Summary

This study provides an attempt to quantify the effects of climate variability and environmental drivers on large-scale trends of carbon fixation and vegetation growth and expansion from 1958-2007 using the SSiB4/TRIFFID dynamic vegetation model. It is clear that a lot of work has gone into the modelling aspect of the study. However, I think that this manuscript requires substantial revisions before I can recommend it for publication in ESD. The structure of the manuscript needs to be revised. I would like you to specify your research questions at the end of the introduction with separate results and discussion sections.

General comments

At the moment, this paper feels like a model evaluation paper. There are a lot of results here and it would be nice to see the key results promoted a bit more. Then I would like to see separate results and discussion sections. At the moment, it is a bit mixed up. After the model description section (section 2), I would like section 3 to be the results section, section 4 to be the discussion section and section 5 to be the conclusions section.

The Princeton meteorological dataset is used to drive the SSiB4/TRIFFID model. There is data available from 1948-2010. Why have you not performed the model experiments for this time period?

Specific comments

Page 1

Abstract

Change the abstract from 3 paragraphs to 1.

Lines 18-20: You state that more than 40% of the global land area has shows significant trends in LAI and GPP since the 1950s. Is this for the period 1958-2007 or from the 1958-1980s? When you mean positive trends, I assume that is an increase in LAI and GPP and the opposite for negative trends? It is better to explicitly state this.

Lines 22-27: The last paragraph goes straight into which environmental driver affects LAI and GPP the most. Add a line to place the results in context.

Page 2

1 Introduction

Line 3: Remove e.g. when adding references to the end of statements. "...at global and regional scales (e.g. Garcia et al., 2014)" should be "...at global and regional scales (Garcia et al., 2014)". This happens throughout the manuscript. Please remove all occurrences.

Line 4: Change "...by altering fluxes exchanges, energy balance, carbon cycle, etc." to "...by altering the exchange of carbon, water and energy between the atmosphere and land surface".

Line 5: Put references in chronological order. Do this throughout the manuscript.

Lines 5-6: Add a reference for this.

Line 8: Change the definition of LAI from "defined as the one-side leaf area in a unit area" to "defined as the one-sided leaf area per unit ground area"

Line 10: Increasing rate of what? Do you mean a strengthening of the land C sink?

Line 26: Put the word atmospheric before CO2.

Line 27: I would say simulate rather than predict since you are not performing model runs into the future.

Line 28: What are the associated surface characteristics? Give one or two examples (e.g. roughness length, albedo).

Lines 30-31: I would like a reference at the end of this statement. Instead of using the phrase "since the later 1980s", use "towards the end of the 1980s" or "since the second half of the 1980s".

Page 3
Lines 8-9: Add some references at the end of this sentence.

Lines 9-10: Give an example of some other external forcing.

Line 15: Change "by applying a dynamic global vegetation model" to "by using the SSiB4/TRIFFID (Simplified Simple Biosphere model version 4/Top-down Representation of Interactive Foliage and Flora Including Dynamics) DGVM...". Just use the abbreviation from now on.

Lines 19-24: Remove these lines and add your research questions here.

2 Model description, observational datasets, and experimental design
Move section 2.4 (Experimental design) to just after the model description section.

The structure of this section should be:
2.1 Model description
2.2 Experimental design
2.3 Data
2.3.1 Meteorological forcing data
2.3.2 Observation-based data

Line 25: Change 2.1 title to "Model description".

Line 26: Change "...is a biophysically based model incorporating estimates fluxes of radiation..." to "...is a biophysically based model which simulates fluxes of radiation...".

Lines 29-32: Change this sentence to "The TRIFFID DGVM (Cox, 2001) was coupled to SSiB version 4 (Xue et al., 2006) to calculate vegetation dynamics, including relevant land-surface characteristics of vegetation cover and structure."

Page 4
Line 2: Delete "Some parameters were also updated in this process".

Lines 2-7: I don't think you need this here. Please add a description of how GPP and LAI are calculated in SSiB4.

2.2 Meteorological forcing data
In this section, please add more information regarding the Princeton dataset. How was it created? Where did you download it from?
Line 11: " modelling" instead of "modeling".

Lines 13-14: Add units.

2.3 Observation-based data
Can you make a section called Data? Add a brief paragraph detailing what datasets were used as input (meteorological, vegetation, soil) to SSiB4/TRIFFID and those used to evaluate the model. Then add the Meteorological forcing data and Observation-based data sections as subsections.

Line 17: Is this the land cover map used by the model or is it used to evaluate the model after spin-up? Where did you download it from? Did you have to do any processing of the land cover map for the study? What is the native resolution of the database?

Line 19: Please explain what S1 is? "SPROT" should be "SPOT".

Line 23: What do you mean by dominance in the GLC2000 dominance map? Is this a map in which the PFT that has the most coverage in each grid box is the dominant PFT?

Line 25: Provide a brief explanation of the differences between the GLC2000 and MODIS land cover map?

Line 26: Do you mean assess and not access?

Lines 27-28: Where did you download GIMMS, GLASS and MODIS LAI datasets from? Can you provide a couple of sentences on the differences between these LAI datasets. Did you have to do any processing of the LAI data?

Page 5
Lines 1-2: Change from "...remapped to 1-degree spatial resolution and a monthly temporal interval." to "...regridded to 1-degree spatial and monthly temporal resolution."

Lines 3-4: This sentence would be better written as
"SSiB4/TRIFFID GPP was evaluated using the upscaled FLUXNET GPP (hereafter referred to as FLUXNET-MTE) (Jung et al., 2009; Jung et al., 2011)." Also where did you download the data from? Provide more information on how the dataset was created.

Line 7: Change "MTE-GPP data was remapped to 1-degree spatial and a monthly temporal resolution." to "FLUXNET-MTE GPP was regridded to 1-degree spatial and monthly temporal resolution.".

Lines 9-10: Change this sentence to "In this study, SSiB4/TRIFFID was used to simulate the global vegetation distribution and assess the sensitivity of ecosystem trends to climate and eCO2."

Line 10: Remove "For this purpose". "performed" instead of "conducted"

Lines 13-14: Remove the sentence "Meanwhile, the effect of largescale disturbance (LSD) on restricting tree expansion to savanna areas was investigated." Put this in the results/discussion sections.

Line 17: Remove "firstly". What are the multiple biotic variables?

Pages 6-14
3 Vegetation initial conditions
This section should now be your results section. Each subsection should have the questions as the heading, so the reader does not have to go back to the introduction again. In each subsection, have a sentence that summarises the main finding. This makes it easier for the reader to understand the key findings.
I suggest the following. Obviously, you should add your own question after each subsection number. I have only added what I think the section should be about.

3 Results
3.1 Evaluating the quasi-equilibrium simulation. Comparison to land cover map. Effect of large-scale disturbance.
3.2 Evaluating GPP/LAI.
3.3 Assessment of vegetation temporal variability.
3.4 External forcing effects on ecosystem trends.

The discussion section (section 4) should have 4 subsections, each discussing the corresponding results from section 3. The Conclusions section will be section 5.

Page 6
3.1 Quasi-equilibrium simulation
Lines 3-16: The first 2 paragraphs could be moved to the discussion section.

Lines 17-25: Move this paragraph to the beginning of this section.

Line 11: Do you mean allocation instead of reallocation?

Line 12: Don't start a sentence with "Figure X shows...". Make a statement regarding the result and reference the figure in brackets at the end of the sentence. Do this throughout the manuscript.

Line 23: Delete the phrase "That being said".

Page 7
Lines 3-5: Delete the sentence "Detailed comparison of the simulated...".

Line 27: You could reference Figure 4 here.

Page 8
Line 28: Re-write this sentence as "The spatial correlation coefficient between model and FLUXNET-MTE GPP is 0.93 (P<0.05) (Figure 7)".

Line 30: The standard way to quote global GPP values is in PgC/yr. Remove 1135 gC/m2/yr.

Line 32: Lack of N-limitation.

Page 9
Line 8: Change "for the model validation" to "for model evaluation".

Page 10
Line 6: I don't think you need Figure 9 as it is referenced only once. You could add a reference at the end of the sentence instead.

Lines 6-7: State the temperatures as Celsius instead.

Lines 18-19: Remove the information regarding the stipples (dots) on Figure 10 as it is already included in the caption.

Lines 24-25: Reference a figure at the end of this sentence.

Page 11
Can you include a few sentences on how elevated CO2 affects GPP/LAI in the model as part of the discussion?

Page 12
Lines 6-8: Remove these lines.

Page 14
6. Conclusion
I would like to see some more discussion in the Conclusions section. It is a bit short. Of the three sensitivity experiments, please state which one is the most important and why?

Line 9: Change "to the climate variability" to " to climate variability".

Lines 10-11: Delete the phrase "The results show". Use "We have shown that the SSiB4/TRIFFID model can simulate the vegetation distribution and temporal variability for the X time period."

Lines 28-30: Is there a University service for making the data available rather than a google drive account? Can you obtain a doi for the data? Also can you specify what data you have made available?

Figure 2
Can you use different colours for the lines as they are difficult to distinguish?

Figure 4
I don't think you need this figure. Can you remove?

Figure 5
Can you include the MODIS dataset since you mention it on Page 4, line 24?

Figure 6
Please plot the differences (model - obs) instead.

Figure 7
Plot the difference instead.

Figure 8
You haven't said what the black line is? Is this SSiB4/TRIFFID?
Change first line of caption to "Comparison of standardized LAI anomalies between simulation and observations for 9 sub-regions."