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Biogeosciences Discussions



# *Interactive comment on* "Modeling the impact of drought on canopy carbon and water fluxes through parameter optimization using an ensemble Kalman filter" *by* W. Ju et al.

**Anonymous Referee #2**

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This manuscript 1) selected three parameters to which the BEPS model was most sensitive; 2) applied the Kalman filter using these three parameters; and 3) found the temporal variations of these optimized parameters and dependency of these parameters on humidity. Based on this finding, authors argued that efforts are needed to develop algorithms that can properly describe the variations of these parameters under different environmental conditions.

I have a few major concerns on this manuscript, and am afraid that their finding was obtained artificially through the misuse of the model-parameter optimization technique.

My concern is based on that:

1) Authors are saying that temporal variation of the parameters and its dependency on humidity can be real response of ecosystem. However, such dependency can be a false product if the model is not properly parameterized to incorporate the drought effect. That is, if the model has structural deficiencies and thus cannot simulate the drought effect, ***we had better say that the model parameterization should be improved, not say that parameter should be modified to permit its temporal variation.***

Keeping this in our mind, the photosynthesis-conductance model in the model described in the manuscript seems to have one structural deficiency in simulating drought effects on ecosystem carbon and water exchanges. Authors said that the photosynthesis-conductance was based on the model by Wang and Leuning (1998) (WL98). However, compared to the original code suggested in Wang and Leuning (1998) (Eqn. (5) in WL98), the model used in this manuscript (Eqn. (2) in this manuscript) omitted the function $f_w$ to describe the sensitivity of stomata to soil water content. The absence of this function can make pseudo-variation of other parameters.

Recently, Tuzet et al. (2003) also extended WL98 model to incorporate the role of leaf water potential which is affected by water uptake by roots and transport through the canopy (Tuzet et al., 2003: Coupled model of stomatal conductance, photosynthesis and transpiration, *Plant, Cell and Environment*, 26, 1097-1116). So at least after incorporating the effects of water availability to plant canopy into the BEPS model like Wang and Leuning (1998) or Tuzet et al. (2003) and author find temporal variation of the input parameters and its dependency on humidity, authors may argue the same statement.



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This study did the similar analysis as Reichstein et al. (2003) and Mo et al. (2008) did. In addition, this manuscript cited a few papers such as Wang et al. (2006), Wolf et al. (2006), and Mo et al. (2008) showing the evidence of temporal variation of $V_{cmax}$. However, Reichstein et al. (2003), Wolf et al. (2006) and Mo et al. (2008)(in which authors of this manuscript is one of coauthors) also applied the same equation as the equation used in this study. In Wang et al. (2006), they adopted the effect of water stress. Authors should note that Wang et al. (2006) used a fixed $V_{cmax}$ ($V_{cmax}$ in this manuscript corresponds to $V_{cmax}$ at 25 $^oC$ at Wang et al. (2006)). Temporal variation of parameters in Wang et al. (2008) is not $V_{cmax}$, but $V_{x,25}$ which is considering the effects of temperature and water supply.

2) Ecosystem models are subject to equifinality. That is, different parameter sets can produce the same fluxes (See Hollinger and Richardson, 2005: Uncertainty in eddy covariance measurements and its application to physiological models, *Tree Physio.*, 25, 873-885). Even though the model used in the manuscript showed strong dependency on the three parameters ($Vc_{max}, m, D_0$), it is possible that another combination of different parameters can give the same values as the values that the optimization of the three parameters reproduced. In this sense, authors did not attempt to optimize parameters which make impact on soil respiration in this manuscript. Is there any reason why not to do this?

3) Recently, the similar studies, which applied the model-parameter optimization techniques, have been done. Importantly, this manuscript did the similar analysis following the previous studies and uses the similar title. However, I could not find any clues and finding to improve our understanding of the biosphere-atmosphere interaction. In particular, authors are not kind to explain unique findings of this study,



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compared to other previous studies. What is difference or similarity of this study, compared to other similar studies? If authors want to emphasize the uniqueness in Asia, the title does not seem to be appropriate. I believe that authors should clearly explain what is the main contribution of this study to the scientific community and highlight something unique in Asia if there is./

**Specific comments:**

1) Page 8284, Line 11: Please provide the observed LAI and describe if the observed LAI showed any temporal changes or not.

2) Page 8284, Line 21: Time step o the BEPS model is 1 day based on Ju et l. (2006). So, how is it possible to use daytime data only for the parameter optimization? In relation to this, time step of this model should be provided in the manuscript.

3) Page 8284, Line 21: Why did authors apply the parameter optimization only using the daytime data, not daily mean (or daily sum)?

4) Page 8284, Line 21: How did authors fill the missing data which are inevitable in the eddy-covariance method?

5) Page 8285, Line 16: In Wang and Leuning (1998), a function for considering water supply was adopted.

6) Page 8285, Line 17: $C_{s,i}$ in the denominator of the second term of the right-hand-



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side of equation (2) should be $C_{s,i} - \Gamma$ (here $\Gamma$ is a compensation point).

7) Page 8285, Line 24: Can authors quantify the impact of the parameter optimization on canopy transpiration?

8) Page 8287, Line 10: What is scientific basis of 15% uncertainties of the observed GPP and LE?

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Interactive comment on Biogeosciences Discuss., 6, 8279, 2009.