Spatial modeling of extreme rainfall events in Berlin-Brandenburg with a max-stable process.

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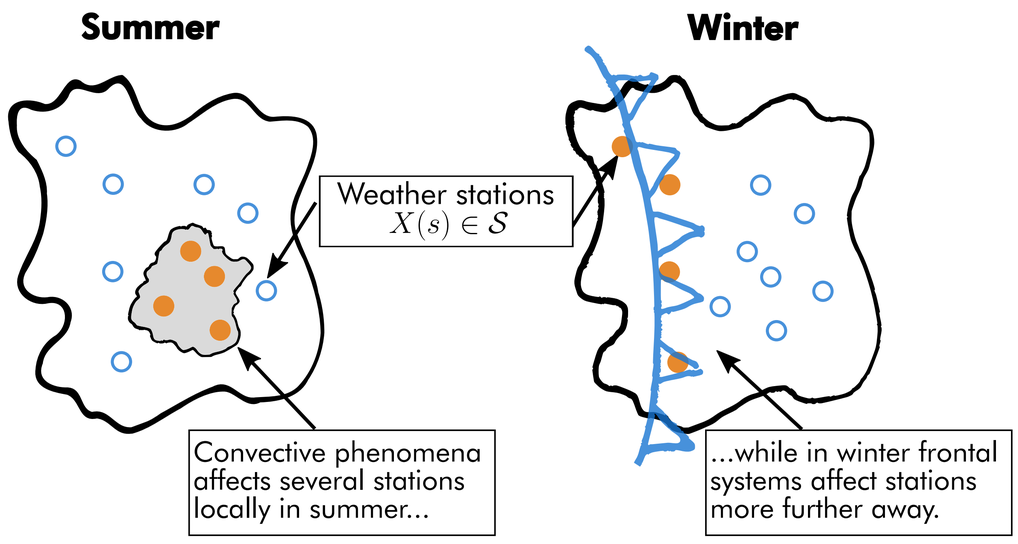
Goal: To estimate how the change in residual spatial dependence of rainfall maxima for different seasons influences the estimate of return levels when using a Max-Stable process.

Why? When using rainfall monthly block maxima for winter and summer, we suspect that the extremal dependence will behave differently due to different rainfall processes.

Background: Different seasons, different rainfall generating mechanisms



- How do we account for this difference in a statistical model?
- Does this seasonal difference affect the estimate of the 100-year return level resulting from a statistical model?

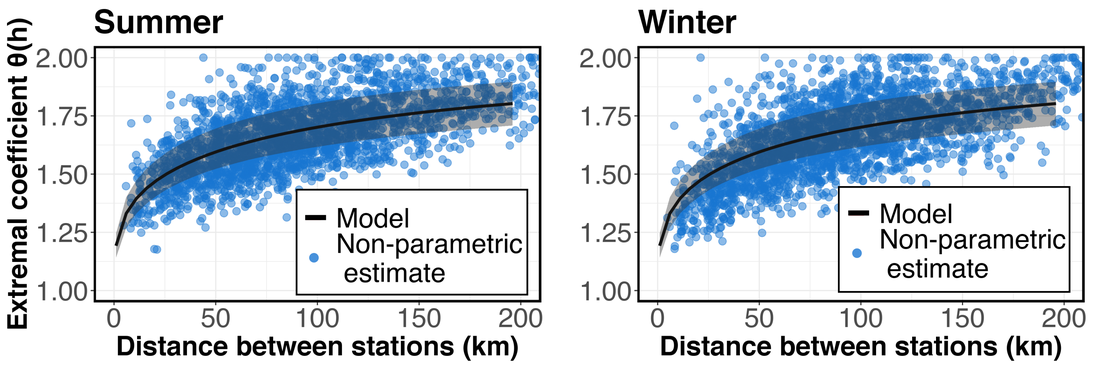


Figure 1: Comparison of the pairwise extremal dependence for both seasons. The parametric estimates (solid line) come from the Brown-Resnick model described in methods. We study if the seasonal difference will have an impact in the statistical modeling.

Methods and Results

Non-residual dependence: Response surfaces (VGLM with spatial covariates, see Fischer et al 2017) for the three GEV parameters (μ,σ,ξ) modeled for each station X(s) as:

$$g(\theta(s))) = \theta_0 + \sum_{i=1}^{I} \beta_i^{\theta} P_i(\mathrm{x}) + \sum_{j=1}^{J} \beta_j^{\theta} P_j(\mathrm{y}), \qquad \theta(s) \in \{\mu(s), \sigma(s), \xi(s)\}$$

- This model assumes the data from each station is *independent* from each other

Residual extremal dependence: Brown-Resnick Max-Stable process using pairwise likelihood for parameter inference (see Padoan et al. 2012, Davison et al. 2012).

- For this model, the *dependence* structure is completely given by the variogram γ = γ(h), where h is the distance between two stations.
- We assume the dependence structure is isotropic in all cases.

Modeling Uncertainty: Credibility intervals using the 95% HDI from an MCMC sampling scheme using Stan.

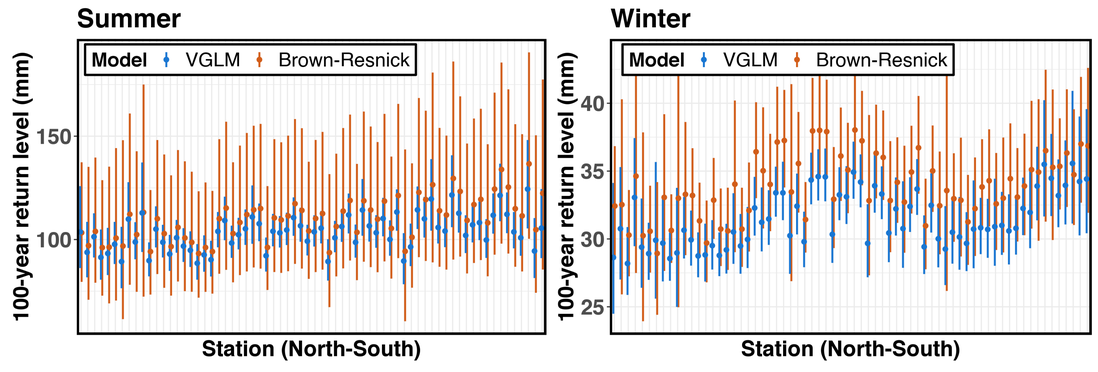
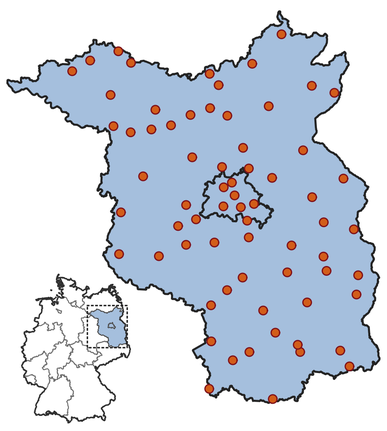


Figure 2: Comparing an approach ignoring the residual dependence (VGLM) and accounting for it (Brown-Resnick). Does the seasonal change in residual dependence impact the performance of the models when estimating the 100-year return level?

Data

- Monthly block maxima from daily precipitation sums (mm)
- 70 weather stations in Berlin-Brandenburg (source: DWD)
- Station records: from 1970 to 2018
- Seasonal Block maxima:
  Summer - May, June, July, Aug.
  Winter - Nov, Dec, Jan, Feb.
- Hourly data also available (not shown in poster)



Summary and Next Steps

- The dependence in winter grows weaker with longer distances than in summer, but the difference seems to be very slight.
- Accounting for extremal dependence has a bigger impact in summer, the difference is not so clear in winter.
- The uncertainty in winter is less for the Brown-Resnick model than in summer. Is the dependence model a better fit in this case?
- Next step: Get an estimate of the performance of both models, with the use of an objective verification score.
- Repeat the procedure in a different region of Germany.

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