July 10, 2014

Dear the Editor of Biogeosciences,

Subject: Regarding revision of the BG manuscript (**bg-2014-131**)

Thank you very much for reviewing carefully our manuscript, entitled "**Net primary production of Chinese fir plantation ecosystems and its relationship to climate"** by Ling WANG, Baoli DUAN, Yuanbin ZHANG and Frank BERNINGER published in BGD. We are submitting the replies to the queries of the honorable reviewers.

We are very grateful to the reviewer's constructive, valuable, and preferable comments, and appreciate deeply the reviewer's hard works on critical reading of our manuscript. We checked carefully all the comments and revised the manuscript almost following the comments. The comments are very helpful to improve clarity and quality of the paper. Detailed responses to the reviewer's comments including changes that have been made to the original manuscript are written in the attached sheets.

We wish to sincerely thank you and the reviewers again for editing and reviewing our manuscript. If there are still inappropriate points before acceptance, we are pleased to revise them as soon as possible.

Sincerely yours,

Ling Wang (PhD)
Chengdu Institute of Biology
Chinese Academy of Sciences
PO Box 416, Chengdu 610041, China
E-mail: lynn084@gmail.com

[You can contact also] Baoli Duan (Professor)
Institute of Mountain Hazards and Environment
Chinese Academy of Sciences
PO Box 416, Chengdu 610041, China
E-mail: duanbl@imde.ac.cn

Replies to Reviewer's comments (2)

We wish to reply to the valuable and constructive comments raised by the reviewer 2 as follows. The portions revised following the comments and suggestions by the reviewer are shown on the revised manuscript by red letters. The comments are copied by blue italic letters below.

1. The Abstract is a bit confusing. It would be nice to re-write it trying to highlight only the key messages.

We appreciate this valuable comment. In accordance with this comment, we revised abstract to describe more clearly and highlight only the key messages as follows.

[Original] This article focuses on the relationship between the net primary production (NPP) of Chinese fir and the climate. Spatial-temporal NPP pattern in the potential distribution area of Chinese fir from 2000 to 2010 was characterized utilizing the Moderate Resolution Imaging Spectroradiometer (MODIS) data in a Geographic Information Systems (GIS) environment. The results showed that the production of Chinese fir was higher in southern and eastern regions than in northern and western areas, which was consistent with the spatial pattern of temperature and precipitation. The relationship between NPP of Chinese fir and climate variables was analyzed comprehensively on three scales: regional scale, zonal gradients and pixel scale. On the regional scale, precipitation showed higher correlation coefficients with NPP than did temperature. When scaling to pixels, the spatial variability pattern indicated that temperature was more important in central and eastern regions, while precipitation was crucial in the northern part. Negative correlations between NPP and precipitation and temperature were found in the southern region. The zonal analysis revealed that the impact of precipitation on the production was more complicated than that of temperature. When compared to natural forests, plantations appear to be more sensitive to the mode of precipitation, which indicates their higher vulnerability under climate change which could potentially lead to increasing variability in rainfall. Temporally, NPP values decreased despite of increasing temperatures, and more in plantations than among other vegetation types, which draws attention to carbon sequestration potential by plantations under climate change.

[Revision] This article focuses on the relationship between the net primary production (NPP) of Chinese fir and temperature and precipitation. Spatial-temporal NPP pattern in the potential distribution area of Chinese fir from 2000 to 2010 was characterized utilizing MODIS MOD17 product in a Geographic Information Systems (GIS) environment. The results showed that the highest NPP value of Chinese fir presents in the Fujian province in the eastern part of the study region. The relationship between NPP of Chinese fir and climate variables was analyzed spatially and temporally. On the regional scale, precipitation showed higher correlation coefficients with NPP than did temperature. The spatial variability pattern indicated that temperature was more important in central and eastern regions (*e.g.* Hunan and Fujian province), while precipitation was crucial in the northern part (*e.g.* Anhui province). The zonal analysis revealed that the impact of precipitation on the production was more complicated than that of temperature. When compared to natural forests, plantations appear to be more sensitive to the mode of precipitation, which indicates their higher vulnerability under climate change. Temporally, NPP values decreased despite of increasing temperatures, and more in plantations than among other vegetation types, which draws attention to carbon sequestration potential by plantations under climate change.

2. The material and methods section should be completed in different parts: MODIS data - the way the MODIS data are presented is confusing, the authors refer to MODIS GPP without giving details about the product they are using. Are they referring to the MOD17 product? What they mean with "The FPAR and epsilon max were determined using remote sensing MODIS"? To my knowledge the epsilon max is derived using Biome Parameter Lookup Table (BPLUT).

For the comment "*The material and methods section should be completed in different parts: MODIS data - the way the MODIS data are presented is confusing, the authors refer to MODIS GPP without giving details about the product they are using. Are they referring to the MOD17 product?*" Yes, we used MOD17 product. Since this paragraph was briefly description of the MODIS GPP algorithm. We deleted it and replaced it with one sentence "MODIS product MOD 17 was chosen for evaluation of GPP and NPP in our study."

We appreciate the correct comment *"What they mean with "The FPAR and epsilon max were determined using remote sensing MODIS"? To my knowledge the epsilon max is derived using Biome Parameter Lookup Table (BPLUT)."* Yes, the ε max is derived using Biome Parameter Lookup Table (BPLUT). It is the calculation of ε that needs the MODIS land cover data. This paragraph was deleted as we said above.

3. Climate data - the authors describe the study area as "a region of low mountains and hills with a very broken topography and complicated geology", in such conditions the propagation of the meteorological data from few stations to the whole region can be not trivial. How the interpolation of the meteo data has been performed? How the obtained maps compare with already available gridded meteorological products?

For the comment *"Climate data - the authors describe the study area as "a region of low mountains and hills with a very broken topography and complicated geology", in such conditions the propagation of the meteorological data from few stations to the whole region can be not trivial."*, we would like to clarify that we utilized 75 stations data to model the temperature and precipitation. However we gave a misleading number of stations, which is 41 in our manuscript. This number only referred to the stations that are included in the study area which is irregular and not continuous (see Fig.1 in our manuscript). So we changed the original 41 stations in Page 6 Line 4 to 75 stations.

For the comment *"How the interpolation of the meteo data has been performed?*, We chose Kriging as an estimator to interpolate the climatic data to be gridded surface with resolution of 1 km. Kriging is a linear optimum interpolation method for regionalized single variable with the minimum variance of the estimation variance. It evaluates uncertainty of the estimation at non-sampled points by kriging variance, which offers a measure of the estimation precision and reliability of the spatial variable distribution. The cross validation result for the kriging model is good as in the Fig.1 below.

For the comment *"How the obtained maps compare with already available gridded meteorological products?"*, we compare our climatic data with WorldClim data which is a set of global climate layers (climate grids) with a spatial resolution of about 1 square kilometer (Fig.2). Our surface is smoother than worldclim data, but they have similar characteristic. In addition, difference between each other is also due to the time difference Since the available Worldclim data is for the 1950-2000 period.

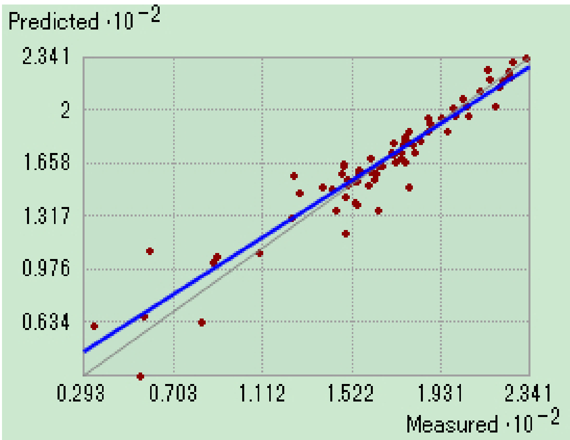

Fig.1 Cross validation result for kriging model for making temperature surface. Measured represents the station temperature which is ˚C× 10.

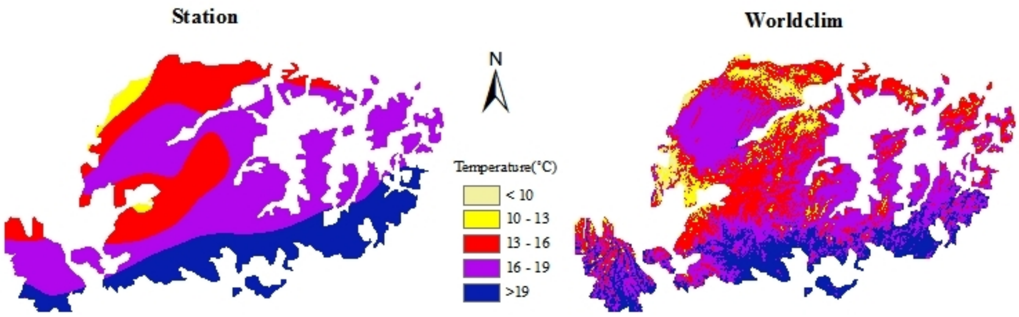

Fig.2 Comparision between interplated station data and Worldclim data.

4. Analysis between NPP pattern and climate variables – it is not clear if and how the presence of different land cover classes has been taken into account in the analysis of the spatial patterns of NPP Validation of MODIS data using flux tower data – how the temporal GPP corresponding to flux tower has been derived from MODIS data? how big is the tower footprint? How big is the MODIS area used to extract the GPP trend? The data analysis has some weakness and clarifications are needed.

For the comment *"Analysis between NPP pattern and climate variables – it is not clear if and how the presence of different land cover classes has been taken into account in the analysis of the spatial patterns of NPP Validation of MODIS data using flux tower data"*, the classification of land cover was not taken into account in the analysis of the spatial patterns of NPP Validation of MODIS data using flux tower data.

Reply to the comment *"how big is the tower footprint?"* is as follows. The sensors measuring flux were installed at about 39m above the ground. According to the study on source area in Qianyanzhou station by Shen *et al*. (2005), the footprint of the tower is within 1.7 km.

Shen Y., Liu Y., 2005. Examination of source area in- flux measurements at the mid-subtropical forest region. *Acta Phytoecologica Sinica* 29 (2), 202-207.

For the comment *"How big is the MODIS area used to extract the GPP trend?"*, 4×4 pixels around the tower were extracted to correspond with the eddy flux data.

Our reply to the comment *"how the temporal GPP corresponding to flux tower has been derived from MODIS data?"*is as follows.
Eddy flux GPP on daily basis in 2006 were provided by Qianyanzhou Experimental Station. Correspondingly, MODIS GPP data in 2006 were downloaded. Subsets of 4×4 pixels around the tower were extracted. In accordance with MODIS GPP, which is an 8-day composite, 8-day summations of eddy flux GPP were created to make a correlation with average of MODIS GPP subsets.

5. Fig. 4 eddy and MODIS GPP are correlated but the relation is not as good as we can expect; possible reasons of the scatter in the relationship have to be discussed.

MODIS GPP is based on the light use efficiency model. Any parameters that contribute to the calculation of GPP would influence the value of it. Land cover is a potential source of bias because of the spatial heterogeneity of the landscape. MODIS did not capture finer scale light use efficiency. We checked the land cover in our study area, and found that two pixels surrounding the eddy tower were classified into open shrublands. However, in maximum source location of the tower, the dominate vegetation is forest, which contribute the most of the tower flux. Such bias made the correlation not so perfect. However, we compared our result with Wang *et.al* (2014), which Validates MODIS-GPP product at 10 flux sites in northern China. Our correlation coefficient is very similar with the one after them calibrating the GPP model.

Wang, X., Ma, M., Li, X., *et.al*, 2013. Validation of MODIS-GPP product at 10 flux sites in northern China. *International Journal of Remote Sensing* 34(2), 587-599.

6. Attention should be given to other factors (besides temperature and precipitation) that can have an effect on the spatial and temporal variability of fir productivity (fires, harvest, deforestation, stress events . . .)

We appreciate the reviewer's valuable comments on this part. We agreed with the comment that other factors (fires, harvest, deforestation, stress events . . .) can have an effect on the spatial and temporal variability of Chinese fir productivity.

Considering this comment, we added some discussion to the revised manuscript by red letters as follows.

[Revision] Page 13 Line 24: Fires, harvest, deforestation or other disturbances that change the land-use could alter terrestrial net fluxes at regional and global scales. However, it is extremely challenging to estimate the carbon balance change associated with land-use change because of current lack of information on the amount and spatial pattern of deforestation (Piao *et al.*, 2012; Houghton, 2007). However, most of the plantation in south China is collective owned stand. Farmers has always been repeatedly planted Chinese fir on the same sites without intercropping or periods of fallow (Bi *et al.*, 2007), which reduce the land-use change impact.

Page 14 Line 13: Droughts in autumn 2004, floods and hurricanes in 2007 and snowstorms in 2008 were reported in current study area. Our results (Fig.6) shown that NPP of Chinese fir decreased in 2005, which was to some extend influenced by autumn droughts in 2004. Floods and hurricanes in 2007 also corresponded with a declined NPP value in 2007 compared to that in 2006. While snowstorms in 2008 made the NPP value even lower than that in 2007.

Houghton, R. A., 2007. Balancing the global carbon budget. *Annual Review of Earth and Planetary Sciences* 35, 313-347.

Piao, S. L., Ito, A., Li, S. G., et al., 2012. The carbon budget of terrestrial ecosystems in East Asia over the last two decades. *Biogeosciences* 9(9), 3571-3586.

Bi, J., Blanco, J. A., Seely, B., et al., 2007. Yield decline in Chinese-fir plantations: a simulation investigation with implications for model complexity. *Canadian Journal*

of Forest Research 37(9), 1615-1630.
Acknowledgments: The authors wish to express their grateful thanks to an anonymous reviewer for the valuable comments and suggestions that helped improve the clarity of the manuscript.