Complex large scale influence on extreme precipitation

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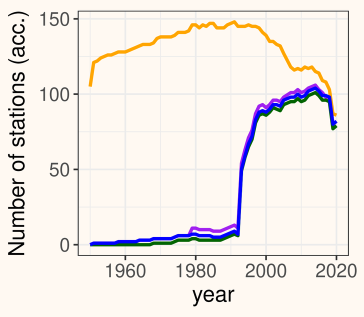
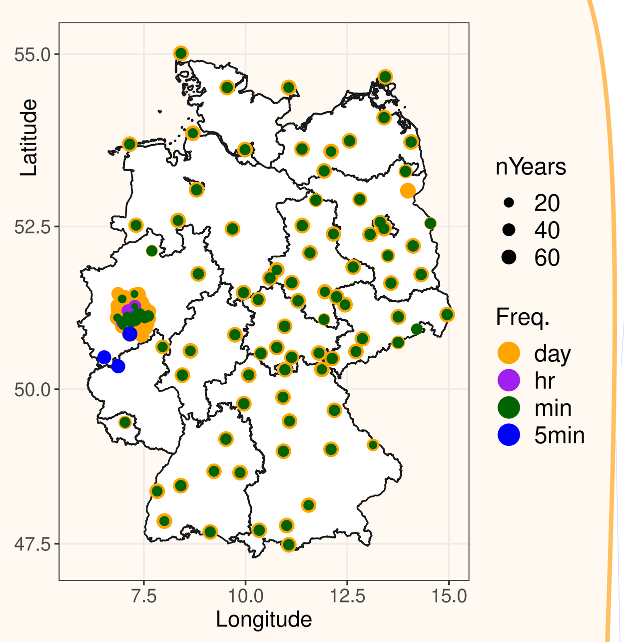
Motivation

How will extreme rain change in the future? How do large-scale variables, like NAO, blocking and temperature influence those extremes? A statistical analysis.

Data and Methods

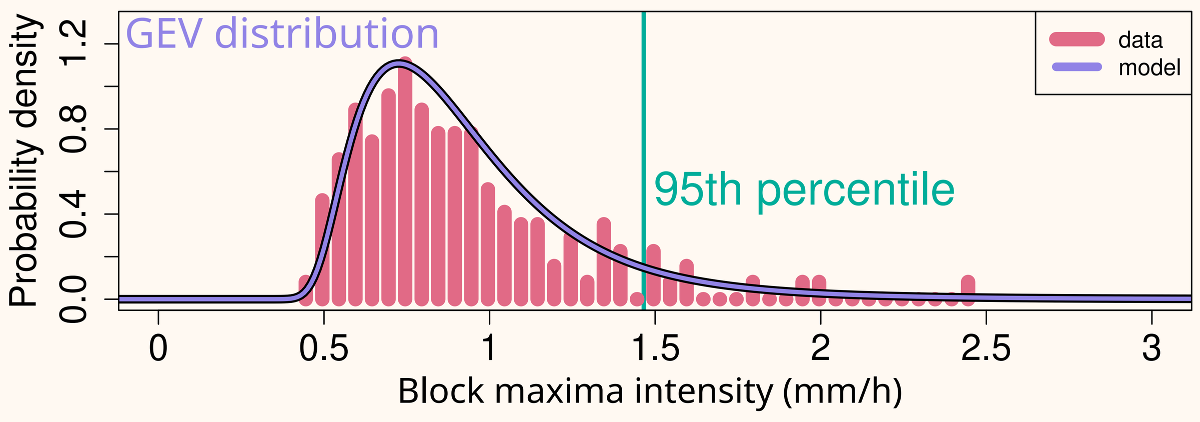
Data





- precipitation from 194 stations
  - by DWD, Wupperverband
- large scale variables
  - by NOAA, ERA5

Methods



GEV distribution

$$G(z) = \exp\left\{-\left[1+\xi\left(\frac{z-\mu}{\sigma}\right)\right]^{-1/\xi}\right\}$$

$$\mu(d) = \tilde{\mu}(\sigma_0(d+\theta)^{-\eta}+\tau)$$

$$\sigma(d) = \sigma_0(d+\theta)^{-(\eta+\eta_2)}+\tau$$

$$\xi = \text{const.}$$

GEV parameters depend on duration:
$\Phi_d = \{\mu, \sigma, \xi\} = \Phi_d(d)$

d-GEV parameters depend on large scale values X:
$\Phi_m = \{\tilde{\mu}, \sigma_0, \xi, \theta, \eta, \eta_2, \tau\} = f(X)$

e.g.
$\tilde{\mu}$ ~ blocking^2 + time

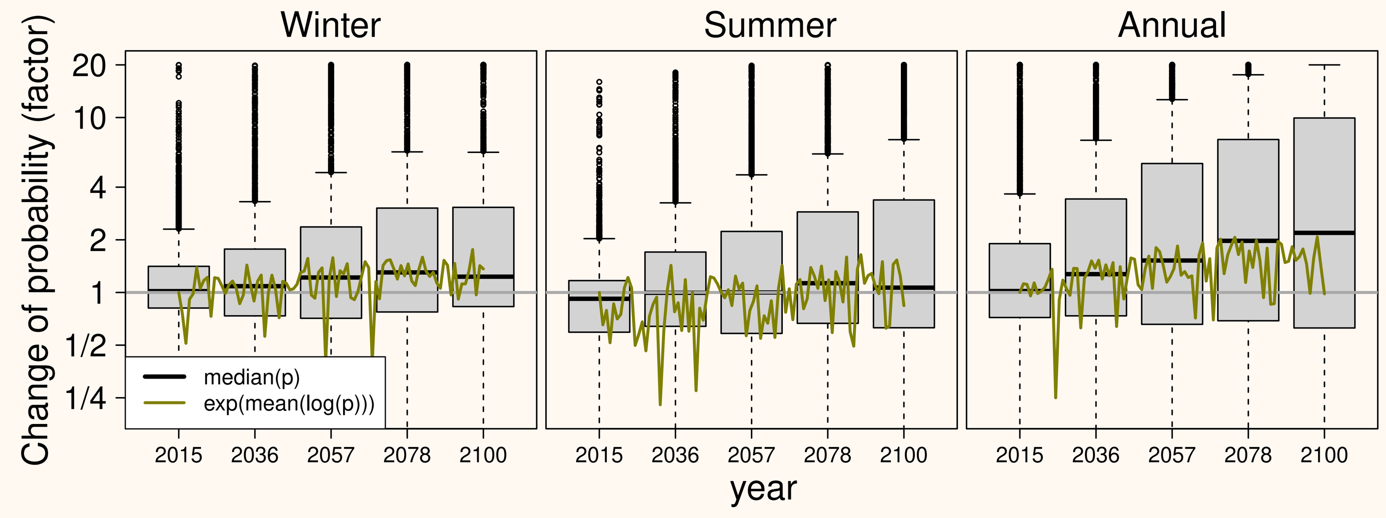
(example)
Replace GLM by GAM?

Future Projections of Extremes

to project average values **easy** **vs.** to project extremes **difficult**

We use the modeled relations between average **large-scale variables** and extreme **intensity** in the past to create future IDF-relations based on climate projections and the projected average large-scale values.

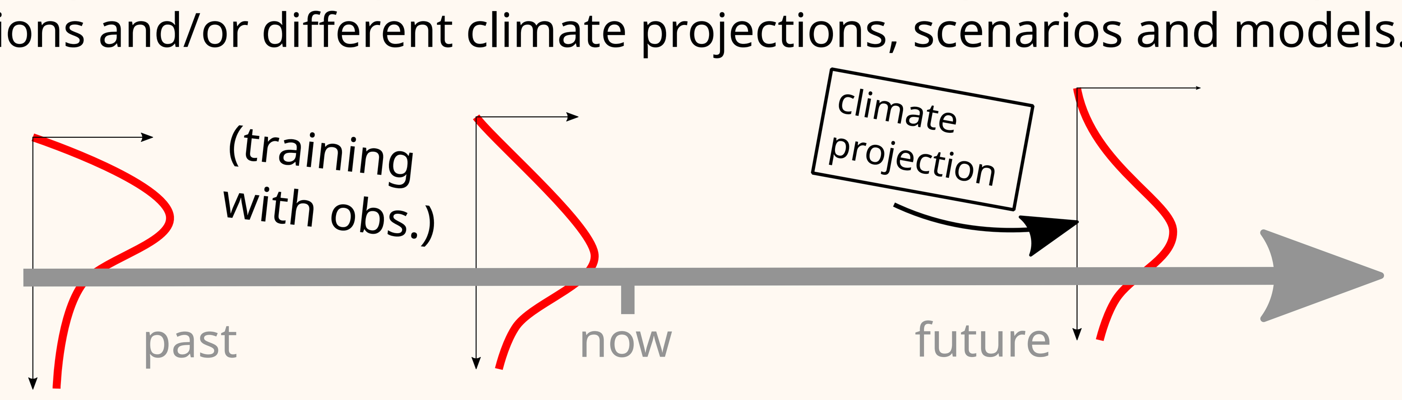
How does the probability of the 20-year event (p=5%) from 2015 change in the future?



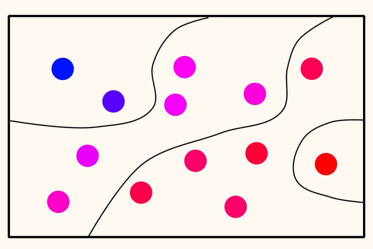
positive trend or no trend, depending on method (median or log-mean over stations)

Ideas and Outlook

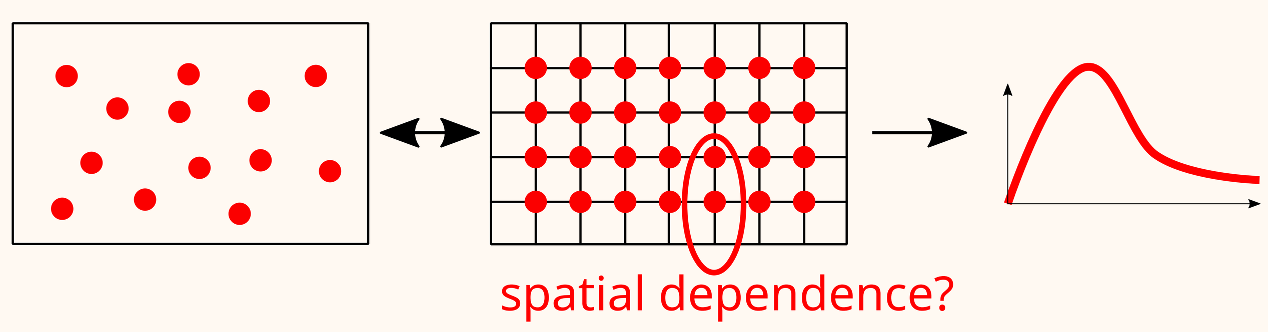
- Investigate the change of IDF relations with respect to decadal predictions and/or different climate projections, scenarios and models.



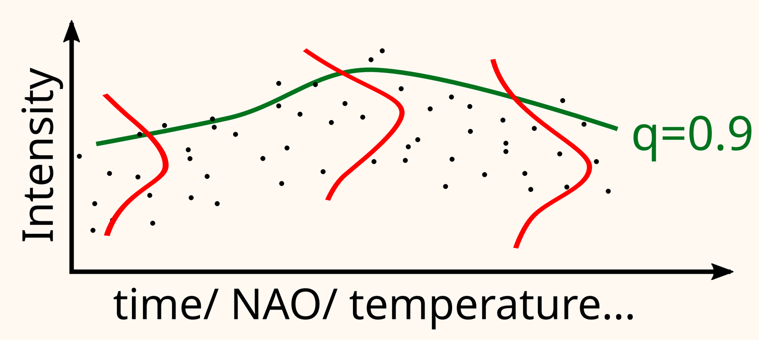
- Exploit smoothness in space (use location covariates).



- Identify further meaningful covariates: topography, altitude, land cover, slope
- Develop approaches to combine gridded data sets (high spatial resolution) and station-based data (long time records).



- Use q-GAM instead of GEV and Maximum-Likelihood-Estimation



Large Scale Influence in the Past

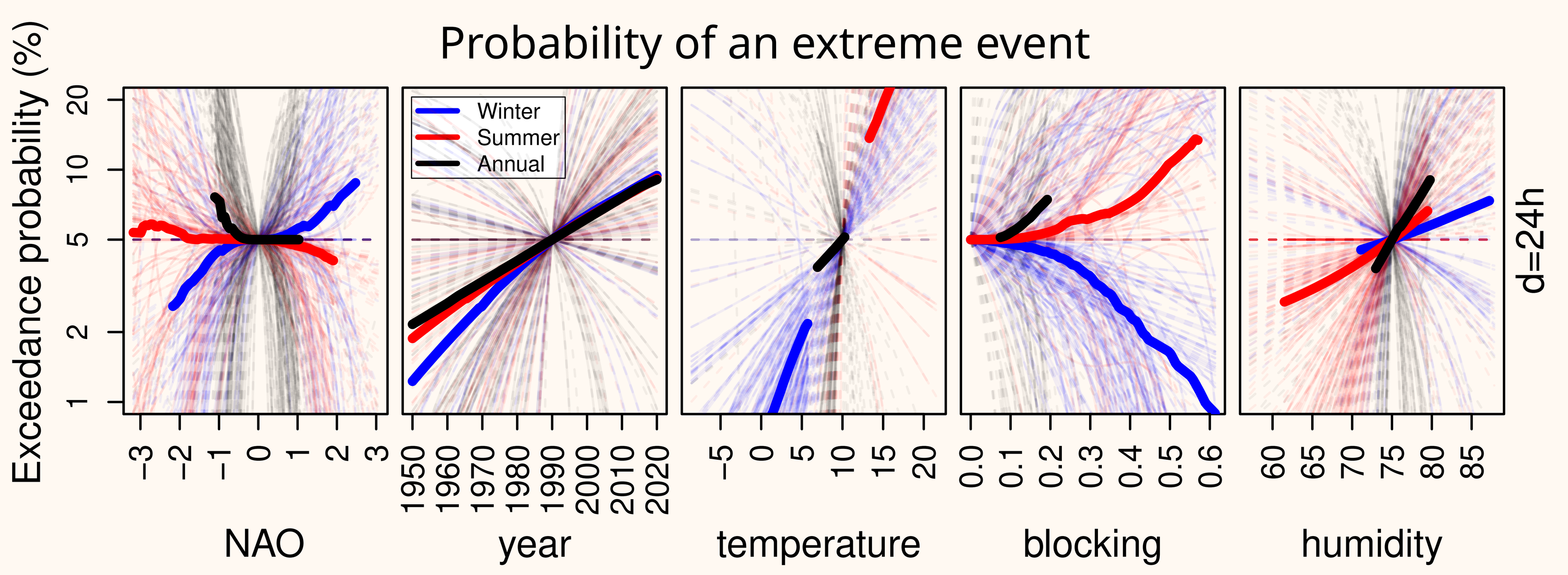
(Fauer et al, 2023)

Research question: How does the probability of an extreme event react, when one variable is changed? All other variables are fixed.

Our statistical model describes the relationship between:

intensity
probability ⟷ **large-scale-variable**

Here, we keep intensity constant, vary the large-scale-variable and estimate the probability. This way, we get the probability as function of the large-scale-variable:



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