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# Free Energy as Link to Hydrological Responses and Landscape Organization

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The water balance equation remained the single most basis of all hydrological models during the last decades. While we strive to find ways to integrate the whole human-hydro-geo-eco-system into the water balance, energy as driver for the processes we hope to capture is often forgotten. In order to advance hydrological models catchments as self-organizing systems are topic in many publications since several years (e.g. Grayson and Blöschl 2001). Recent studies propose the concept of optimality for hydro-eco-systems (Schymanski and Kleidon 2008). Moreover the arrangement and persistence of macropores, as highly dissipative structures and as one common bio-geo interaction, were shown to result in faster dissipation of Helmholtz Free Energy (Zehe et al. 2009).

The hypothesis that landscapes might arrange in a way to maximize the dissipation of free energy has been the starting point of this analysis. Based on data from three completely different catchments in Chile and Germany we conducted a model assessment of the behavior of the Helmholtz Free Energy of the soil water domain and the entropy and heat exchange at the atmospheric boundary for different landscape organizations at representative hillslope settings using the model CATFLOW. In a second step we sought further for internal topologies and functional entities by developing a toy-model.

The study revealed quickly that the different components of the energy balance of the hydro-eco-system cross several orders of magnitude. Hence a mere first-order approach to maximized dissipation of Free Energy is not giving us any enhanced insight nor does it reflect reality. We propose a conditioned schemes as e.g. when it rains the option to dissipate energy through evaporation or transpiration is basically closed and vise versa. Further we discuss approaches to understand the hydro-geo-eco-system beyond mechanized descriptions of highly conceptualized compartments through functional units.