI month relative to phenological peak.

In regards to the results presented in Section 3.4, I understand the authors choice to only present the most significant results (SOI in relation to peak magnitude), but I think it would be worthwhile to also present the best rainfall correlation results as well. The authors clearly state that Australia is the driest inhabited continent with one of the most variable rainfall climates in the world and vast areas of dryland systems. This warrants at least the presentation of precipitation related results, even if they were non-significant. Understanding where, and perhaps why, the EVI phenology metrics do not coincide with rainfall is an important result. A second row of maps in Figure 6 would suffice in displaying these results.

Specific Comments

Line 55. I believe the correct term is recurring. The term reoccur more specifically refers to a single event that happens a second time, while recurring defines periodicity.

Lines 71-80. I would suggest moving these lines to the beginning of the introduction. They provide a good general overview of land surface phenology and would give readers unfamiliar with the topic a good initial understanding of its importance in relation to

other disciplines and applications.

Line 118-199. This sentence is a bit hard to understand; referring to 80% and then 50% of the land area does not allow for quick comprehension. Perhaps... rainfall exceeds 600mm over 20% of the land area and is less than 300mm over 50% of the land area.

Line 128. "a set of 36 trajectories" is unclear. Please be more specific. "EVI time series over 36 sites..." Also, it may be more reader-friendly to use "time series" rather than "trajectories" when describing the EVI.

Line 180. Parameters of the Savitsky-Golay filter should be identified as this can have a large effect on the resulting smoothed time-series (see general comments).

Line 186. Width of moving window needs to be identified (see general comments)

Line 237. "two" should be "to"

Figure 4. An additional map displaying the standard deviation or range in peak timing would be an ideal addition to the figure as it is difficult to trace a given pixel or area across each year to determine the extent of variability. The color bar of the legend could be larger and vertical lines denoting temporal increments would greatly help interpretation (e.g. lines at monthly intervals).

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