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Critical evaluation of the Penman-Monteith equation for simulating canopy evapotranspiration

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Evaporative water losses from ecosystems are strongly determined by vegetation and its dynamic control of surface conductance. Surface conductance varies at the hourly scale by opening and closing stomata, whereas seasonal variations in leaf area index have an effect on maximum possible surface conductance as well as the surface albedo and aerodynamic conductance. This means that vegetation imacts all components of the surface energy balance, i.e. absorbed shortwave radiation, longwave radiative exchange, sensible heat exchange and latent heat flux via evapotranspiration. The latter is the component that is most strongly affected by vegetation. The Penman-Monteith (PM) equation is commonly considered the best physically-based analytical expression for latent heat flux from a vegetated surface. It has been shown in a previous study that, contrary to common belief, the PM equation is inadequate at the leaf scale, due to neglecting the two-sided sensible heat flux exchange and associated omissions (Schymanski and Or, HESS 21(2), 2016), and a correction at the leaf scale has been proposed. Here we evaluate if the correction is useful at the canopy scale and discuss the (in-)adequacy of the assumptions underlying the PM equation for understanding canopy-scale processes.