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Modeling evaporation from leaves

Monday, 30 May 2022 17:50 (15 minutes)

Current predictions with respect to the global climate suggest that severe weather events will occur more often and more intense than in recent years. One example for such extreme events are heat waves, which have a significant impact on agriculture and daily life in urban areas. With evaporative cooling, plants can help to reduce the heat in big cities during such periods.
In the scope of our project, we model leaves as porous media to describe the process of evapotranspiration. The rate of evaporation depends on the leaf structure, flow and transport processes within the leaf, as well as environmental conditions such as solar radiation and wind speed. To capture the respective effects on different spatial scales, we model an individual leaf on both the pore-scale and the REV-scale. In a first step, we apply a pore-network model [1] to discretely describe the leaf structure. Especially challenging is the accurate represenation of the small openings on the lower surface (stomata), which regulate the gas exchange between the leaf and the atmosphere [2]. In a second step, we use the information obtained with the pore-network model to parameterize an REV-scale model such that larger computational domains can be handled.
Collaborations with experimental scientists yield the required data to adapt the simulation to realistic scenarios. By comparing simulation results with measured data, we aim at improving the accuracy of our model.
So far, only the gas exchange between leaf and atmosphere is considered. Under certain conditions, liquid drops form on the stomata and influence the exchange processes. In the future, we will extend our model to take these drops into account.

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References

[1] Weishaupt, K., Joekar-Niasar, V., & Helmig, R. (2019). An efficient coupling of free flow and porous media flow using the pore-network modeling approach. Journal of Computational Physics: X, 1, 100011. https://doi.org/10.1016/j.jcpx.2019.100011
[2] Lehmann, P., & Or, D. (2015). Effects of stomata clustering on leaf gas exchange. New Phytologist, 207(4), 1015–1025. https://doi.org/10.1111/nph.13442

Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Online

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