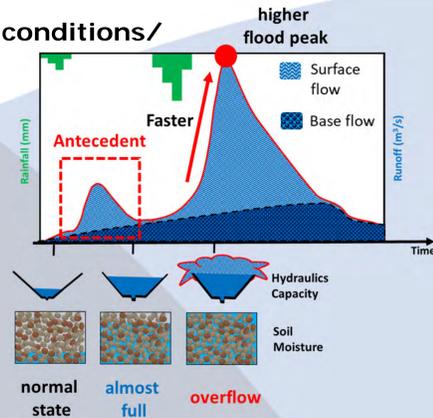


Objectives

- Similarity (or dissimilarity) of floods based on **hydrographs** (runoff event time series)
- Exploration & Quantification of novel hydrograph characteristics:
 1. Entire **continuous shape** of hydrograph
 2. **Temporal cascade** – relationship of sub-events & antecedent conditions
- Method for detecting **unseasonal & rare** flood dynamics

Temporal cascade:

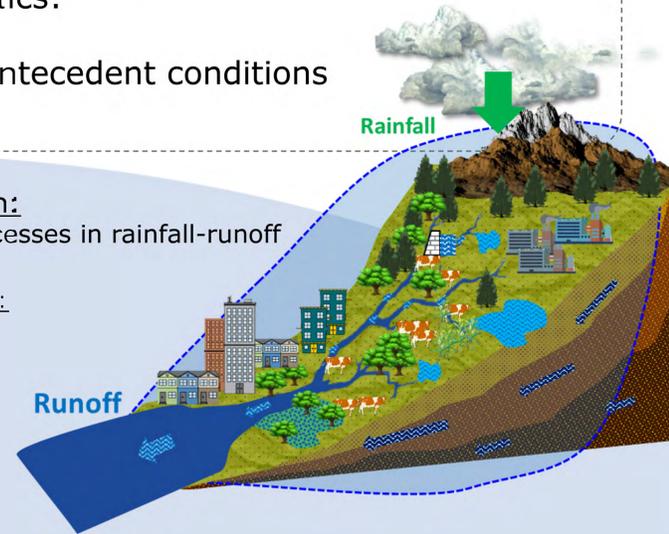
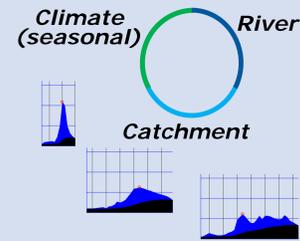
... depends on **antecedent conditions/** preceding sub-events



Runoff hydrograph:

~ **fingerprint** of the processes in rainfall-runoff

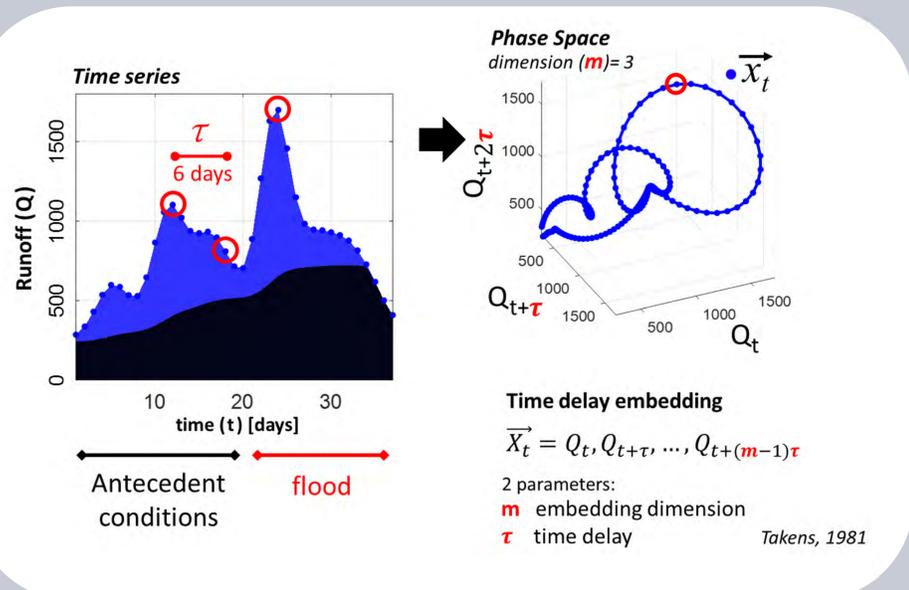
Shape varies on:



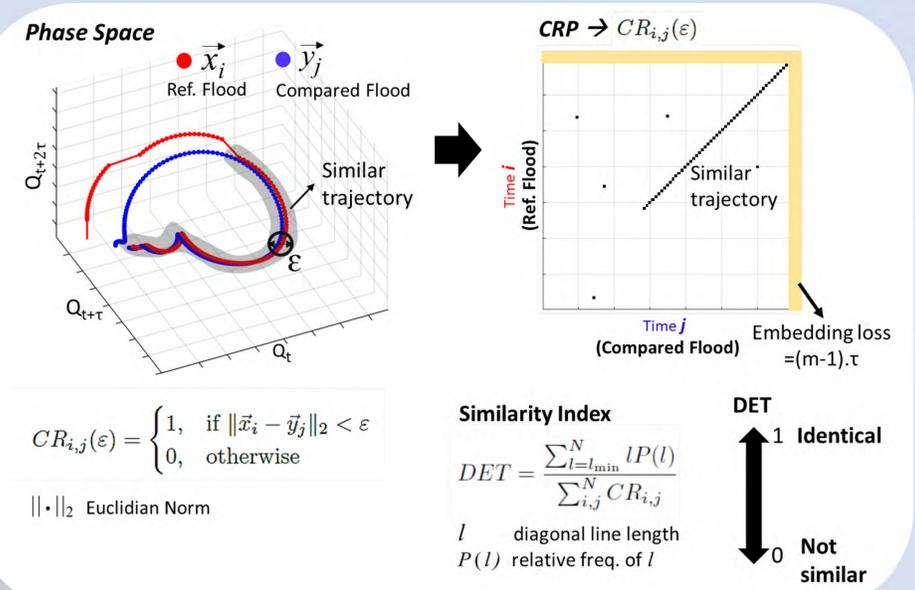
Methods

- **Phase space (PS)** trajectory to represent continuous shape of hydrograph
- Multi-dimensional **time-delay embedded PS** to represent temporal cascades of sub-events/ antecedent conditions
- **Cross Recurrence Plots (CRP)** to compare and quantify similar flood PS trajectories

Representing **continuous hydrograph** & **temporal cascades** as phase space trajectory

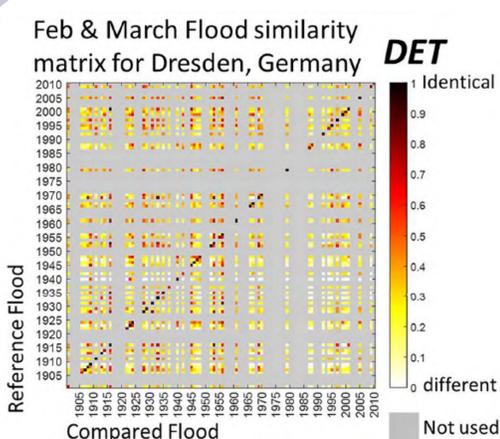


Pairwise comparing 2 flood phase space trajectories using **CRP & DET** as similarity index

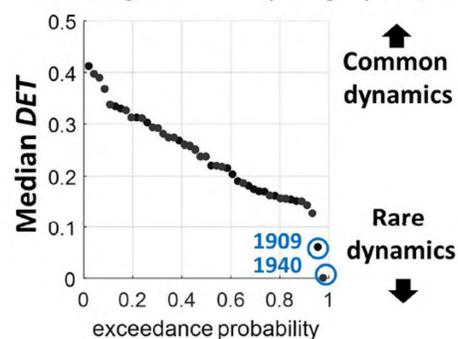


Application Example

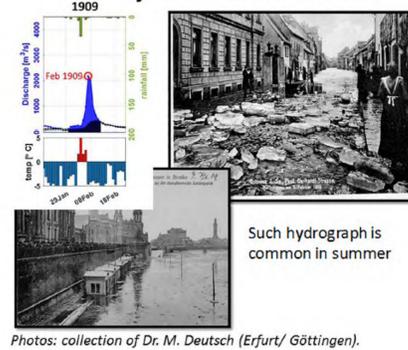
- Pairwise comparison matrix for February & March floods hydrographs in Dresden (1901–2010)
- Detection of unseasonal and rare flood dynamics as also found in historical archives



Detecting unusual hydrographs (DET)

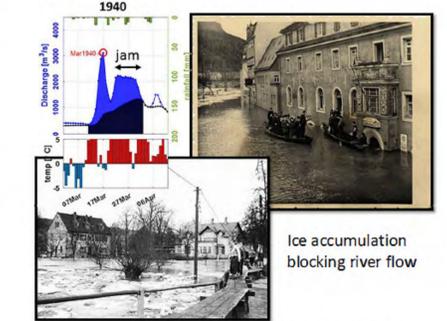


Unseasonable Flood February 1909 Rain-on-ice



Photos: collection of Dr. M. Deutsch (Erfurt/ Göttingen).

Rare Flood March 1940 Ice Jam



Photos: collection of Dr. M. Deutsch (Erfurt/ Göttingen) (top) & twitter @th_wmh (bottom)

Outlook

- Non-stationarity detection
- Spatial flood similarity assessment
- Novel model assessment & calibration metrics

Reference

Wendi, D., Merz, B., & Marwan, N. (2019). Assessing hydrograph similarity and rare runoff dynamics by cross recurrence plots. *Water Resources Research*.

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