EGU22-4076
https://doi.org/10.5194/egusphere-egu22-4076
EGU General Assembly 2022

Information theory approach for enhancing time series analysis and predictability of soil environments

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Soil environments are naturally governed by a multitude of interdependent chemical, biological, and physical processes that define their macro-state. In the context of farming these features are further complemented and affected by anthropogenic activities (ploughing, fertilizing, use of pesticides, etc.) that systematically aim to change soil and plant environments to enhance yield, but often with unforeseen detrimental effects (biodiversity loss, erosion, etc.). Assessing strategies for sustainable environmental management is therefore a highly challenging task that is often accompanied by incomplete knowledge of systemic feedback mechanisms and a lack of continuous and reliable data.

To address this issue, we investigate the use of complexity metrics from information theory to gain insights about underlying patterns of multivariate soil systems and their potential implications for time series analysis. Here we apply existing methods for the processing and analysis of similar systems, we verify current theories about the dynamics and mechanisms of ecological processes in time and study innate interactions between separate components. Thereby, we will use available agricultural datasets that display a wide range of soil properties and explore several notions of complexity approaches, such as entropy measures (e.g., Permutation entropy, transfer entropy, Shannon entropy) and the Hurst exponent. Characteristic features will be highlighted that can be used to enhance time series prediction accuracy and systemic soil functions understanding.