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## Recurrence based coupling analysis between event-like data and continuous data

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Extreme events such as earthquakes, tsunamis, heat waves, droughts, floods, heavy precipitation, or tornados -- affect the human communities and cause tremendous loss of property and wealth, but can be related to multiple and complex sources. For example, a flood is a natural event caused by many drivers such as extreme precipitation, soil moisture, or temperature. We are interested in understanding the direct and indirect coupling between flood events with different climatological and hydrological drivers such as soil moisture and temperature.

We use multivariate recurrence plot and recurrence quantification analysis as a powerful framework to study the couplings between the different systems, especially the direction of coupling. The standard delay-embedding method is not a suitable for the recurrence analysis of event-like data. Therefore, we apply the novel edit-distance method to compute recurrence plots of time series of flood events and use the standard recurrence plot method for the continuous varying time series such as soil moisture and temperature. The coupling analysis is performed using the mean conditional probabilities of recurrence derived from the different recurrence plots. We demonstrate this approach on a prototype system and apply it on the hydrological data. Using this approach we are able to indicate the coupling direction and lag between the different coupled systems.