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Prof. J. Chen
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RE: bg-2009-225

Dear Prof. Chen,

We hereby submit Author Reply for Editor and Referee Comments on the manuscript (paper # bg-2009-225) entitled “Partitioning of Catchment Water Budget and its Implications for Ecosystem Carbon Exchange” with manuscript authors: D. Lee, J. Kim, K.-S. Lee, and S. Kim. Reply to the editor’s comments is attached at the end of this letter. Reply to the referee’s comments has been uploaded separately. Author reply is provided with the new page/line numbers in the revised manuscript to show where the changes/corrections have been made. We very much appreciate the reviewers’ critical yet constructive comments, allowing us to sharpen our focus and improve the manuscript.

Sincerely,

Dongho Lee

## Reply to Editor's Comments

This study attempts to relate watershed-scale net primary productivity to transpiration. Isotope measurements are used to partition the total evapotranspiration into transpiration and evaporation. Long-time series of precipitation and discharge data for the Han River watershed are used for this analysis. The estimation of the various hydrological components is carefully done. The results of water use efficiency are certainly useful for assessing the carbon cycle at the watershed level. However, I have the following questions:

**Comments:**

The *NPP* values of 250-300 gC/m$^2$/y shown in Figure 5 are surprisingly small, unless much of the watershed is devoid of vegetation. The values are extracted from a M.Sc. thesis by Kim (2006), perhaps using tree ring data. (1) I wonder if this is biomass increment rather than *NPP*. Biomass increment is often 1/3 to 1/4 of *NPP*. (2) How was the watershed-averaged *NPP* obtained with tree ring data? Even with this low *NPP*, (3) I am also surprised to see that *WUE* values obtained from this study are even larger than those from other studies. (4) Are those *WUE* values reported in the other studies obtained on the basis of transpiration or *ET*?

**Reply:**

(1) The M. Sc. thesis of Kim has been recently accepted for publication in Ecological Research. The data reported by Kim et al. (in press) is the 'wood biomass production (WBP)' calculated using DBH measurements and biometric equations rather than *NPP*, as pointed out by the editor. Although *NPP* was not derived from WBP data in the paper, theoretical and empirical relationships have been suggested to estimate *NPP* from total (below and above ground) wood production data (e.g., Jenkins et al., 2001) and therefore the data may serve as a reliable productivity measure. The main reason to show Fig. 5 was to examine the relationship between transpiration and productivity, thereby estimating possible variability of *WUE*. Without having long-term *WUE* data by independent methods (i.e., micrometeorological), the cited 'WBP' data are the only long-term estimate that can be used to infer water-carbon relationship. We revised Fig. 5 and the associated text by changing '*NPP*' into 'WBP' and adding relevant explanations (<u>from page 23 line 12 to page 24 line 2</u>).

<Reference>

Jenkins, J.C., Birdsey, R.A., Pan, Y. (2001) Biomass and NPP estimation for the Mid-Atlantic region (USA) using plot-level forest inventory data. Ecol Appl 11:1174–1193.

Kim, Y., Kang, S., Lim, J.-H., Lee, D. and Kim, J., *in press*, Inter-annual and inter-plot variations of wood biomass production as related to biotic and abiotic characteristics at a deciduous forest in complex terrain, Korea. Ecol. Res.

(2) Currently, no productivity data are available at watershed scale in Korea. The WBP data reported by Kim et al. (in press) were measured from 10 plots in the Gwangneung watershed (area of ~2 $km^2$) with the size of each plot being 20m X 20m. The total number of measured tree specimen encompassed 259 from 17 species. We considered that the data can be representative in terms of carbon uptake characteristic of the forests in the watershed. We added the above explanation in the revised manuscript (from page 23 line 12 to line 17)

(3) Based on the tower *ET* and *GPP* data, the annual average *WUE* for the Gwangneung forest was estimated to be 2.9 ~ 3.4 g C/kg $H_2O$ from 2006 to 2008 (Kang et al., 2009; Kwon et al., in press) which are greater than those reported by other studies. The seasonal variation of *WUE* in Gwangneung forest indicated remarkable increase in early and late growing periods (April, May and October) which are typically dry seasons in Korea. During April and May, *GPP* increased at a much greater extent than *ET* thereby increasing *WUE* (up to ~5 g C/kg $H_2O$). During October, *ET* decreases at greater extent than *GPP* and *WUE* increased accordingly. This decoupled response between *GPP* and *ET* with growing stages is not observed in Kuglitsch et al. (2008) and Yu et al. (2008) studies, and considered to be one of the main causes of the higher *WUE* in Gwangneung forest. Although the implications of this finding merit further discussion, we will have more specific reports on *WUE* in Korean forests with in-depth discussions on biophysical and eco-physiological processes that support higher *WUE*. Following the editor's comment, we have added the above explanation in the revised manuscript (from page 24 line 21 to page 25 line 8)

<References>

Kang, M., Park, S., Kwon, H., Choi, H.T., Choi, Y.-J., and Kim, J.: Evapotranspiration from a deciduous forest in a complex terrain and a heterogeneous farmland under monsoon climate. Asia-Pacific Journal of Atmospheric Sciences, 45(2), 175-191, 2009.

Kuglitsch, F. G. et al.: Characterisation of ecosystem water-use efficiency of European forests from eddy covariance measurements, Biogeosciences Discuss., 5, 4481–4519, 2008.

Kwon, H., Kim, J., Lim, J.-H., and Hong, J.: Interannual variability of net ecosystem

carbon exchange in two major ecosystems in Korea, Biogeosciences (in press)
Yu, G., Song, X., Wang, Q., Liu, Y., Guan, D., Yan, J., Sun, X., Zhang, L., and Wen, X.: Water-use efficiency of forest ecosystems in eastern China and its relations to climatic variables, New Phytologist, 177, 927-937, 2008.

(4) The *WUE* values from the cited reports were calculated based on *GPP* divided by *ET* after accounting for intercepted evaporation in Kuglitsch et al. (2008), while the intercepted evaporation was not separated in Yu et al. (2008) and the Gwangneung data. To avoid confusion, we indicated the types of *WUE* based on the calculation method such as *GPP*/*T* and *GPP*/*ET*. (from page 24 line 9 to line 20)

**Comments:**

It is plausible that *NPP* is related to transpiration as both are controlled by the stomatal conductance. However, *NPP* is only part of the carbon cycle, and heterotrophic respiration is not directly related to transpiration. It is therefore not justified to say "The proposed relations provide a simple and practical way to assess the distribution and strength of carbon sink." In Abstract. It should be made clear that transpiration estimation from watershed water budgets and isotope measurements provides useful information for the carbon cycle but not complete information.

**Reply:**

It is the *GPP*, not *NPP* or *NEE*, that can be constrained by the inter-dependency between water and carbon exchanges and independent measurement of transpiration (or *ET*). The 'WBP' data in Fig. 5 were used as an alternative to *GPP* since long-term *GPP* data for corresponding period are not available. To avoid confusion, we changed 'carbon sink' into '*GPP*' in the text. (page 2 line 6~7, line 17, line 20; page 5 line 4; page 27 line 19)