Ingredients of Runoff Events:

Regional Differences between Small and Large Floods

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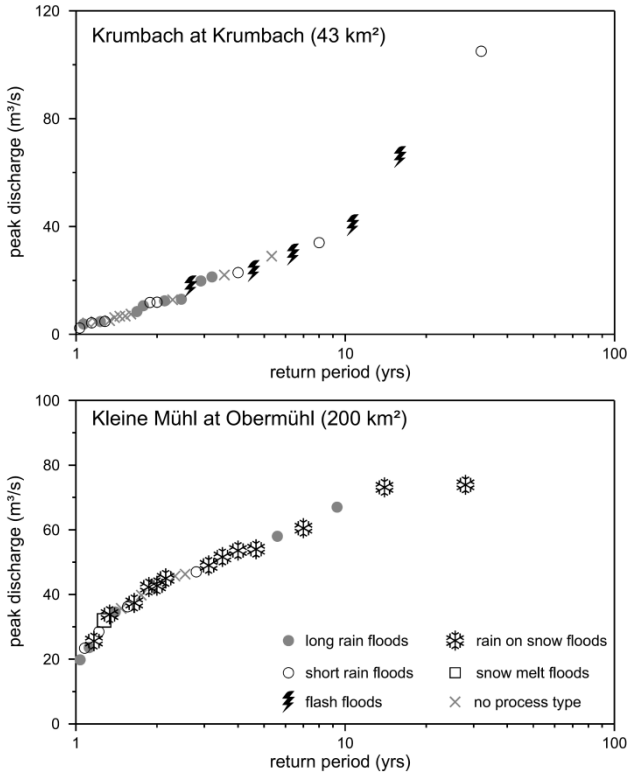
Potsdam, 17.09.2019

Motivation

Objective: investigate **transformation of processes** from small runoff events to large floods at catchment scale

Tool: a framework for **causative classification of runoff events**

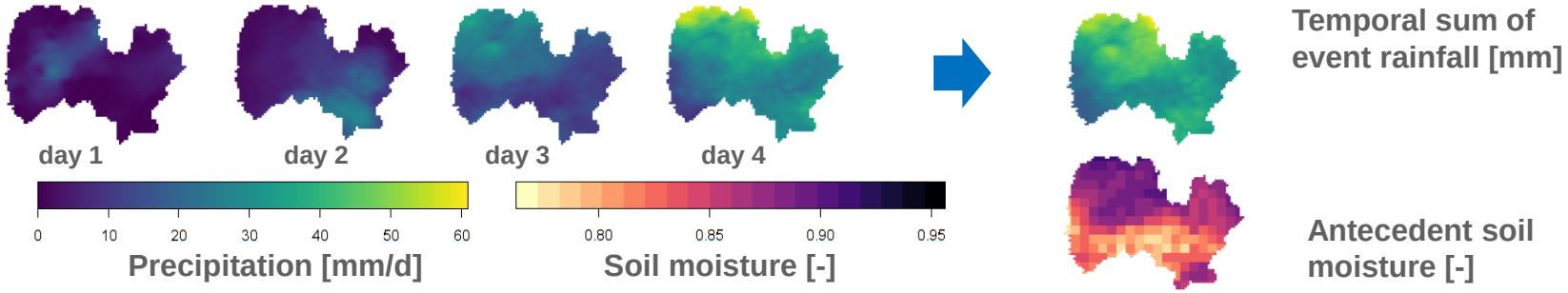


Merz, R., Blöschl, G., 2008. Flood frequency hydrology: 1. Temporal, spatial, and causal expansion of information. WRR

Proposed framework

Novelty

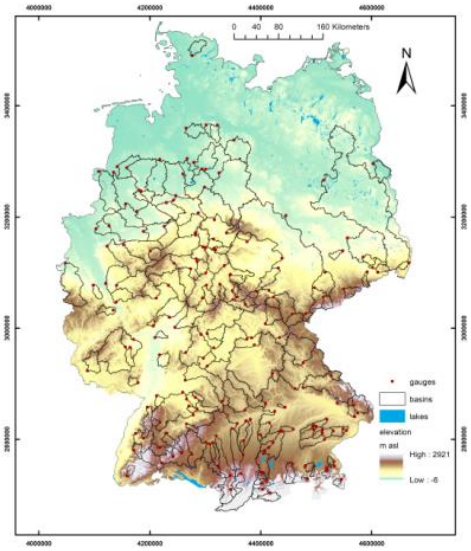
- **Space-time dynamics** of rainfall and snowmelt events and spatial patterns of antecedent soil moisture as indicators



- **Dimensionless indicators** (cv, covariance and ratios)
- **Adaptive** and **hierarchical** structure
- All runoff events of **various sizes**
- **Runoff-free** classification

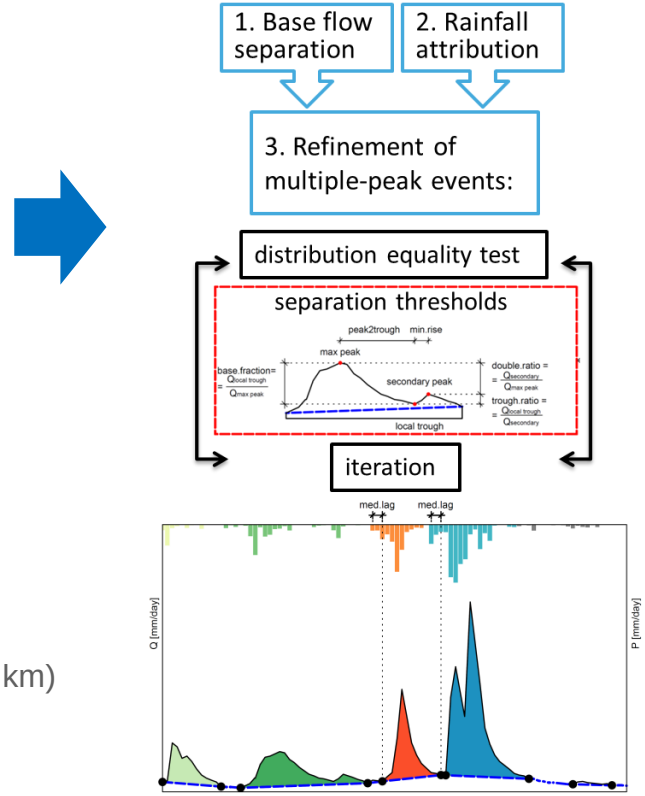
Viglione, A., Chirico, G.B., Woods, R., Blöschl, G., 2010. Generalised synthesis of space-time variability in flood response: An analytical framework. JoH

Study area and events



- **Study period:** 1951-2013
- **Study area:** 185 German mesoscale catchments
- **Daily observation datasets:** discharge, gridded precipitation (1 km), gridded temperature (4 km)
- **Daily modelled gridded datasets (4 km):** snow water equivalent, soil moisture

Rainfall-runoff event separation



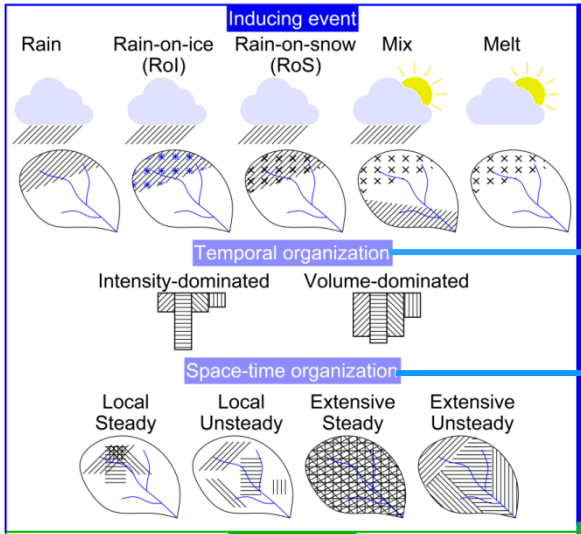
220,000 events of various sizes

Tarasova, L., Basso S., Zink M., and R. Merz 2018. Time-series-based event separation and temporal dynamics of event runoff response in Germany. WRR

Samaniego, L., Kumar, R., Attinger, S., 2010. Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale. WRR

Proposed framework

Indicators and thresholds



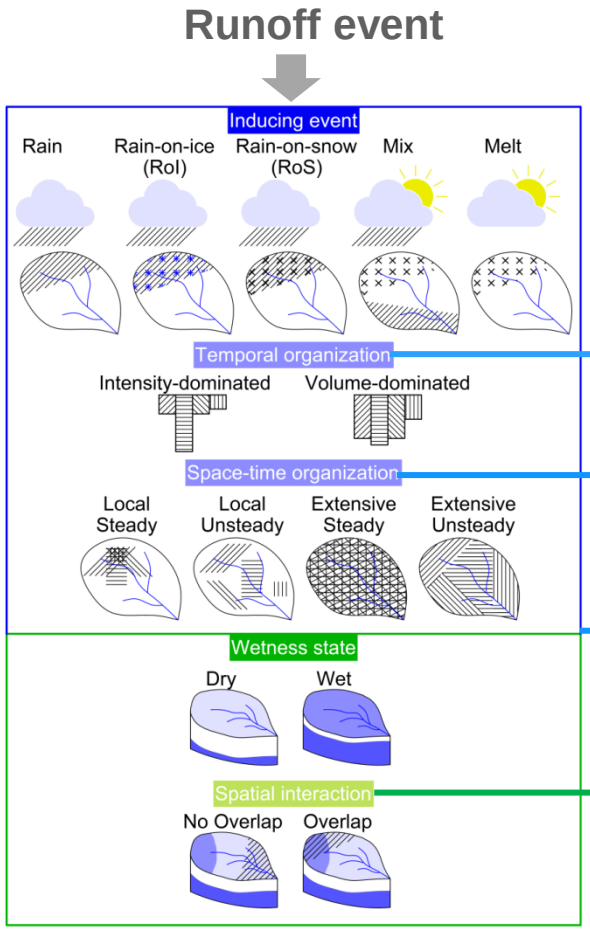
Indicators

- **Ratio of snowmelt/rainfall** and precipitation volume
- **Spatial covariance** of snow cover and rainfall
- **Spatial covariance** of pre-event level of soil freezing and rainfall
- **Temporal cv** of precipitation rate
- **Ratio of intensity and volume**
- **Spatial cv** of precipitation volume
- Mean **spatial covariance** of precipitation rates between consecutive time steps
- Catchment-averaged antecedent **soil moisture**
- **Spatial covariance** of precipitation volume and antecedent soil moisture

Thresholds

- **Covariance:** 1
- **Temporal cv:** 1
- **Spatial cv:** Q_2
- **Ratio (rainfall, snowmelt):** 0.95
- **Ratio (volume, intensity):** 0.5
- **Soil moisture**: max curvature of fitted non-linear function of pre-event soil moisture and event runoff coefficients

Layer-wise process characterization



Rainfall, Rain-on-ice, Rain-on-snow,
Mixture of rainfall and snowmelt, Snowmelt

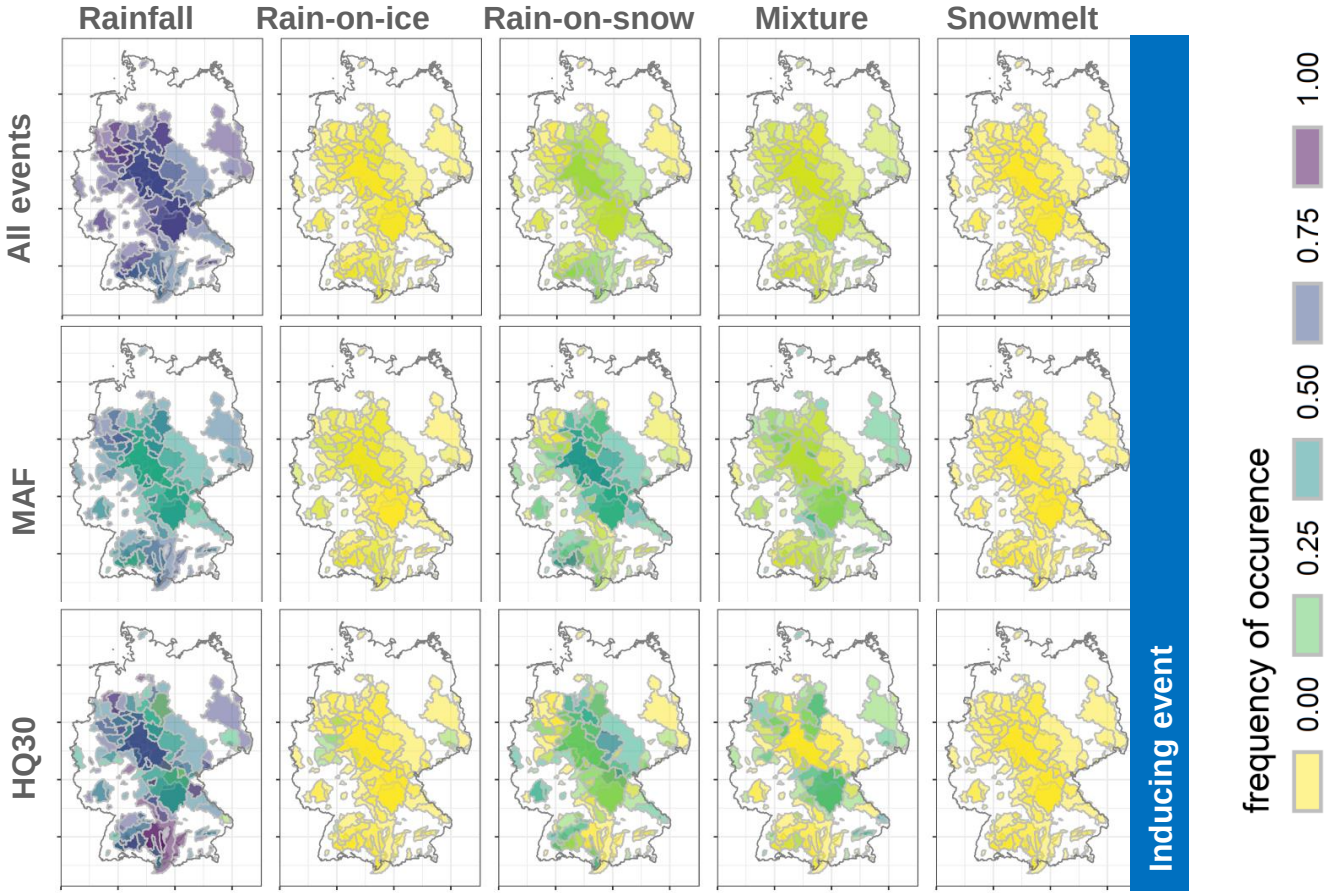
Intensity, Volume

Local Steady, Local Unsteady,
Extensive Steady, Extensive Unsteady

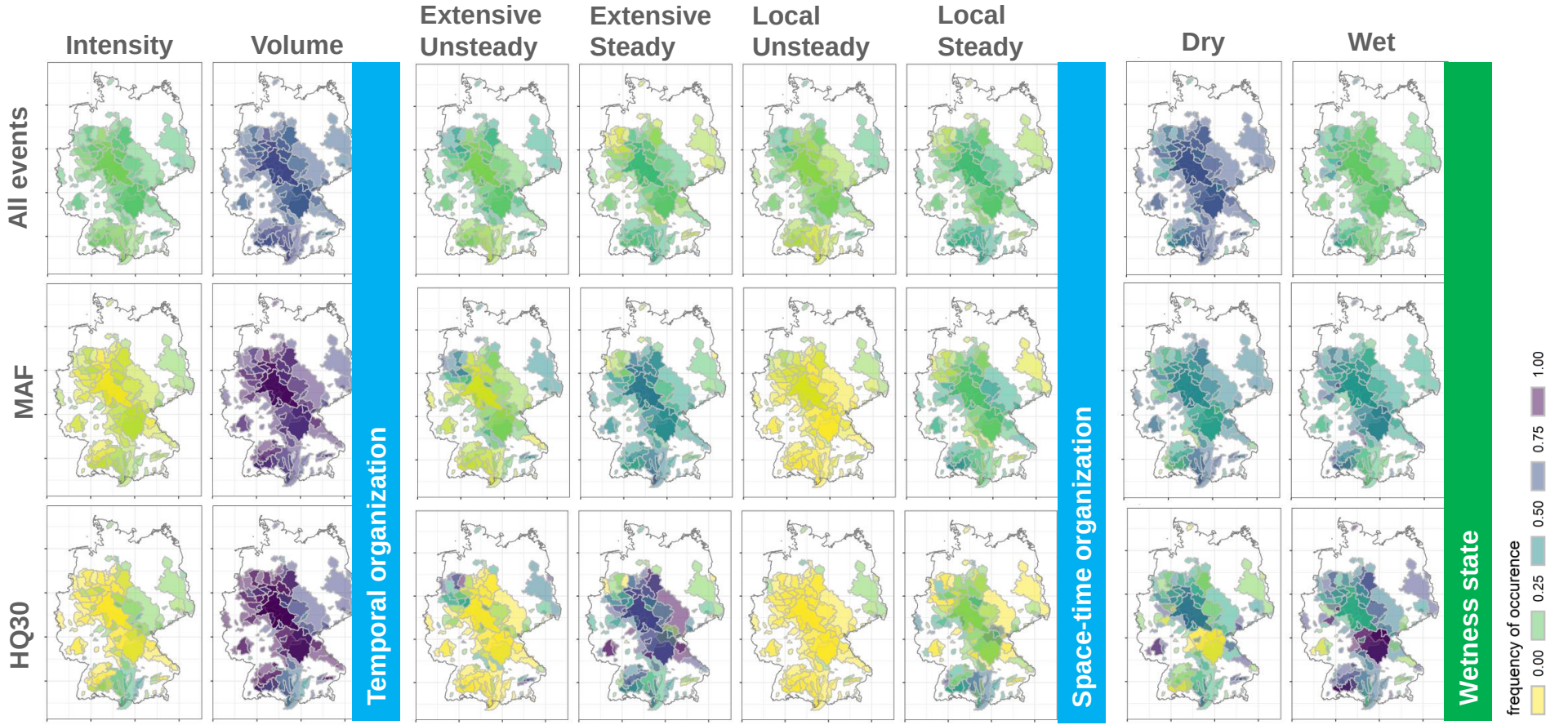
Wet, Dry

No Overlap, Overlap

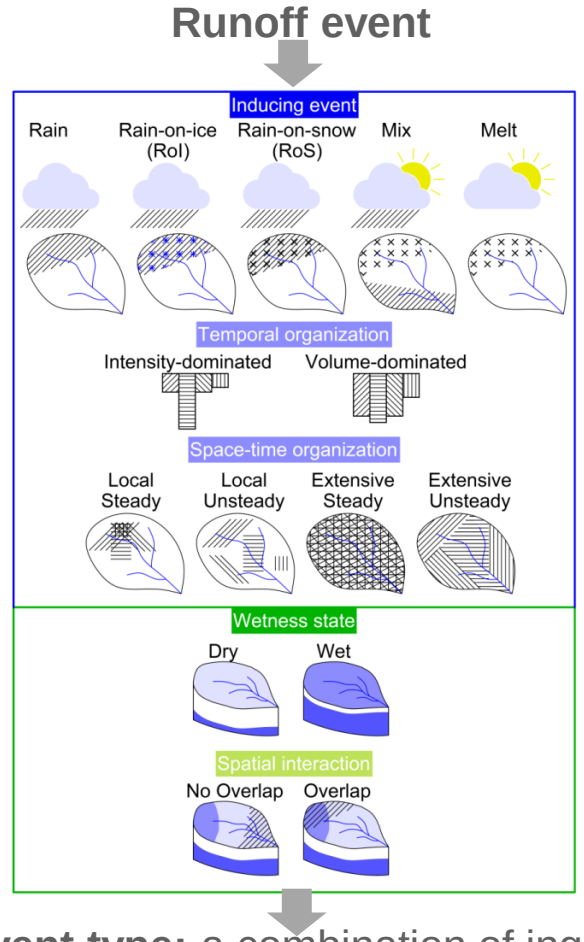
Transformation of processes from small to large events

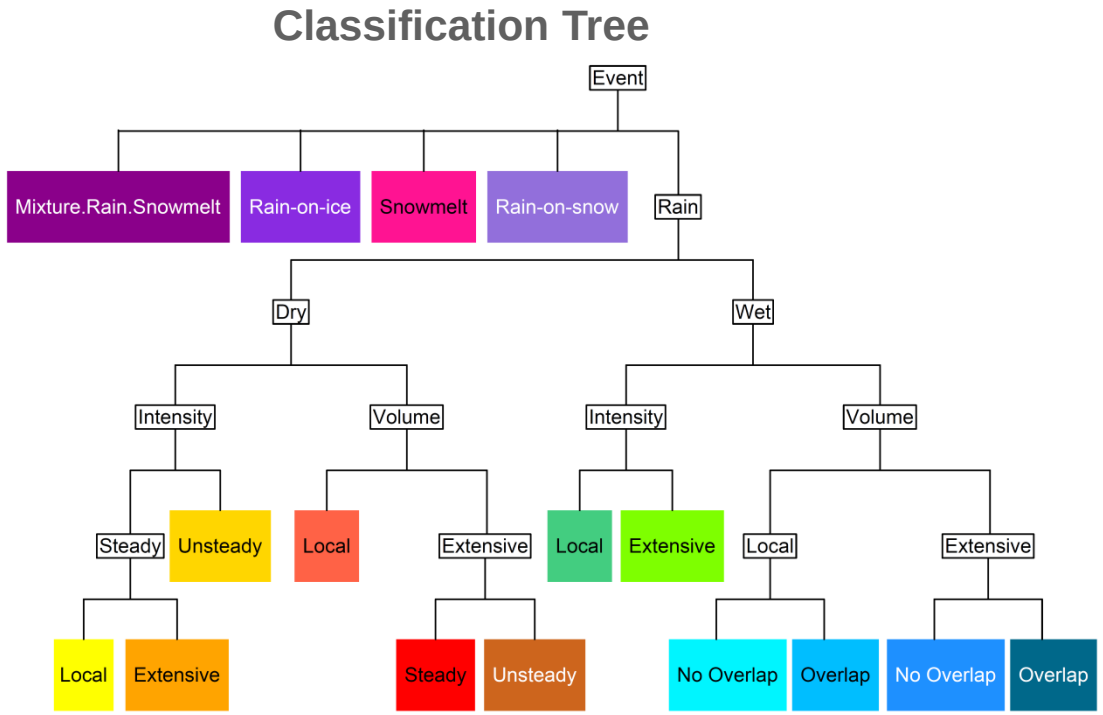


Transformation of processes from small to large events



Hierarchical classification



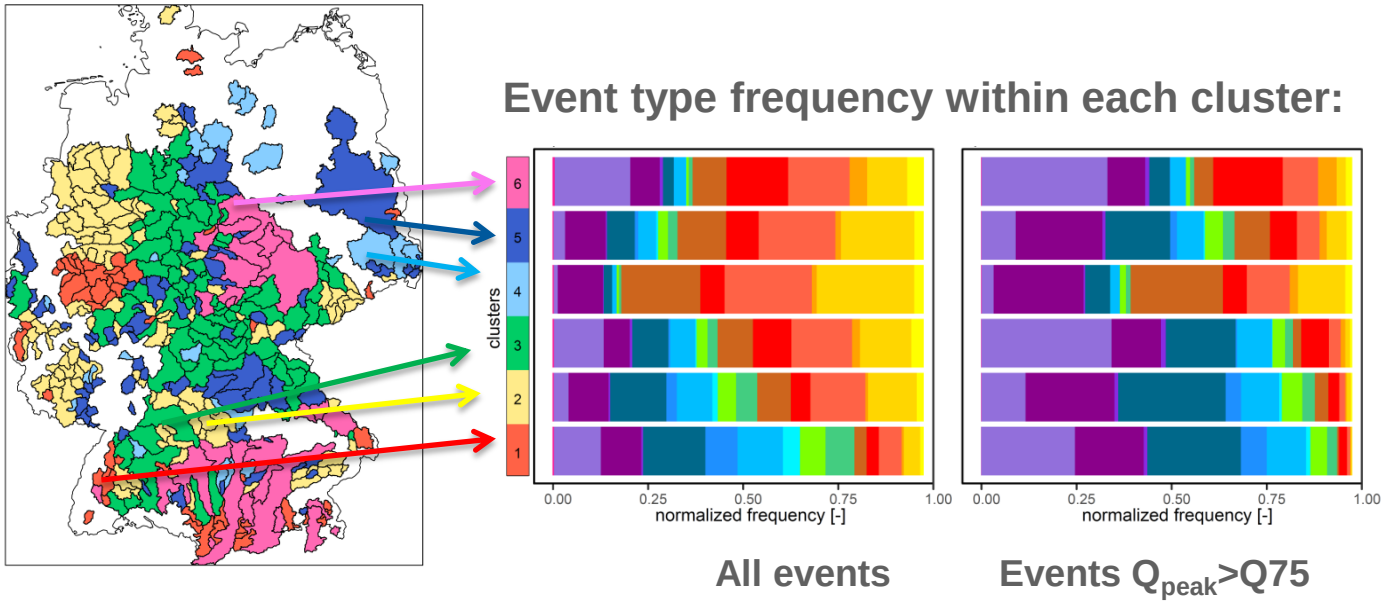


16 types

Event type: a combination of ingredients (e.g., Rain.Dry.Intensity.Local.Steady)

Event type frequency

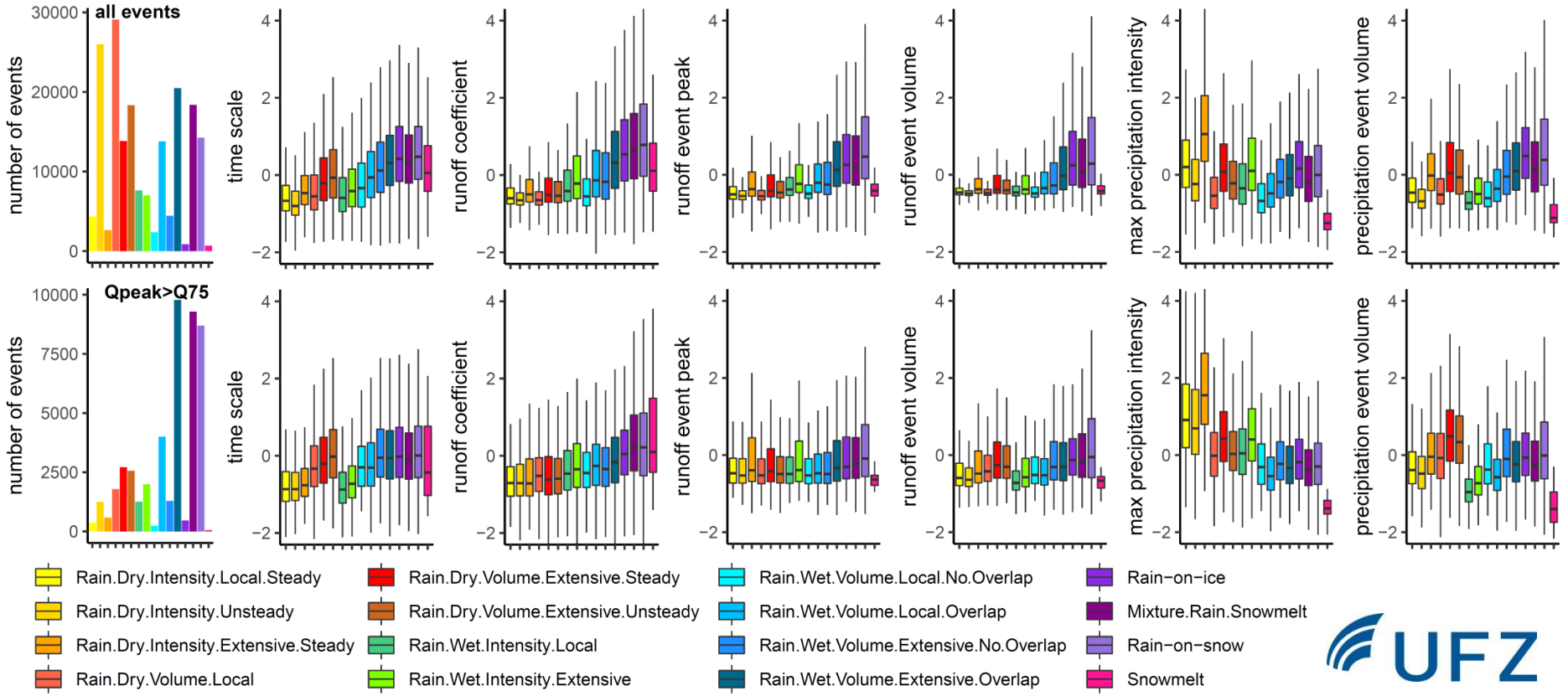
Regional clustering



- **Study period:** 1979-2002
- **Study area:** 392 catchments
- 196,000 events

Runoff characteristics of event types

*The values are rescaled to mean=0 for all catchments



Summary

- Changing relevance of **rain-on-snow** from ordinary to larger events
- Variable importance of **intensity-dominated** events for higher return periods among different regions
- Emergence of **regional pattern** of event type frequency

  ➡ **regionalization**
- Distinct differences of **runoff characteristics** of classified event types

  ➡ **flood-type specific design hydrographs**

Thank you for your attention!

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