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Discussions

Interactive comment on "Ecosystem carbon exchange of a subtropical evergreen coniferous plantation subjected to seasonal drought, 2003–2007" *by* X.-F. Wen et al.

Anonymous Referee #2

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Wen et al present a 5 year record of eddy covariance measurements in an evergreen needleleaf plantation in southeastern China. The analysis focuses on the effects of drought on interannual variability in the flux record.

I found many aspects of the analysis interesting, but many fundamental improvements must be made before this manuscript is acceptable for publication. My primary concerns are the results and discussion sections. There are frequent misunderstandings of correlation versus causation when interpreting the cause of change in NEP. For example, are high air temperatures limiting NEP during drought as suggested on 8700 l. 10? Probably not. Lower NEP likely follows from reduced GEP due to water limitations

from droughts that also correspond to higher temperatures. See also the last sentence of the conclusions. Another major concern is the dearth of biological explanations for the observed fluxes including the coupling of GEP and RE through plant and microbial activity. How did drought impact leaf area index (LAI) and how may this have impacted fluxes? The reader gets some indication that canopy function was somewhat compromised if senescence was induced (8699 l. 25).

I am also concerned about the quality of the flux measurements from this area of complex terrain. I recommend that the authors perform a sensitivity analysis on annual fluxes which may reveal that a stricter ustar criterion is justified.

Specific comments: 8692 l. 6: 'out of step' is colloquial. 8692 l. 10: This sentence does not make sense to me; it appears to hinge on the readers' definition of 'sensitivity'. 8692 l. 26: replace this speculative statement with a clearer and more powerful statement from the interesting Meehl and Tebaldi 2004 paper. 8693 l. 10: The wording of this passage is somewhat awkward. The challenge is that NEP is usually the measured term and GEP and RE are the ecosystem-level processes that respond to biological and environmental cues. A brief re-wording will clarify this point for the non-expert. 8694 l. 20: Measurements from both predominant wind directions (all wind directions given Figure 1) will be compromised by the substantial topography including advective fluxes and leeward rotors behind hilltops. Whereas the methods are largely sound I encourage the authors to take more care in data thresholding as discussed later. 8695 l. 1: The contributions of Pinus elliottii make for an interesting potential comparison with the slash pine flux studies in the Florida slash pine plantation (Clark et al., 2004; Clark et al., 1999; Gholz and Clark, 2002; Powell et al., 2008) 8695 l. 6: please provide a more scientific description of the soil type to add value to this study in future comparisons. 8696 l. 14: quantify 'abnormal' Section 2.3: The effects of the hilly topography may necessitate some form of 'angle of attack' filter where half-hourly flux calculations are ignored if the ratio of mean vertical and horizontal wind velocities exceeds some threshold. Nighttime data must be approached with substantial caution given the likelihood for advective flux at night in this terrain. The u* threshold of 0.19 m/s is likely too low for a relatively tall canopy in such a terrain in a warm climate with the potential for substantial thermal inversions. At the minimum, some u* sensitivity analysis should be performed; the work of Reichstein et al. (2005) is a good place to start. This being said, the annual sums strike me as very reasonable given the vegetation and site description although a sensitivity analysis may reveal them to be somewhat on the high end of C sequestration. 8696 l. 20: defining nighttime by radiometer output rather than orbital characteristics like the zenith angle induces some ambiguity for flux partitioning. 8699 l. 23: please quantify precisely the magnitude of these droughts here in the Results section. 8699 l. 25: This point is interesting but qualitative. Senescence was induced in what species (or all?) during the 2003 drought? How did this impact the LAI? These sorts of biological explanations would go a long way toward a comprehensive interpretation of surface fluxes at this site. 8700 l. 10: it was not determined that NEP was decreased due to higher temperatures from higher RE; decreased available water and consequent limitations to GEP is a more likely explanation of the observations. 8700: l. 15: four significant digits for annual flux sums is optimistic, especially for partitioned sums. Two significant digits is a more conservative representation (see also line 21). 8700 l. 17: It has yet to be substantiated that NEP is lowest in 2005 because of low air temperature and net radiation; low temperatures may decrease respiration depending on the response of RE to substrate availability, temperature and moisture. 8701: What is the relationship between vapour pressure deficit and GEP? How is it determined that air temperature is 'almost sufficiently high'? Annual averages may not capture the duration of low temperature events that decrease enzyme kinetics well below their optimum. The results section should delve into the seasonal dynamics that may emerge to become important at the longer time scales because analyses of mean values can obscure the mechanisms, especially nonlinear processes, that are important for explaining flux in this ecosystem, especially when a focus of this paper is on the response of NEP and its constituent processes to drought. 8702 l. 7: RE is controlled by substrate availability (including recent photosynthetic assimilates; it is

coupled to GEP), and this includes biomass. There is a large biological element to land surface exchange that is largely missing from this paper. For example in the next line GEP is controlled by photosynthetically active radiation, temperature, atmospheric water demand and root-zone water supply, but also by the amount of leaves in the canopy (the leaf area index, LAI) and the distribution and function of these leaves in different parts of the canopy. 8702 l. 11: No evidence was presented that soul water from deeper soil layers supplied the canopy during the early stages of drought. 8702 l. 24: how so is GEP exponentially related to air temperature? There is certainly some nonlinear relationship between leaf temperature and GEP that is poorly-represented by a quadratic approximation (quadratic relationships have little mechanistic meaning; remove them from figures 5 and 7. A 3rd order or higher polynomial would by definition fit the data better and there is little justification for any higher-order polynomial when explaining surface fluxes. See also 8701 l. 25, all quadratic explanations for what is ultimately a mechanistic relationship should be removed.) 8702 l. 25: This statement is indicative of the correlation/causation confusion alluded to before. GEP doe s not 'respond' exponentially to air temperature (although there would be an extremely fast decline at the enzyme denaturation point). This apparent response emerges through relationships to other processes to which GEP responds more strongly in places where temperature is rarely limiting, namely PPFD. 8703 l. 7: How is it determined that soil moisture conditions are not in the 'optimal' condition across most soils? This is an extremely sweeping statement that hinges heavily on one's definition of optimum. 8704 l. 8: this statement is inconsistent, soil moisture is both related and unrelated to annual flux sums? 8704 l. 27: is there evidence that GEP is relatively higher under diffuse light environments (for a given PPFD) in this canopy? I'm assuming that there is a substantial contribution of shaded leaves that arguably benefit from increased diffuse irradiation. 8705 l. 20: The table of sites with 5+ years of data is somewhat arbitrary and could either be made comprehensive or chosen for the purposes of comparison with plantation and/or evergreen forests in the temperate zone.

References: Clark, K.L., Gholz, H.L. and Castro, M.S., 2004. Carbon dynamics along a chronosequence of slash pine plantations in north Florida. Ecological Applications, 14(4): 1154-1171. Clark, K.L., Gholz, H.L., Moncrieff, J.B., Cropley, F. and Loescher, H.W., 1999. Environmental controls over net exchanges of carbon dioxide from contrasting florida ecosystems. Ecological Applications, 9(3): 936-948. Gholz, H.L. and Clark, K.L., 2002. Energy exchange across a chronosequence of slash pine forests in Florida. Agricultural and Forest Meteorology, 112(2): 87-102. Powell, T.L. et al., 2008. Carbon exchange of a mature naturally-regenerated pine forest in north Florida. Global Change Biology, online early. Reichstein, M. et al., 2005. On the separation of net ecosystem exchange into assimilation and ecosystem respiration: review and improved algorithm. Global Change Biology, 11: 1424-1439.

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