Workshop on
“fine-scale rainfall nowcasting”

31 March 2014, Antwerp

Investing in Opportunities
This project has received European Regional Development Funding through INTERREG IV B.
INTERREG IVB

Programme

Block 1: Radar-based rainfall forecasting by national meteo services (integration with numerical weather prediction)

Block 2: Methods for fine-scale rainfall nowcasting (for urban drainage applications)

Block 3: Quantification of uncertainties in rainfall nowcasting (statistical methods and stochastic modeling)

Programme

Block 1: Radar-based rainfall forecasting by national meteo services (integration with numerical weather prediction)

- Maarten Reyniers, RMI Belgium
- Jean-Luc Cheze, MeteoFrance
- Jarmo Koistinen, FMI Finland

Programme

Block 2: Methods for fine-scale rainfall nowcasting (for urban drainage applications)

- UKMO's STEPS system for radar-based rainfall nowcasting and experiences incl. hydrological impact analysis: Clive Pierce, UK Met Office
- Recent experiences with STEPS for Belgium (PLURISK project): Loris Foresti, RMI Belgium
- Radar-based cell tracking and rainfall nowcasting: Lipen Wang, KU Leuven
- Danish experiences with short term nowcasting in urban drainage applications: Søren Thorndahl, Aalborg University

Programme

Block 3: Methods for fine-scale rainfall nowcasting (cont…) + Quantification of uncertainties in rainfall nowcasting (statistical methods and stochastic modeling)

- Probabilistic radar nowcasting for urban runoff nowcasting: Miguel Rico-Ramirez, University of Bristol
- Probabilistic uncertainty estimation in urban runoff nowcasting: David Getreuer Jensen, Aalborg University
- Multifractal predictability and prediction: Daniel Schertzer, ParisTech
- Uncertainty analysis in nowcasting and urban drainage: Patrick Willems, KU Leuven

Uncertainty analysis in nowcasting and urban drainage

Patrick Willems, KU Leuven

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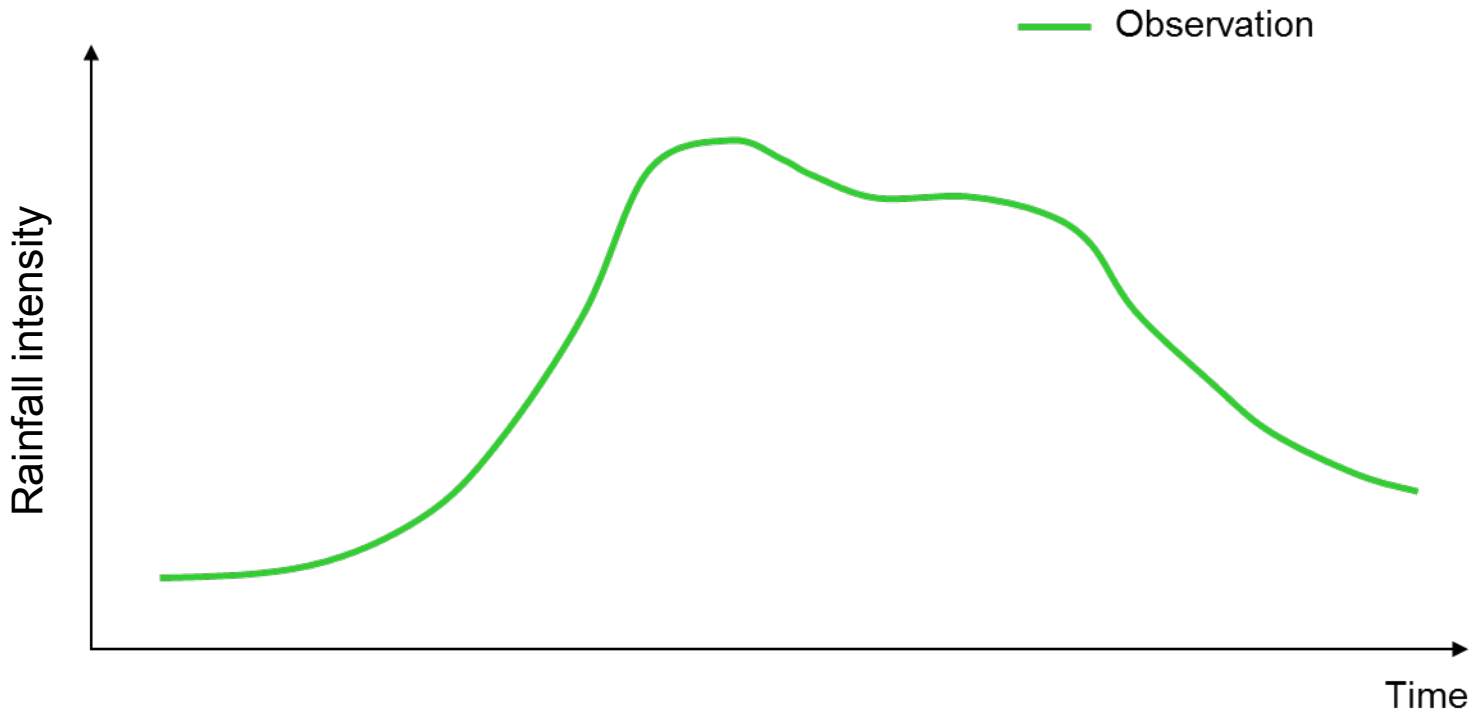
Rainfall forecast uncertainty quantification

- Statistical quantification of total forecast uncertainty
  - Rainfall residuals = $R\downarrow OBS - R\downarrow FOR \,/R\downarrow FOR$
  - Non-parametric data-based approach (NDA) (empirical frequency distribution of rainfall residuals)
  - As function of rainfall intensity, lead time, …
- EPS: Ensemble forecasts
- …

Van Steenbergen, N., Ronsyn, J., Willems, P. (2012), 'Non-parametric data-based approach for probabilistic flood forecasting in support of uncertainty communication', Environmental Modelling & Software, 33, 92-105

Rainfall forecast uncertainty quantification

Statistical non-parametric data-based approach:



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Rainfall forecast uncertainty quantification

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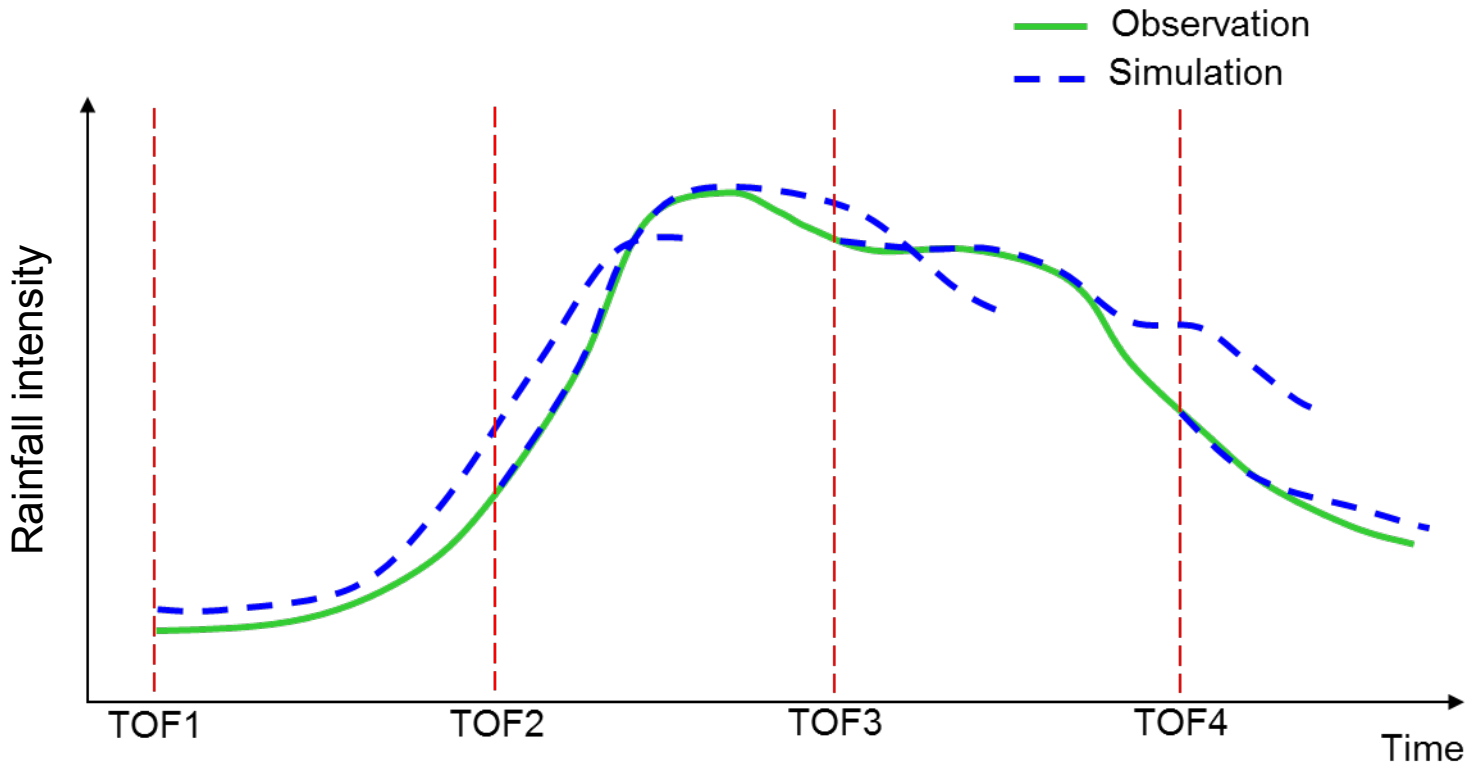

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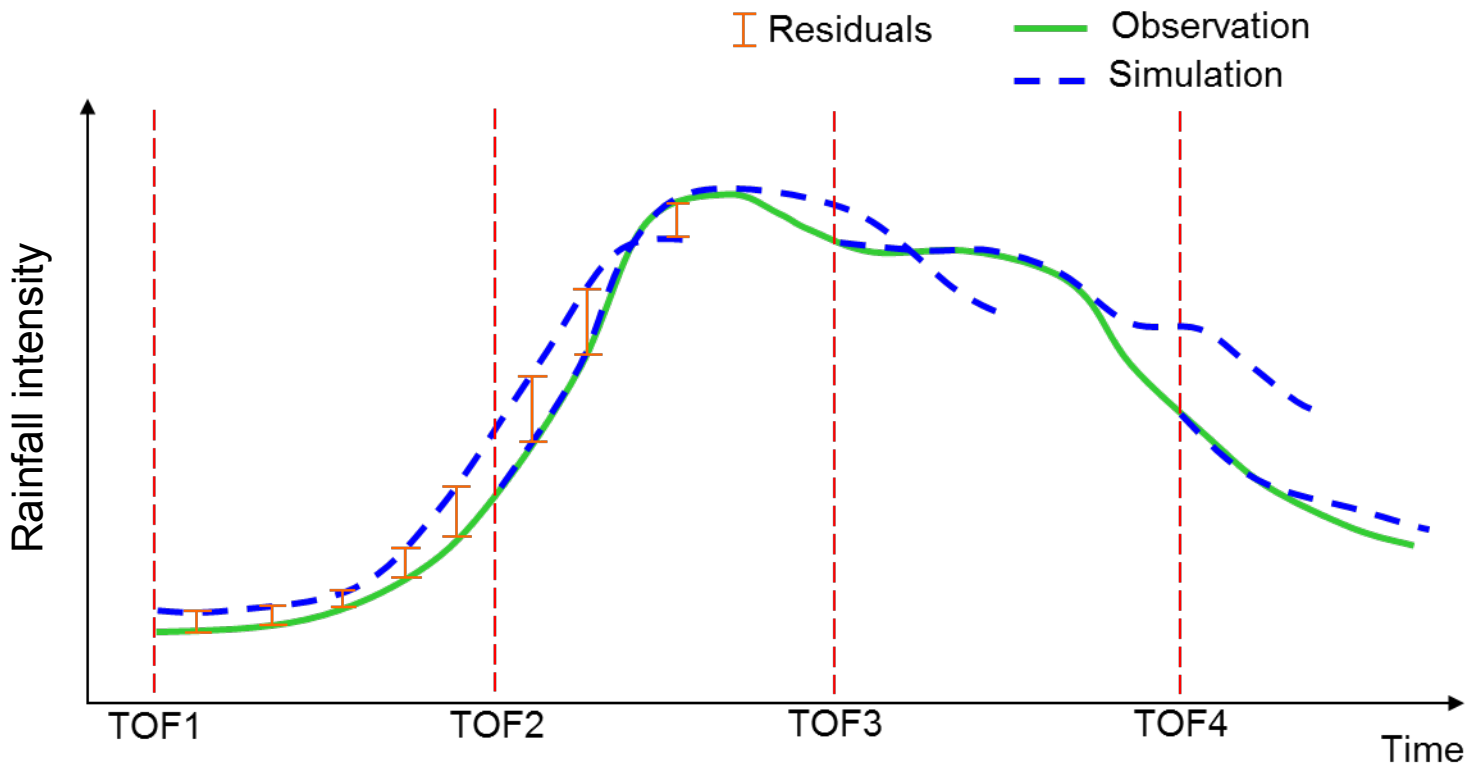

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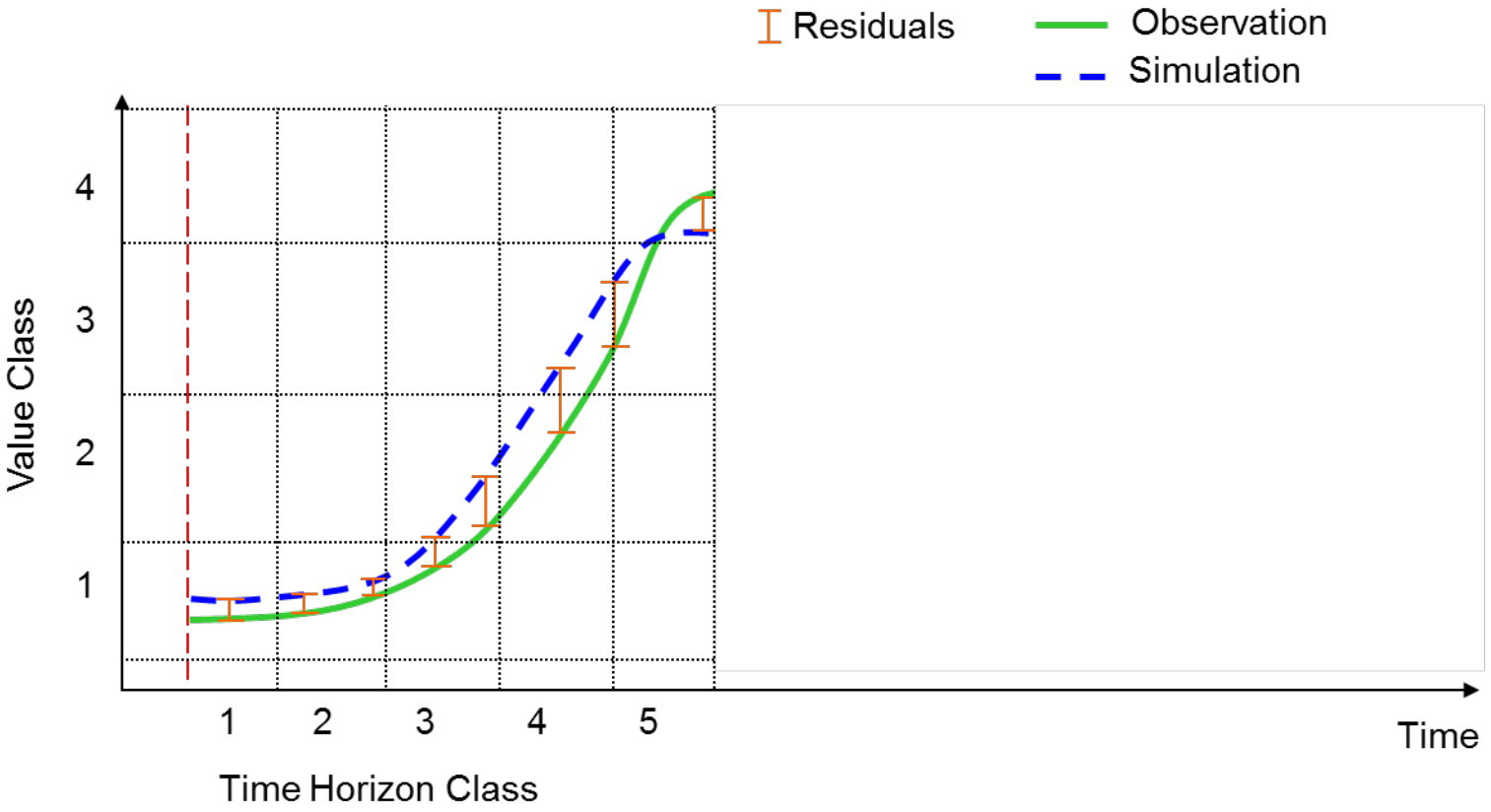

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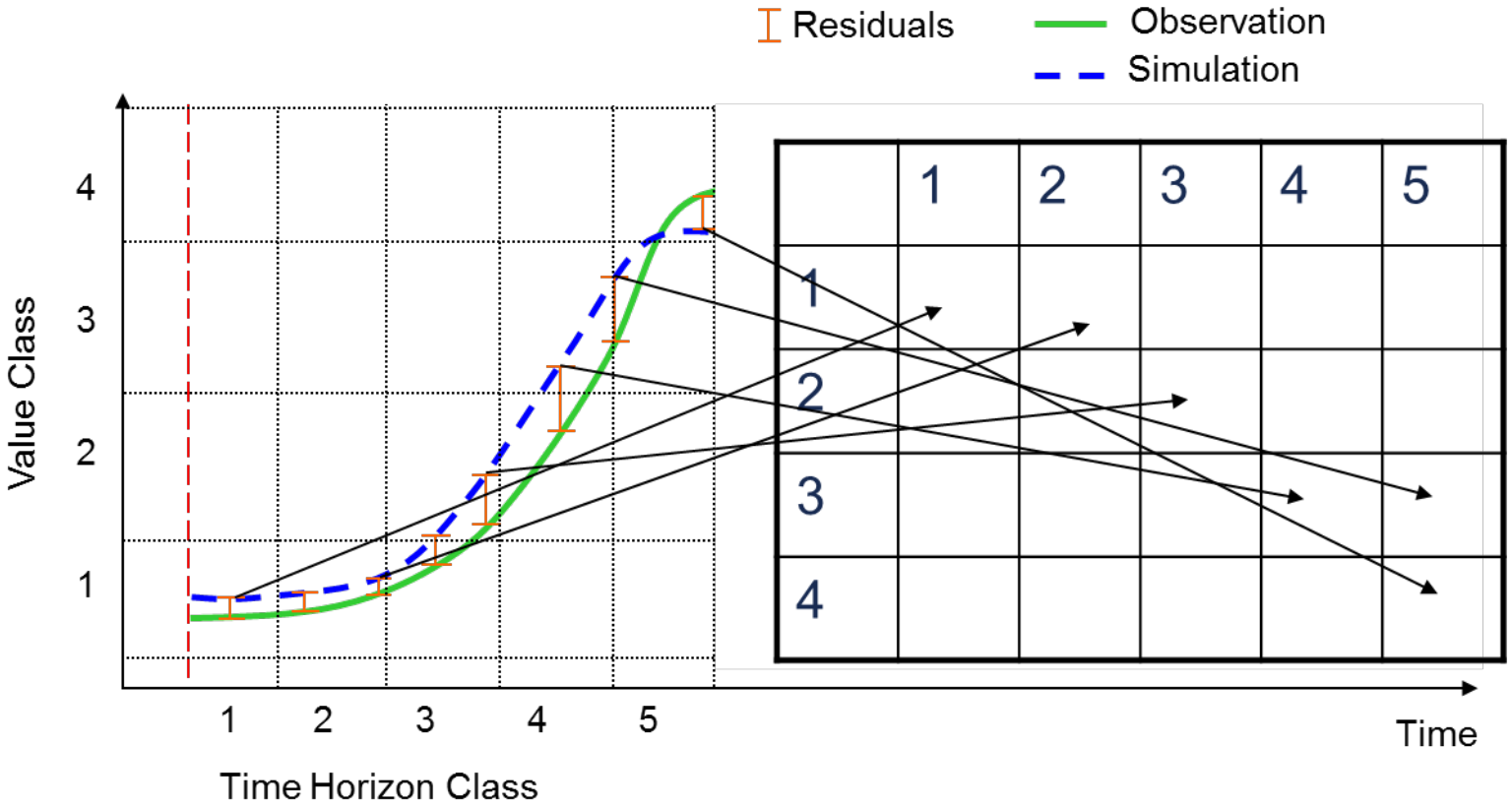

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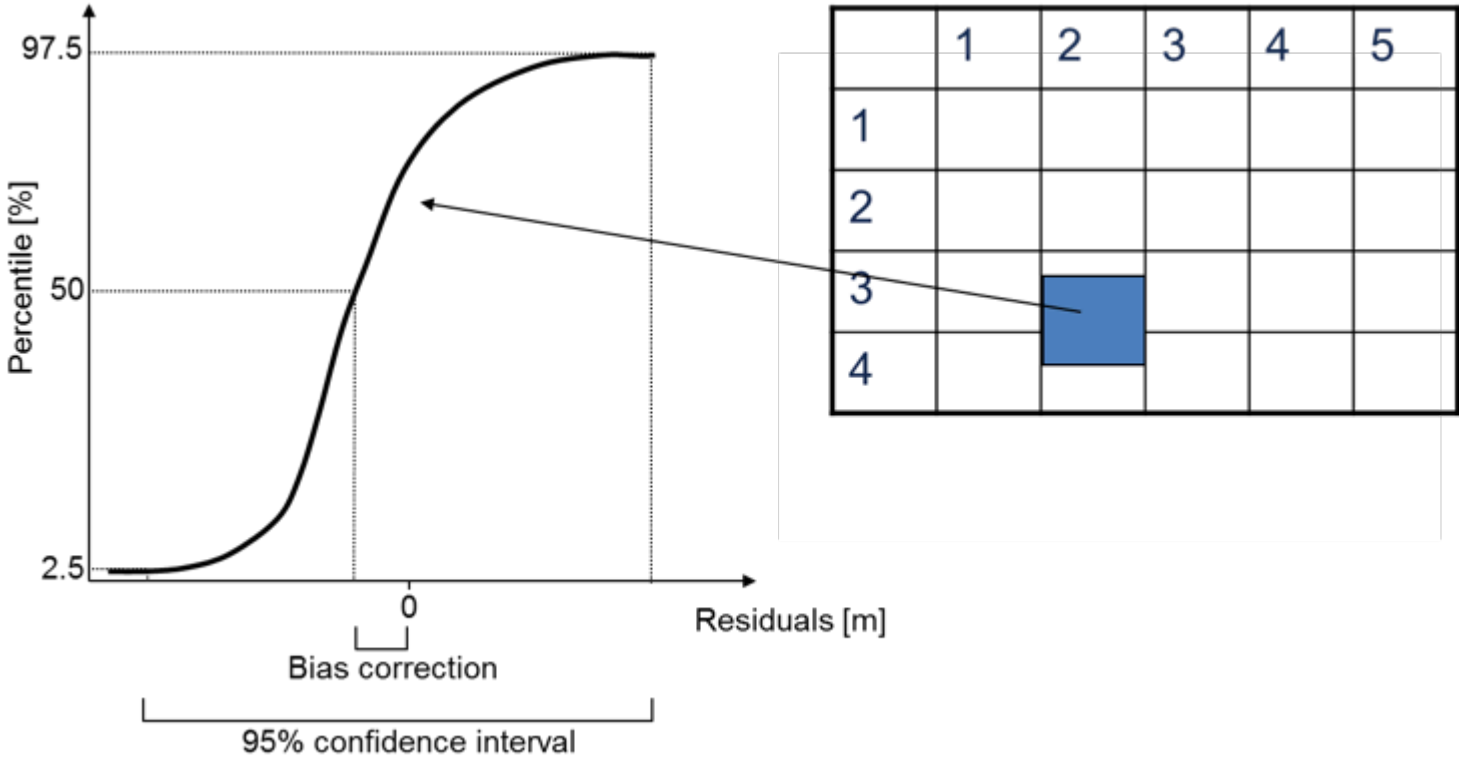

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Rainfall forecast uncertainty quantification

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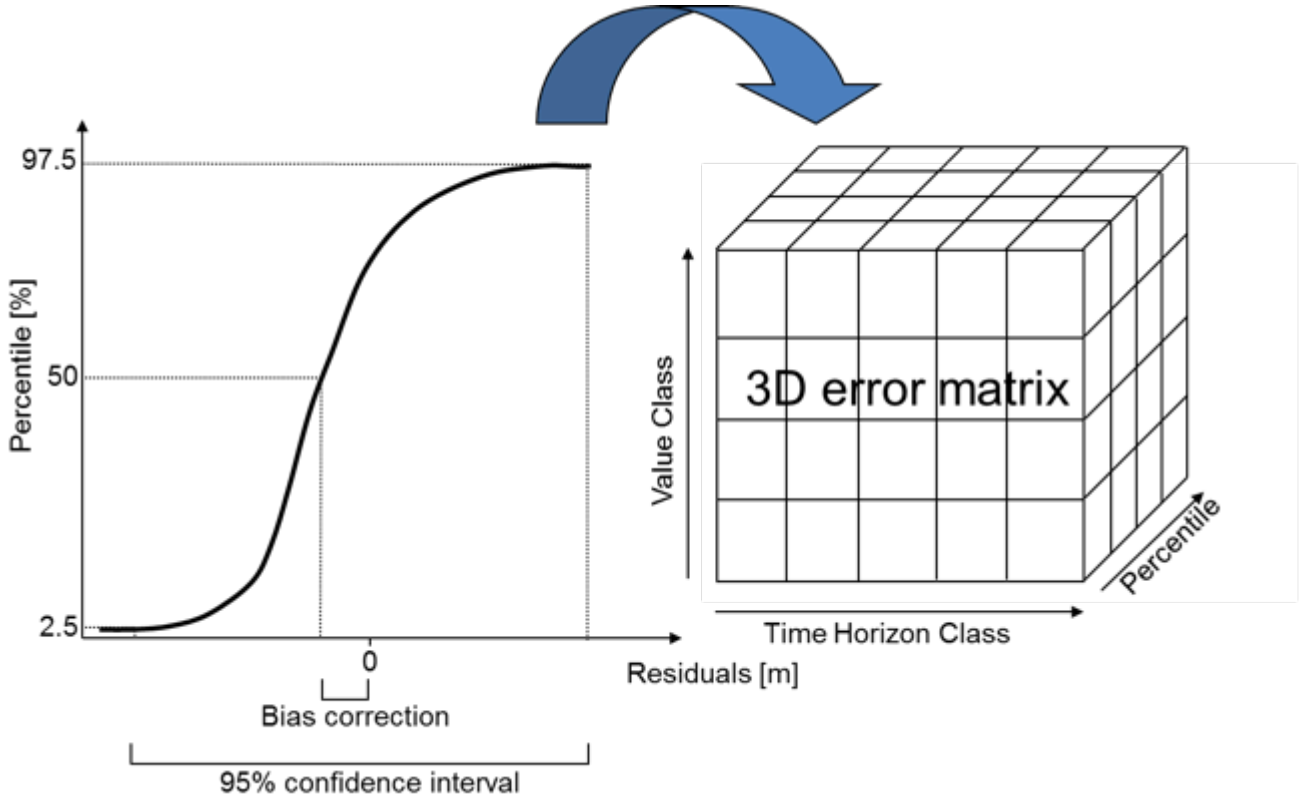

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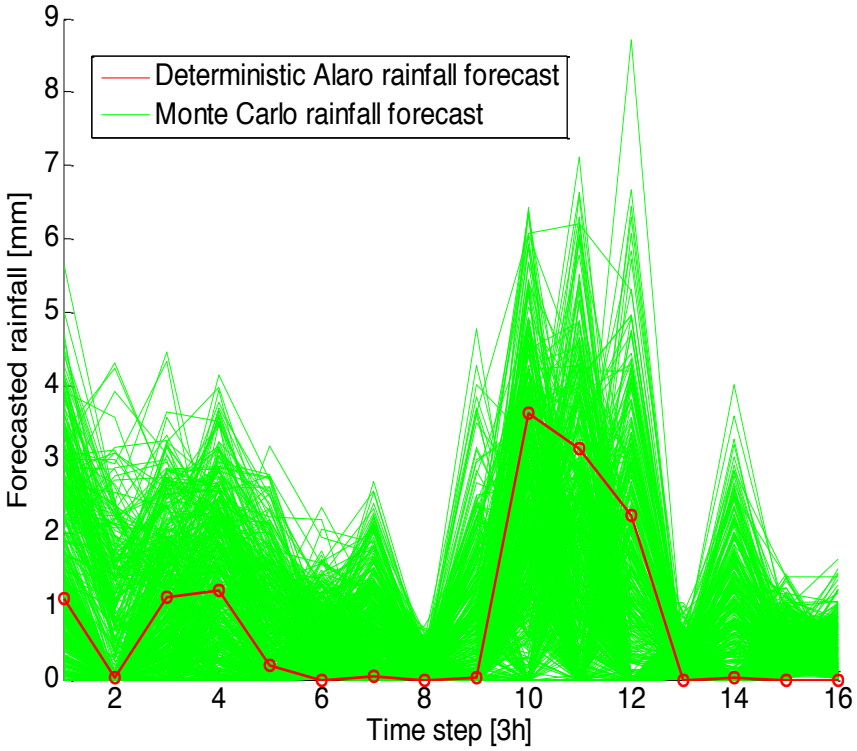
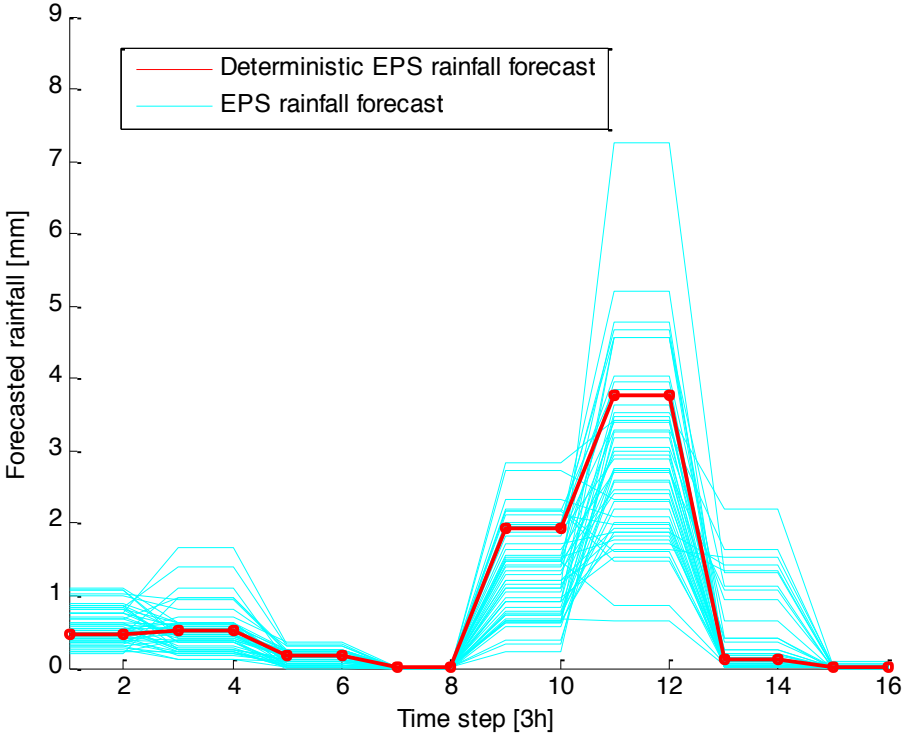
Rainfall forecast uncertainty quantification

Statistical vs. EPS approach:





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Rainfall forecast uncertainty quantification

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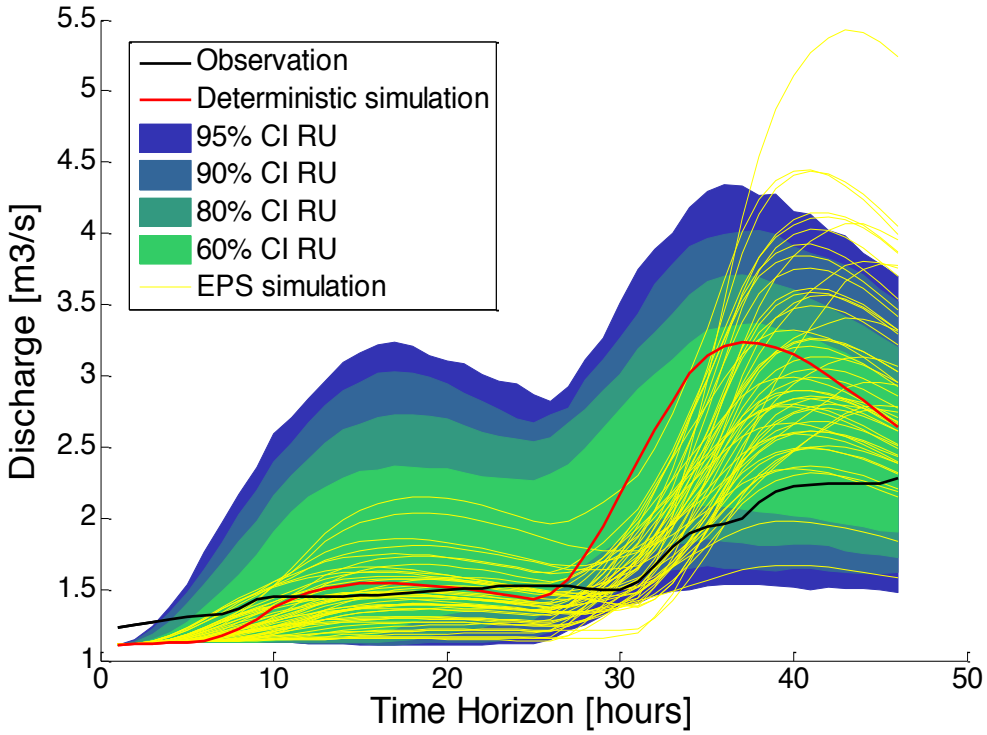


Van Steenbergen, N., Willems, P. (2014), 'Rainfall uncertainty in flood forecasting: Belgian case study of Rivierbeek', ASCE - Journal of Hydrologic Engineering, in press

Flood forecast uncertainty quantification

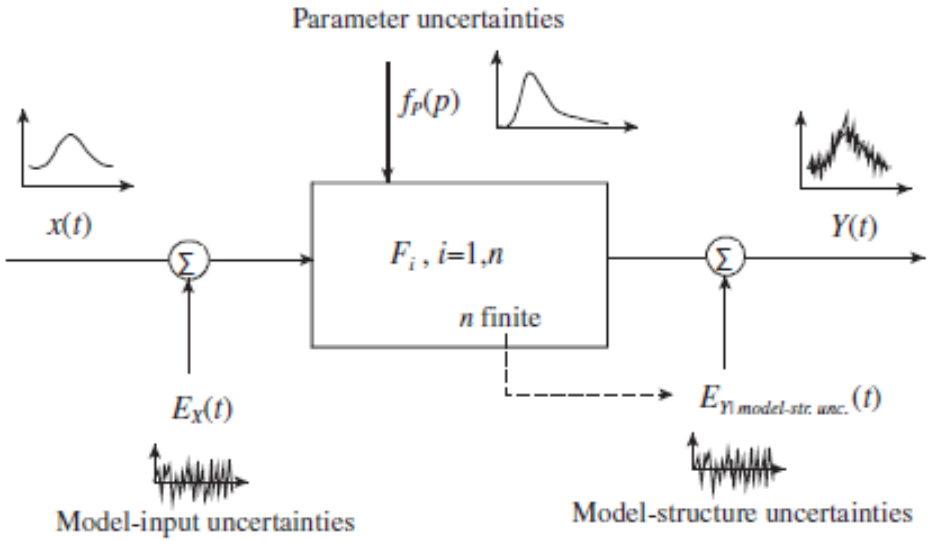
- 3 key uncertainty sources:
  - Model Uncertainty (MU)
  - Rainfall forecast Uncertainty (RU)
  - Initial Conditions Uncertainty (ICU)
- Quantification of total forecast uncertainty
  - NDA
  - Residuals = $Q\downarrow OBS - Q\downarrow FOR \,/ Q\downarrow FOR$
- Quantification of uncertainty on initial conditions
  - Resimulation of historical forecasts with optimal initial conditions based on long term simulation with observed input
- Quantification of model uncertainty
  - Long term historical simulation with observed rainfall

Van Steenbergen, N., Ronsyn, J., Willems, P. (2012), 'Non-parametric data-based approach for probabilistic flood forecasting in support of uncertainty communication', Environmental Modelling & Software, 33, 92-105

Flood forecast uncertainty quantification

Uncertainty decomposition

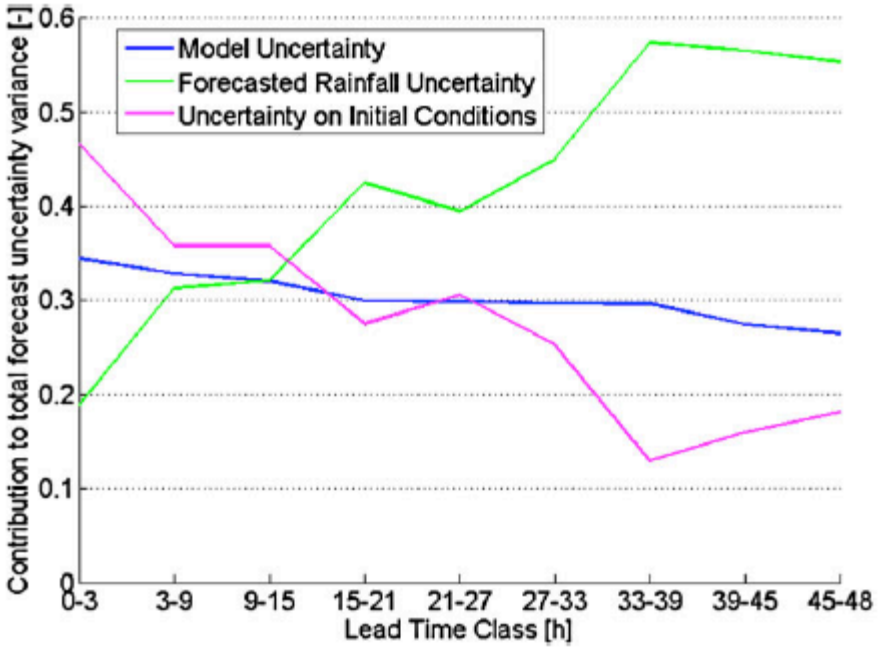
$$S^2_{E_{Y-Y_o}} = S^2_{E_{Y_o}} + S^2_{E_{Y|inputs\ X}} + S^2_{E_{Y|model\text{-}str.unc.}} + S^2_{E_{Y|parameters\ P}} + \ldots$$

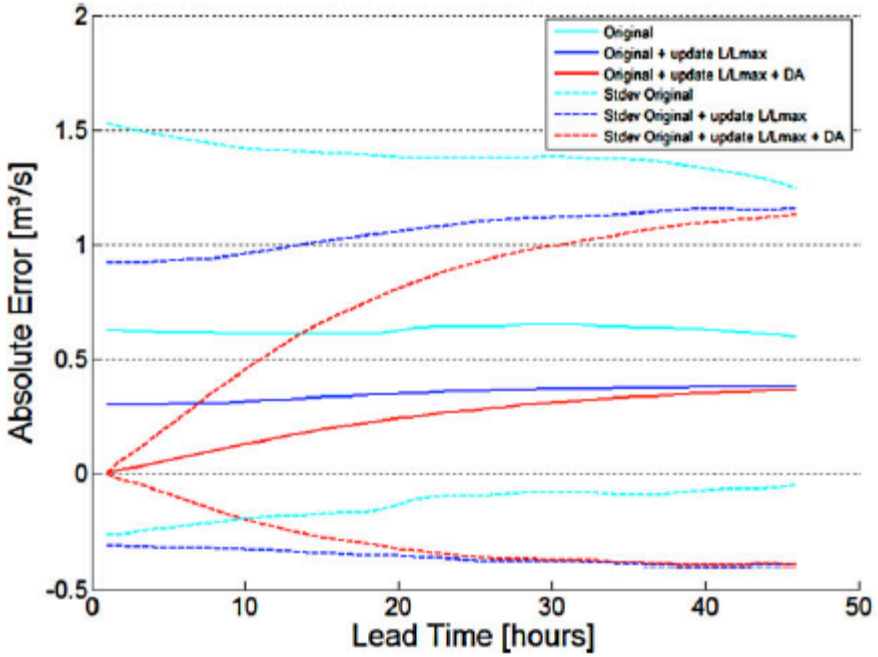


Willems, P. (2012), 'Model uncertainty analysis by variance decomposition', Physics and Chemistry of the Earth, 42-44, 21-30

Flood forecast uncertainty quantification

Uncertainty decomposition





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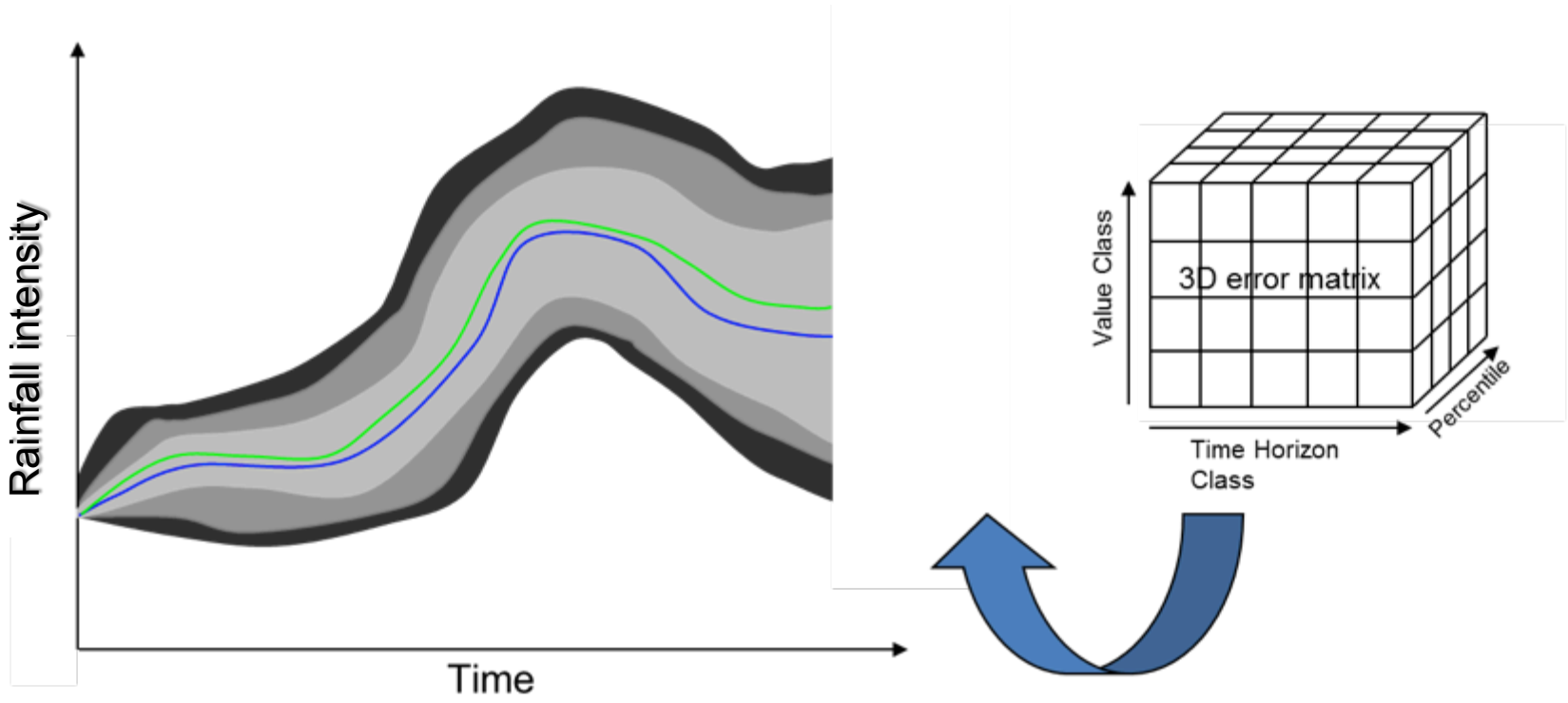
Flood forecast uncertainty quantification



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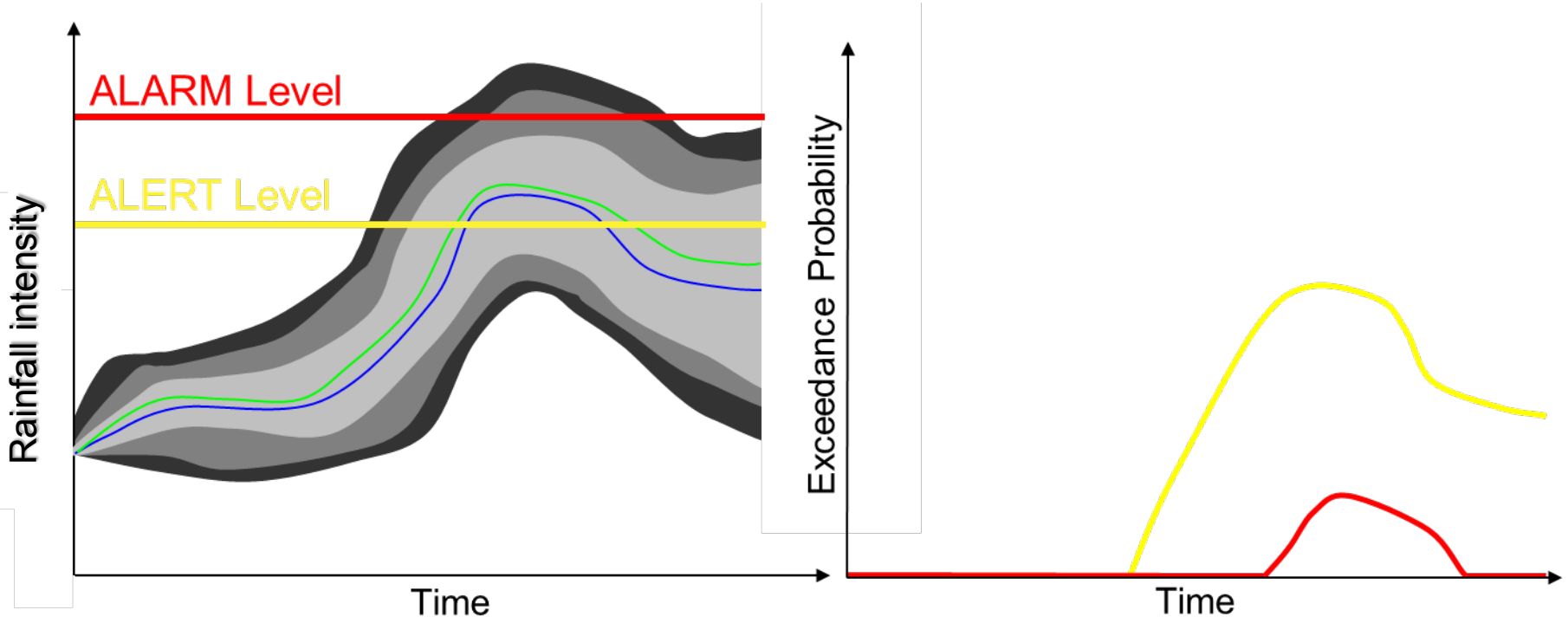

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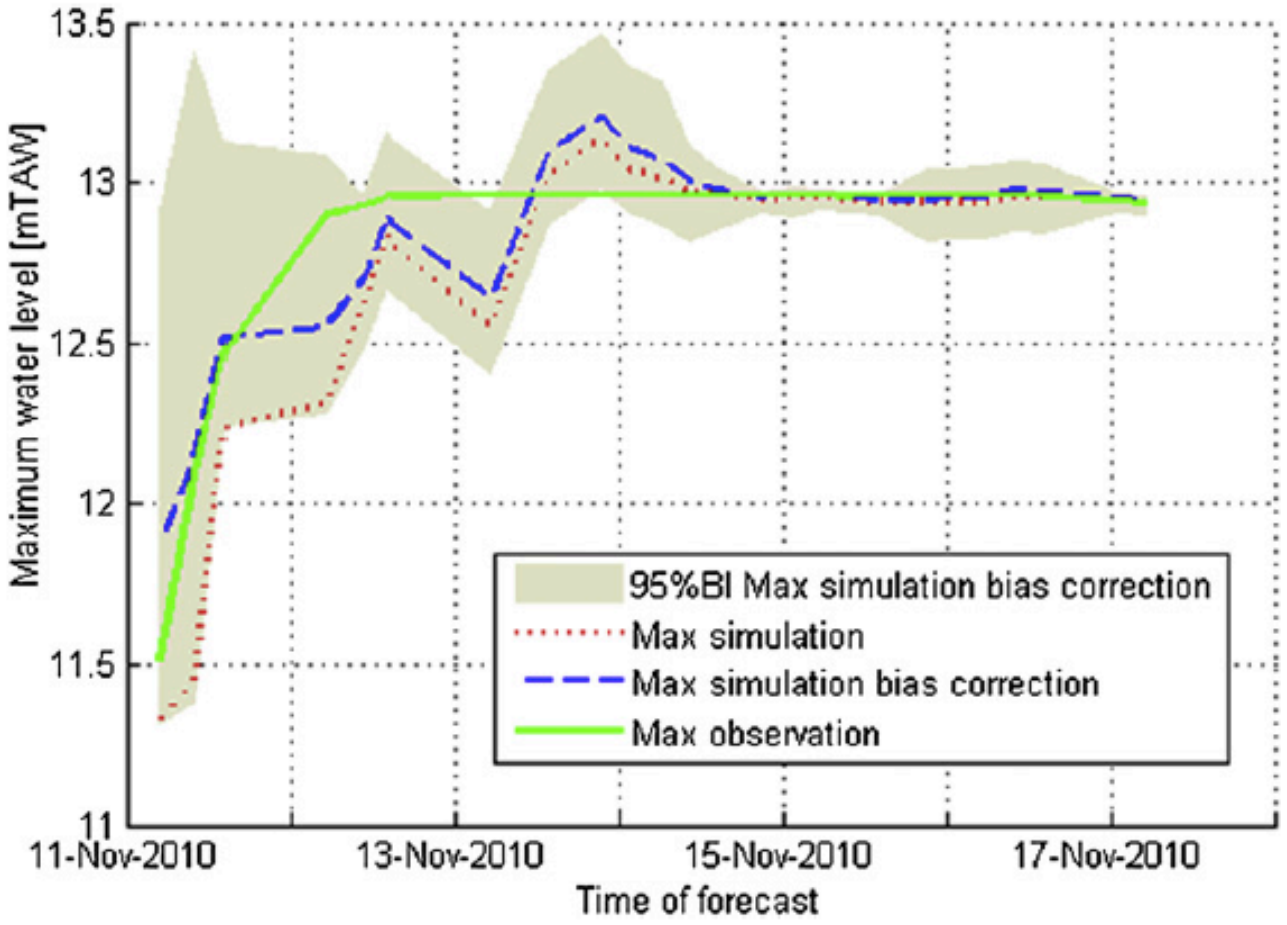

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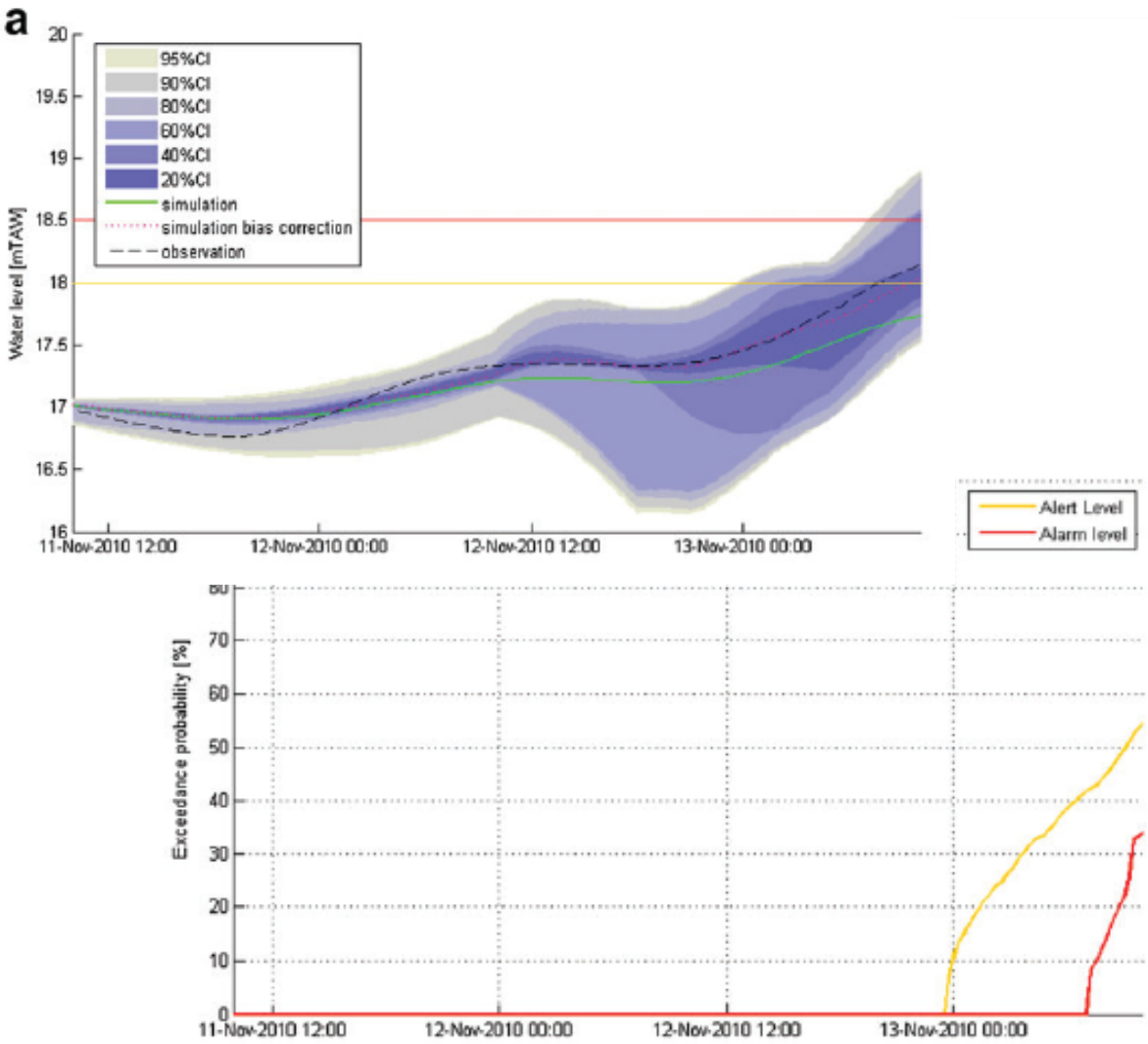
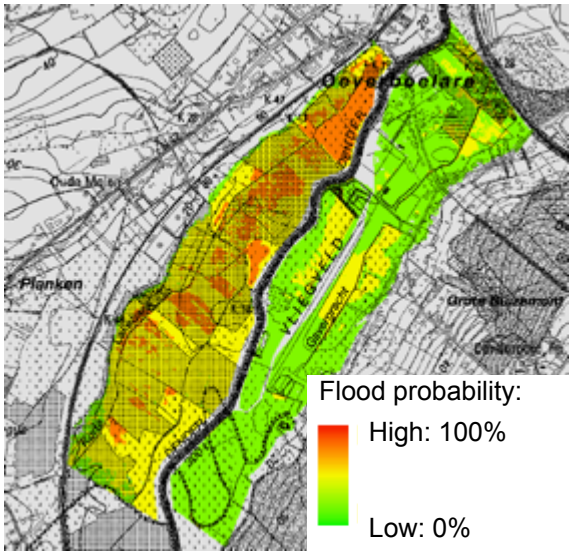
Uncertainty communication



Flood probability map:



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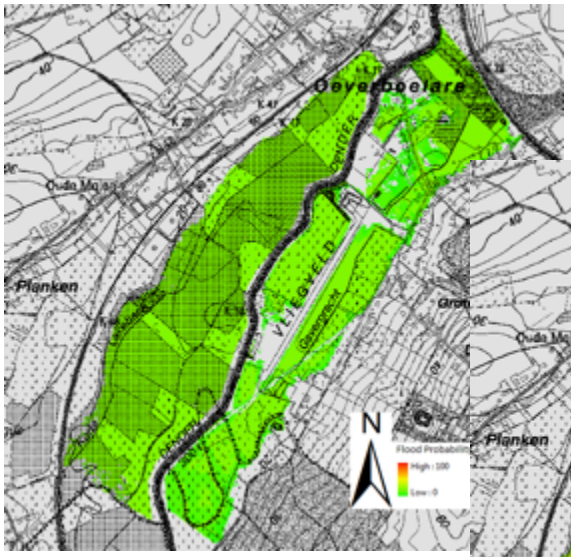
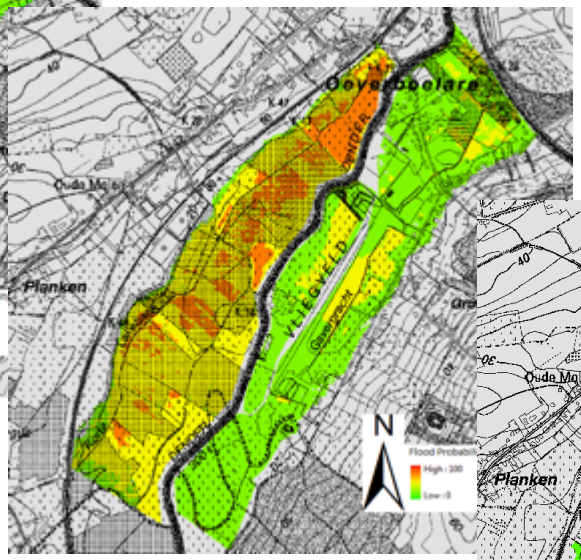
Inundation uncertainty mapping

Flood probability map:



13/11/2010 05:00

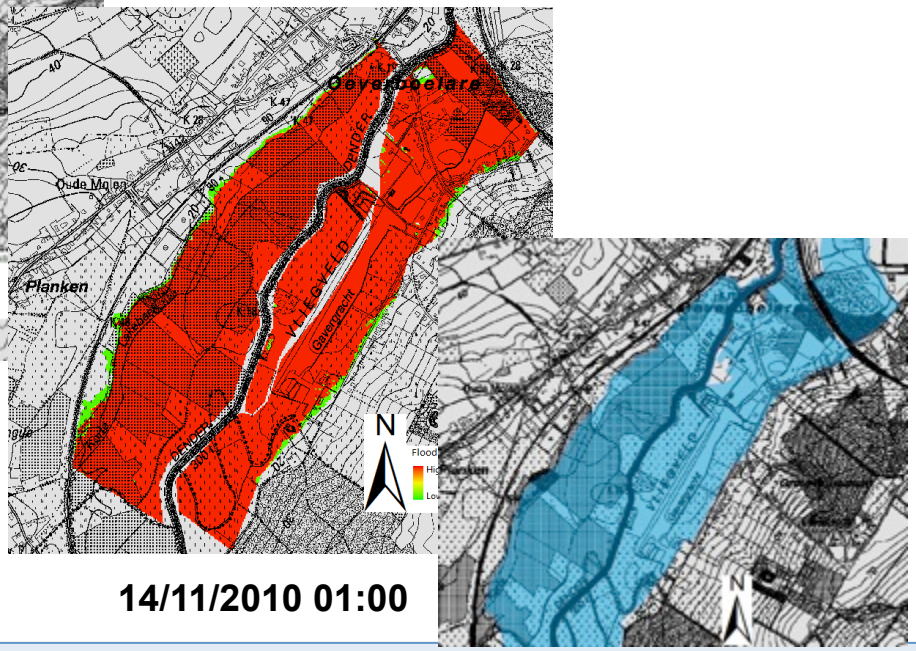


13/11/2010 10:00

Flood probability:

Hoog: 100%

Laag: 0%



14/11/2010 01:00

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Uncertainty quantification

		Observations (OBS)	
Forecasts (FOR)	FOR or OBS > alarm level?	Yes	No
	Yes	Correct alarm (HIT)	False alarm (FA)
	No	Missed alarm (MIS)	Correct rejection (CR)

Correct Alarm ratio: $$CAR = \frac{HIT}{HIT + FA}$$

Miss Rate: $$MR = \frac{MIS}{MIS + CR}$$

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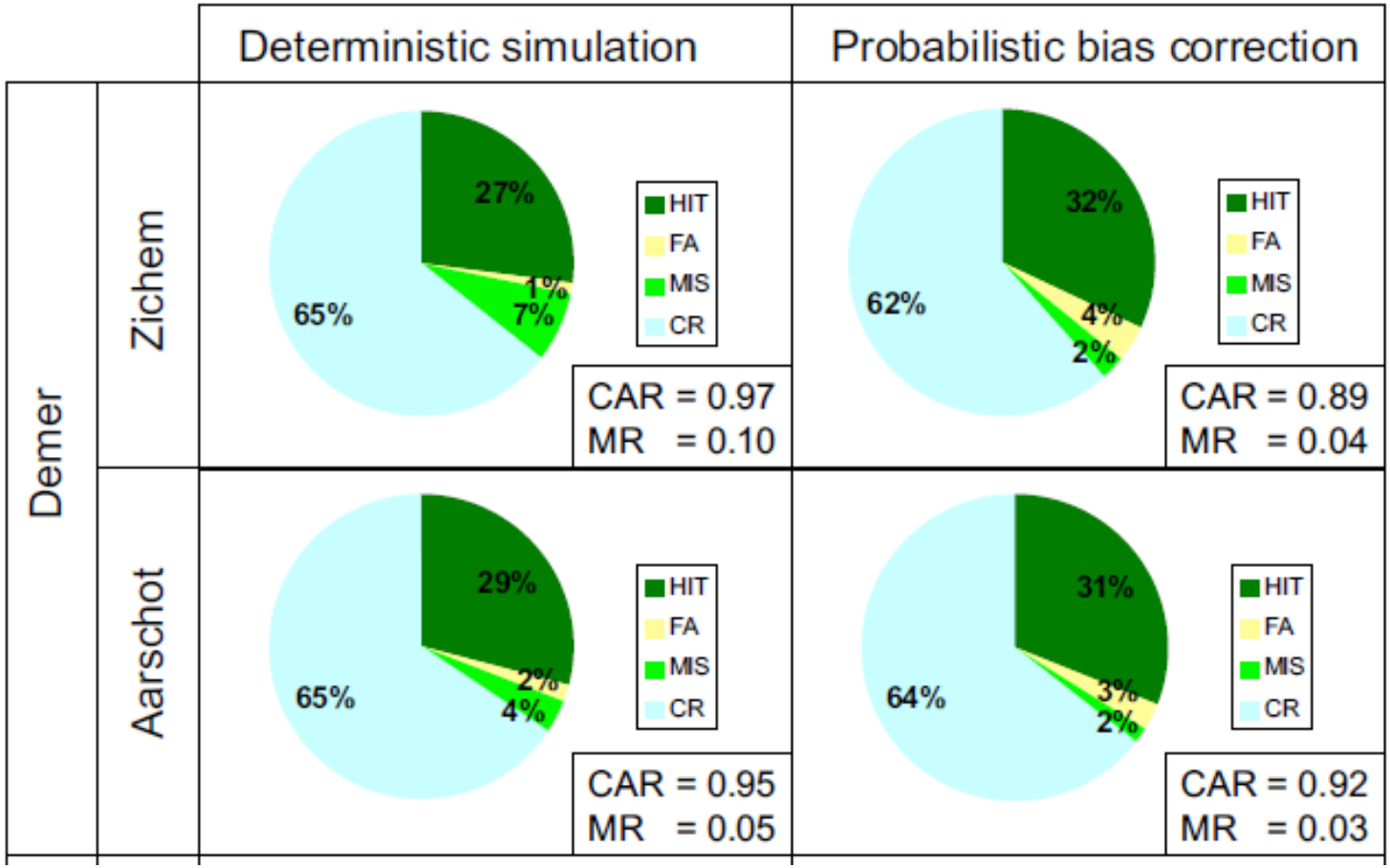
Uncertainty quantification



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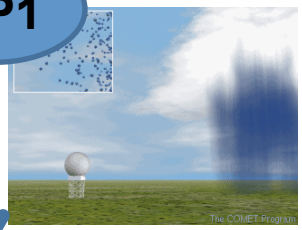
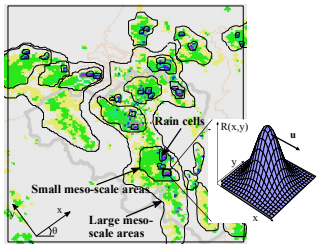
project PLURISK

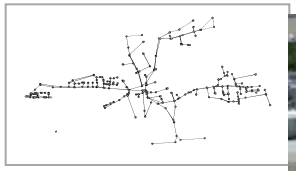
WP1 Nowcasting of fine-scale extreme rainfall





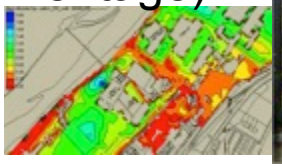
RMI & KU Leuven - Hydr

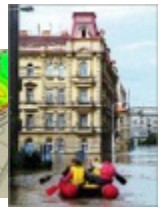
WP2 2D fine scale modelling, mapping and nowcasting of urban inundations



KU Leuven – Hydr

WP3 Socio-economic risk quantification of urban inundations (incl. cultural heritage)





KU Leuven HIVA & Lemaire

WP4 Risk communication and warning

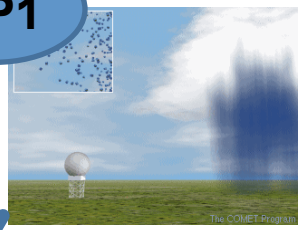
HIVA & RMI

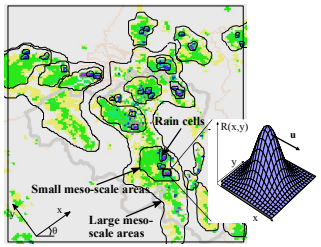
WP5 Risk reduction by new sustainable management strategies (better interfacing urban water management, spatial planning and eco-management)

Gembloux Agro-Bio Tech

project PLURISK

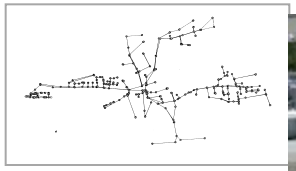
WP1 Nowcasting of fine-scale extreme rainfall





Nation-wide rainfall nowcasting system

WP2 2D fine scale modelling, mapping and nowcasting of urban inundations



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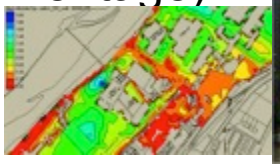

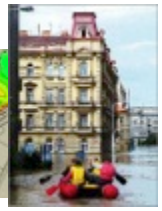

demonstrated and tested for 3 Belgian cities; applicable to any Belgian urban area

WP4 Risk communication and warning

WP5 Risk reduction by new sustainable management strategies (better interfacing urban water management, spatial planning and eco-management)