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Convergent cross-mapping for causal Inference in carbon and water fluxes processes.

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Evapotranspiration (ET) is the sum of water vapor fluxes from soil evaporation (Es), wet canopy evaporation (Ew) and plant transpiration at dry canopy surface (ED). ET is tightly coupled with vegetation photosynthesis (gross primary productivity, GPP) being both, ET and GPP, the two dominant processes in global land water and carbon cycles. The remaining components of ET, Es and Ew, are indirectly also related with GPP, mostly due to vegetation cover changes. The better understanding and assessing of the relations between these processes would potentially lead to an optimized management of water and carbon resources. In the present work, we apply a modern method for observational causal inference, the convergent cross mapping (CCM) technique, as a way to infer patterns and associations from the above mentioned land fluxes and some of their potential drivers (such as water availability and, temperature stress). The CCM method benefits from having few assumptions and its goal is to reconstruct the system dynamics by using only time series data of the considered variables. Preliminary results over a selection of sites in different ecosystems are promising and indicate the potential of the CCM technique. The method not only infers weak and strong causal relationships between the variables, but also provides insight about the underlying complexity of these interactions by means of the embedding dimension.