Spatio-Temporal Censored Model of Precipitation Climatology

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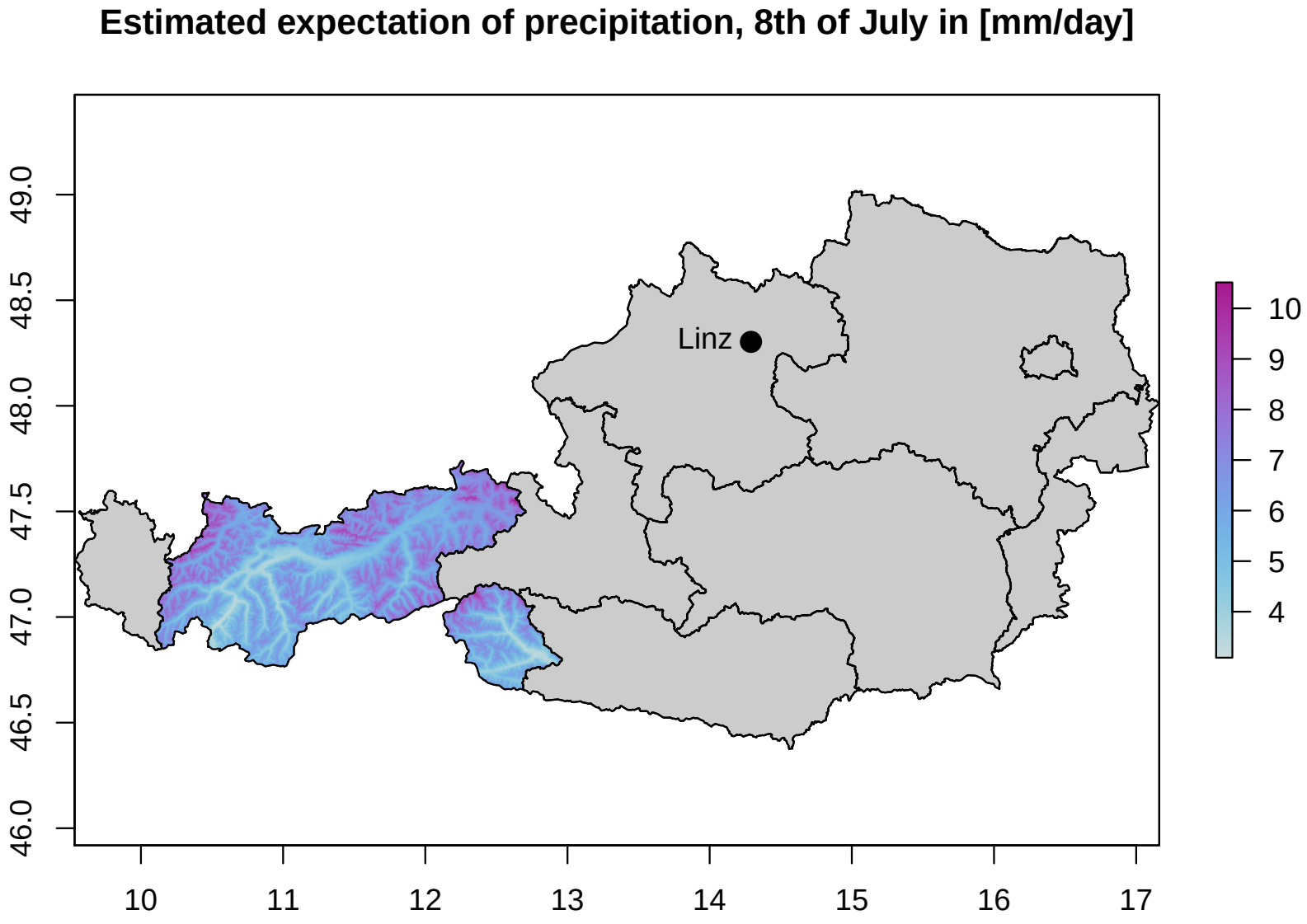
Introduction



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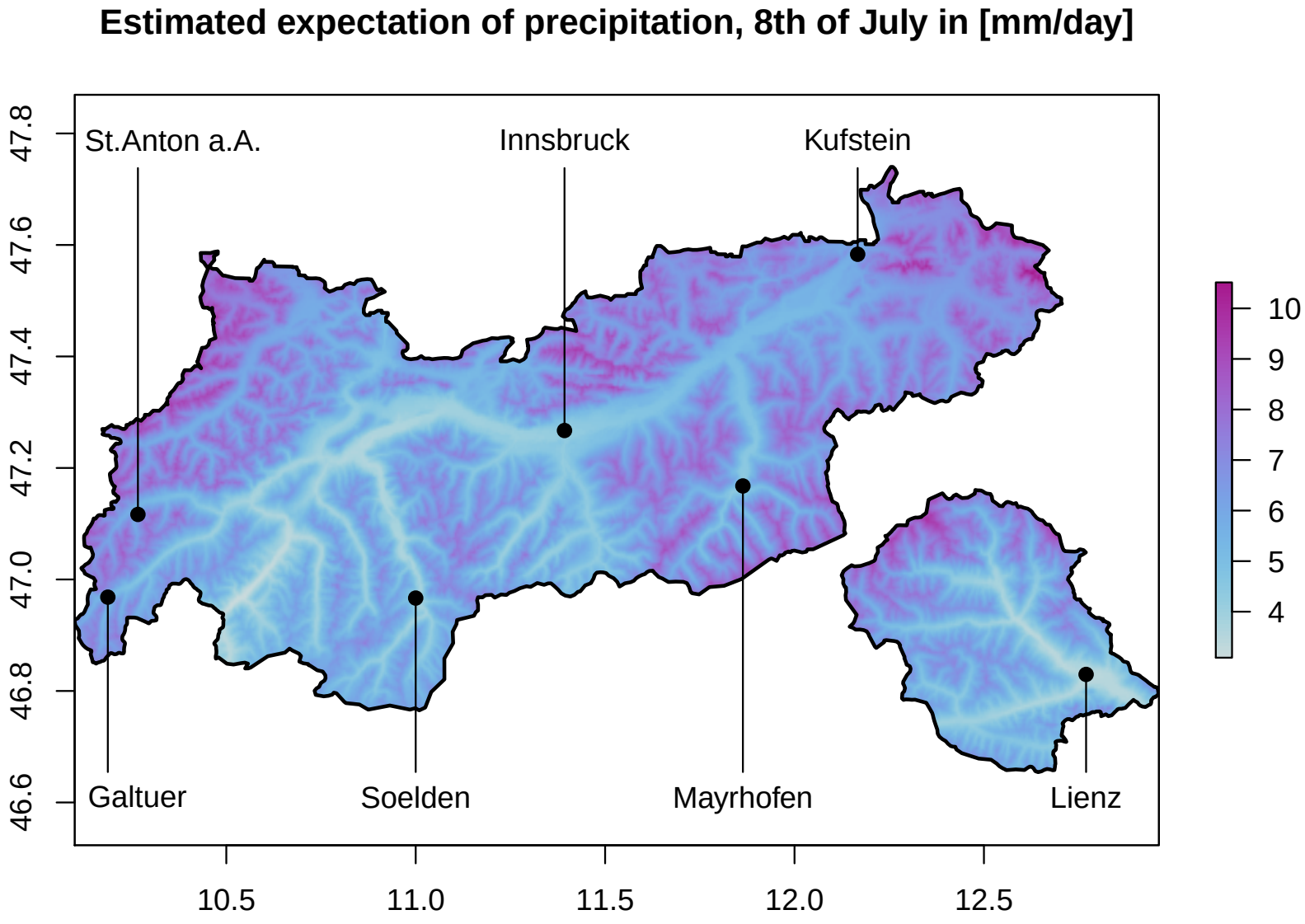

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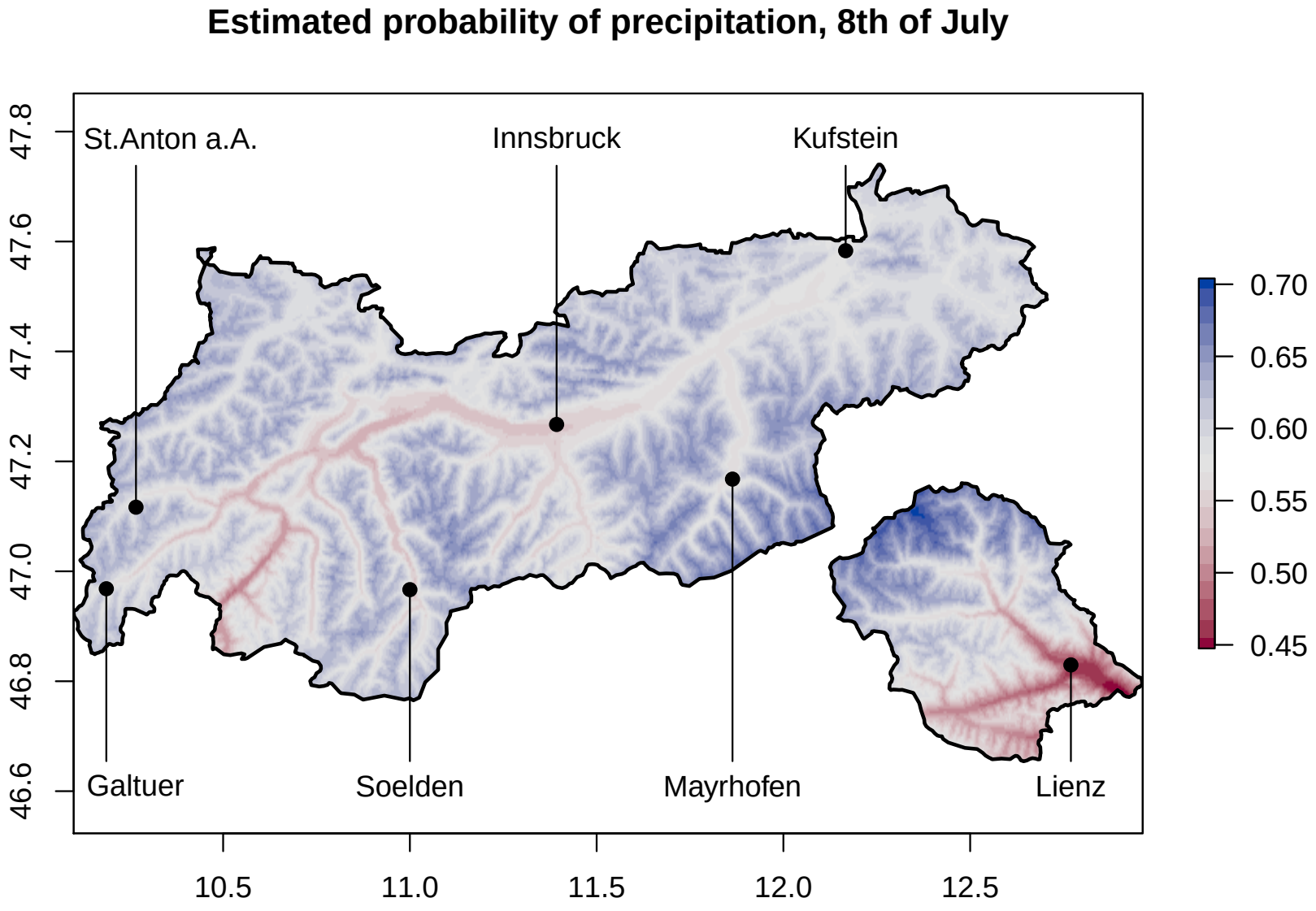

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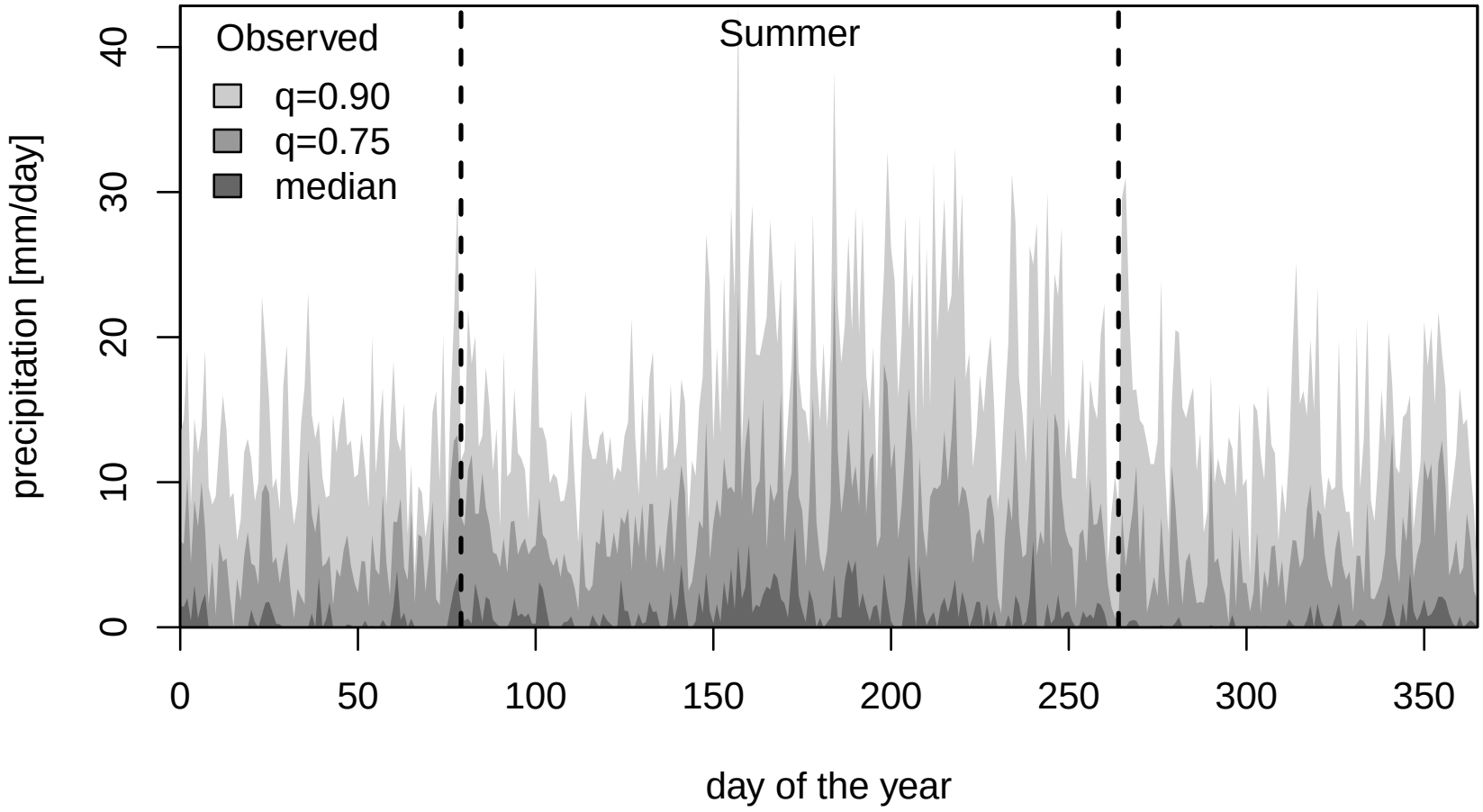

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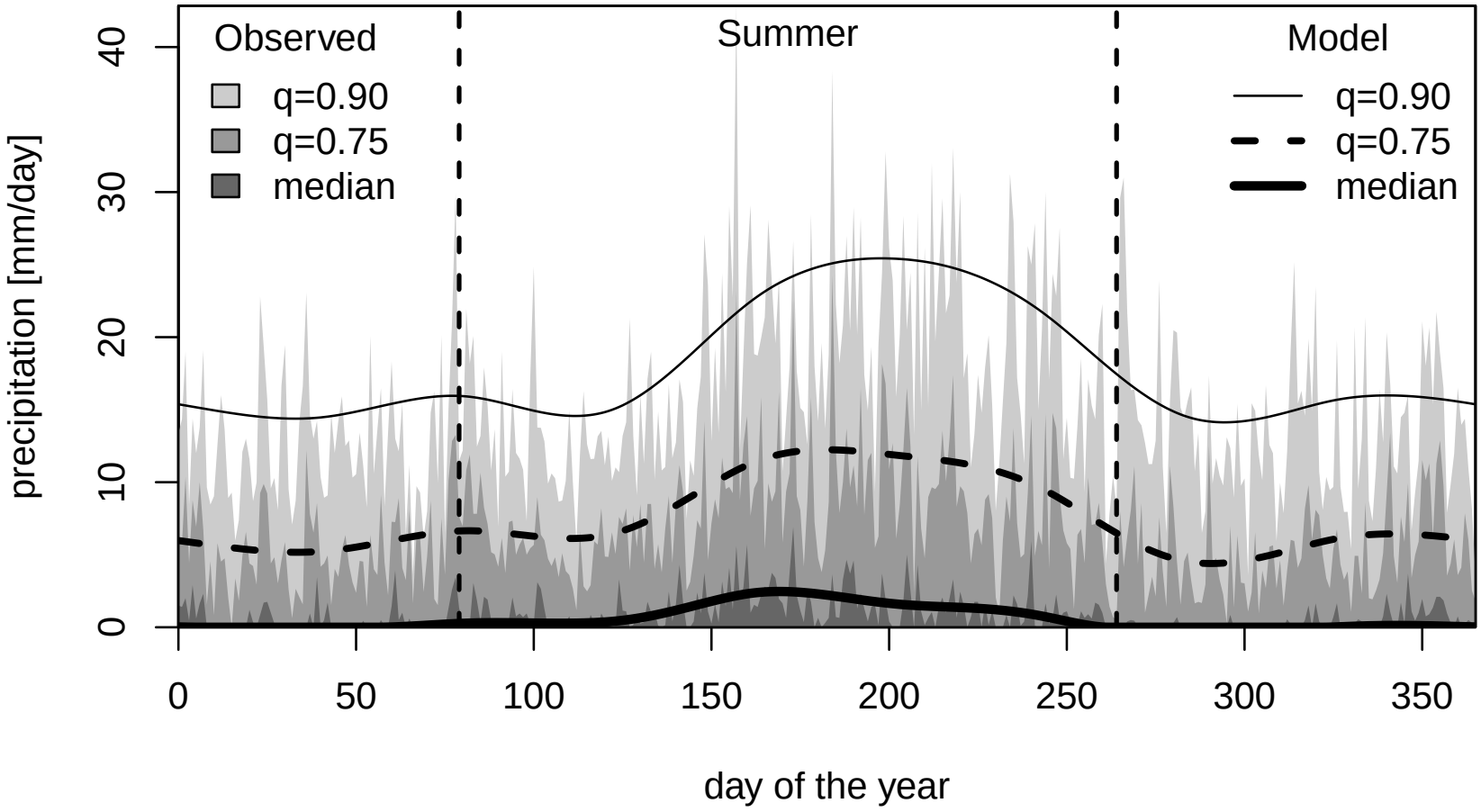

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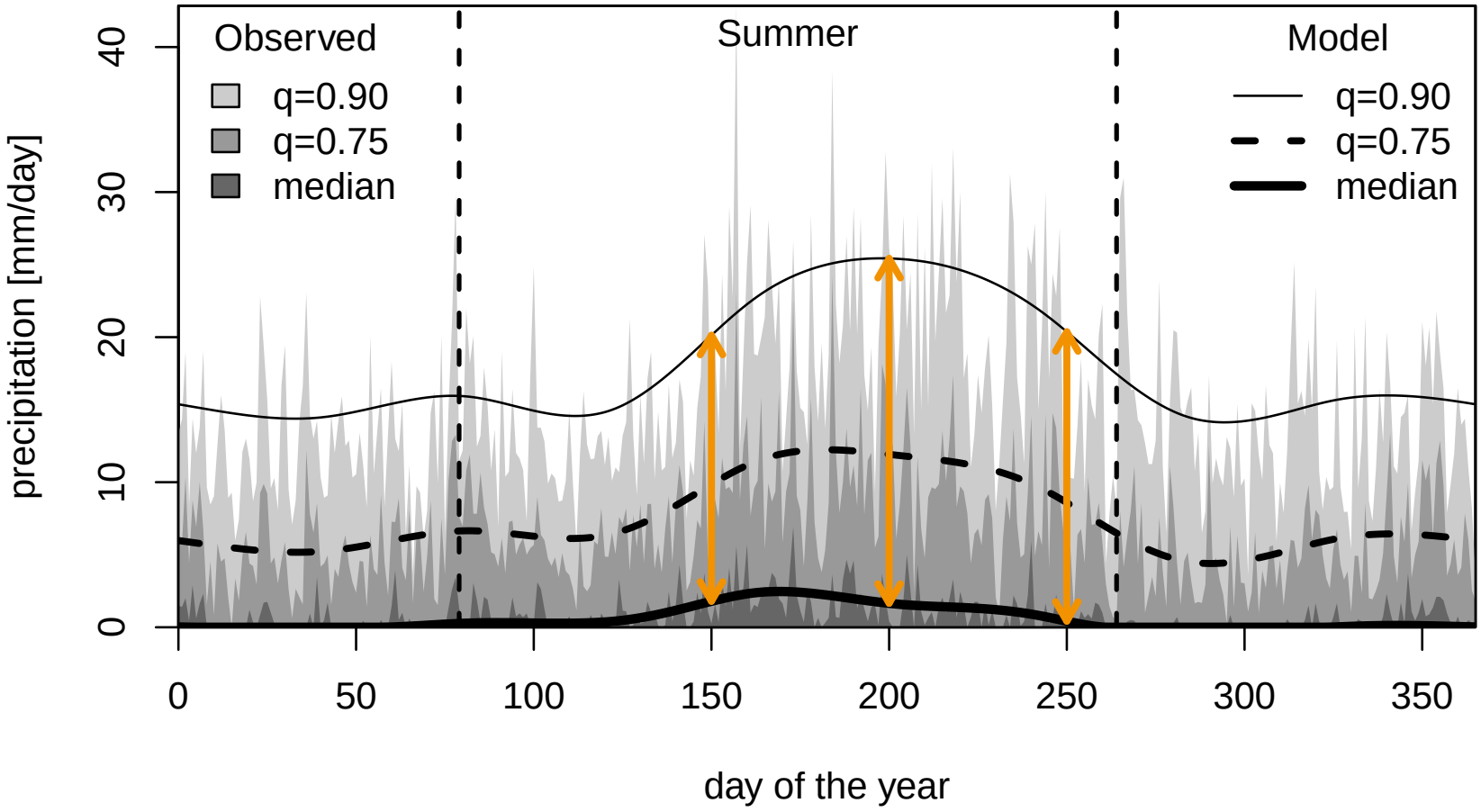

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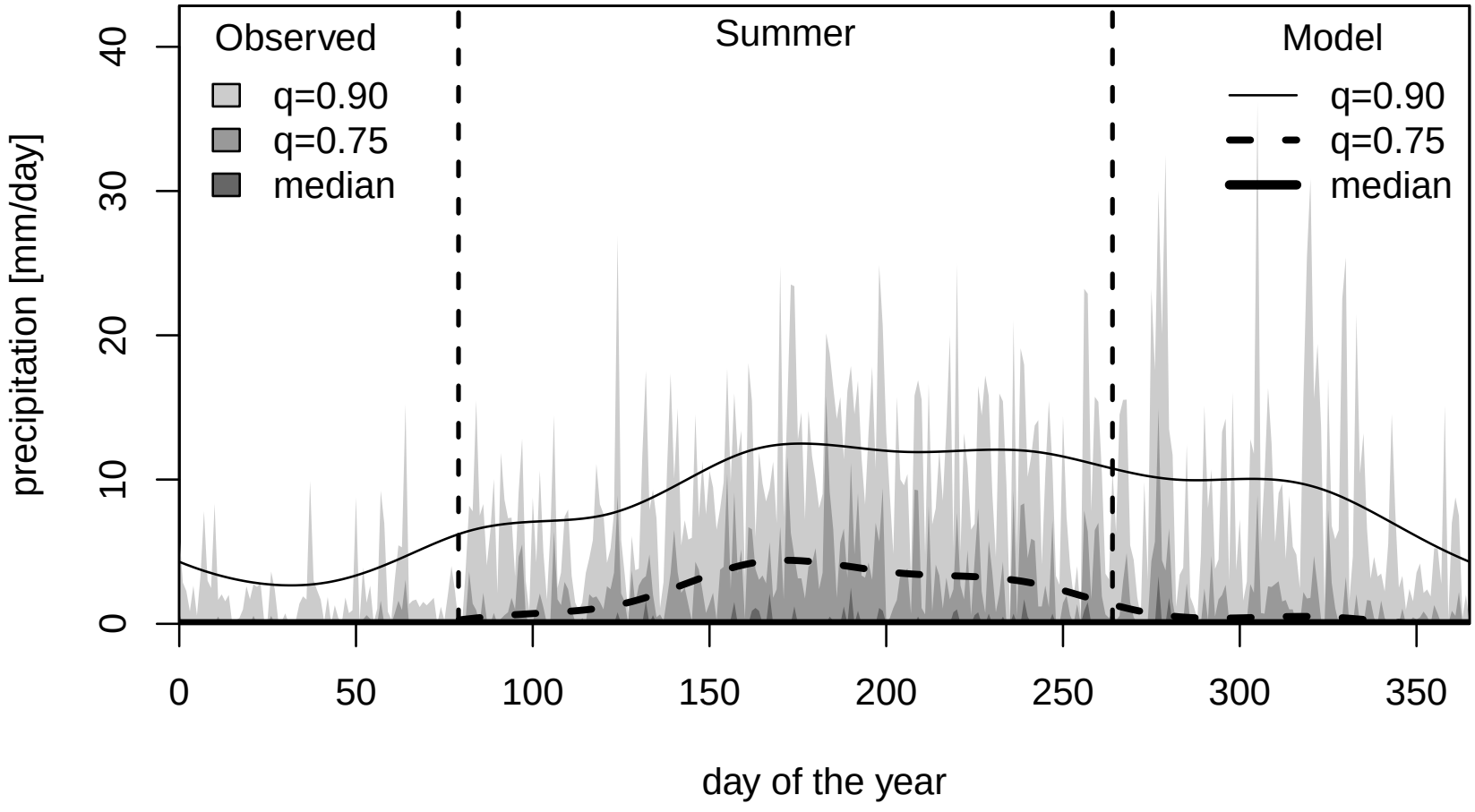
Nikolsdorf



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- **improving** snow **forecasts**

Strategy

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Model setup

- **generalized additive model** for μ and σ^2 (GAMLSS)

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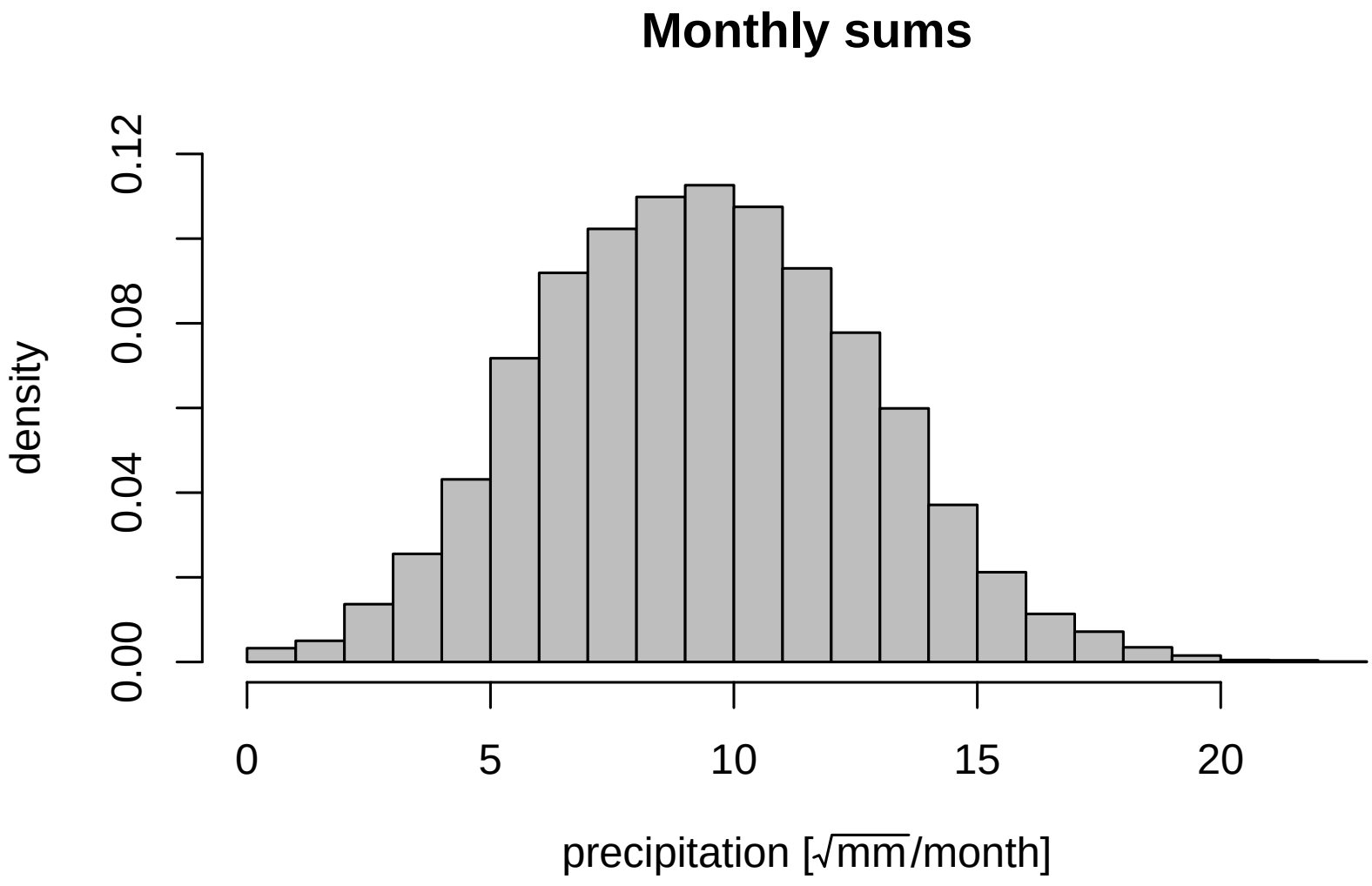
Open question

- which distribution?

  $y \sim \mathcal{N}(\mu, \sigma^2)$ not suitable for all aggregation levels

The data: monthly sums



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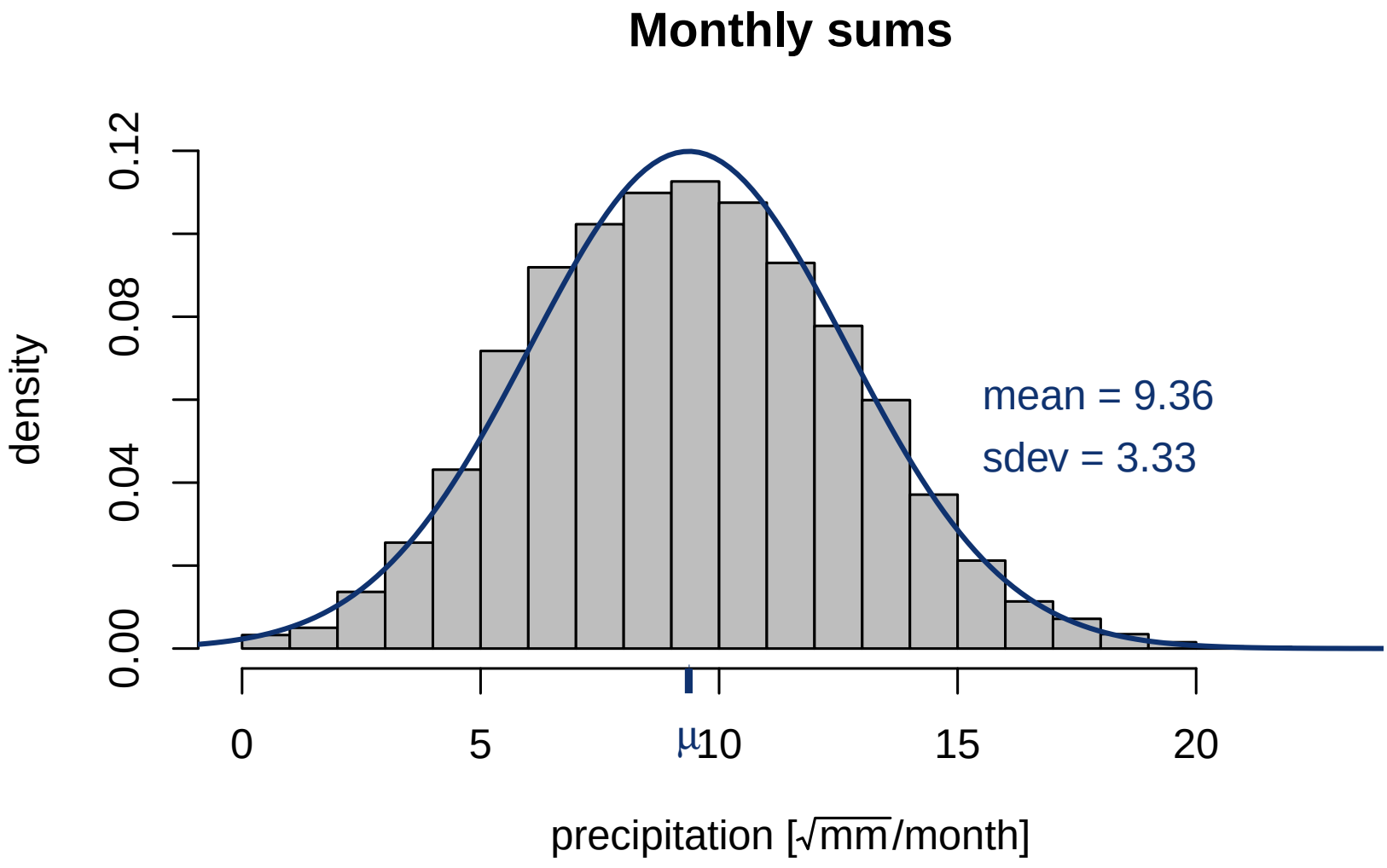
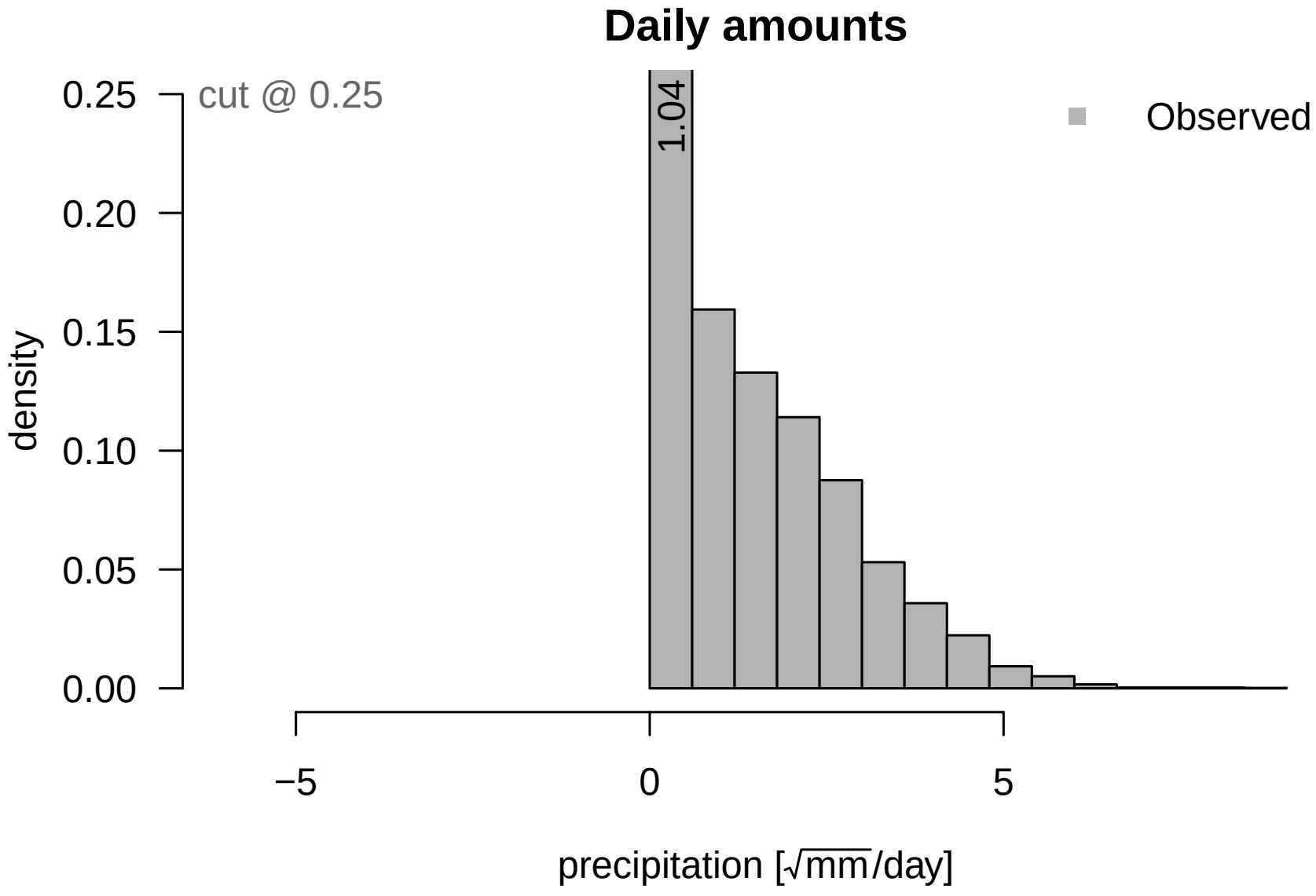


The data: daily amounts



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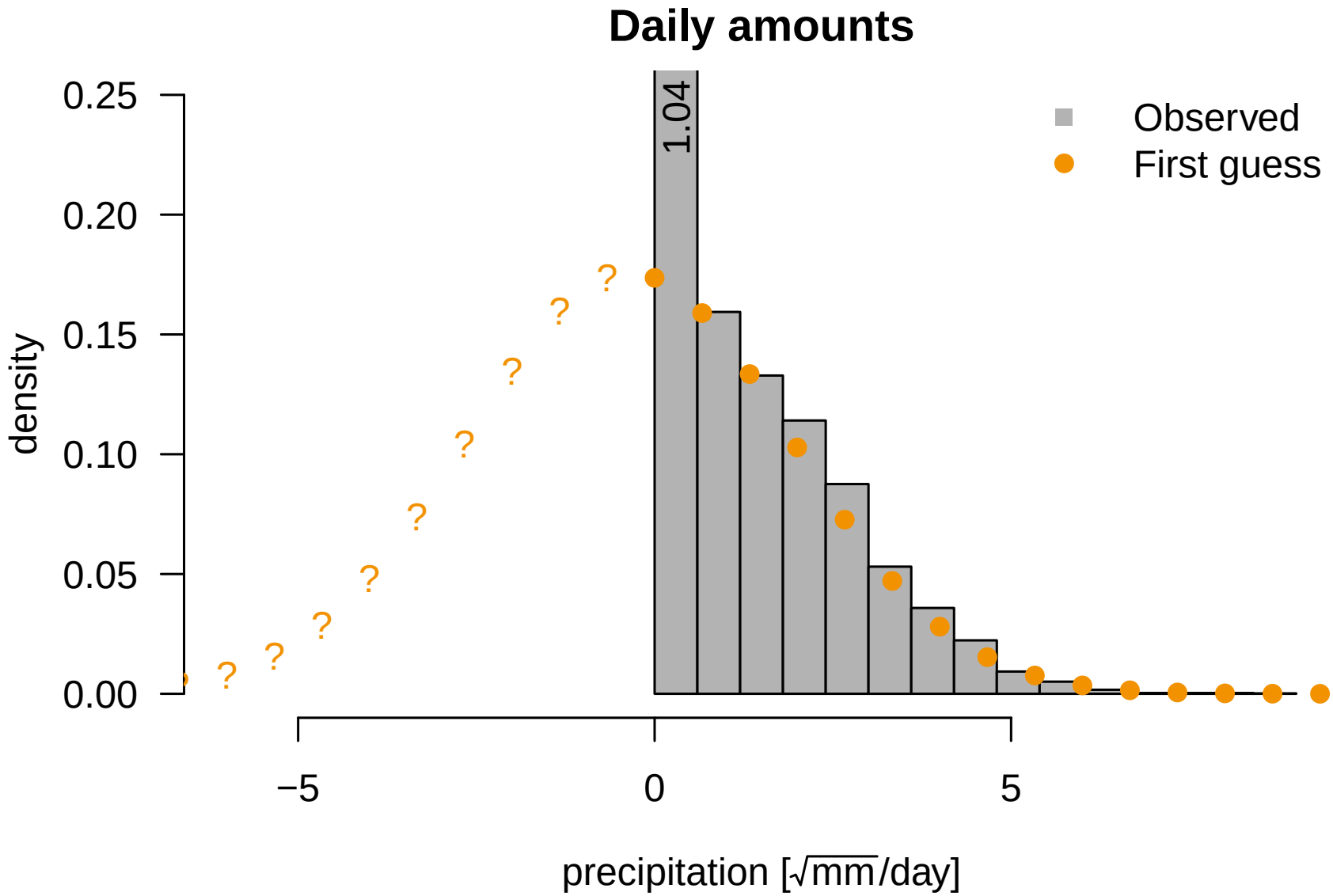

Censoring

Can be seen as censored if . . .

- **limited** to a threshold
- values exceeding threshold **cannot occur** or **not observable**

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- survival in 5 *yr* clinical study: **right** $y_i \leqslant 5$
- hours worked this week: **two sided** $0 \leqslant y_i \leqslant 168$

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- precipitation: **left** $0 \leqslant y_i$

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- hours worked this week: **two sided** $0 \leqslant y_i \leqslant 168$
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Left censored Gaussian distribution

$$y^* \sim \mathcal{N}(\mu, \sigma^2), \quad y = \max(\tau = 0, y^*)$$

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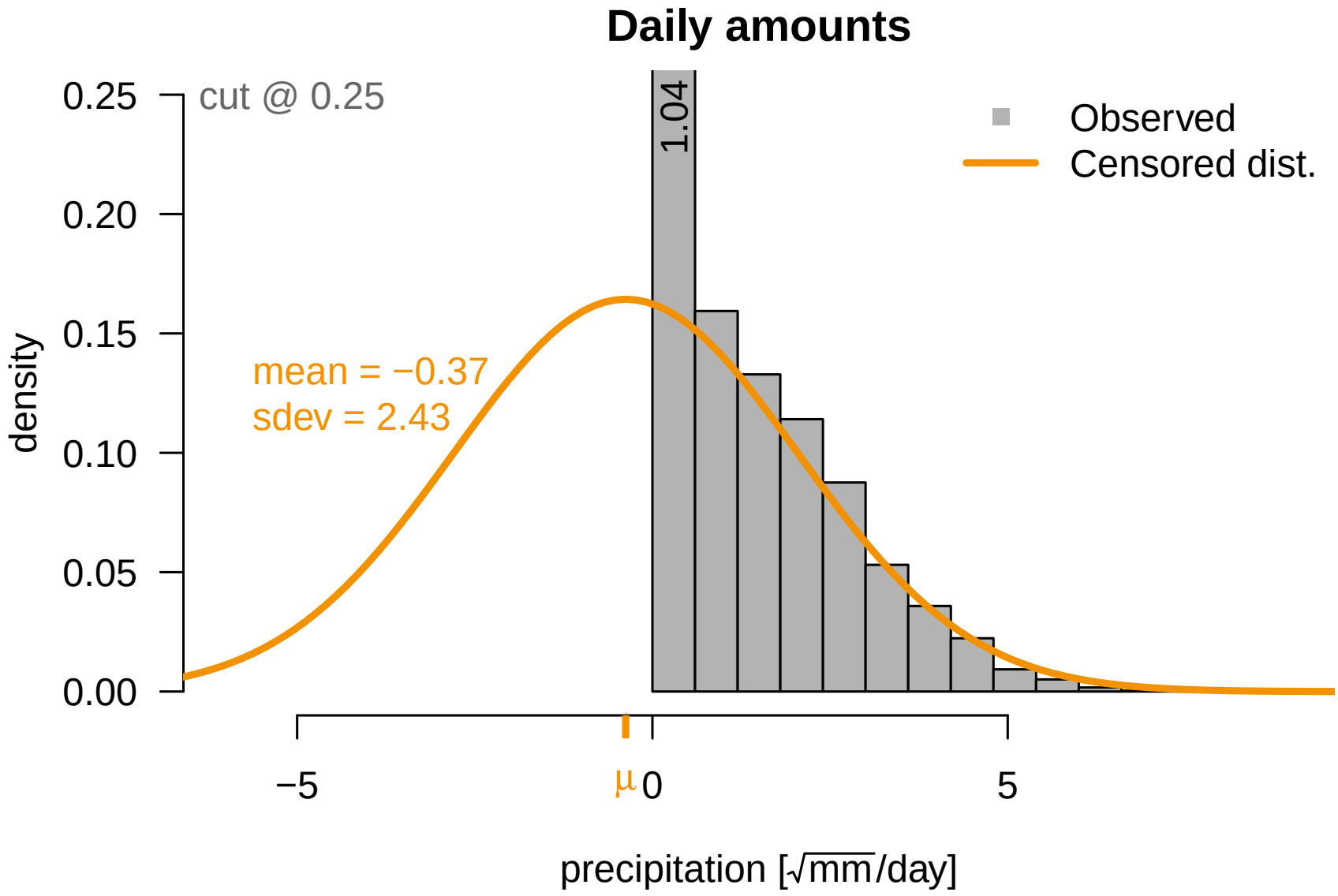

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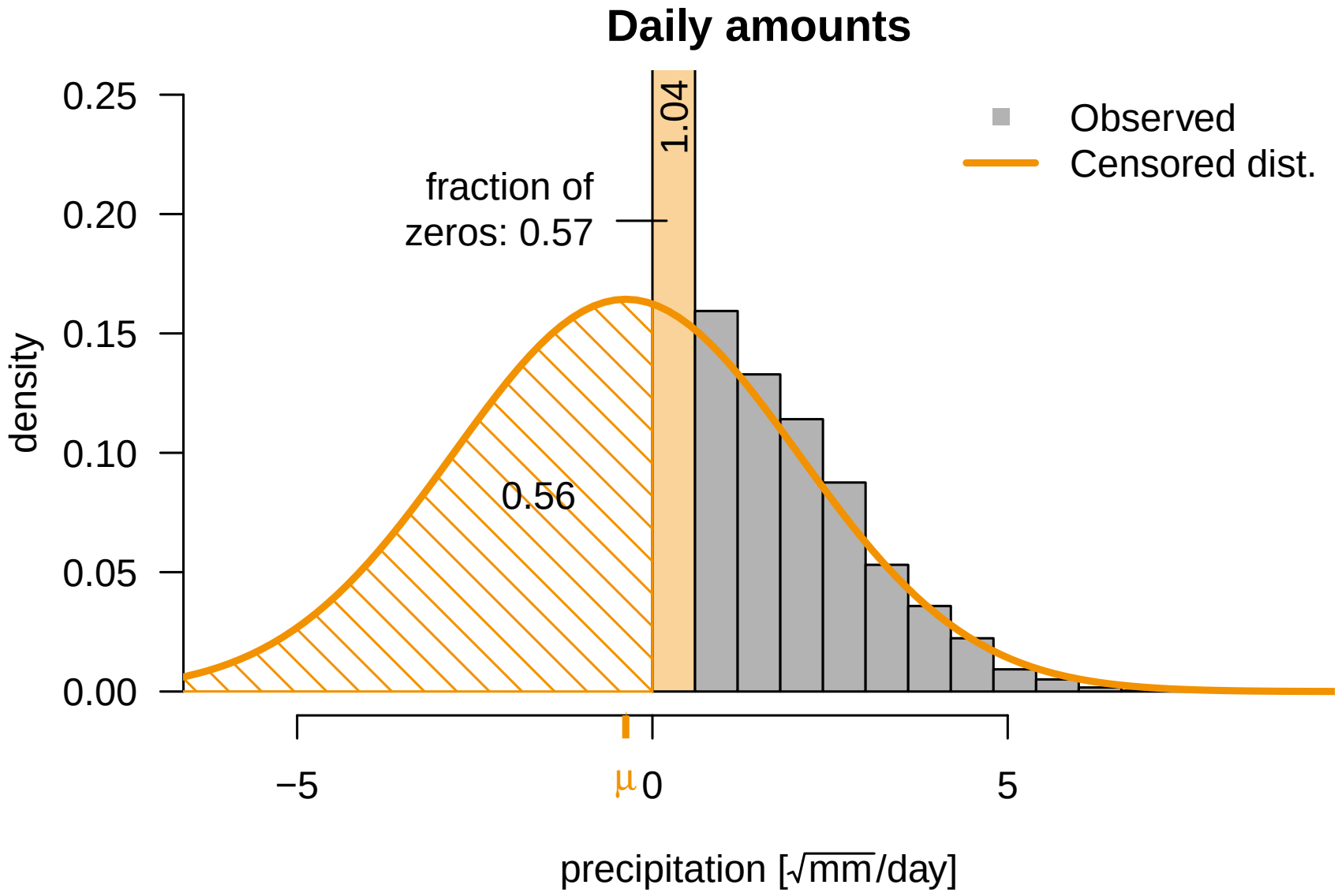

Model setup

Assumptions

$$y \sim \mathcal{D}(\mu, \sigma^2), \quad \mu = \eta_\mu, \quad \log(\sigma) = \eta_\sigma$$

y	response; daily precipitation (transformed)
$\mathcal{D}(\dots)$	left censored Gaussian distribution on 0
μ/σ	location/scale

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Linear predictor

$$\eta = \beta_0 + \underbrace{\beta_1 \text{ alt}}_{\text{altitude}} + \underbrace{f_1(\text{yday})}_{\text{seasonal}} + \underbrace{f_2(\text{long}, \text{lat})}_{\text{spatial}} + \underbrace{f_3(\underline{\text{yday}}, \text{long}, \text{lat})}_{\text{spatial season}}$$

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μ/σ	location/scale
η	linear predictor; identical for μ and $\log(\sigma)$

Model and Results

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Model estimation

- **R** package **bamlss** (Umlauf et al. (2015); Poster 72)
- censored Gaussian distribution

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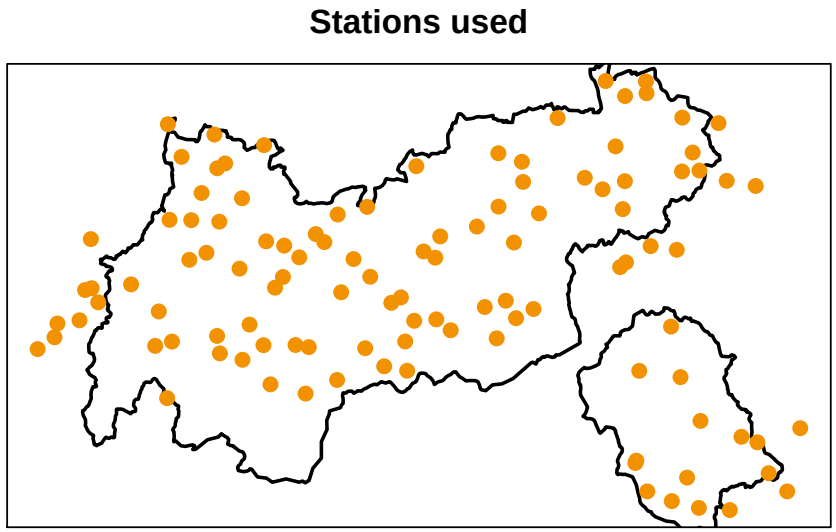
Data set

- 110 stations
- 41 *years*
- daily rain/snow amounts
- $\sim$ 1.5 million observations



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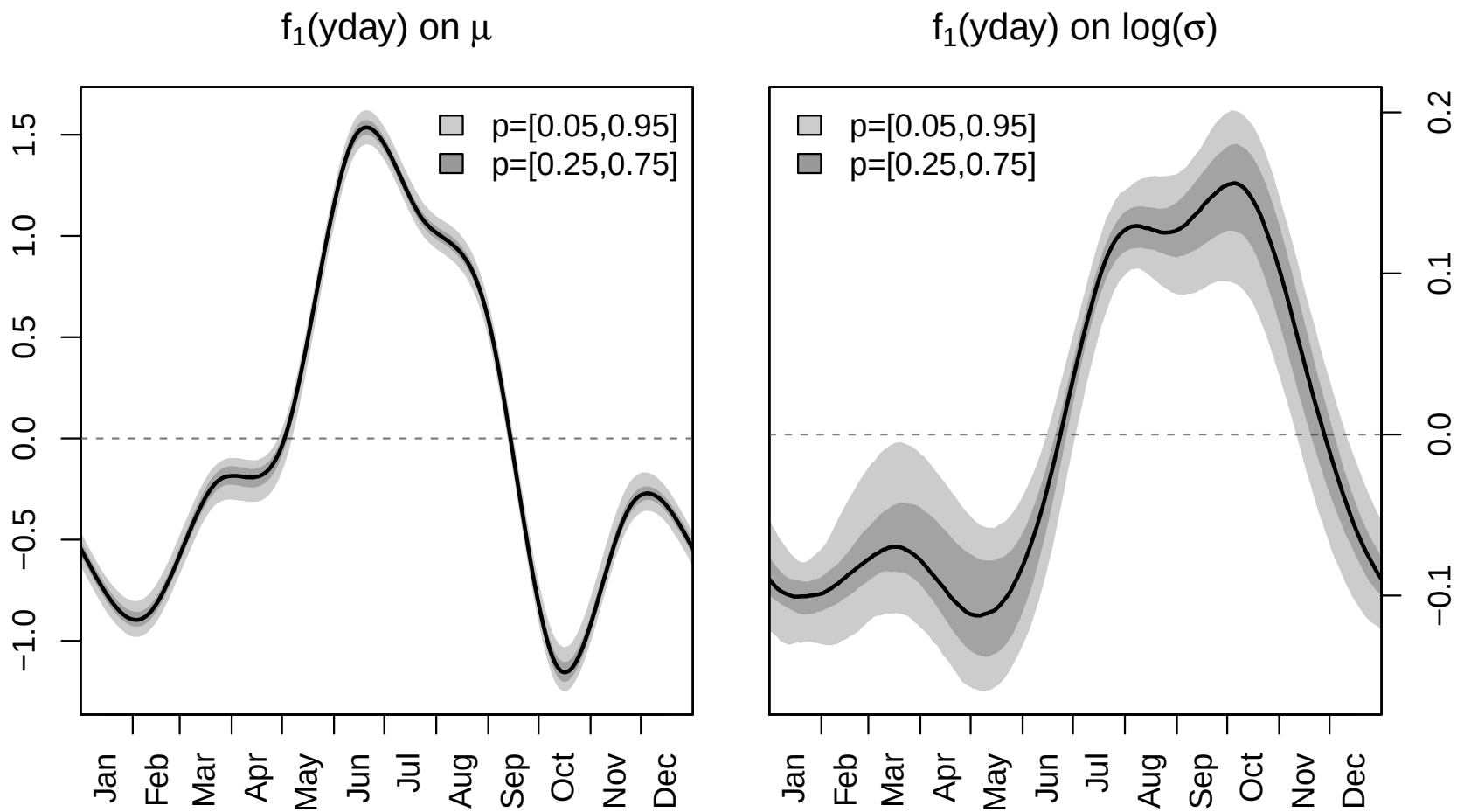

$$\eta = \beta_0 + \beta_1 \text{ alt} + \underbrace{f_1(\text{yday})}_{\textit{season}} + f_2(\text{long}, \text{lat}) + f_3(\text{yday}, \text{long}, \text{lat})$$

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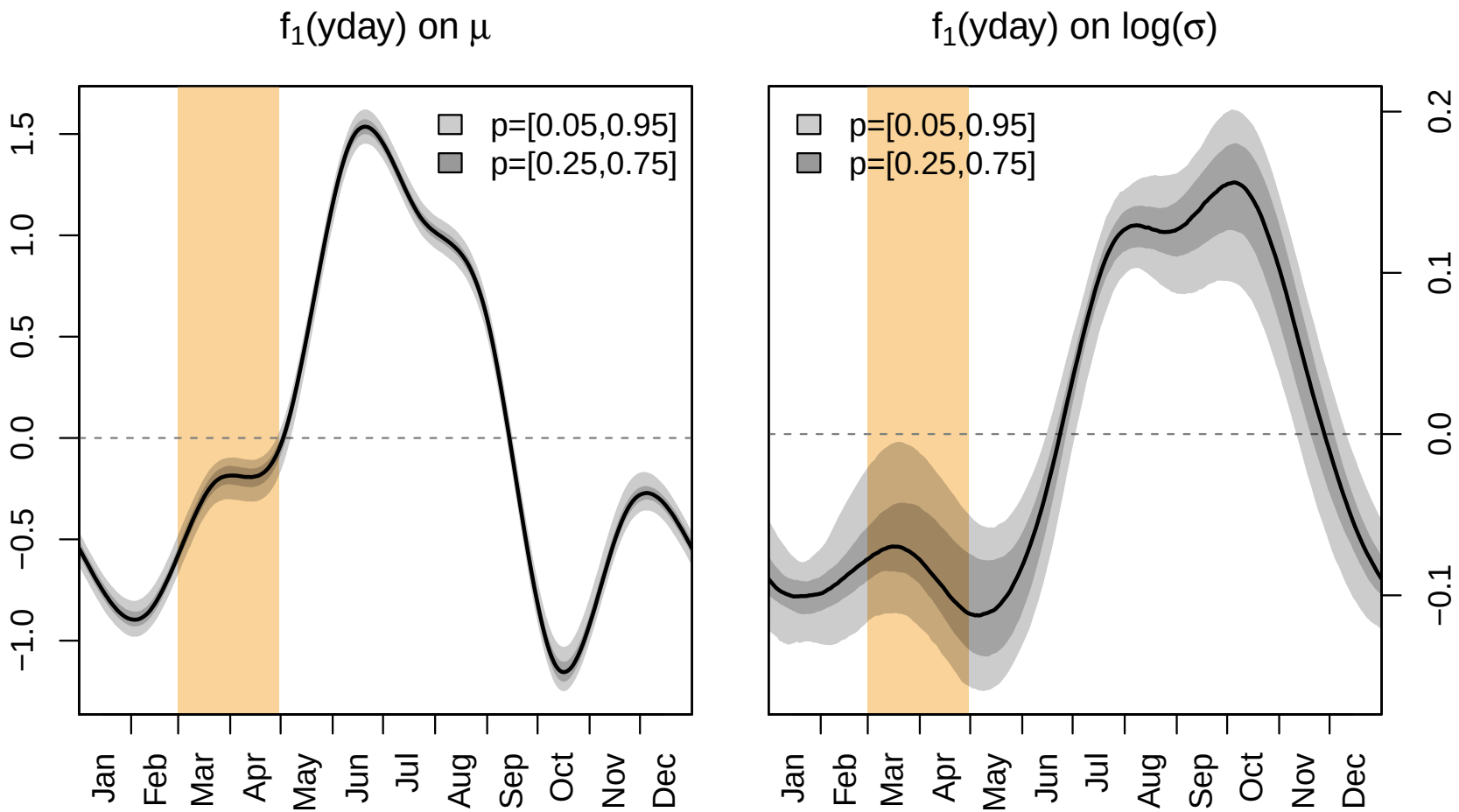

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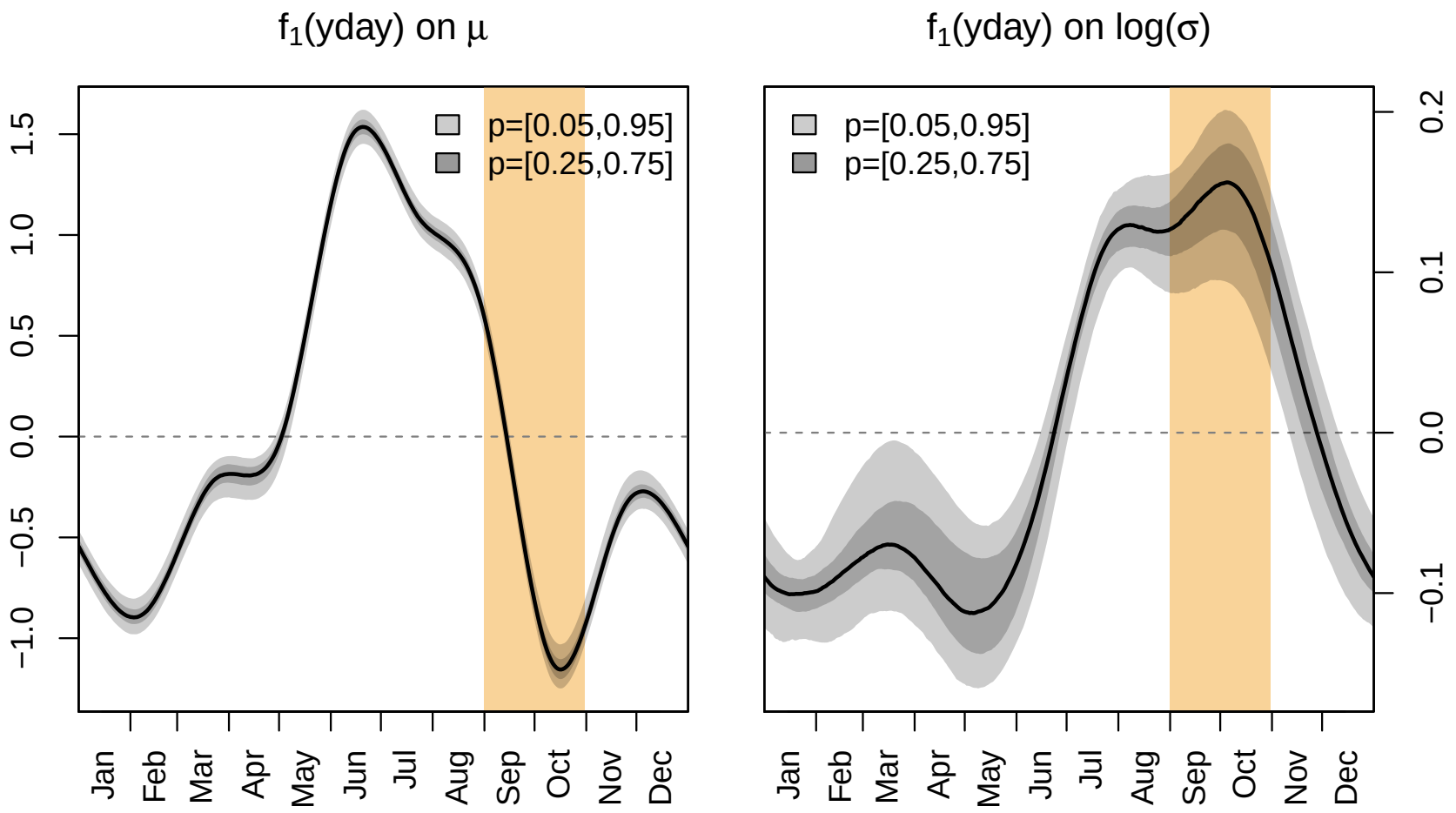

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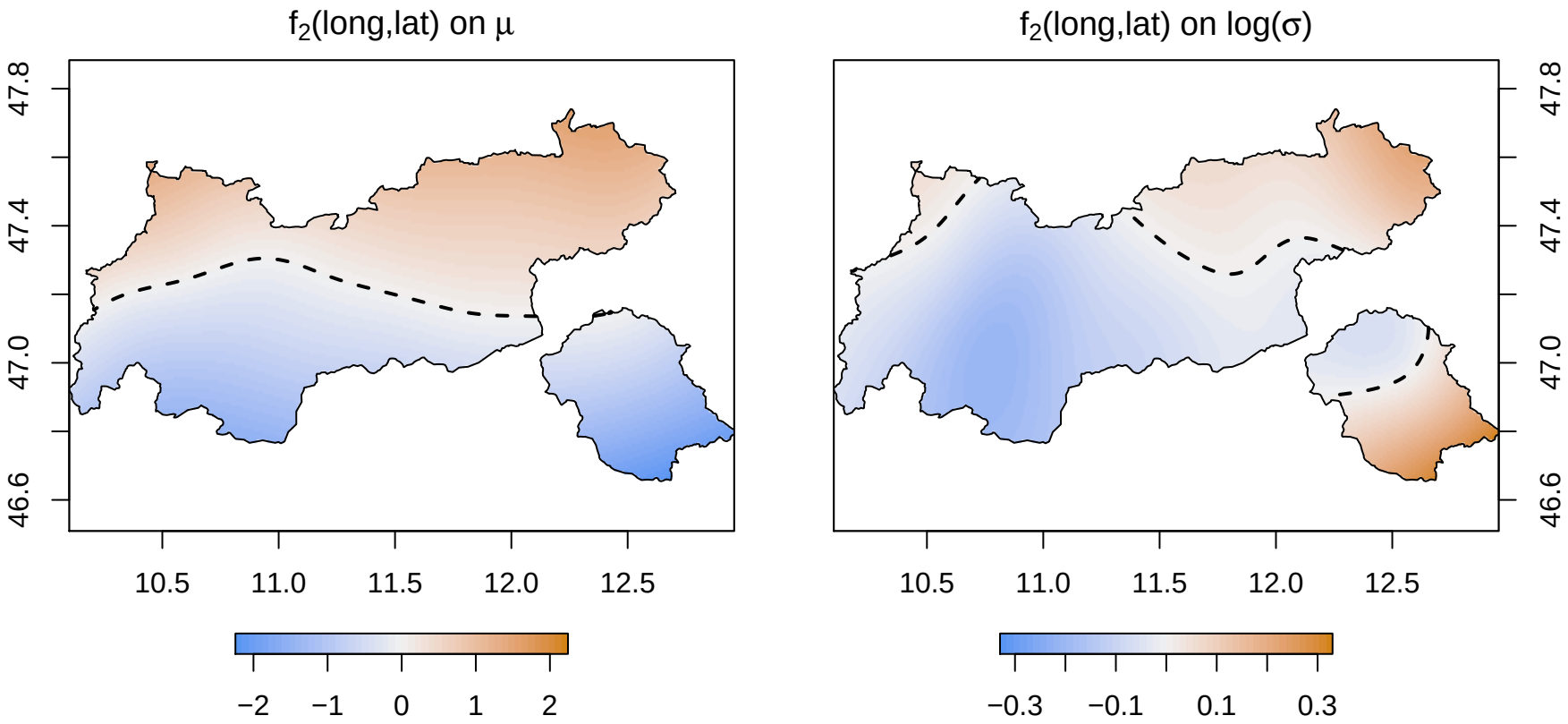

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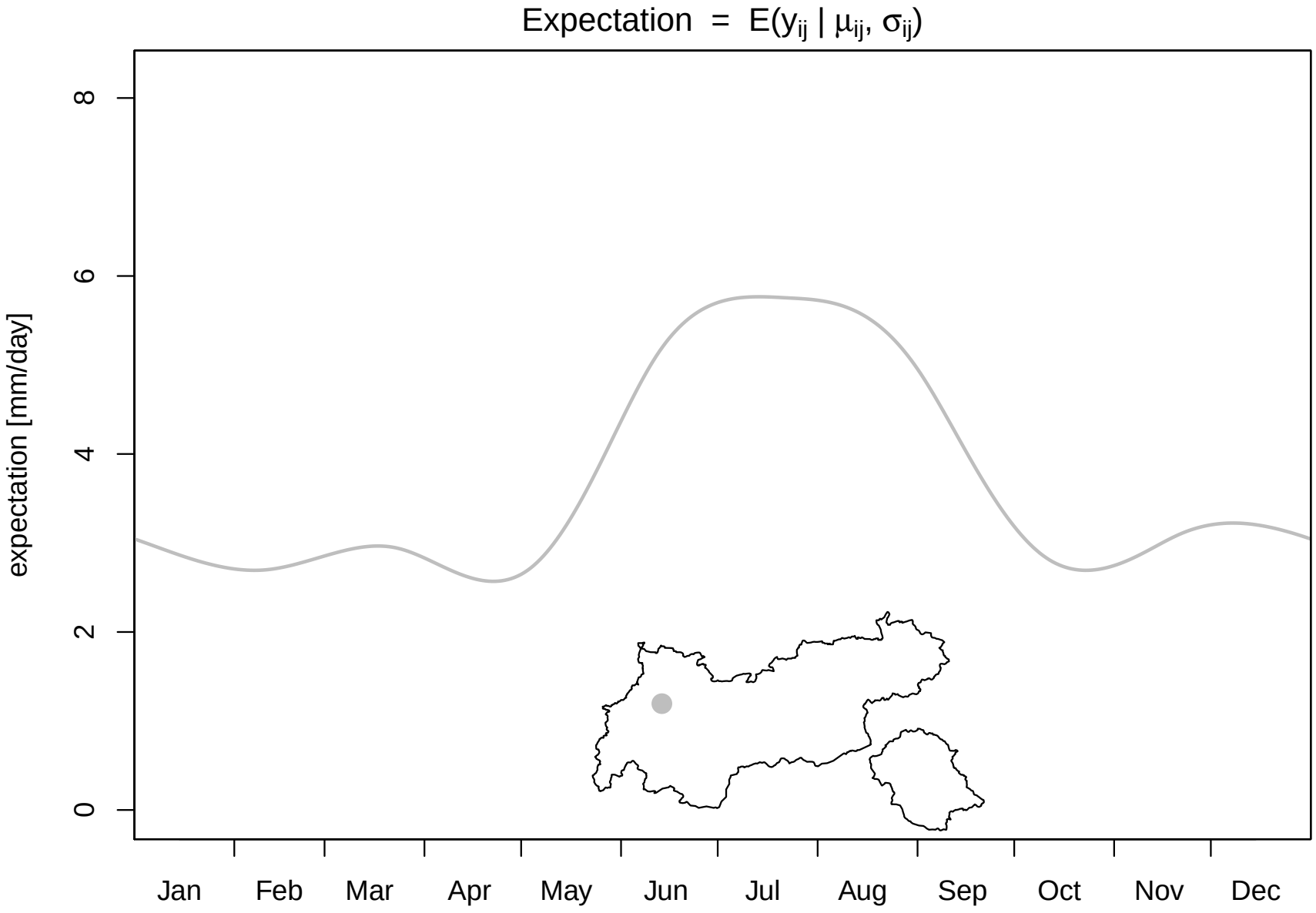

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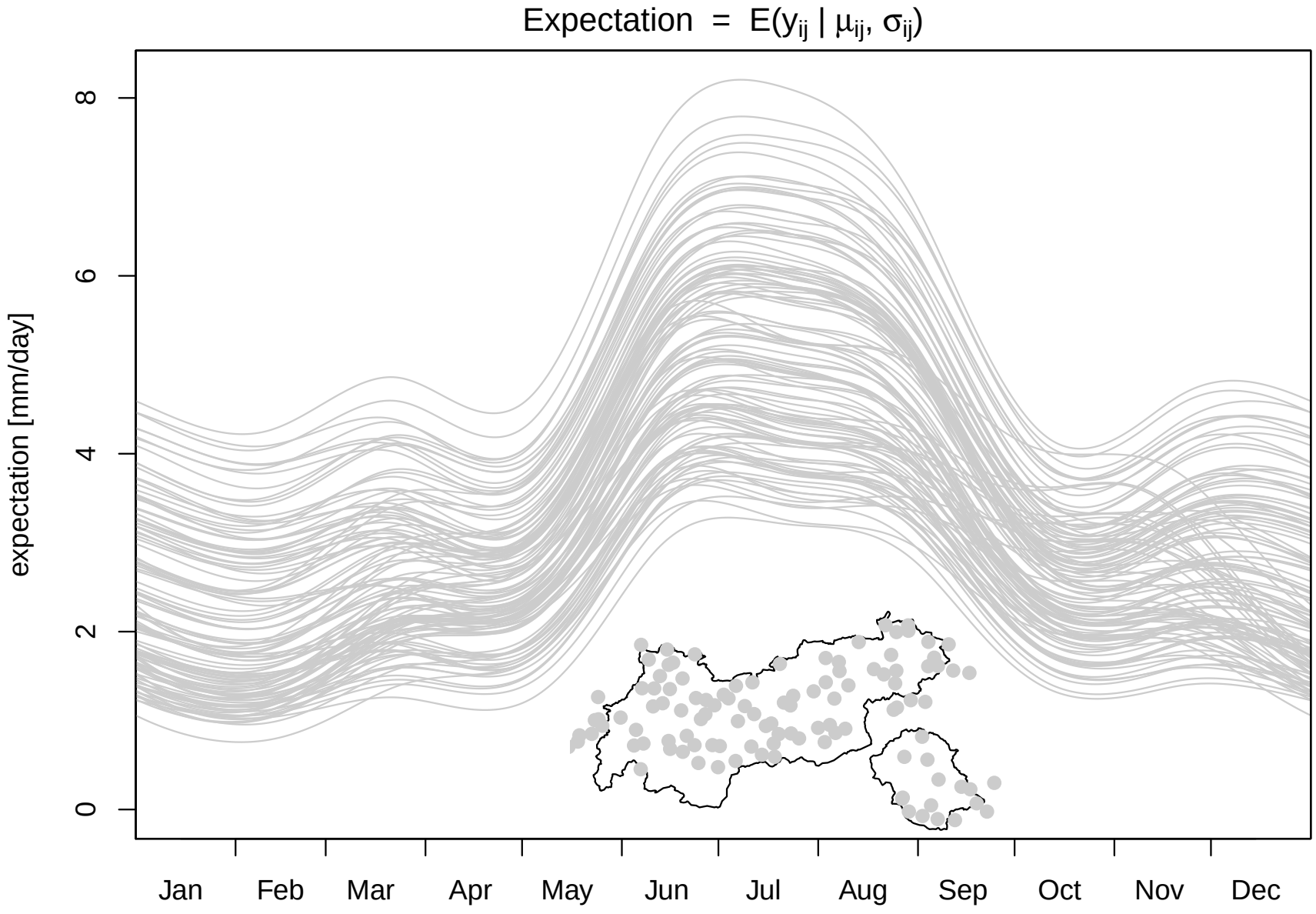

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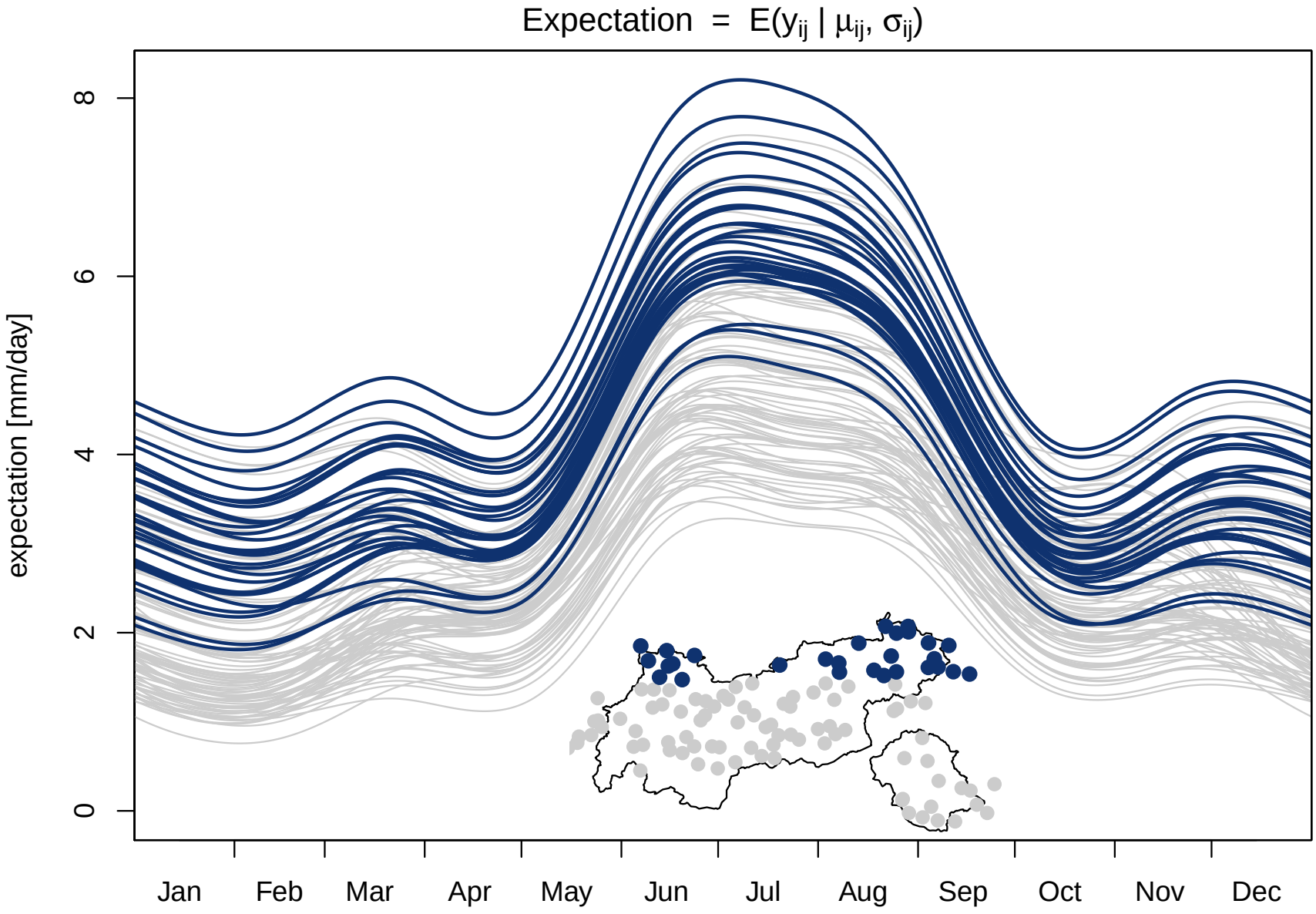

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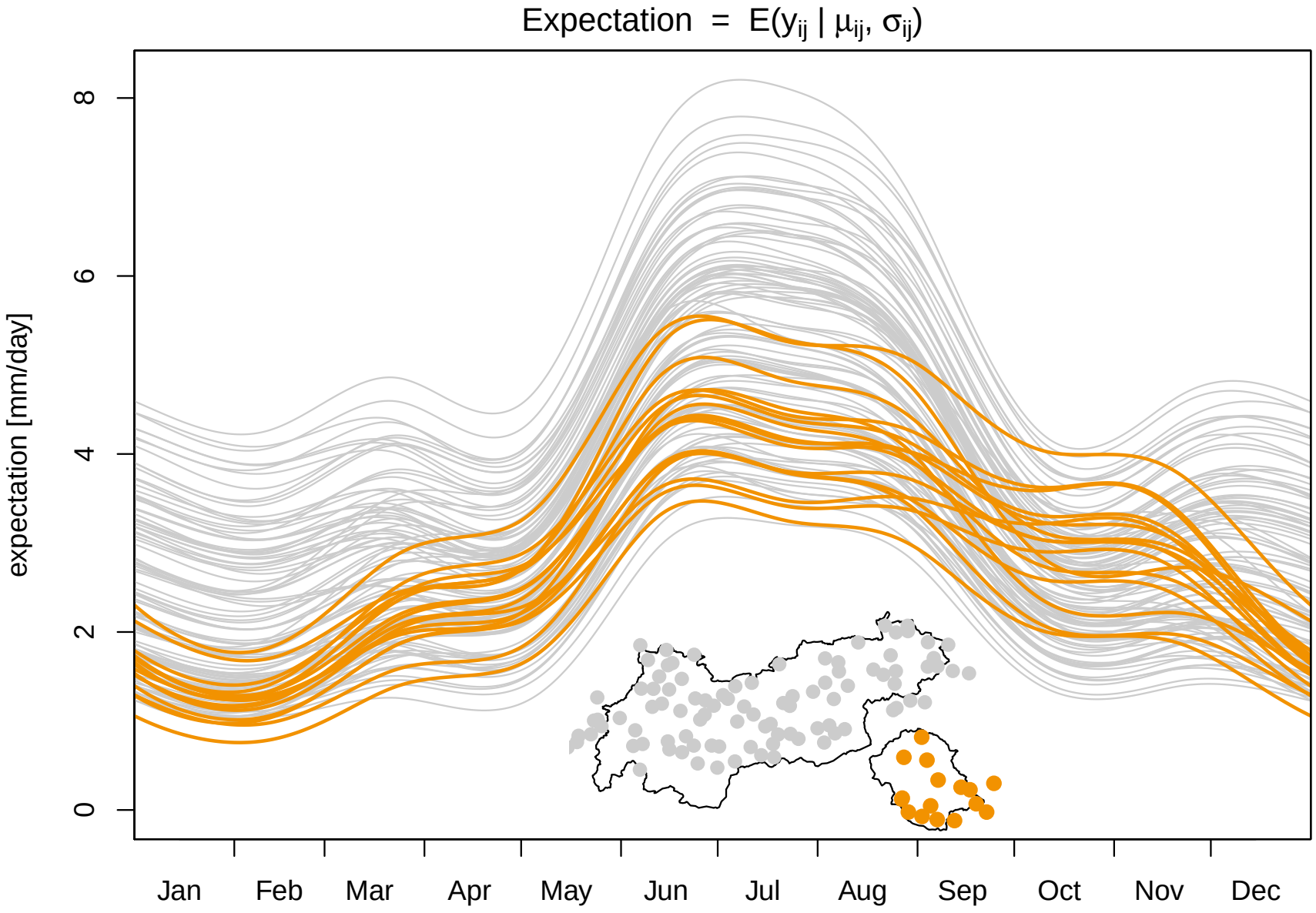

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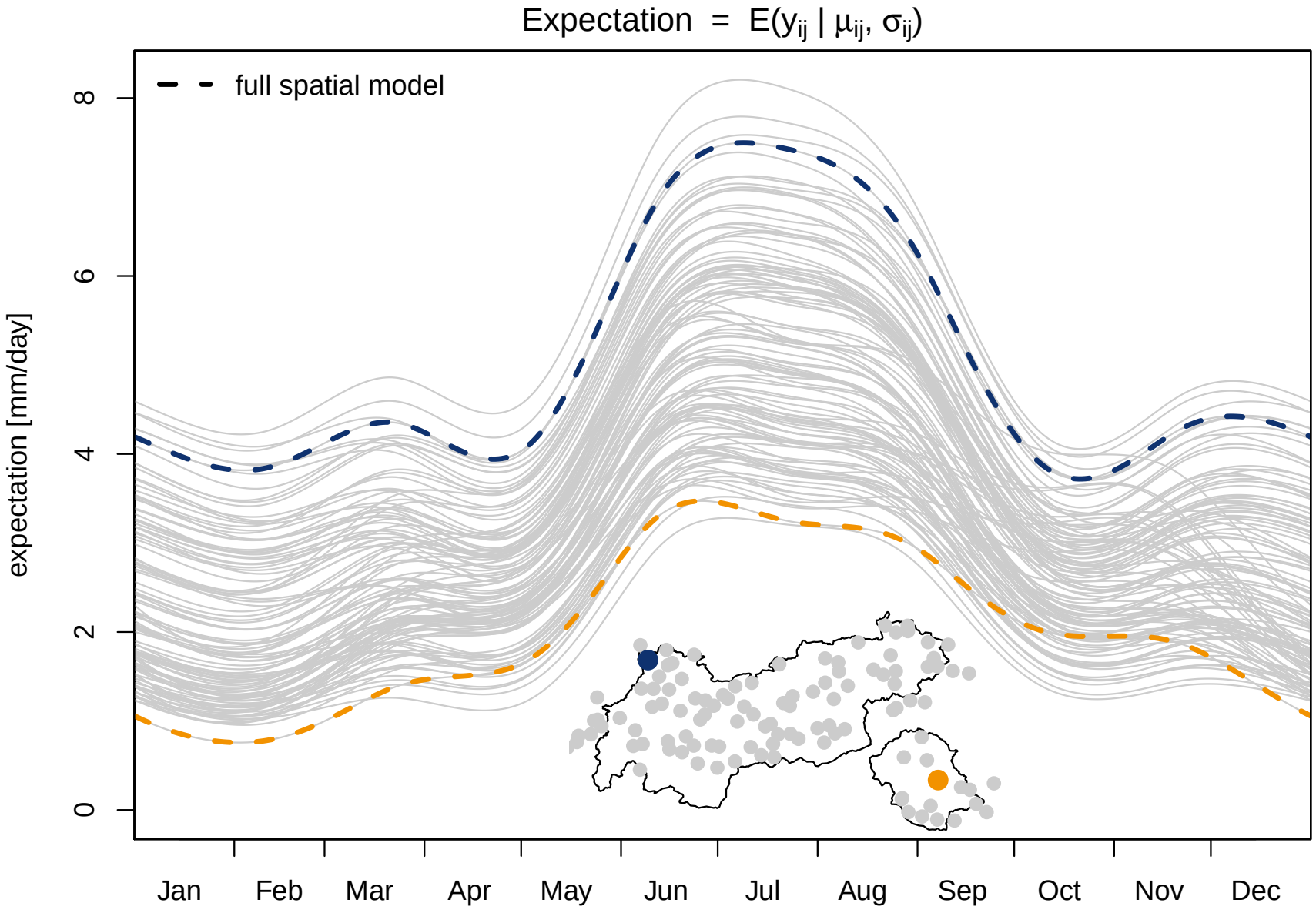

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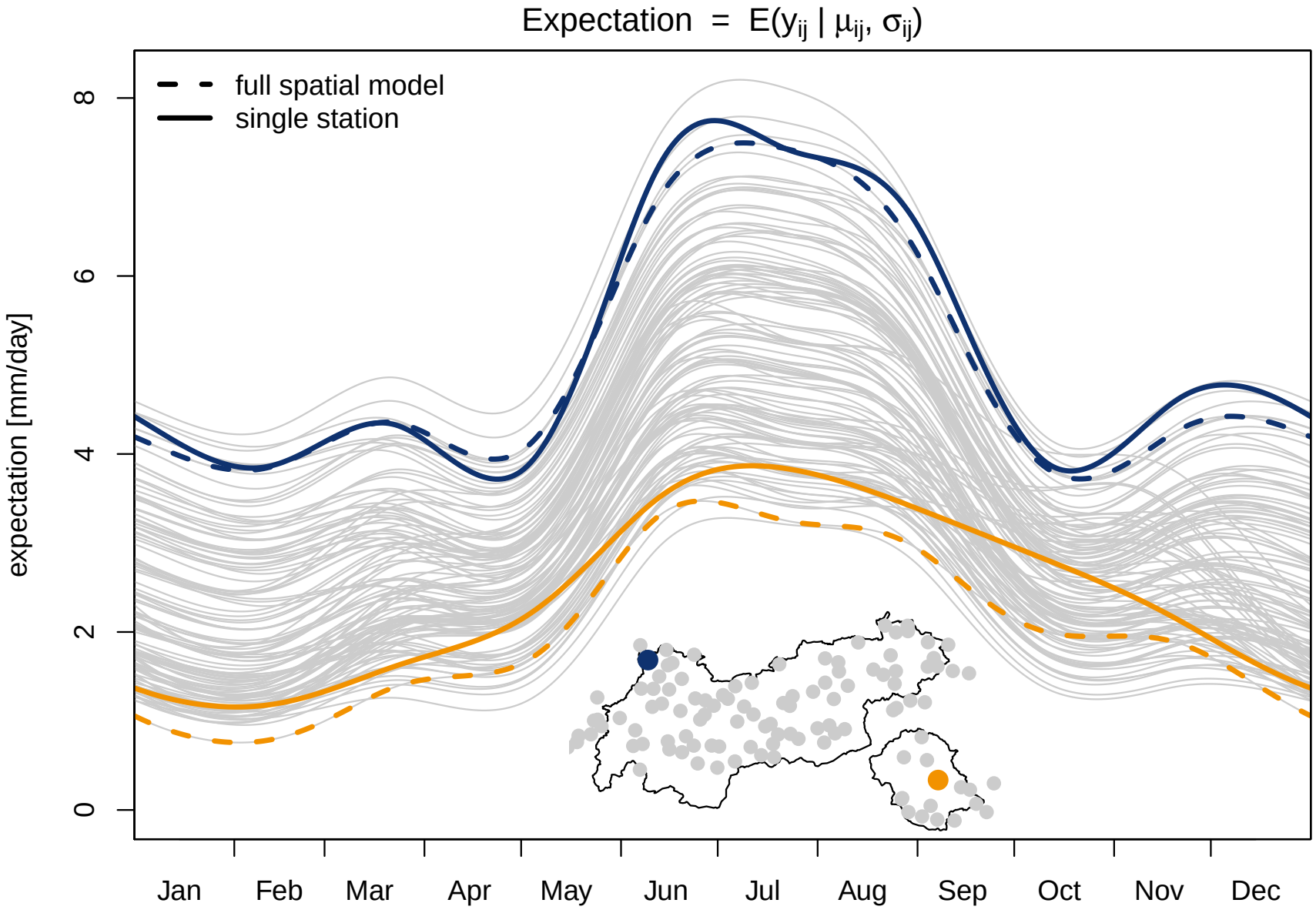
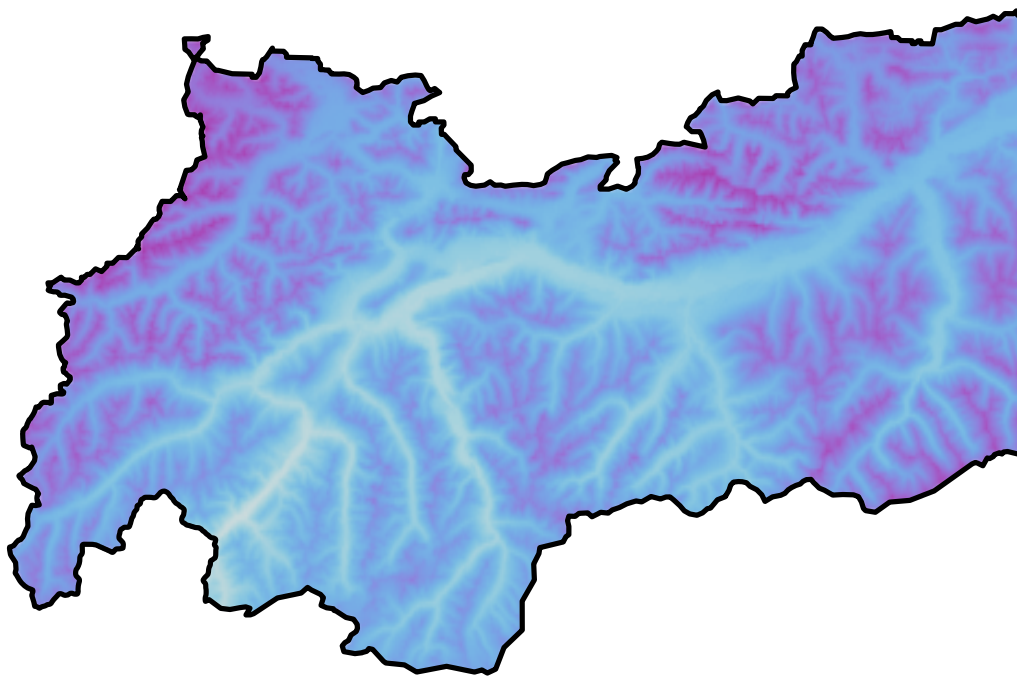


Summary

- “simple”, generalized setup
- full **spatio-temporal** model with **censored** response
- **spatial/temporal** resolution arbitrary scalable
- accurate estimate at station level



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- “simple”, generalized setup
- full **spatio-temporal** model with **censored** response
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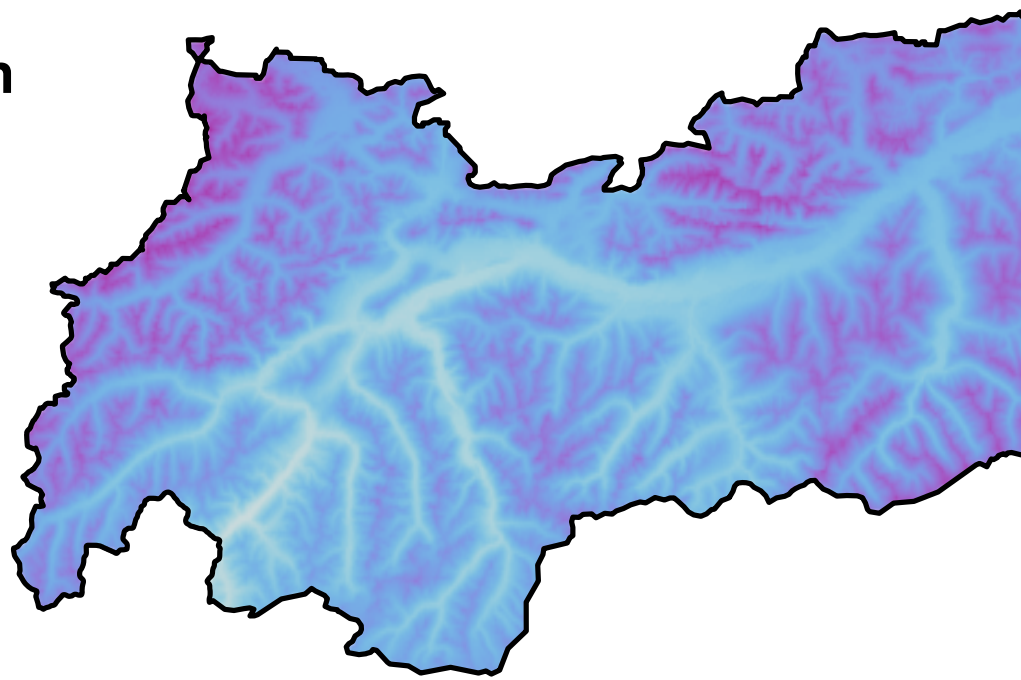
- handling zero-observations
- **full** climatological **distribution**
- quantiles
- probability of precipitation



Thank you for your attention!

Further details:

Scientific article in progress.

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References

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Model and Results

Model on monthly sums

- **R** package **mgcv**
- $y = (\text{monthly sums})^{\frac{1}{2}}$
- $y \sim \mathcal{N}(\mu, \sigma^2)$
- $\mu = \eta_\mu$, $\log(\sigma) = \eta_\sigma$

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Model on daily amounts

- **R** package **bamlss**
- $y = (\text{daily amounts})^{\frac{1}{1.5}}$
- $y^* \sim \mathcal{N}(\mu, \sigma^2)$
- $\mu = \eta_\mu$, $\log(\sigma) = \eta_\sigma$

Error statistics ([*mm*/*month*])

	in-sample		out-of-sample	
	mgcv	bamlss	mgcv	bamlss
BIAS	**-0.13**	0.58	**-0.21**	0.77
MAE	37.62	**37.37**	38.41	**37.90**
RMSE	50.44	**50.17**	51.42	**50.84**