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Biogeosciences
Discussions

Interactive comment on "Impact of cloudiness on net ecosystem exchange of carbon dioxide in different types of forest ecosystems in China" *by* M. Zhang et al.

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Response to review comments of editor Pro.Chen on manuscript

'Impact of cloudiness on net ecosystem exchange of carbon dioxide of different types of forest ecosystems in China' By Zhang et al.

We greatly appreciate your comments and suggestion on the manuscript. These comments are of great importance to improve our work. According to your comments, we had tried our best to revise and improve this manuscript. In the revised manuscript, the revision includes the following aspects:

Comment 1: The reasons for the different responses of GEP to cloudiness in these two forests are not clear. Why GEP in CBS decreases at high clearness? It's not convincing that this is due to the decrease in diffuse radiation because trees would benefit from higher direction radiation. Are there any direct temperature effects on GEP as air temperature increases with clearness at this site? Does it get too hot? There could be different temperature response curves for GEP at these two sites. Would it be caused by water stress at high temperatures? I strongly suspect that soil water plays an important role for the decrease of GEP at high clearness. Some more detailed analysis is needed.

Answer: Stronger direct solar radiation and decrease in diffuse radiation under clear sky conditions is one reason that make GEP decrease. Many researches shown that a fraction of forest canopy is illuminated by direct solar radiation consisting of bight 'sunflecks', with the remaining portion of the canopy being in the shade, under clear sky conditions. The sunlit fraction of the canopy has leaves that are often light saturated under clear skies, but leaves in the shade suffer from a lower exposure to incoming radiation, therefore, photosynthesis of forest ecosystem decrease (Mercado et al., 2009; Farquhar Roderick, 2008; Alton et al., 2007). In our study, GEP decreased obviously under stronger PAR (Fig 7a), and GEP reduced with decreasing diffuse PAR at CBS (Fig 7b). However, decrease in diffuse radiation is not only reason that leads to GEP reduction under clear skies. According to Prof. Chen's comments, we analyzed the relationships between other environmental factors and kt, and the relationship between these environmental factors and GEP at the two forest ecosystems. The results showed that increase in air temperature did not induce reduction in GEP under clear skies at the two sites. Soil water content did not change obviously with kt at the two forest ecosystems, so soil water content is not the reason that made GEP decrease under clear skies. However, we found that vapor press deficit (VPD) changed obviously with kt at the two forest ecosystems. VPD decreased linearly with increasing kt (Fig 6d). Previous researches shown VPD is an important factor which affects the stomatal conductance. The decrease in VPD induces stomatal openness and thus enhances leaf photosynthesis (Collatz et al., 1998). Whereas, the increase in VPD associated with clear sky conditions can cause stomatal conductance decrease, which lead to decrease in leaf photosynthesis (Freeman et al., 1998), correspondingly ecosystem photosynthesis decrease. Our analysis showed the changes in GEP with VPD were conic at CBS and DHS (Fig. 7c). GEP decreased under higher VPD at the two forest ecosystems, and the decrease in GEP at CBS was more than that at DHS. Therefore, stronger PAR, decrease in diffuse PAR, and increase in VPD under clear sky condition were the reasons that resulted in more decrease in GEP at CBS. We added the analysis on the relationship between VPD and kt in the section “4.2” paragraph 3 (Page 14, Line 11-18). We added the analysis about the relationship between VPD and GEP in the section “4.3” paragraph 3 (Page 15, Line 29-30, Page 16, 1-5).

Comment 2: Different responses of ecosystem respiration at these two sites may be due to different soil organic matter contents. Do you have any measurements of soil organic matter?

Answer: The soil organic matter contents are one of factors that decide the temperature sensitivity (Q10) of soil respiration, and soil respiration is major component of ecosystem respiration. Therefore, higher soil organic matter leads to higher temperature sensitivity, which results in higher soil respiration and higher ecosystem respiration. That is the reason which decided the different responses of ecosystem respiration to temperature at the two sites. We added the data of soil organic matter at the two sites in Table 1, and we modified the contents to detail the different response of ecosystem respiration to temperature at these two sites. The specific content are in the section “4.3” paragraph 4 (Page 16, Line 6-15).

Comment 3: It is not clear how cloudy sky and clear sky are separated. Do you use a threshold on Kt for this separation? The units or phrases in Table 1 have many errors. For example, precipitation = 70 m, and soil temperature in cm. What's“height of radiation”? Make sure you mean the height of radiometer, or height of rain gauge. How can you measure precipitation at 70 m when the tower is only 32 m?

Answer: We did not use a threshold on kt for separating cloudy sky and clear sky. We added more details about how cloudy skies and clear skies are separated in the section “2.2.3” (Page, 8, Line 15-23).

We already modified the Table 1. We listed the Height of tower, changed “Height of radiation” to “Height of radiometer”, change “precipitation” to “Height of rain gauge”, change “soil temperature” to “depth of soil temperature”, and change “soil moisture” to “depth of soil moisture”. We modified the height of rain gauge at CBS. The height of rain gauge was 61.8m at CBS, because the rain gauge was installed at the top of tower and the height of tower was 61.8m. The specific modifications are in the Table 1.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/6/C3937/2010/bgd-6-C3937-2010-supplement.pdf

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Interactive comment on Biogeosciences Discuss., 6, 8215, 2009.

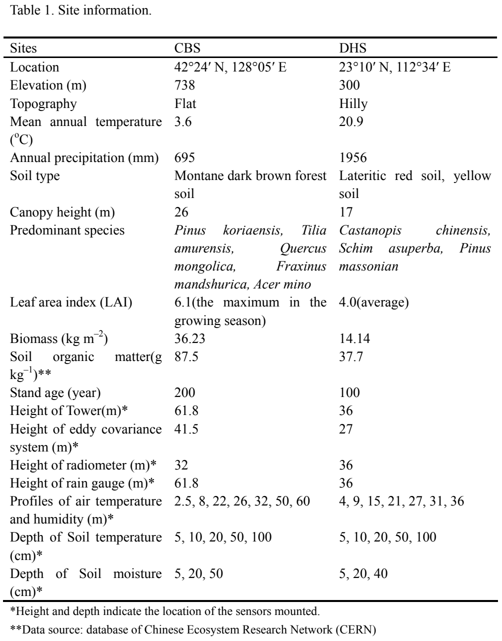

Table 1. Site information.

Sites	CBS	DHS
Location	42°24′ N, 128°05′ E	23°10′ N, 112°34′ E
Elevation (m)	738	300
Topography	Flat	Hilly
Mean annual temperature (°C)	3.6	20.9
Annual precipitation (mm)	695	1956
Soil type	Montane dark brown forest soil	Lateritic red soil, yellow soil
Canopy height (m)	26	17
Predominant species	*Pinus koriaensis, Tilia amurensis, Quercus mongolica, Fraxinus mandshurica, Acer mino*	*Castanopis chinensis, Schim asuperba, Pinus massonian*
Leaf area index (LAI)	6.1(the maximum in the growing season)	4.0(average)
Biomass (kg m^{-2})	36.23	14.14
Soil organic matter(g kg^{-1})**	87.5	37.7
Stand age (year)	200	100
Height of Tower(m)*	61.8	36
Height of eddy covariance system (m)*	41.5	27
Height of radiometer (m)*	32	36
Height of rain gauge (m)*	61.8	36
Profiles of air temperature and humidity (m)*	2.5, 8, 22, 26, 32, 50, 60	4, 9, 15, 21, 27, 31, 36
Depth of Soil temperature (cm)*	5, 10, 20, 50, 100	5, 10, 20, 50, 100
Depth of Soil moisture (cm)*	5, 20, 50	5, 20, 40

*Height and depth indicate the location of the sensors mounted.

**Data source: database of Chinese Ecosystem Research Network (CERN)

Fig. 1.

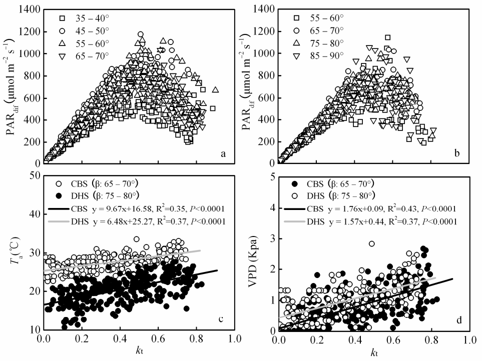

Fig. 6. Changes of diffuse PAR (PAR_{dif}) at (a) CBS, (b) DHS, (c) air temperature (T_a) and (d) vapor pressure deficit(VPD) with the clearness index (k_t) for selected intervals of solar elevation angles from June to August in 2005.

Fig. 2.

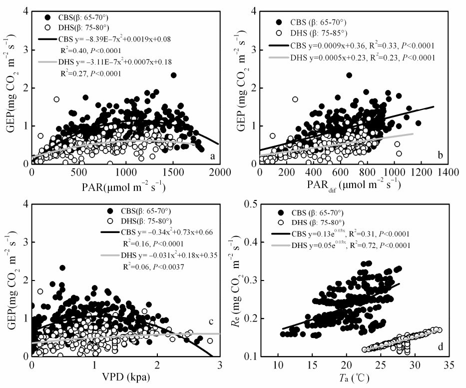

Fig. 7. Changes of GEP with (a) PAR, (b) diffuse PAR ($\mathrm{PAR}_{\mathrm{dif}}$), (c) VPD and Changes of (d) R_e with air temperate (T_a) for selected intervals of solar elevation angles at CBS and DHS from June to August in 2005.

Fig. 3.