C-band calibration / merging with gauge measurements

Raingain Workshop Leuven 16/04/2012

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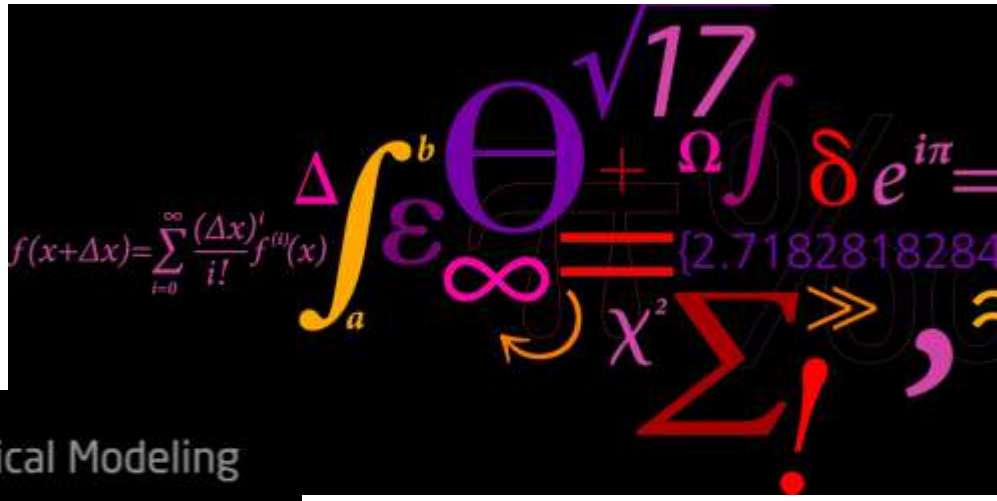
Storm- and Wastewater Informatics



Department of Informatics and Mathematical Modeling

The idea

- Integrate radar and raingauge measurements into one series
- Generate stochastic flow forecasts with the integrated series as input
- Integrated series is not necessarily ‘true rainfall’

Merging Radar and Raingauge

State-space model layout *(as in Grum et al. (2002))*

$$X_t = \begin{bmatrix} \frac{1-\alpha}{8} & \alpha & 1 & \frac{1-\alpha}{8} \\ \frac{8}{8} & & & \frac{8}{8} \\ 1-\alpha & \alpha & & 1-\alpha \\ \frac{1-\alpha}{8} & \alpha & 1 & \frac{1-\alpha}{8} \end{bmatrix} X_{t-1} + v_t$$

[redacted]

$$\begin{vmatrix} Y_{Radar11} \\ \vdots \\ I_{Radar89} \end{vmatrix} = \begin{vmatrix} 1 & & 0 \\ & \ddots & \\ 0 & & 1 \\ \vdots & & \vdots \\ 0 \cdots & 1 & \cdots 0 \end{vmatrix} \begin{vmatrix} X_{11} \\ \vdots \end{vmatrix} + \varepsilon_t \qquad \varepsilon \sim N(0, \Sigma)$$

Results

Quality of 95% flow prediction intervals

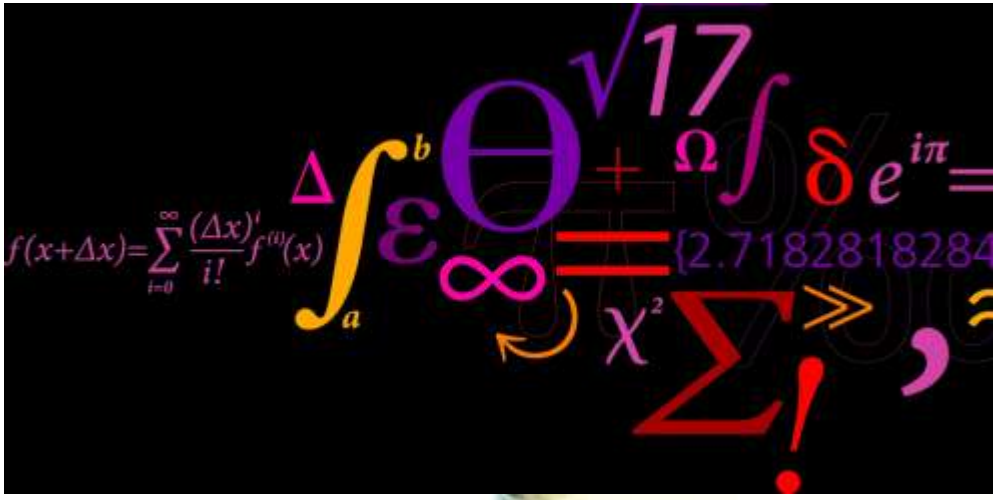
- Rel – reliability, % of observations not included in intervals
- ARIL – interval width relative to observation
- Sk – skill score, combined measure for prediction quality

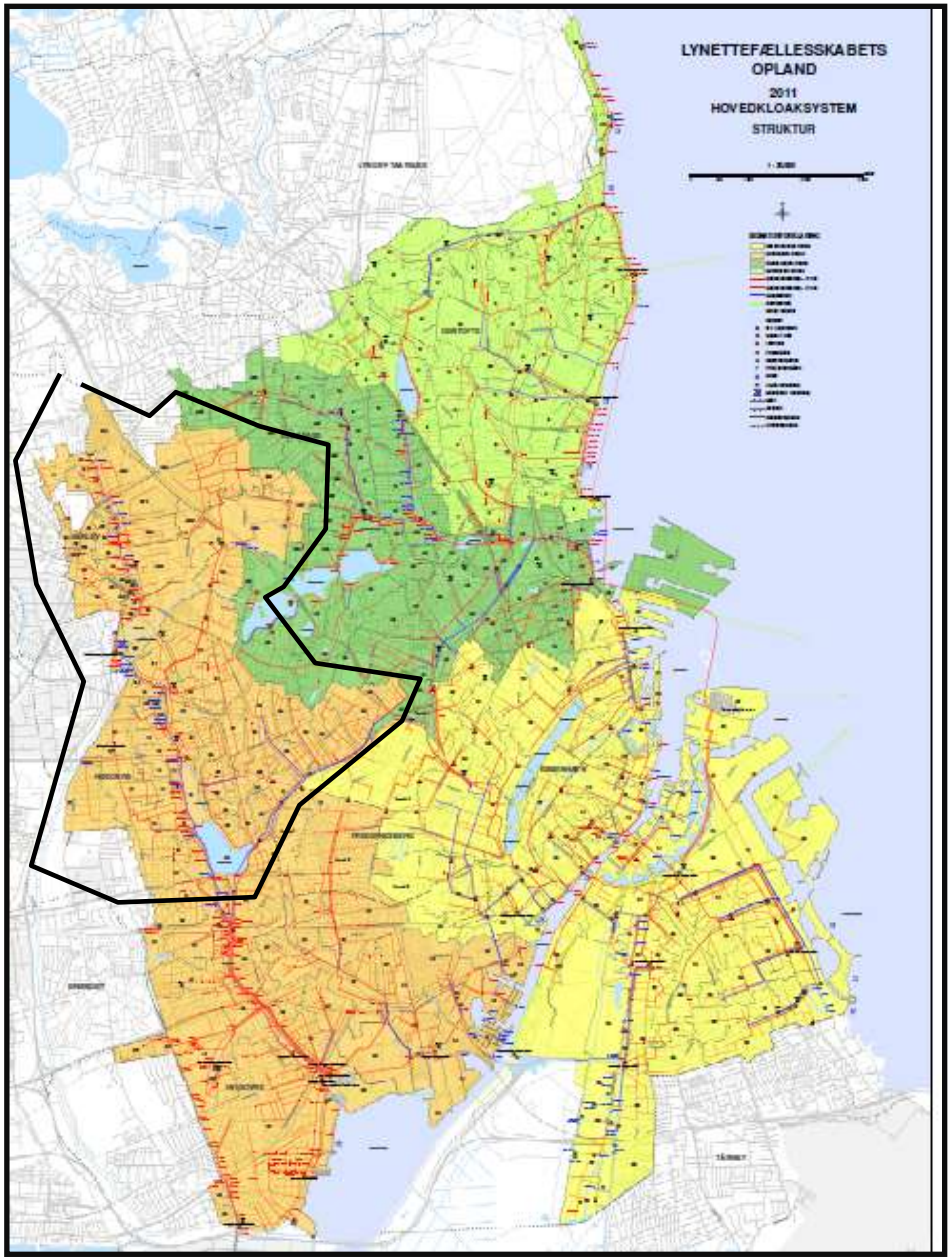
Model Input	Ballerup catchment (1300ha)			Damhusåen catchment (3000ha)		
	Rel	ARIL	Sk	Rel	ARIL	Sk
Rain gauge	5%	65%	1466	4%	116%	11777
Radar uncalibrated	5%	56%	1378	6%	95%	12283
Radar calibrated	5%	56%	1342	6%	90%	10975

Issues / Open Questions

- Performance relative to standard calibrated data (mean field bias)
- Estimating parameters for radar calibration model
  →use flow observations
- Calibrating whole radar matrix
  →Ensemble Kalman Filter or estimation of Kalman Gains

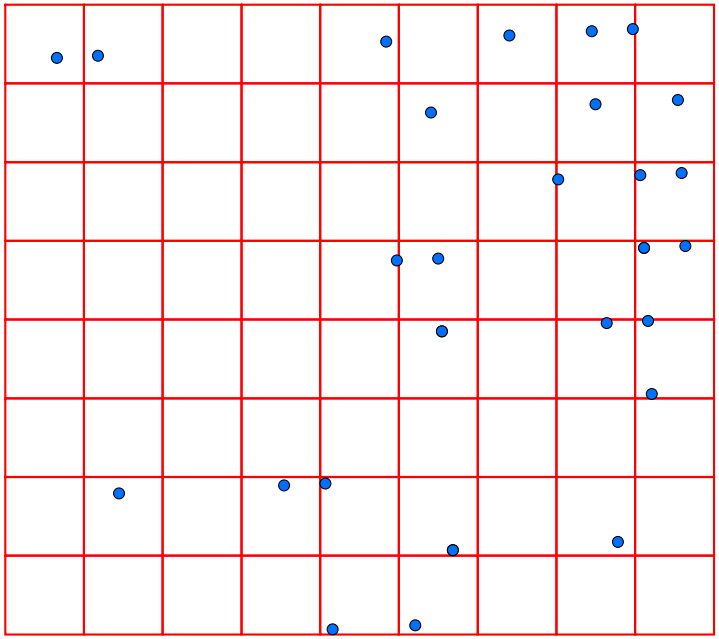
Thank you!


$f(x+\Delta x)=\sum_{i=0}^{\infty}\frac{(\Delta x)^i}{i!}f^{(i)}(x)$
$\int_a^b$
$\sqrt{17}$
$e^{i\pi}$
{2.7182818284


LYNETTEFÆLLESSKABETS
OPLAND
2011
HOVEDKLOAKSYSTEM
STRUKTUR

Dynamic radar calibration

Calibration area

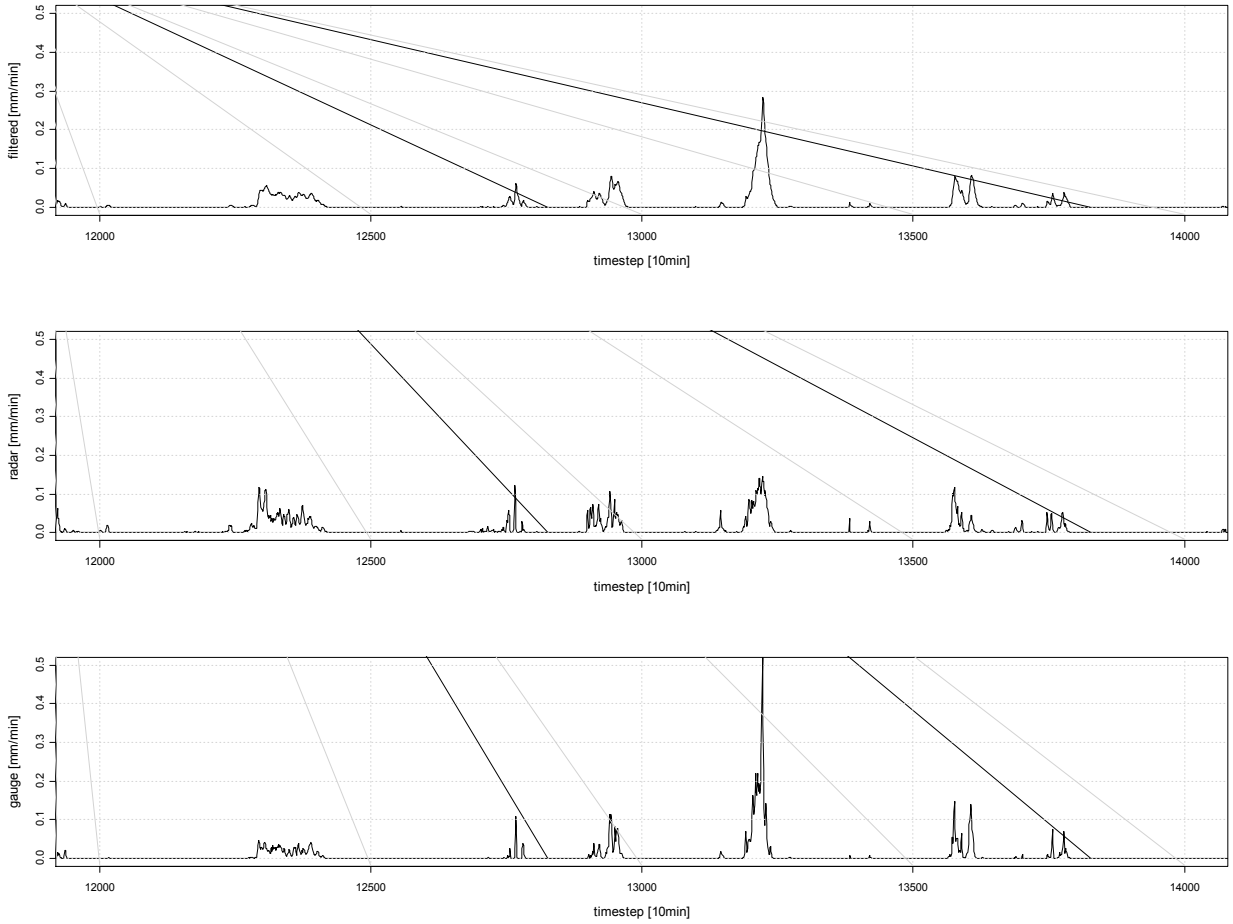


8x9 Pixels results in state vector with 72 elements

$$X_t = \begin{vmatrix} X_{11} \\ \vdots \\ \vdots \\ \vdots \\ X_{19} \end{vmatrix}$$

Dynamic radar calibration

Reconstructed Rainfall



Parameters

weighting

$\alpha = 0.20$

variances

$\sigma_{States}^2 = \exp(-8.73)$

$\sigma_{Radar}^2 = \exp(-7.58)$

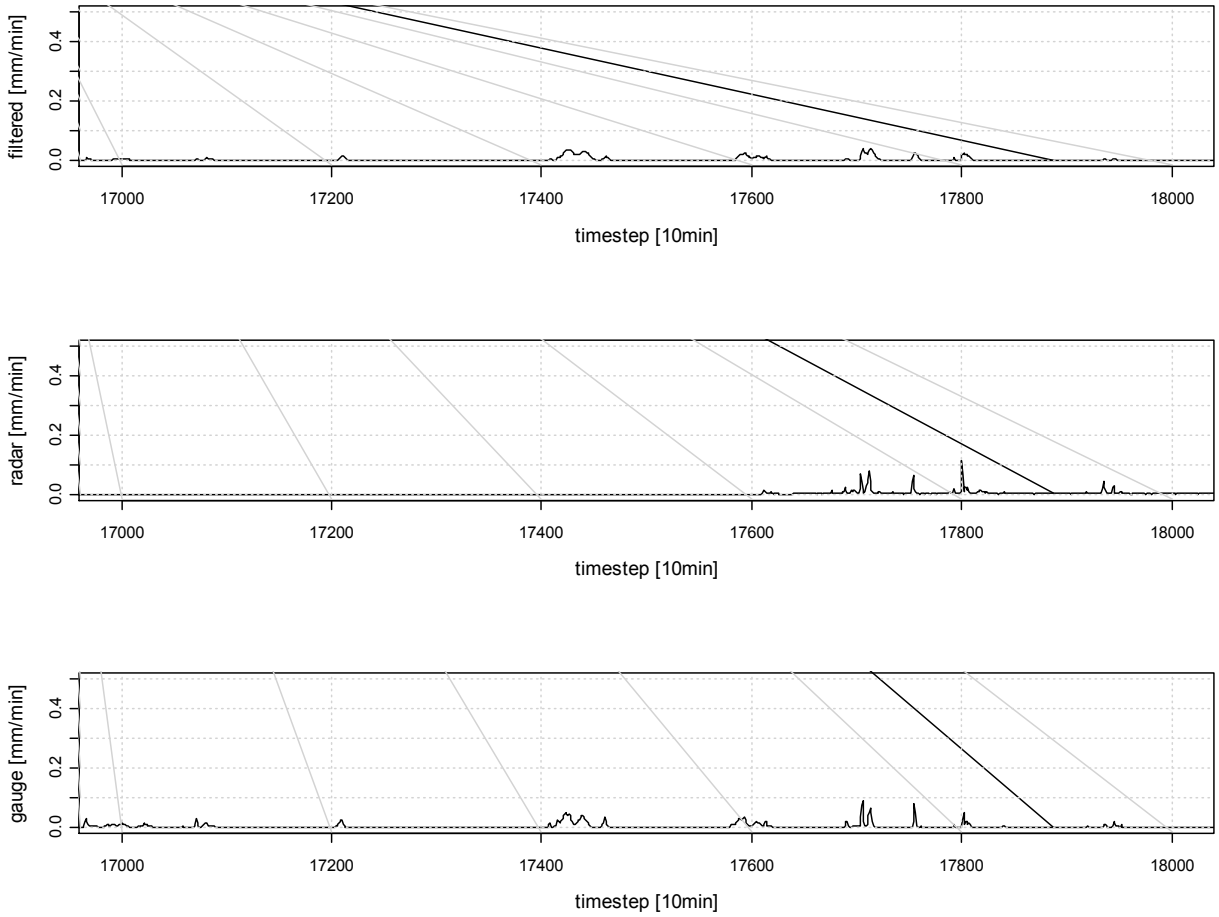
$\sigma_{Gauge}^2 = \exp(-7.33)$

correlation radar pixel

$\rho = 0.73 \cdot dist^{-0.53}$

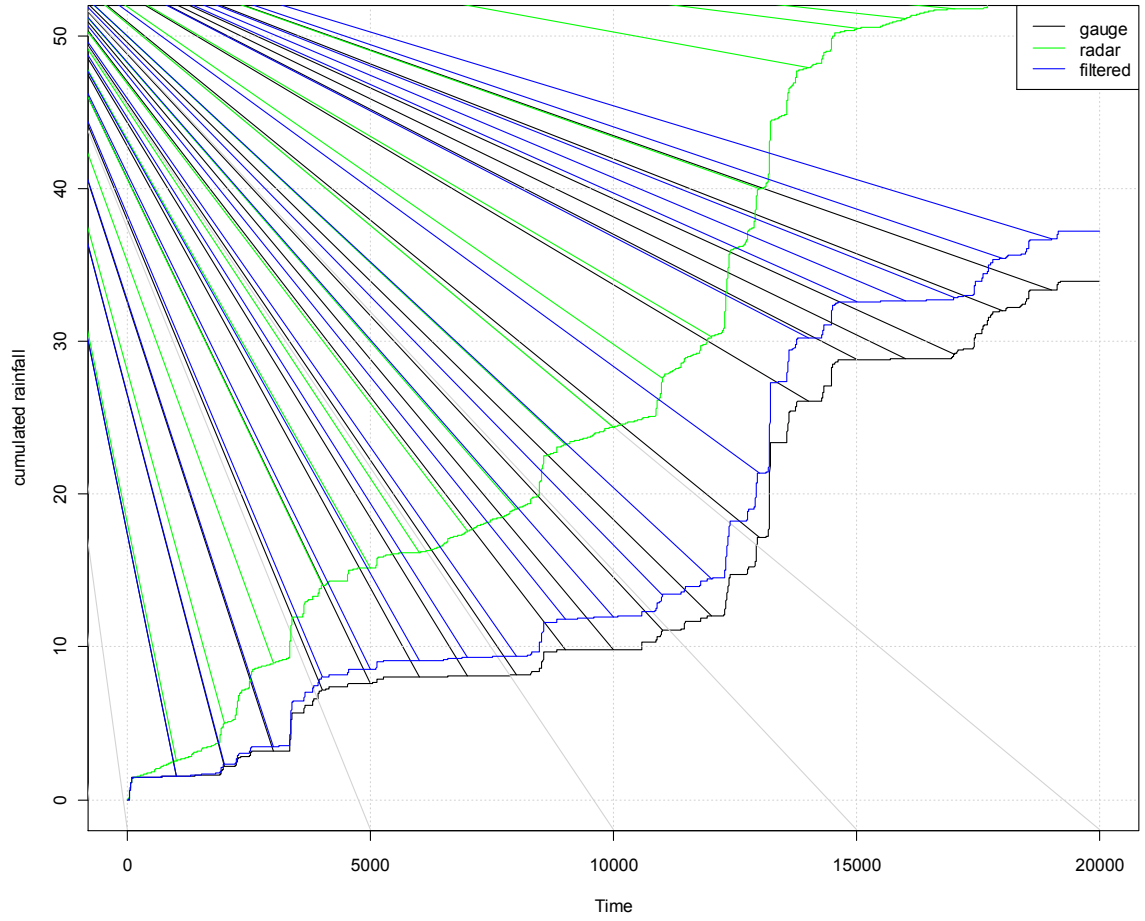
Dynamic radar calibration

Reconstructed Rainfall – Missing Observations



Dynamic radar calibration

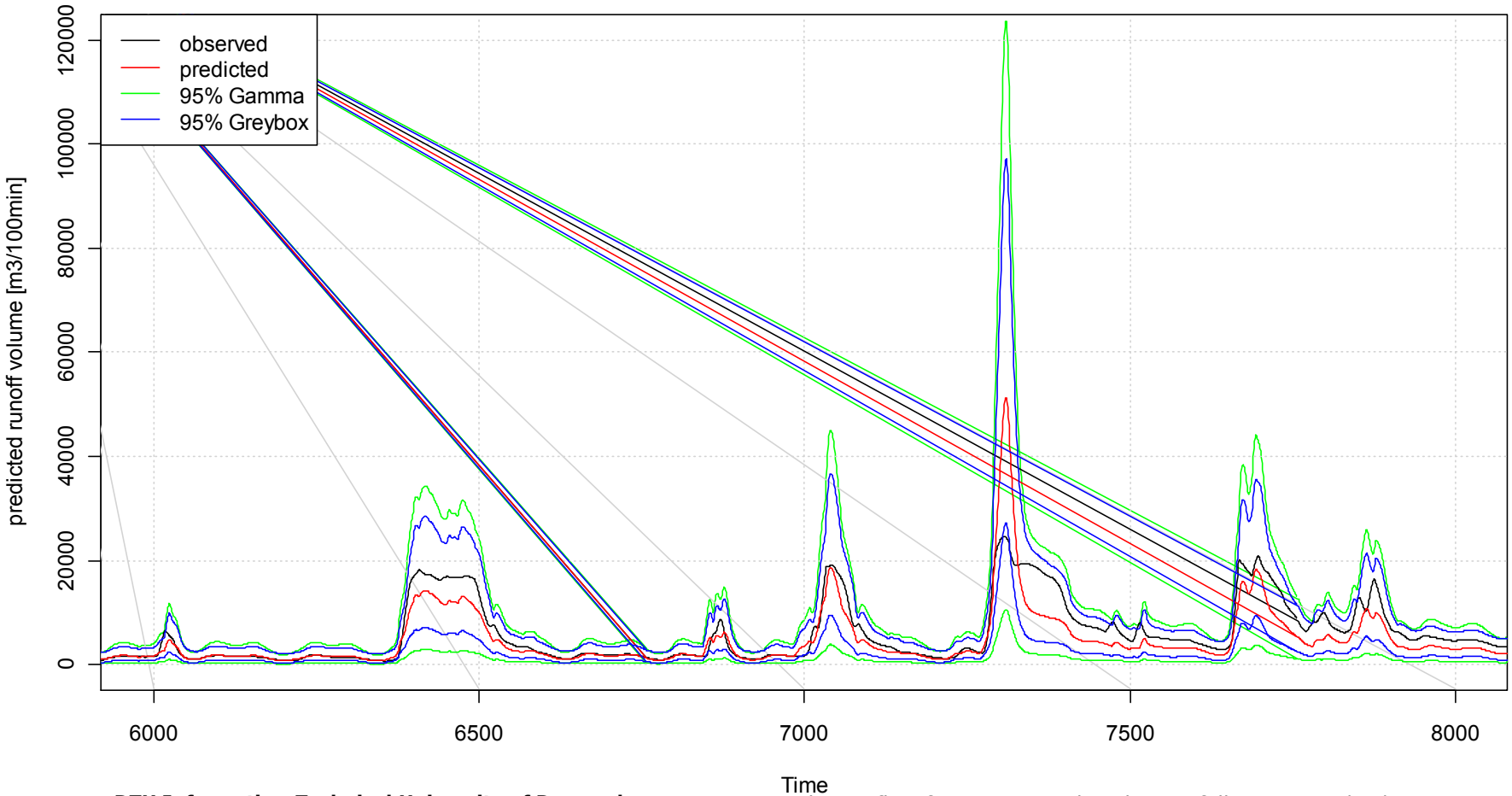
Reconstructed Rainfall – Cumulated Series



$$Sk = Sh + \frac{2}{0.05 \cdot N} \sum_i (U_i + L_i)$$

Results Volume Forecasts

Gamma distribution (DORA) vs. Greybox - Damhusåen



Results Volume Forecasts

Gamma distribution (DORA) vs. Greybox - Ballerup