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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Transferring the concept of minimum energy expenditure from river networks to subsurface flow patterns" *by* S. Hergarten et al.

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Dear Stefan,

Let me shortly explain the link between minimum energy expenditure and maximum free energy dissipation (although I am not sure if this explanation is general enough for ALL systems): Maximum free energy dissipation means that a system out of equilibrium wants to move to thermodynamic equilibrium (TE) as fast as possible, where TE means that all gradients (or potential differences) are zero.

For each problem TE should be determined. For example, in the paper of Zehe et

al. (2013), TE is determined as the state where matric potential equals gravitational potential: If the soil is wetted, gravitational potential increases and the (absolute) matric potential decreases until TE is reached (and vice versa for drying of the soil).

In the system considered in this manuscript, TE is reach if all water is at the level of the outflow (potential (and kinetic) energy is zero). Maximum free energy dissipation thus means that all potential energy (and thus all water) should be exported out of the system as fast as possible. With the given constraints this means that friction should be minimal which is equivalent to minimum energy expenditure is.

References:

Zehe, E.; Ehret, U.; Blume, T.; Kleidon, A.; Scherer, U. & Westhoff, M. A thermodynamic approach to link self-organization, preferential flow and rainfall–runoff behaviour Hydrol. Earth Syst. Sci., 2013, 17, 4297-4322

With kind regards, Martijn

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 5831, 2014.