

## RESPONSES to Reviewer 2: Anonymous Referee

This manuscript applied Eagleson's ecohydrological optimality method to derive the optimal canopy cover ( $M^*$ ) and then compared  $M^*$  with the satellite derived canopy cover based on NDVI. In addition, the authors presented a comprehensive sensitivity analysis in terms of how the optimal canopy cover varies with different vegetation characteristics and climate factors. Overall, this paper is well written and organized and the main conclusions are sound. Although it is a local study focusing on the Northeast China Transect region, from a practical perspective, the implementation of Eagleson's ecohydrological optimality theory can certainly provide some insights in terms of the understanding of climate change impacts on canopy cover dynamics and therefore, can provide useful guidelines for eco-restoration projects, especially for the selection of vegetation species and plant density. However, this paper would benefit from an additional efforts of the authors to improve their writing, as there are some grammar errors and inappropriate wording (listed in the end).

Based on the above considerations, I recommend the manuscript to be returned to the authors for moderate revisions before it can be accepted.

**RESPONSE:** Thanks for the comments. We try to improve our writing according to the review, including grammar errors and inappropriate wording.

1. Page 2 Line 4-5: "Vegetation is considered as the indicator of climate". This is not accurate. Please modify.

**RESPONSE:** This sentence is unnecessary and not clear here. We deleted it.

2. Page 2 Line 16-17: It is quite vague to say "Other studies ... NECT". What kind of effects? Please be specific.

**RESPONSE:** We wrote this sentence into: "NDVI driven by climate changes varied differently between vegetation types and seasons(Piao et al. 2006). Duan et al. (2011) illustrated that precipitation was the most importance factor in affecting the temporal NDVI patterns over semi-arid and arid regions of China. Peng et al. (2012) found > 70% of the temporal variations in NDVI were contributed by precipitation during the growing season in typical and desert steppes in Northeast China. Mao et al.(2012), however, discovered that the correlation between NDVI and temperature was higher than with precipitation over most parts of Northeast China for all vegetation covers; NDVI presented a downward trend with increased temperature and remarkably decreased precipitation. Further, Yuan et al. (2015)

suggested diverse responses of grasslands to precipitation intensities.”

3. Page 2 Line 29: What does “due to the limitation of long term average state” mean?

RESPONSE: The limitation of long term average state means the Eagleson’s method can not be applied in year scale or other smaller scale, so it can not be used to solve practice problems such as water resources and ecological restoration projects. We change this sentence into “...which is partly due to the limitation of long term temporal scale..”.

4. For the introduction section, the importance of Eagleson’s ecohydrological optimality theory should be well elaborated to better and clearly state the objective and motivation of this study.

RESPONSE: Thanks for the advice. We add some sentences in the introduction section: “The NDVI data offer us a method to estimate actual canopy cover. If we can verified Eagleson’s ecohydrological optimality theory by comparing the optimal canopy cover and remote sensing canopy cover, we can discuss the impact of climate factors and vegetation properties on vegetation cover. From this framework, we can certainly provide some insights in terms of the understanding of climate change impacts on canopy cover dynamics and therefore, can provide useful guidelines for eco-restoration projects, especially for the selection of vegetation species and plant density.”

5. Page 3 Line 6: What does “global change gradient” mean?

RESPONSE: It is a mistake here, not “global change gradient”, just “change gradient”.

6. Page 3 Line 17: I do not understand why the high resolution (500 m and 1 km) datasets were resampled to coarse resolution (10 km).

RESPONSE: The spatial resolution is determined depend on the calculated amount. Since the coarse resolution does not influence the method and conclusion, the resolution of 10km x 10km is acceptable.

7. In the methodology sections, please use SI units for variables. Please also check other places.

RESPONSE: We changed “597.3cal/g” into “2500J/g”, “cal/(mm<sup>2</sup>·day)” into “J/(mm<sup>2</sup>·day)”, “cal/(g·K)” into “J/(g·K)”. The other units are retained.

8. Page 6 Line 1-2: Please consider moving “This method ... Table 1.” to somewhere in Section 2.

RESPONSE: The variables in Table 1 are introduced in Section 3, so it is strange to list them in Section 2. Therefore, we still keep Table 1 here.

9. Page 6 Line 22: What kind of “human activity”?

RESPONSE: Here “human activity” refers to the Natural Forest Protection Project (NFPP), which is given in the next sentences. We changed “human activity” into “forest protection project”.

10. Page 7 Line 9-10: The authors mentioned that “This can be explained ... climate changes.” But how?

RESPONSE: For example, the canopy cover might not increase immediately with the increasing precipitation but might increase in next year. We add this sentence after “This can be explained ... climate changes.”

11. Page 7 Line 14-15: How are water balance components calculated? There is no description.

RESPONSE: The water balance components were calculated based on Equation 6, more detail can be found in Appendix. We change this sentence into: “The proportions of the water balance components for annual average growing season are calculated for each part based on Equation 6, as shown in Table 2.”

12. Page 7 Line 22: Please consider changing “within the observed range” to “consistent with previous studies”.

RESPONSE: It is accepted.

13. Page 9 Line 10-16: This part could be moved to or mentioned in the introduction section to clearly state the motivation of this study.

RESPONSE: We deleted this paragraph here and moved some sentences into the introduction section.

14. Please carefully check Equations A.10 and A.12. Ve does not have the correct form.

RESPONSE: We are sorry for the confusion. We rewrote it into: “ $\beta_v$  is equal to 1.0 when the water condition reaches optimal state. When the bare soil evaporation is ignored, Eq. (A.10) can be simplified into”

15. For Table 1, it would be beneficial to the reader to have some statements linking it with the methods section. For example, some sentences can be added after Line 28 on Page 5.

RESPONSE: We added some sentences in the end of Section 3. “The input data and parameters include remote sensing data, meteorological data, vegetation data and soil data. The remote sensing data are the vegetation cover and LAI. The main meteorological data are length of growing season, potential evaporation, air temperature and storm duration. The main vegetation data are surface retention depth, leaf angle and stem height. The main soil data are soil porosity and hydraulic conductivities. ”

16. Table 2, how is interception calculated?

RESPONSE: The interception was calculated based on Equation A.3.

17. In Figure 2, water supply curve should be corresponding to Eq. 7 and water demand curve should be corresponding to Eq. 5.

RESPONSE: Yes, it is a mistake. Eq. 3 should be Eq. 5 and Eq. 5 should be Eq. 7.

18. Please rephrase the caption of Figure 4.

RESPONSE: We revised it into “Variation of  $M^*$ ,  $M$ , precipitation ( $p_t$ ) and air temperature ( $t_a$ ) during 2000-2013 ((a) grassland; (b) forest).”

19. Figure 5 & 6: What are the shaded areas?

RESPONSE: The shaded areas mean the range of  $M^*$  with the change of climate factors or vegetation properties. We added it into the caption of Figure 5 and Figure 6.

#### Technical Corrections

RESPONSE: we accept most of technical corrections and thank for the careful review.

1. Page 1 Line 6: Add “the” before “International”.

2. Page 1 Line 11: Change “trade-off of” to “trade-off between”.

3. Page I line 13: Change “then compare ... to discuss” to “which is compared with  $M$  to further discuss”.

4. Page 1 Line 15: Change “The result” to “Results”, change “matches” to “match”.

5. Page 1 Line 18: Change “climate change to” to “climate change on” and delete “quantitatively”.

6. Page 1 Line 22: Add “.” at the end of this sentence.

7. Page 1 Line 28: Change “the vegetation types” to “vegetation types”.

8. Page 2 Line 3: Change “effected” to “affected”.
9. Page 2 Line 7: Change “common index” to “common indexes”.
10. Page 2 Line 13: Change “researches about” to “studies on”.
11. Page 2 Line 25: Change “the vegetation” to “vegetation”.
12. Page 2 Line 26-27: Change “light ... state” to “light, energy, water and soil conditions in a long term average state.”.
13. Page 2 Line 27: Add “fact that” after “Despite the”.
14. Page 2 Line 28: Change “researches” to “studies”. Please also check other places.
15. Page 2 Line 31: Change “trade-off of” to “trade-off between”.
16. Page 2 Line 32: Change “Mo (2015)” to “Mo et al. (2015)”.
17. Page 3 Line 8: Change “200mm/year” to “200 mm”.
18. Page 5 Line 11: Change “be also” to “also be”, add “the” before “growing”.
19. Page 5 Line 12: Add “can be described as” after “soil column”.
20. Page 6 Line 21: Change “is relatively” to “are relatively”.
21. Page 7 Line 1: Change “effected” to “affected”.
22. Page 7 Line 4: The sentence “The correlation ... is 0.81” repeats previous one. Please either modify or delete this sentence.
23. Page 7 Line 5: Change “researches” to “studies”.
24. Page 7 Line 6: Change “region scales” to “regions”.
25. Page 8 Line 28: Change “shows the” to “shows a”.
26. Page 8 Line 32: Change “to” to “from”.
27. Page 9 Line 20: Change “to” to “on”, change “The main ... follows:” to “Main conclusions are summarized as follows:”.