bias correction – quantile mapping – challenges

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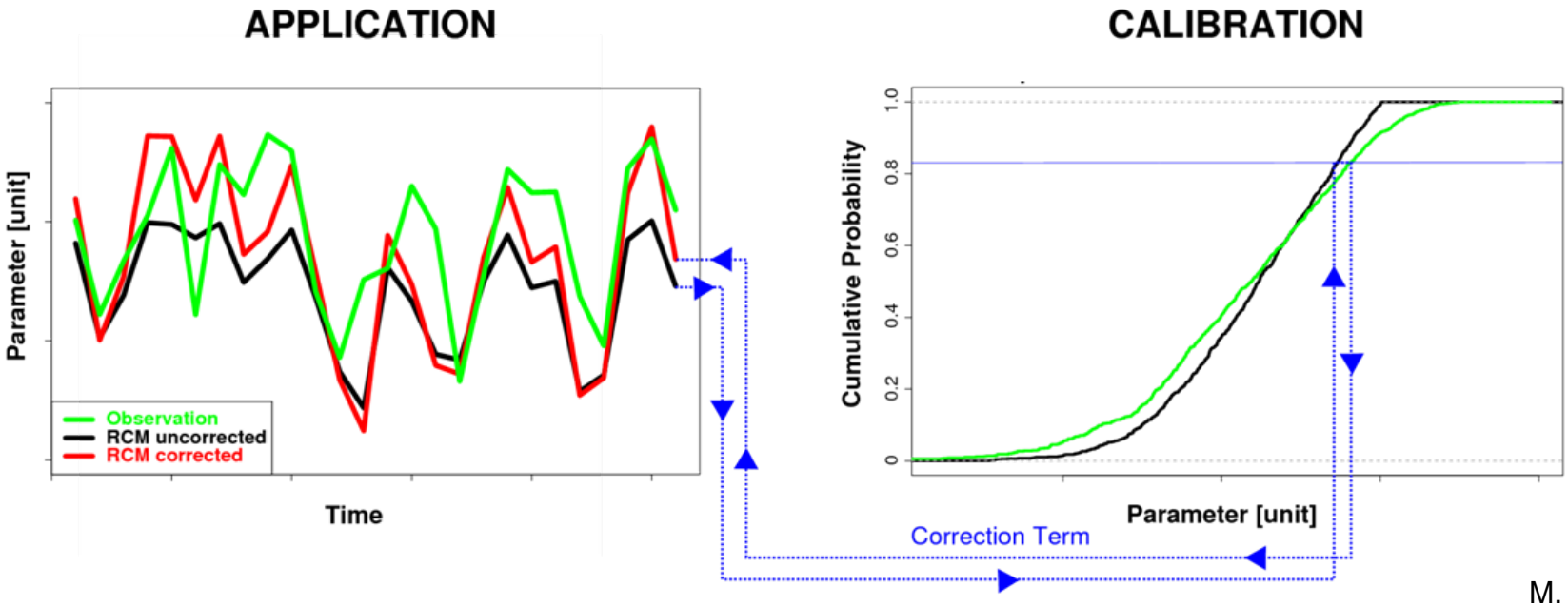
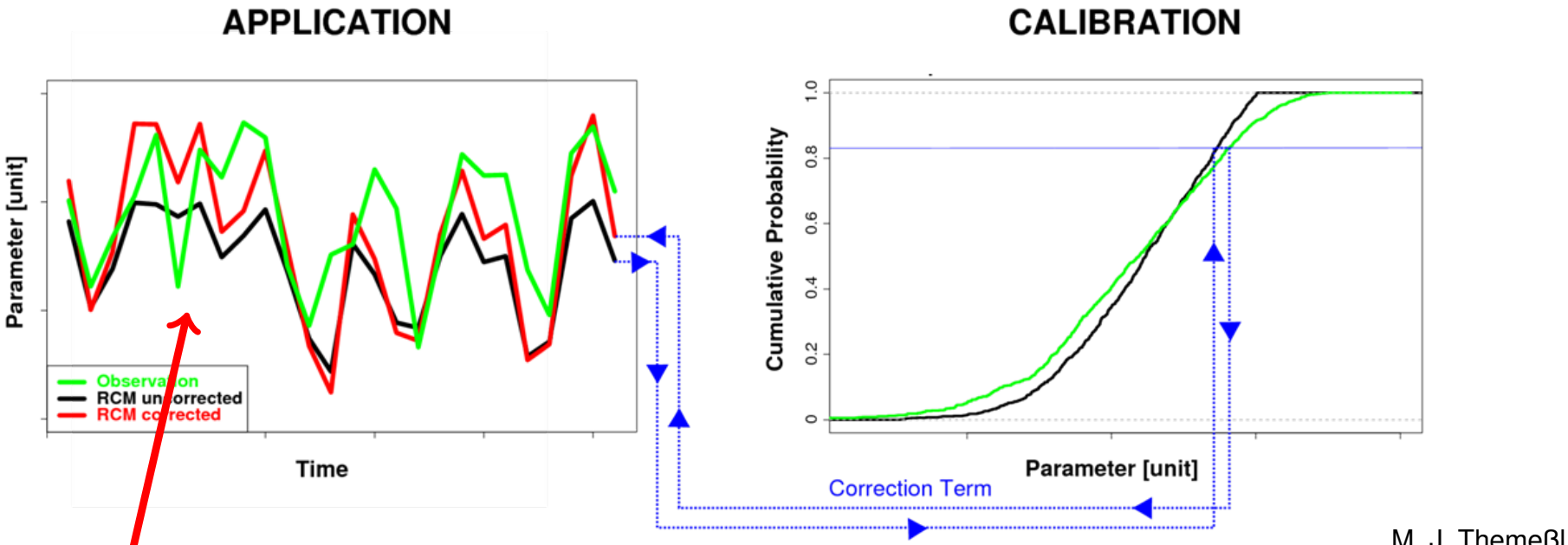
seasonal forecasting and downscaling workshop @ Cantabria University, Santander, 11.09.2014

Quantile mapping



M. J. Themeßl

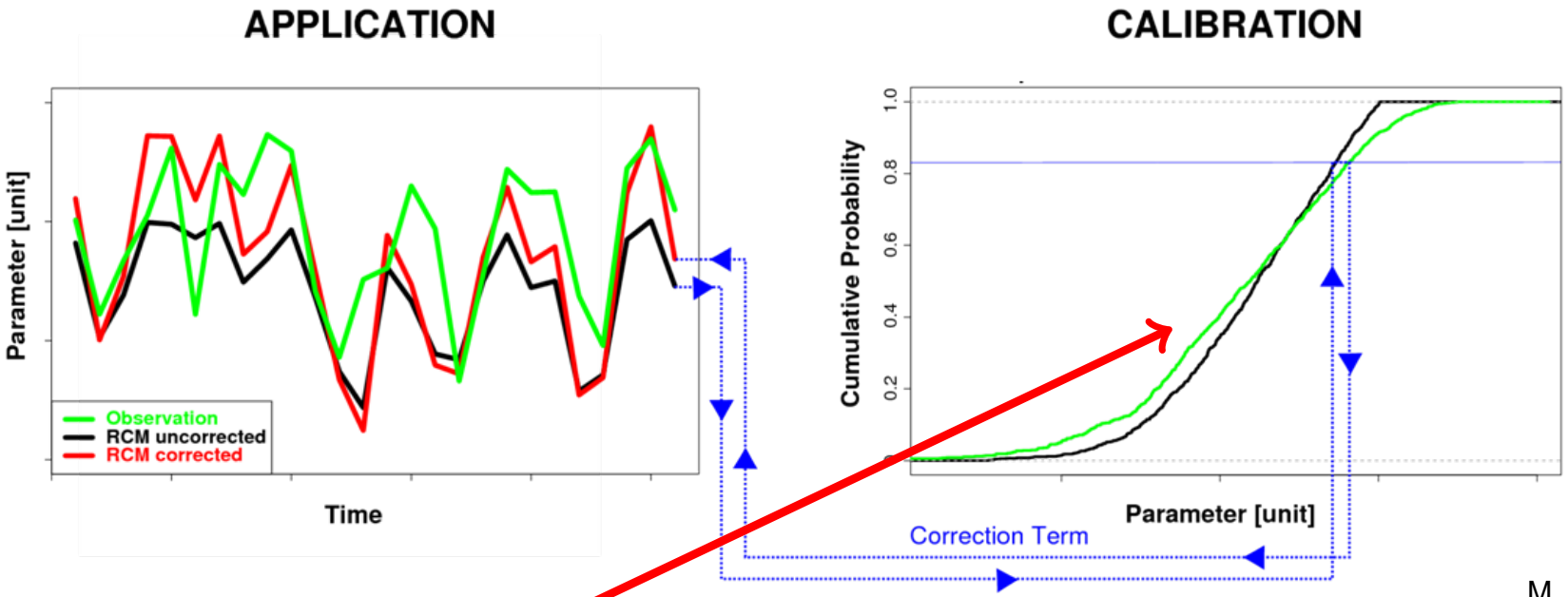
Quantile mapping



M. J. Themeßl

- Daily time-series

Quantile mapping



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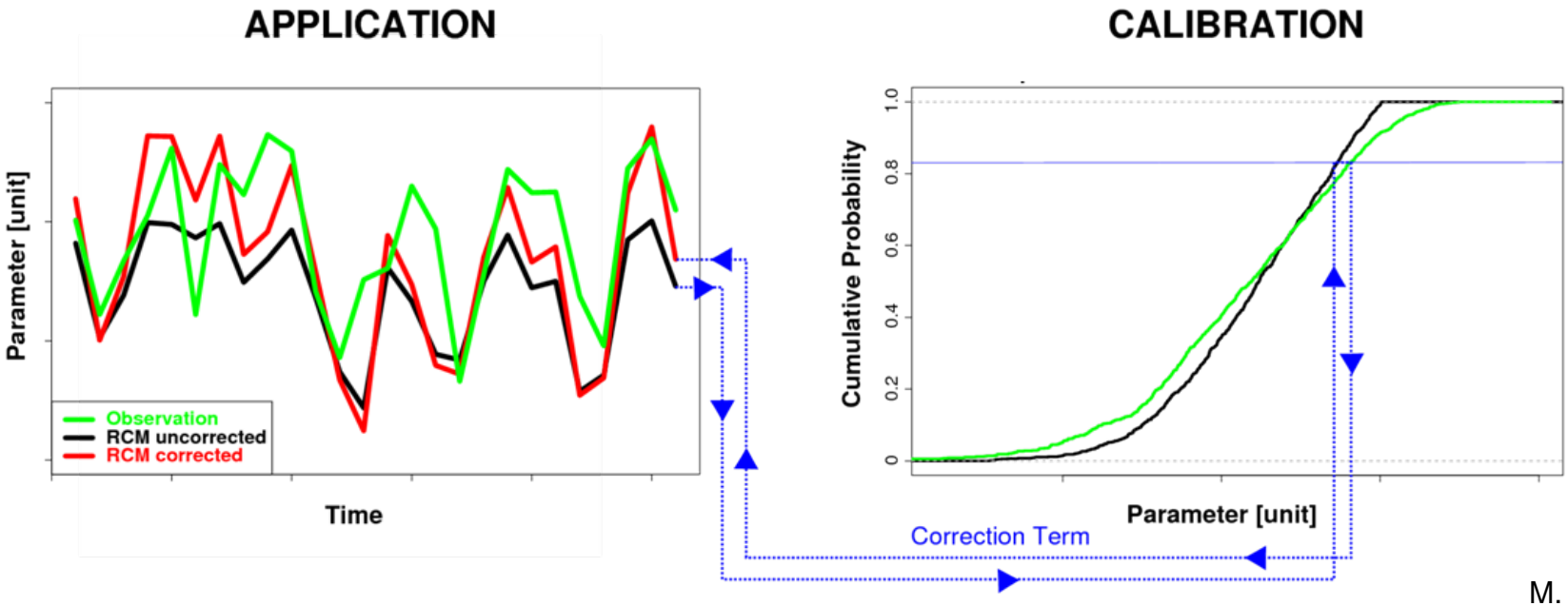
- Daily time-series
- Daily ecdfs considering time-series annual cycle $\rightarrow$ treating each day separately

Quantile mapping



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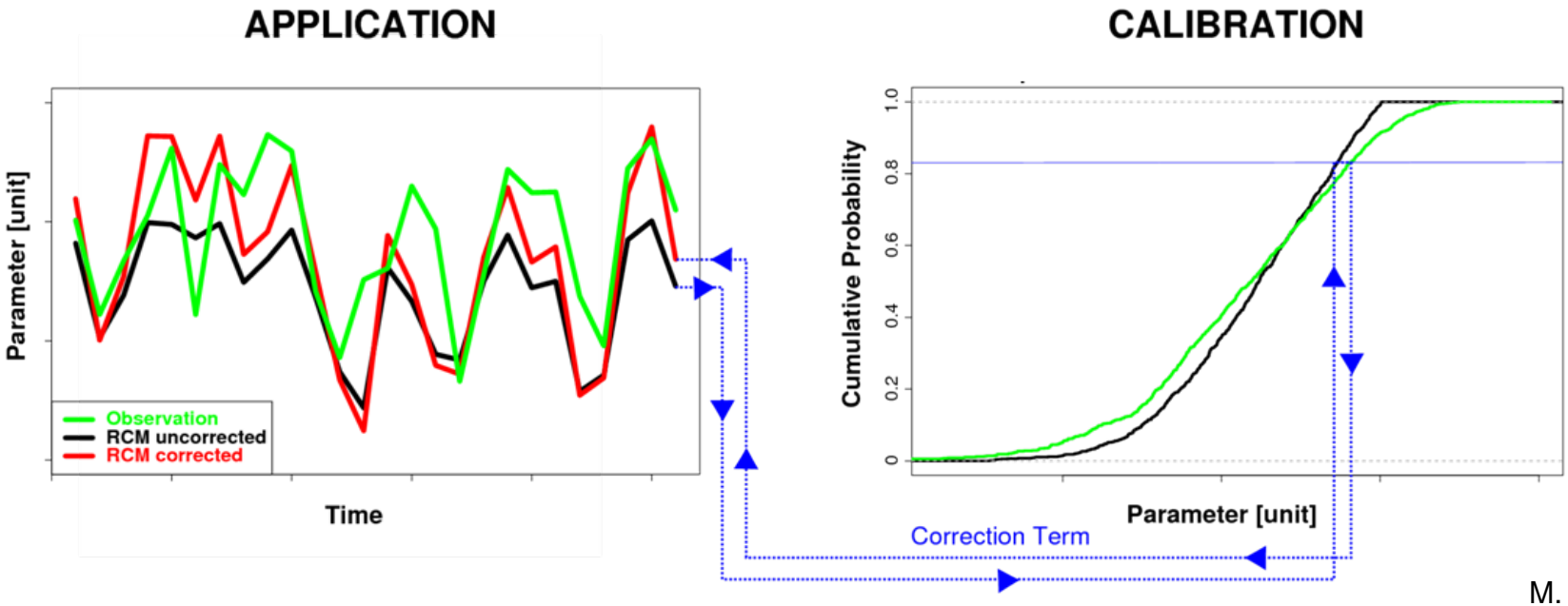
- Including moving window (1 day $\pm$ 15 days) considering seasonal variability

Quantile mapping



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- Daily time-series
- Daily ecdfs considering time-series annual cycle $\rightarrow$ treating each day separately
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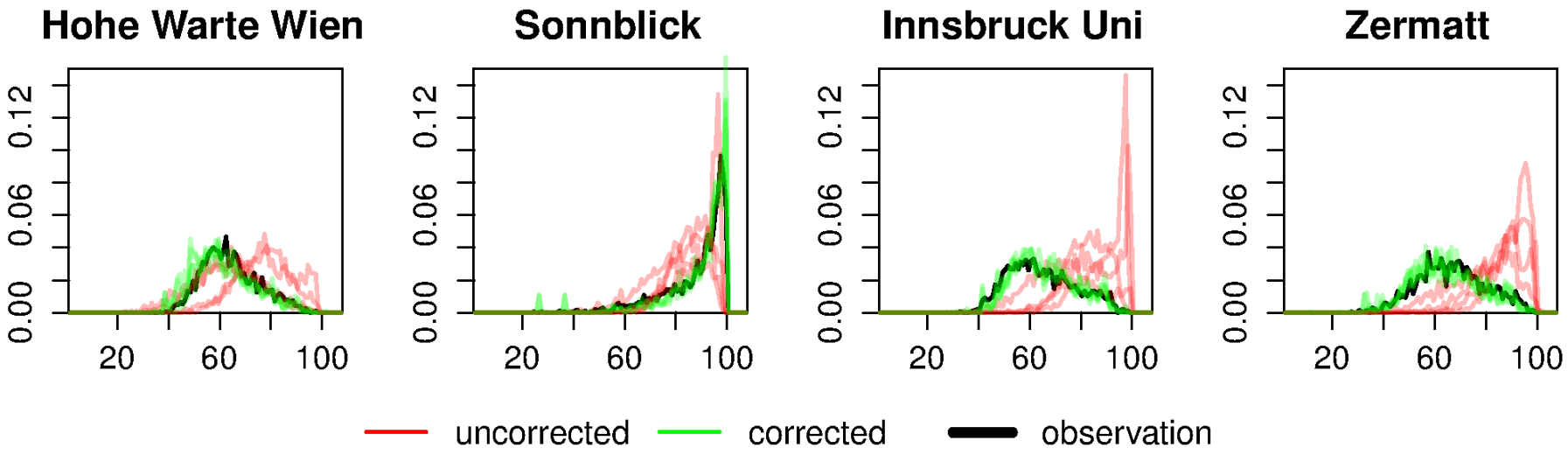
- Point scale (observation stations, grid points)

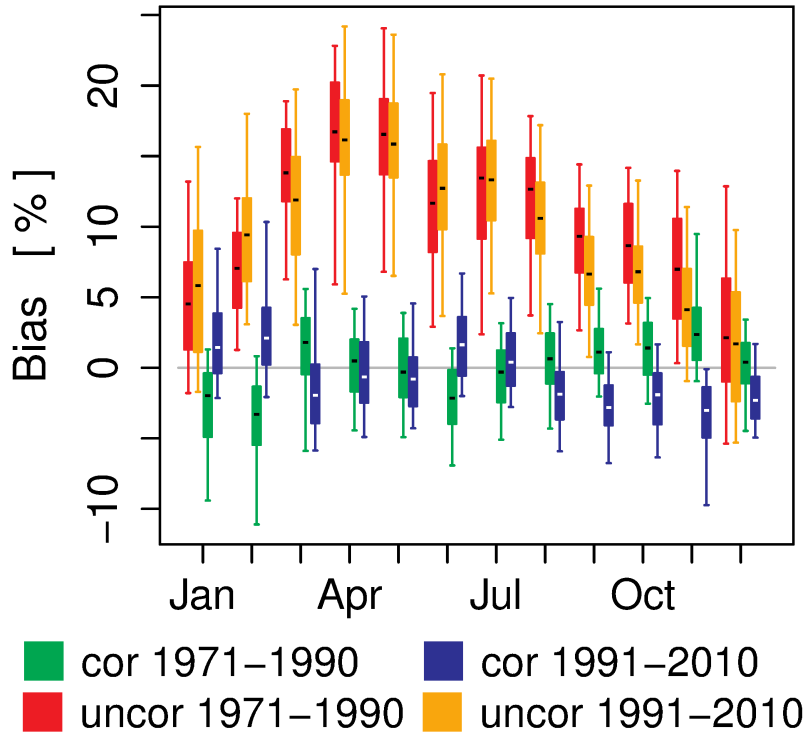
Distribution – example: relative humidity (JJA)



- Multi-model GCM driven
- Calibration: 1971 – 1990 application: 1991 – 2010
- Mapping of distribution works as designed
- (But: Should an RCM be used which cannot represent observed distributions?)

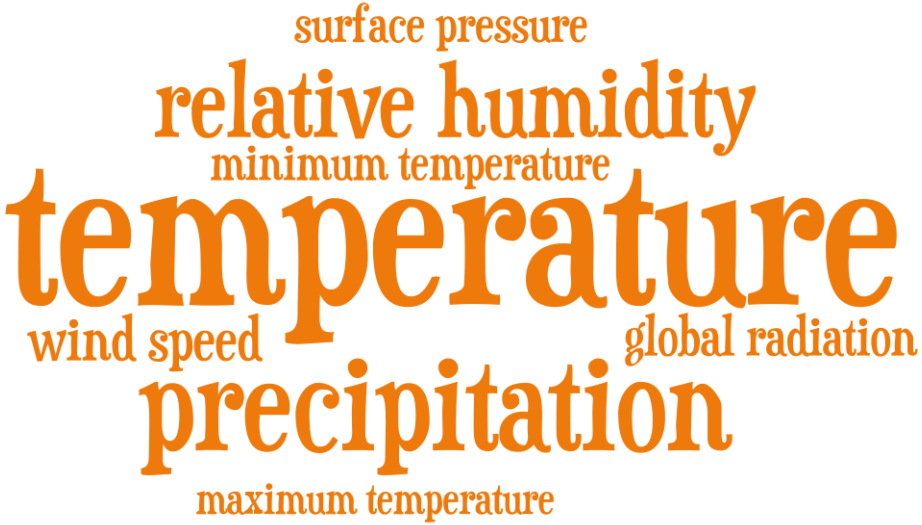
Mean bias – relative humidity

- Mean monthly bias
- Correction independent of annual cycle
- Non-stationarity of bias influences correction
- Assumption for all statistical methods is stationarity of bias



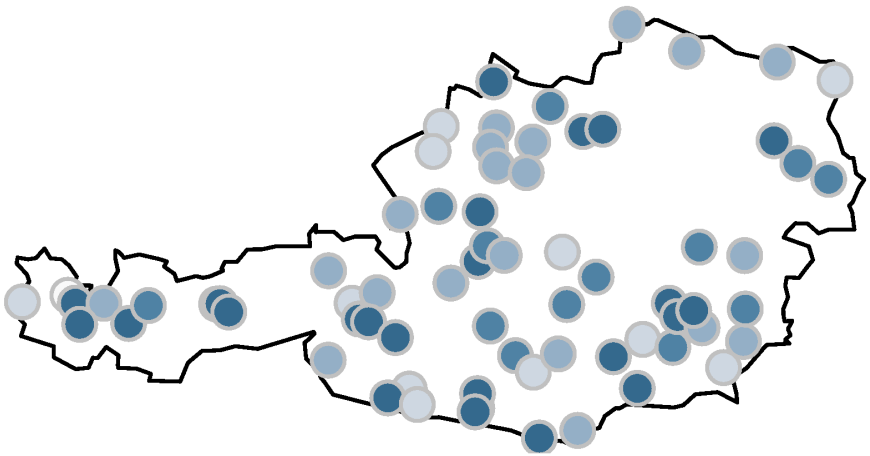
Variables

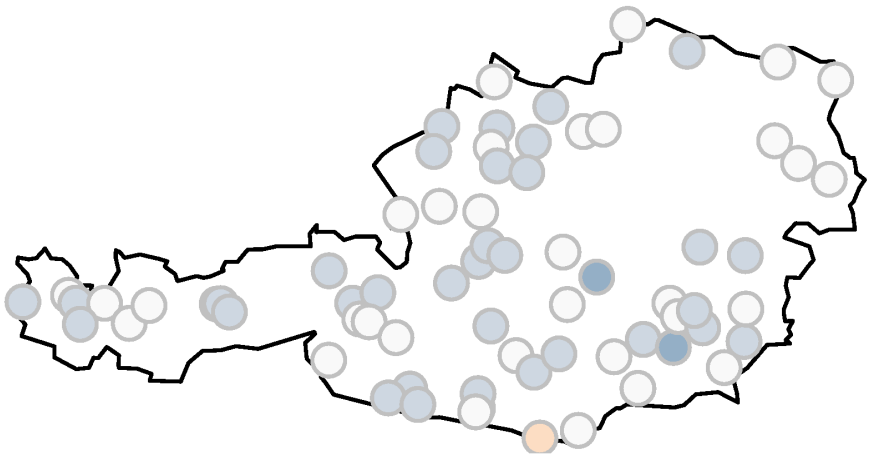
- Quantile mapping can be applied to various climate variables
- Approved down to daily resolution
- Subdaily needs major modifications (or new approach)



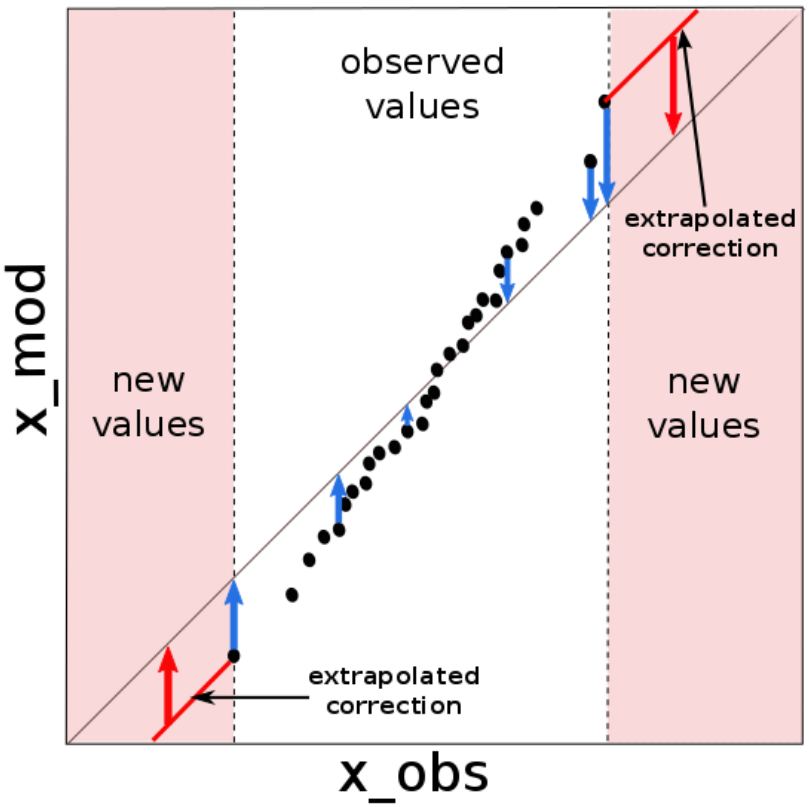
Regions - orography

- Quantile mapping can be applied to various orographies
- Good performance in particular over complex terrain
- Example Austria, with high mountainous (West) and flat (East) regions





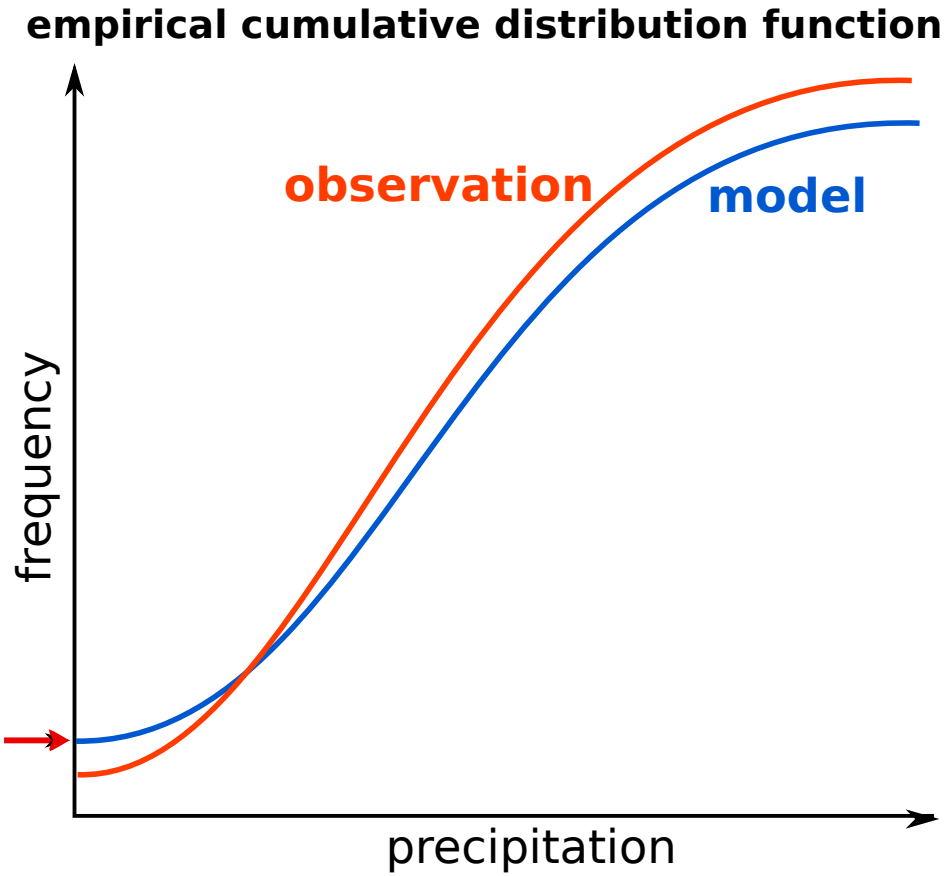
How to handle new extremes



- Simulated extremes outside the observed distribution are corrected
- Correction term is taken from observed extremes
- Assumption: new extremes are biased like old extremes
- Approach is confirmed by a study of Belprat et al. 2013

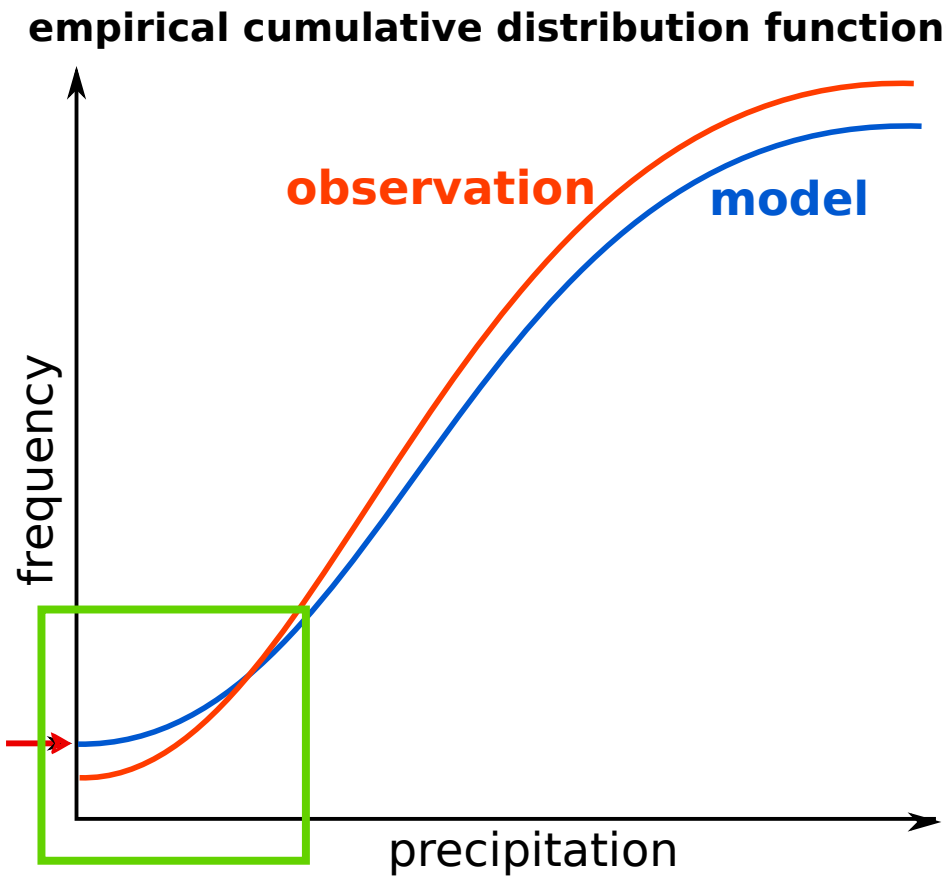
Bellprat, O., Kotlarski, S., Lüthi, D., and Schär, C. (2013). Physical constraints for temperature biases in climate models. *Geophys. Res. Lett.*, 40(15):4042-4047.

Precipitation issues – frequency adaptation



- dry-day frequency of model can be higher than observations
- leads to higher bias after correction, if not taken care of
- only rare cases

precipitation issues – frequency adaptation



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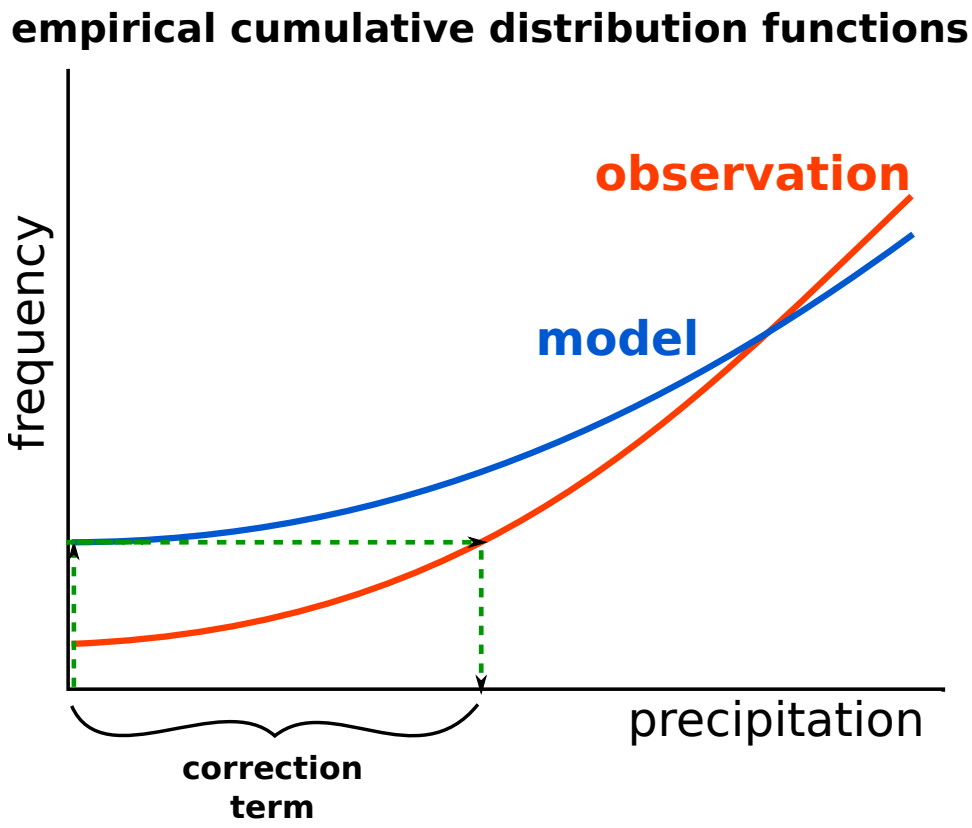

- Model value (dry-days) is mapped to same probability value of ecdf of observation
- $x_{obs}(p_{mod}(x_{mod} = 0)) > 0$
- Solution: adding dry-days randomly on days with $x < 0.1$ mm/h
- Language (IDL) related: bins with width of 0.01 are added between 0 and 0.1

Precipitation issues – drizzeling effect

- Drizzling effect in models (Gutowski et al. 2003)
- Is naturally corrected by quantile mapping

Gutowski, Jr., W. J., Decker, S. G., Donavon, R. A., Pan, Z., Arritt, R. W., and Takle, E. S. (2003). Temporal Spatial Scales of Observed and Simulated Precipitation in Central U.S. Climate. *J. Climate*, 16:3841–3847.

Relative humidity issues – natural limits

- Correction can lead to unrealistic values above 100 %
- Is fixed “hard-coded” by setting values above 100 % to maximal observed value

Maximum and minimum temperature

- it can happen that $\mathrm{tas}_{\mathrm{min}}$ is bigger than $\mathrm{tas}_{\mathrm{max}}$ (variables are corrected independent of each other)
- No solution yet
- *Subdaily problem* as max or min values are instant values compared to daily means $\rightarrow$ needs subdaily approach
- *Inter-variable dependency problem* as $\mathrm{tas}_{\mathrm{min}}$ and $\mathrm{tas}_{\mathrm{max}}$ are separate variables with strong relation $\rightarrow$ correct for daily temperature range instead?
- Ongoing work in various groups

More details can be found here:

- Wilcke, Renate A. I., Mendlik, Thomas and Gobiet, Andreas. Multi-variable error-correction of regional climate models. 2013 *Climatic Change*, 120 (4).
- Wilcke, Renate A. I. (2014), Evaluation of Multi-Variable Quantile Mapping on Regional Climate Models, ISBN 978-3-9503608-3-7, Wegener Center Verlag Graz, PhD thesis.