Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-363-AC1, 2016
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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Leaf-scale experiments reveal important omission in the Penman-Monteith equation" *by* Stanislaus J. Schymanski and Dani Or

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Received and published: 23 August 2016

Thank you for the supportive comment. You have made a very good point, which applies not only to irradiated leaves, but even to our experiments in darkness, using leaves with stomata on one side only. Due to evaporative cooling on one side, there can indeed be a temperature gradient between the two sides of a leaf, which is strongly dependent on leaf thickness and its thermal conductance. We note that both the numerical model used in this study and the analytical solutions based on Penman and Monteith neglect this gradient and assume that both sides of the leaf are at the same temperature. For natural leaves of 0.1-0.5 mm in thickness that are fully hydrated, the temperature gradient would not exceed 0.1- 0.5 K, which justifies the assumption of sin-

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gle temperature for both sides. We have added a conductive heat flux across the leaf to the numerical solution (in a separate study) and found it had only a minor effect on the net exchange of sensible and latent heat fluxes. Even for artificial leaves (perforated aluminum foil with filter paper sandwiched in the middle) with potential air gaps and lower thermal conductance than real leaves, the measured "leaf temperature" was only 1K different between the two sides of the leaf surfaces. Moreover, the simulated leaf temperatures considering heat transport between the two surfaces bracket the temperature when the heat exchange is neglected. In other words, neglecting conductive heat flux across a thin, planar hydrated leaf is justified for representing steady-state latent and sensible heat exchange with the atmosphere.

Nevertheless, we will explain this point in more detail in a follow-up technical paper on the wind-tunnel and artificial leaves, and also highlight the challenges in including irradiance in the wind tunnel experiments. Our preliminary measurements have shown that while the latent heat flux under irradiance was consistent between wind tunnel experiments and models, the sensible heat flux could not be measured correctly. This deviation was attributed to stray irradiance absorbed by the wind tunnel walls. We are working on solutions to reduce stray shortwave irradiance (by focusing the beam on the leaf surface only) and results will be presented in the technical note.

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