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Maximum Entropy Production under periodic forcing: results of a simple toy model

In recent years, optimality principles have been proposed as a new way to estimate model parameters. The principle of maximum entropy production (MEP) is one of these proposed principles, which states that nature organizes itself in such a way that each flux maximizes its entropy. When fluxes are described as a gradient divided by a resistance, and there are two or more competing fluxes, one can then determine the resistance of one flux, given the resistance of the other fluxes.
Using this principle, Kleidon and Schymanski (2008) showed with a simple example how hydraulic conductivity could be determined given the water potential of the vegetation and the resistance for root water uptake. However, besides the fact that they did not check their results with data, they also assumed a constant input. Given such a constant input, one can easily show that the optimal resistance for groundwater flow is equal to the given resistance of root water uptake, regardless of gradients that drive the fluxes.
Yet, we know that, in reality, the resistances of different fluxes are not equal. In this study we show that this can be explained by the 'periodic' input of rainfall. With simple toy models, we show that under periodic forcing the optimized resistances do differ from the given one when optimized with MEP.
We first applied a periodic input to the 1-reservoir model of Kleidon and Schymanski (2008). In this model, the optimized resistance starts differing from the given one when the reservoir gets empty in-between two rainfall pulses. In a second step - in which we tested the principle to two coupled reservoirs - a different optimal resistance occurred when transpiration was assumed from only one of the two reservoirs.
Both concepts should still be tested against real data, but since they form the building blocks for many hydrological models, it has the potential to improve our models significantly. For example, the 2-reservoir model can be interpreted as a double domain model for the unsaturated zone where one reservoir represents the matrix flow, and the other the macropore flow.