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Common but wrong assumptions about evapotranspiration and their effect on perceived sensitivity to climate

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Evaporative water losses from catchments are strongly determined by vegetation at diurnal and seasonal time scales. The opening and closing of stomata controls surface conductance at the hourly scale, 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 implies that vegetation impacts all components of the surface energy balance, i.e. absorbed shortwave radiation, longwave radiative exchange, ground heat flux, sensible heat exchange and latent heat flux. At the same time, all the surface energy balance components are linked through the surface temperature feedback in a non-linear way that precludes exact analytical solutions of the problem.

The Penman-Monteith (PM) equation is commonly considered the best physically-based analytical approximation for calculating evapotranspiration (ET) from a vegetated surface. However, common misconceptions about appropriate use of the equation as well as the underlying assumptions can result in substantially skewed predictions of ET sensitivity to variability in climatic conditions. These misconceptions include:

- Disregard for the two-sided sensible heat exchange by plant leaves and associated omissions (Schymanski and Or, HESS 21(2), 2016)
- Representation of ET as a product of "unstressed" ET and a moisture stress factor
- Omission of interactions between surface temperature, buoyancy and the aerodynamic conductance

Here we used eddy covariance observations and modelling results to illustrate the effects of the above misconceptions on our understanding of ET sensitivity to climate. Our results cast a serious shadow of doubt on the suitability of state-of-the-art ET models and call for in-depth research on the process of free (thermal) convection, surface-atmosphere coupling at the plot scale and their interactions with the biological control of the canopy conductance.