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Connectivity as a spatial performance metric to validate simulated spatial patterns of continuous hydrological states and fluxes in distributed hydrological modelling.

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Distributed hydrological models are traditionally evaluated against single spatially aggregated catchment scale observations, e.g. river discharge or hydraulic head data with the conviction that they are suitable measures for the simulation of spatially explicit hydrological processes within a catchment. Recent studies have shown that this is disputable and often a false conclusion and raise the demand for a model evaluation framework that focuses on distributed instead of aggregated variables, such as remotely sensed data. However no single spatial performance metric has been identified yet that proved suitable for a robust comparison of observed and simulated spatial patterns of hydrological variables, nor there exists an agreed procedure to do so.

This study promotes a novel spatial performance metric which is based on a connectivity analysis. The connectivity of a continuous variable is best analyzed through a decomposition of the maps into a series of binary sets, which are based on threshold values. The probability of connection of all clusters in a specific binary set is used as a metric to describe the spatial pattern of the variable and reflects if the clusters are rather disperse or centralized.

The applicability, robustness and sensitivity of the new metric are assessed by comparing simulated and observed land-surface temperature (LST) patterns. The applied model is MIKE She, a coupled, physically based and fully distributed hydrological model and the observed LST maps are derived from the MODIS sensor; 33 LST maps with full coverage are available for a 6 year simulation period of the Skjern river, the HOBE hydrological observatory in western Jutland (DK).

Considering an increasing and decreasing threshold value for the decomposition of the LST maps allows to investigate the connectivity of the warm and the cold clusters individually. The evolution of the metric along an increasing and decreasing threshold value is unique for each LST map and thus allows an advanced pattern comparison. This is achieved by directly comparing the connectivity of the observed and the simulated LST maps in respect to a baseline, which is the connectivity of a random field. Thus the connectivity metric quantifies how much better the model's spatial performance is in respect to a random LST distribution. Connectivity as a spatial performance metric is favorable for the comparison of simulated and observed LST maps because it is very visual, easy to apply, bias insensitive, global and adds further insights into the pattern comparison that other spatial metrics usually overlook. A localized constrain can be added to the metric if desired.