

Retrieving hydrological connectivity from empirical causality in karst systems

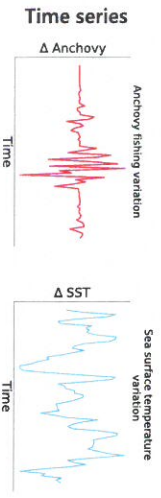
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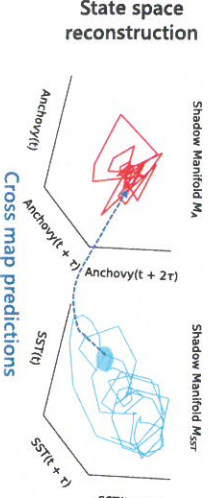
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Testing causality between time series with Convergent Cross Mapping (CCM)

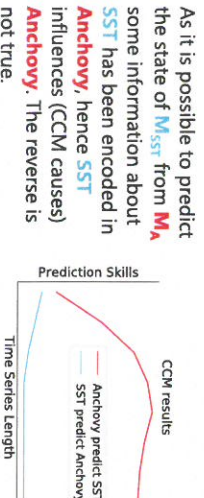
CCM is a test based on nonlinear state space reconstruction that distinguishes causality from correlation (Sugihara et al., 2012). Demonstration with ecological data :



Shadow manifolds are reconstructed using multiple lags of the original time series as coordinates. Because each point on the shadow manifold corresponds to a time index, the shadow manifolds are cross mapped.



CCM applies a cross map prediction methods to check if points and their nearest neighbors on the shadow manifold M_{SST} can predict the states on M_A and vice versa. A causal relationship is revealed if prediction skills increase with longer time series (convergence).



Sugihara, G., R. May, H. H. Chhah, E. Doyale, M. Fogarty, and S. Munch. "Detecting Causality in Complex Ecosystems." *Science* 338, no. 6106 (October 26, 2012): 496-500. doi:10.1126/science.1221073.

Research

Karst = soluble rock with caves and fissures

Where does water go in the karst?

1. Assess **CCM** potential to reveal hydrological connections
2. Build a flexible structure modeling framework driven by CCM results

A modeling framework for the Lomme Karst System

FRAMEWORK

=

GENERIC MODEL COMPONENTS

PF PRODUCTION FUNCTIONS*

TF TRANSFER FUNCTIONS**

+

EVALUATION TOOLS

OBJECTIVE FUNCTIONS INCLUDING **CCM**

(*) PRODUCTION FUNCTIONS generate water volumes.

(**) TRANSFER FUNCTIONS route water volumes

The Lomme Karst System

The Lomme Karst System (Rochefort, Belgium) is the downstream part of the Lomme river basin where the river crosses for 7 km a 1 km wide karst, infiltrating into it and flooding the caves in case of high discharge event.

The Lomme Karst System is monitored by:

KARAG
Karst Aquifer Research by
Geophysics
www.karag.be



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