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Scaling ecosystem function: Small steps toward a Maximum Entropy framework

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Scaling is a procedure that takes information at one scale in time and/or space and uses it to derive processes at another. Following this definition, scaling inherently involves a transfer of information. It is apparent then that ecological scaling is related to Information Theory, the study of the quantification and transfer of information. Techniques from information theory have found widespread applications in ecology and Earth science, namely studies of ecological diversity, landscape patterning, and modelling, but have found fewer applications to date in scaling Earth system processes. I discuss two applications of information-based scaling to: 1) minimize the effects of nonlinearities due to Jansen's Inequality when upscaling carbon dioxide flux estimates and 2) to minimize bias when downscaling subpixel/subgrid surface patterns using Tikhonov Regularization. All scaling approaches require the inference of unavailable information, which is an ill-posed problem. A classic solution to this problem of missing information was introduced by Jaynes (1957) with the Maximum Entropy Principle (MaxEnt): in making inferences on the basis of partial information, we must use that probability distribution which has the maximum entropy subject to whatever is known. Progress toward a MaxEnt framework for scaling in the Biogeosciences will be discussed in the context of the examples introduced here.