# Event based climatology of extreme precipitation in Europe

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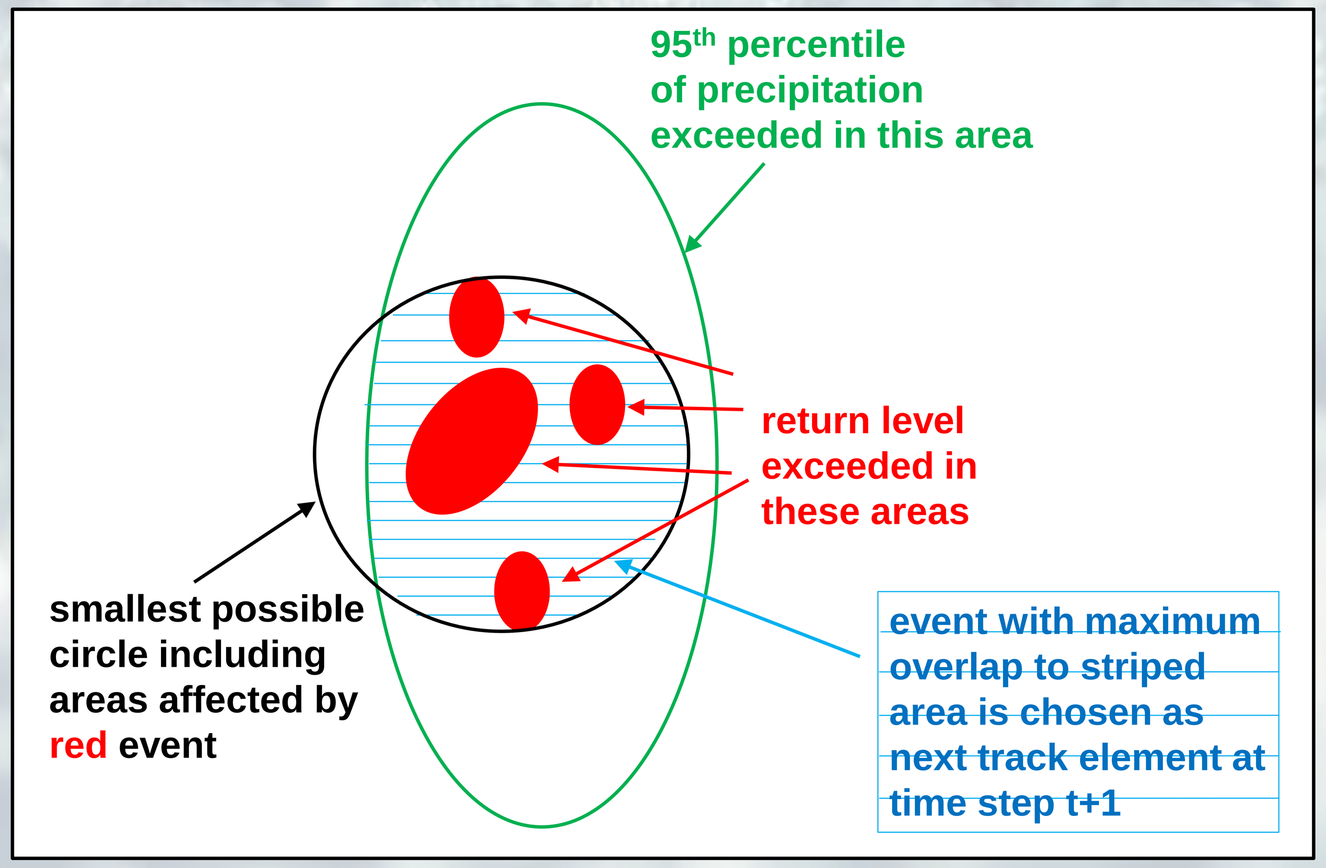
**The aim of this study is to identify extreme precipitation events that may be critical to infrastructure. Critical infrastructure is protected from heavy precipitation by drainage systems which are designed to discharge events with a specified return period. For example the International Union of Railways recommends protection from 10-year events. The method introduced in this study identifies events which exceed the drainage system capacity designed for 10-year return levels. A climatology of such events is presented.**

## Method

1. Identification of grid boxes exceeding the local threshold (here 10-year return level).
2. Accumulation periods of 24 hours (1 time step) to 72 hours are considered.
3. Neighbouring grid boxes located within a continuous area of substantial rain (here 95th percentile) are considered as part of the same event.
4. Events are tracked in time. The next track element is the event at time t+1 with maximum overlap to the previously affected area.




5. Precipitation Severity Index (PSI) to compare events:

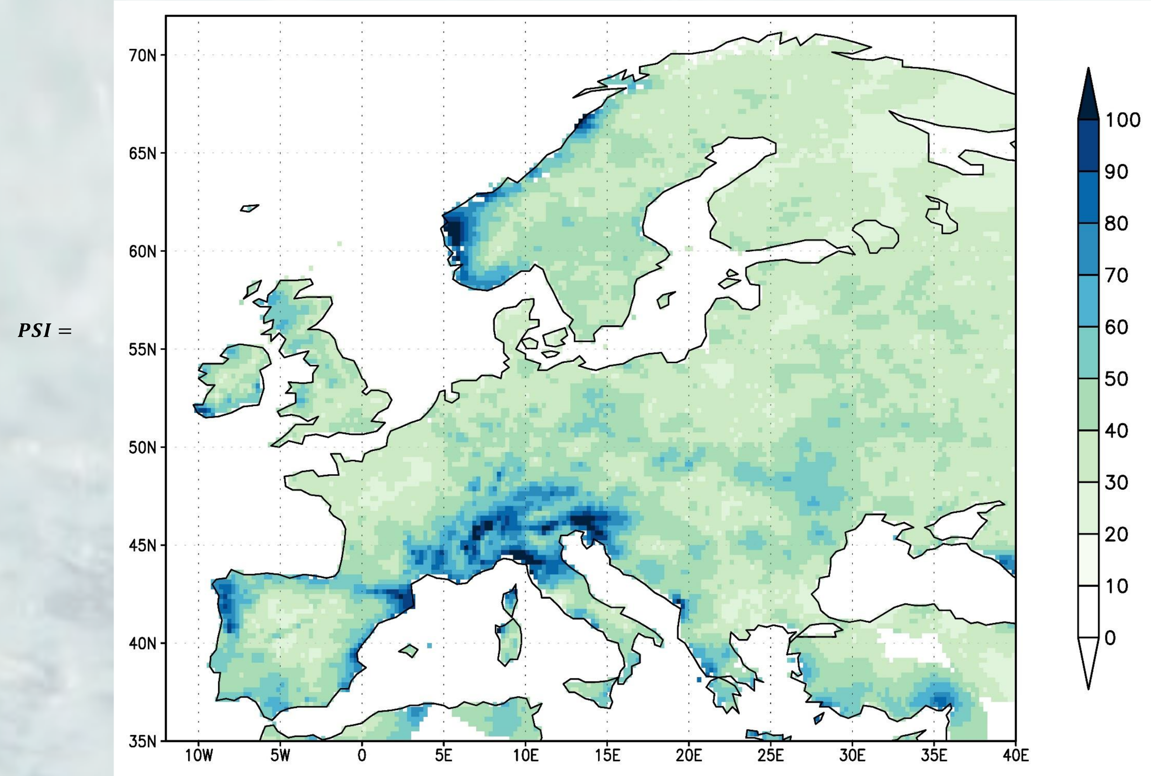
$$PSI = \sum_{t}^{T}\sum_{k}^{K}\frac{precip_{k,t}}{annualprecip_k} * A_k$$

*T: time range, K: number of affected grid boxes (within red area), $A_k$: area of grid box k, annualprecip: long-term mean annual precipitation sum expected for grid box*

## Threshold calculation

1. Return values are evaluated by applying a Peak-over-Threshold analysis and fitting a generalized Pareto distribution.
2. Intensity-Duration-Frequency curves are fitted following WMO recommendations (Guide to hydrological practices, WMO 2009) with $i = \frac{a}{t^c+b}$, where i is the average rainfall intensity, t is the rainfall duration and a, b, c are coefficients varying with the location and return period.

*Precipitation intensity is shown for an accumulation period of 24 hours and a return period of 10 years. Units in mm. Calculated from E-OBS data for the period 1971-2000.*

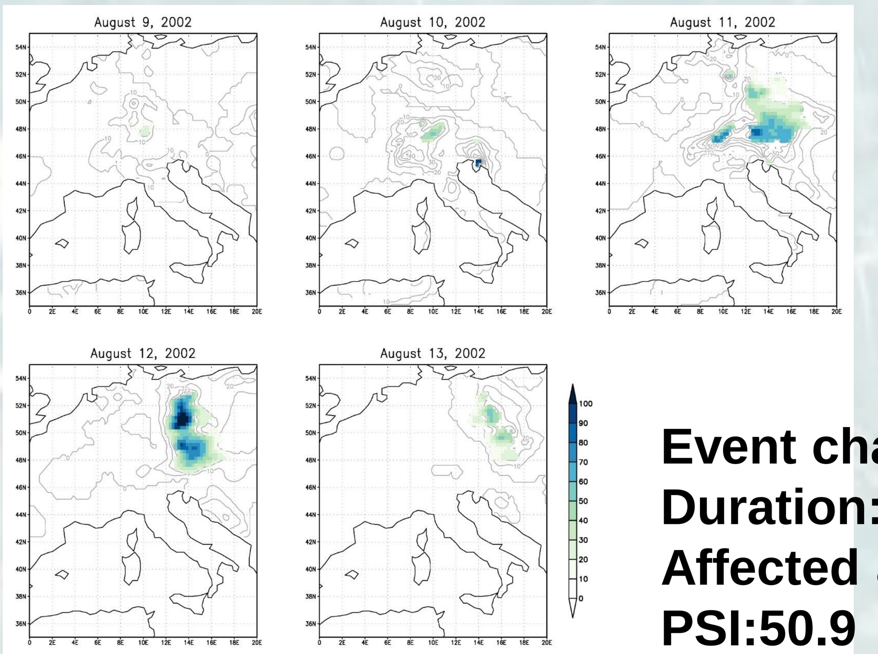


## E-OBS data set

- Gridded observational data set for Europe
- 0.25° x 0.25° horizontal resolution
- Daily precipitation sums
- Period 1950-2013 (shown here 1971-2013)
- Reference: Haylock et al. 2008

## Example

First episode of heavy precipitation leading to the Central European flood of August 2002.

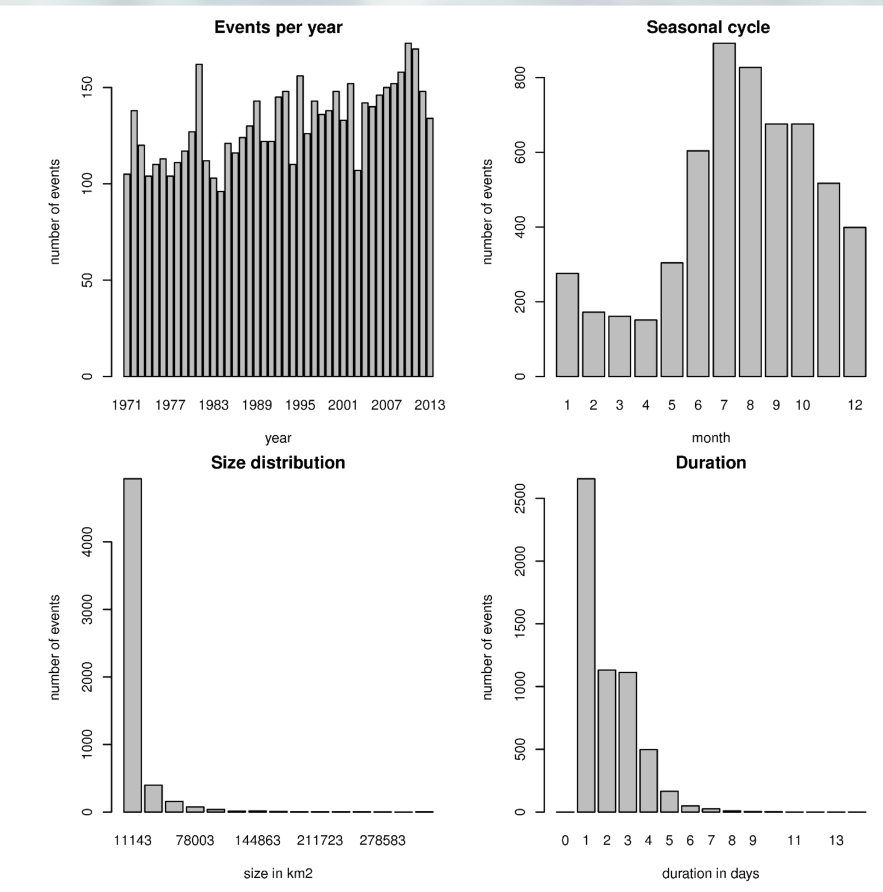


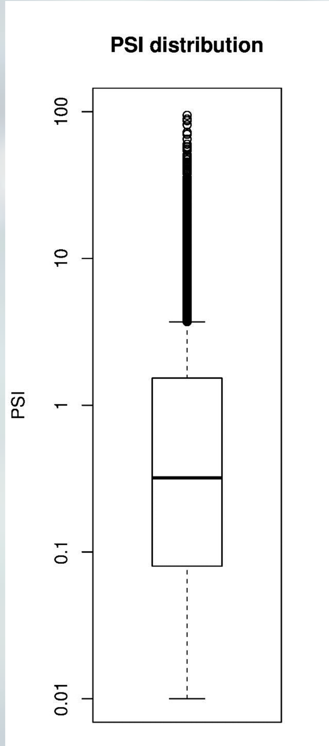

*Precipitation in mm/day. Colour denotes exceedance of 10-year return level*

Event characteristics:
Duration: 5 days
Affected area: 18.4 $\cdot 10^4$ km$^2$
PSI:50.9

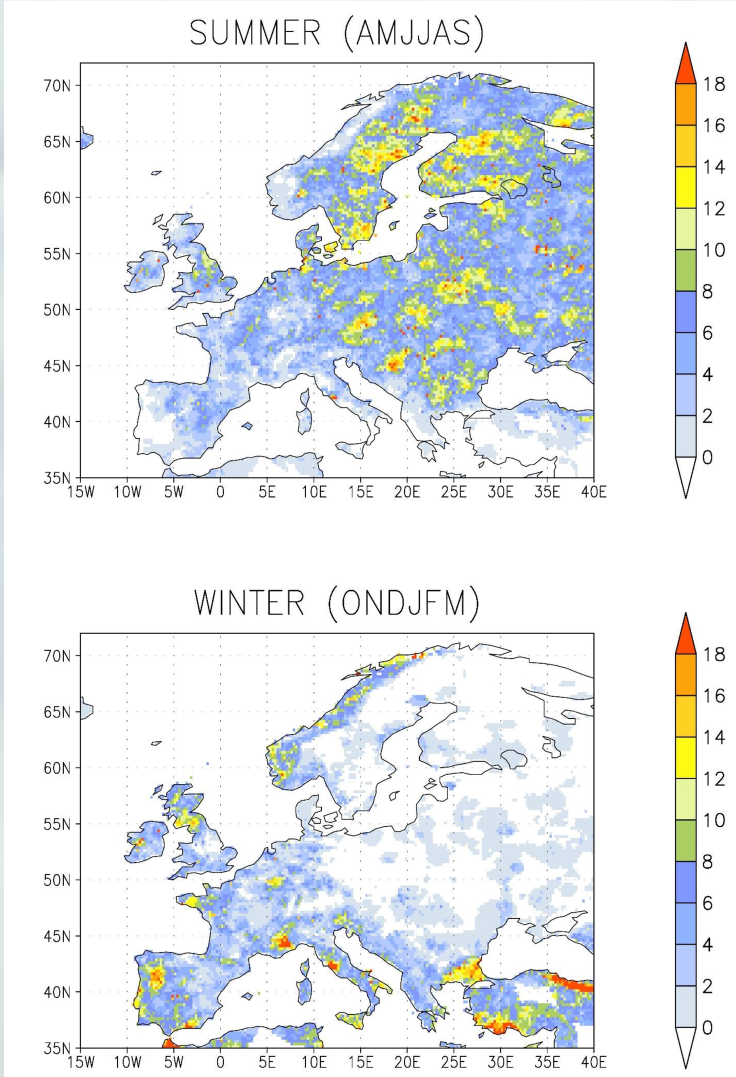
## Climatology

*Annual cycle, interannual variability and distribution of size, duration and PSI for the region 11°E-35°W,35°N-72°N during the period 1971-2013.*




*Number of individual events per grid box for the period 1971-2013. Shown for the summer and winter half year*




## Results

- Introduction of method to identify heavy precipitation events, which can become critical to infrastructure
- Events can comprise several grid boxes and can last for several time steps
- Central and Eastern Europe: More events during summer
- Western and Southern Europe: More events during winter
- Average duration of events: 2 days
- Average size: 10547 km$^2$
- Average severity (PSI): 2.1

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