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Dr. X. Lee  
Editor-in-Chief  
Agricultural and Forest Meteorology  
Yale University New Haven, CT

Dear Dr. Lee,

We are pleased to submit our manuscript “When does vapor pressure deficit drive or reduce evapotranspiration?” for consideration for publication in the *Journal of Agricultural and Forest Meteorology*. This research is particularly relevant now, given that vapor pressure deficit (VPD) is expected to increase as greenhouse gas concentration increases, but current research across ecology, climate, and meteorology exhibits a range of views on whether these increases in VPD drive increases in ET (atmospheric demand dominates ET response) or decreases in ET (plant response dominates ET response).

We show that for the majority of plant types and environmental conditions, ET decreases with increasing VPD, suggesting that the plant water conservation response to increasing VPD overwhelms the increase in atmospheric demand. However more water intensive ecosystems (e.g. crops) are more likely to allow increases to ET with increasing VPD than water conservative ecosystems (e.g. shrubs, savannah).

While deriving these results, we developed a novel analytical framework for calculating ET as a function of environmental variables. For the first time we explicitly account for changes in photosynthesis associated with changes in VPD by leveraging recent results on the relationship between ET, VPD and gross primary production [Zhou *et al.*, 2014, 2015]. This approach reveals that a consequence of recently proposed optimal stomatal conductance theory [Medlyn *et al.*, 2011, 2017] is that the ET-VPD curve is concave upward. That is, ET decreases with increasing VPD up until some ecosystem-specific VPD threshold, after which plant response cannot fully cancel increases in atmospheric demand (VPD) and further increases in VPD result in increases to ET. Furthermore, the fundamental shape of the ET-VPD curve could shift from concave up to concave down if one used pre-Medlyn *et al.* 2011 stomatal conductance theory.

A previous version of this manuscript was rejected from *Global Change Biology*. The current version of the manuscript is greatly improved based on reviewers’ comments; we applied recent results [Medlyn *et al.* 2017] to extend our analysis to three more plant types, we added additional discussion of our simplifying assumptions and their consequences for interpreting results, and we included a section showing how the concave up nature of the ET-VPD curve is a direct result of optimal stomatal conductance theory. This last addition was motivated by a reviewer’s comment that the shape of the ET-VPD curve should be concave downward. This comment, which the reviewer supported via an unreferenced figure rather than a citation, highlights for us the importance of publishing this manuscript, as experienced researchers in land-atmosphere feedbacks and coupling maintain divergent [yet strong] opinions on the shape of the one-way ET-VPD curve, which is fundamental to disentangling more complex feedbacks between the land surface and the atmosphere. We believe it is crucial for the community to see that the nature of the ET-VPD curve is dependent on use of cutting-edge stomatal conductance theory and is very much an active area of research.

Thank you very much for your time and consideration of this manuscript.

Sincerely,

Adam Massmann

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