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Geoscientific Model Development
Discussions

Interactive comment on "Integrated Modeling of Photosynthesis and Transfer of Energy, Mass and Momentum in the Soil-Plant-Atmosphere Continuum System" *by* Yunfei Wang et al.

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The authors integrated photosynthesis and transfer of energy, mass and momentum in the soil-plant-atmosphere continuum system. The topic of this work is important, which may provide better insight into root water uptake modeling and the impacts of water availability on vegetation growth in terrestrial biosphere models. However, the manuscript still needs to be substantially improved.

1. SCOPE is a vertical (1-D) integrated radiative transfer and energy balance model, which is widely used in the simulations of vegetation photosynthesis process and fluorescence at the leaf and canopy level. The soil model is very simplified in SCOPE. It is interesting to see the STEMMUS Model, which is good at dealing with the mass and

heat transfer processes in unsaturated soil, is implemented into SCOPE. However, I do not see significant improvements in the SCOPE_STEMMUS model in current manuscript, although the SCOPE_STEMMUS includes root water uptake in unsaturated soil. I think this shortcoming lies in the model validations based on the measurements at the Yangling station. As we know, SCOPE model has the abilities to simulate the vegetation photosynthesis and evapotranspiration under the unstressed water conditions (Zhang et al., 2020; Shan et al., 2019; Zhang et al., 2018). And the Yangling station has irrigation and vegetation growth do not have water and heat stresses in 2017. Therefore, we can see very similar simulations from SCOPE and SCOPE_STEMMUS in Figure 6 and 7, which means the similar ability of SCOPE_STEMMUS and SCOPE in simulating ET and T. I think more sites that have water or heat stresses should be used for the validations to prove the better ability of SCOPE_STEMMUS.

2. For the development of SCOPE model, Bayat et al. (2019) have extended the SCOPE model to combine optical reflectance and soil moisture observations for remote sensing of ecosystem functioning under water stress conditions. Bayat's work has overcome the shortcoming in biased estimations of GPP and ET under water stressed conditions and the significant improvements of GPP and ET in SCOPE_SM model have shown in the paper. We also see the same abilities of SCOPE_SM and SCOPE_STEMMUS in simulating ET in this manuscript. Therefore, the authors should declare what the improvements are in SCOPE_STEMMUS model. Terrestrial biosphere models typically use empirical functions to represent vegetation responses to soil drought, especially in the water-limited areas. These functions largely neglect recent advances in plant ecophysiology that link xylem hydraulic functioning with stomatal responses to climate. I think this may be a direction to declare the new insights in the impacts of water tress on the vegetation growth, due to the descriptions of root water uptake in STEMMUS model.

3. In Table 1, some information should be updated. Nowadays, CLM5.0, CALBLE and JULES have large improvements in the hydraulic functioning with stomatal responses

to the warming climate (De Kauwe et al., 2020; Lawrence et al., 2020; Eller et al., 2020). And the authors should have more discussion about the root water uptake and the hydraulic functioning in the SCOPE_STEMMUS model in this manuscript.

4. The quality of some figures should be improved. This paper focus on the model developments and the better ability of the new model should be clear to the readers. For example, Figure 2 should be removed to the supplemental material. And Figure 5 and 8 are difficult for the readers to see and these figures should be redraw.

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