Hydrol. Earth Syst. Sci. Discuss., 12, C2211–C2214, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C2211/2015/

Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Optimality and inference in hydrology from entropy production considerations: synthetic hillslope numerical experiments" *by* S. J. Kollet

Anonymous Referee #2

Received and published: 24 June 2015

General comments

This paper applies the maximum entropy production (or maximum power) principle to a relative simple model of the unsaturated zone. It determines the power in each grid cell of which the spatiotemporal mean is taken. This is done for different values of Ksat and it appears that two maxima in power exist.

Subsequently, a conceptual model is described and from the spatiotemporal mean of the fluxes and of power an effective conductance is calculated. Interestingly, the two optimum values of Ksat collapse into a single value of the effective conductance. Both

analyses are done for a case of homogeneous Ksat and a heterogeneous Ksat field. This is an interesting paper and eventually worth publishing. However, some more clarification and rewriting are needed before that.

For example, I was especially confused by the conceptual model (Fig. 5). This model is presented as being the same model as in Kleidon and Schymanski (2008) and Westhoff et al. (2014). However, in their models there is competition between runoff and evaporation which is missing in Fig. 5. But I was even more confused, because Kleidon and Schymanski (2008) and Westhoff et al. (2014) optimized their conductance within the framework of their model, where for each value of the conductance the power is calculated. In this paper, the maximum power principle is used to come to a macroscopic head difference and a macroscopic conductance that can replace the microscopic heads and the microscopic K(theta). This is a completely different methodology to get the macroscopic parameters. I suggest to better communicate this in the revised version.

Besides this I also miss a verification of the macroscopic model: Once the optimum macroscopic parameters have been defined, run the macroscopic model with the same climatic forcing as the microscopic model and compare the resulting fluxes with the microscopic model. This may also shed more light on the fact that two optima of Ksat collapse into one optima in lambda (why this happens is still unclear to me).

More specific comments are below:

P5127, L25: add a graph with time series of the forcing

P5131, Eq. 10 and 11: Power cannot be summed. Instead the mean should be taken, so it should be divided by NT and NK.

P5132, L7-13: To make this point clearer, I suggest adding a similar figure as Fig.1 but than for a dry and a wet period in time.

P5133, L1: The zone of net inflow is not necessary a net exporter of power. Rephrase to ‘incoming water produces more power than outgoing water’ or ‘incoming fluxes are driven by larger gradients than outgoing fluxes

P5133, L3: Are the different zones related to the part they cover at the pf-curves (e.g. convex or concave parts of the curve)?

P5133, L22-23: If the cross-section is taken a little bit to the right or left, the P values will be much larger in the groundwater reservoir.

P5133, L27: Why does the spatiotemporal mean darcy flux change with changing Ksat? The input (rainfall) and output (evaporation) of water is fixed, so the total mean flux should remain constant.

P5135, L20- P5136, L3: I suggest to move this part to the introduction, since it explains the objective of the paper much better than currently.

P5137, L11-14: I don’t understand this explanation

P5138, L1-7: I don’t understand this part. Please be more specific: e.g. to which subfigures are you referring? Do you mean that the slope of lambda in increasing monotonously?

P5140, L4: Power can indeed not be measured directly, but suction heads and K(theta) can. With this, power can be calculated (although I recognize that these observations are point measurements, while in real hillslopes macropores are also present)

Fig. 3: Indicate in Fig. 2 which cross-section is taken for this figure.

Technical corrections:

P5126, L18: Two maxima in power were found, but for different conductance values (and unique climatic forcing)

P5127, L20: If PF.CLM provides evaporation, than net radiation, sensible heat and ground heat fluxes are not needed for this exercise.

P5128, L6: remove the percentage sign?

P5128, L12: ‘and of . . . at the top’: rephrase

P5129, L12: PCP: keep to the conventions of HESS: Variables consist of one letter/symbol and the rest in sub- or superscript (applies also to other variables)

P5129, Eq. 4: add the overflow terms

P5133, L8-9: The stair-step like representation can also be seen as a numerical artefact.

P5134, L26: What is meant by ‘correct location’?

P5136, L24: the maximum at log(Ksat) = -3 is difficult to see in Fig. 6a. It rather seems to have a maximum at the edge of the parameter space.

P5138, L9-10: please rephrase. There exist a maximum in power in the MATHEMATICAL model of the hillslope.

Fig 1: Indicate that blue is relatively dry and red is wet (or use a logarithmic scale).

Fig 1: qˆinf is larger than 0

Fig 2: Indicate that negative means incoming water and positive is outgoing water

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