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Earth System Dynamics Discussions

Interactive comment on "Quantifying the thermodynamic entropy budget of the land surface: is this useful?" *by* N. A. Brunsell et al.

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General comments

As an entropist it is good to see one's discipline used in unconventional areas. And as maximum entropy production (MEP) principles are indeed completely universal, I am quite convinced that MEP can make useful contributions to land management studies. However, several very basic considerations must be settled first.

- What does the investigator really want to know? - Is maximum entropy production a useful proxy for what is really sought, i.e. is there a unique match between the two? - Is the MEP question well posed, and are the basic requirements for an MEP calculation satisfied?

Unfortunately I miss answers to all these fundamental questions. Do the authors deep

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down want to measure changes in vegetation cover over time? That is probably more easily and reliably measured by satellite imaging. Or do they want to quantify the sustainability of the use of the land? Sustainability is a philosophical concept which has not been defined uniquely to allow for a quantification, so any such measure would be hand waiving.

Lacking a unique answer to the first question one can hardly make a solid connection to MEP - as the authors actually realize up front in the title of the paper, 'is it useful?'.

To carry out an entropy calculation one needs well defined state probabilities, or macroscopic state functions. That will typically require the system to be in equilibrium or in a stationary state. Assuming the latter, at least on a time scale long enough to average out fluctuations but short on the daily scale, is probably valid. More critical for the present study is the need for fixed boundary conditions in order for comparisons between different situations to be meaningful. A statement like "a 'green' planet has a higher entropy production than a 'desert' planet" is obvious and carries no new information. The overall entropy production of the planet is determined solely by the temperature of the incoming radiation from the sun and the temperature of the planet which radiates back to space. The solar temperature is fixed, so all we can hope to change is the planet temperature, and here a desert has a higher albedo and a higher temperature than vegetation, so obviously its entropy production is smaller. If we also take the planet temperature as fixed at the value observed from space, the global entropy production is specified, and all we can do is to manipulate the location of that entropy production for our own benefit.

Regardless of the quality of the modeling presented here, the results are only useful if these very fundamental questions can be answered in the beginning.

Specific comments

The sign of H in eq. (1) puzzles me. H and LE are the sensible and latent heats, respectively, two closely related quantities so why don't they have the same sign? The

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arrows in Fig. 1 point in the same direction, away from the surface.

Latent heat is clearly more efficient in carrying energy away than is sensible heat due to the exceptionally large heat of vaporization of water. But that heat as well as its accompanying entropy is delivered somewhere else in the form of rain. The study seems to forget about this conservation of mass in the balance statements.

In the conclusion it is stated that "this is supportive of the idea of using entropy production as a measure of ecological succession and more generally or a measure of ecological sustainability". This claim needs a lot more explanation to make sense.

Error bars on the figures are badly needed, indicating not just statistical error but also systematical errors.

Interactive comment on Earth Syst. Dynam. Discuss., 2, 71, 2011.