Geoscientific

Model Development

Discussions

[GMDD]

Interactive

comment

Interactive comment on "Evaluating the E3SM Land Model at a temperate forest site using flux and soil water measurements" *by* Junyi Liang et al.

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This paper reports an effort of tuning an Earth system model, E3SM, to fit observed leaf area index (LAI), gross primary production (GPP, derived from eddy flux data), and soil respiration at a temperate deciduous forest site. The authors specifically tested different empirical relationships between volumetric water content (VWC) and soil water potential (SWP), and found tuning soil water potential improve the simulation of soil respiration. So, they concluded that "modelling soil respiration can be significantly improved by better model representations of the soil water retention curve." I agree with the authors that the well data-constrained model, Hanson model, increased the prediction of soil water potential, and may improve the simulation of GPP, which have been shown by the results (Figs. 3 and 7). But for the improvement of soil respiration, I

think it's just a coincidence. From the Fig. 5a (page 9), we can see the new VMC-SWP relationship (i.e., Hanson model) increases soil respiration rate overall, but it does NOT change the pattern. This means the performance of soil respiration modeling is not improved. The authors also pointed out that the original model underestimates GPP and soil respiration (Line 13, page 7, and Fig. 2). So, the improvement of soil respiration prediction was not due to the improvement of SWP simulation, but because increases in GPP. The increases in GPP may increase carbon allocation to roots or total soil carbon, and therefore increase soil respiration. And, according to Fig. 7, the most possible reason for underestimating soil respiration is that the root respiration is not high enough in growing season, which also leads to the seasonal pattern that does not fit the observations because root respiration is usually high in growing season and very low in non-growing season.

A detailed report on the tuning of an ESM is valuable even if no new mechanisms were added. It helps to understand model performance and the thoughts behind the model development. For improving simulation of soil respiration, the authors had looked at the sensitivity to temperature, LAI, GPP, and relative contributions of roots and soil carbon, and tuned a bunch of parameters (Table 2 in page 5). A detailed analysis of the successes and fails of these tunings would be interesting. For example, I'd like to see how the improvement of SWP prediction affects plant physiology, photosynthesis, allocation, NPP (because NPP=Rh at equilibrium). These variables may change soil respiration.

Specifically, for water effects on soil heterotrophic respiration, the model uses two equations to link volumetric water content to heterotrophic respiration: VMC–>SWP and SWPRh. The second equation (SWPRh, Eq 9 in page 4) is much more critical than the first one for modeling heterotrophic respiration. It represents the knowledge of how soil moisture affects microbial physiology. It needs to be explored in detail if the goal of this research is to improve the simulation of soil respiration.

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