Simulation of Uncertainty in Rainfall-Runoff Models and their Statistical Evaluation in the FLOREON+ System

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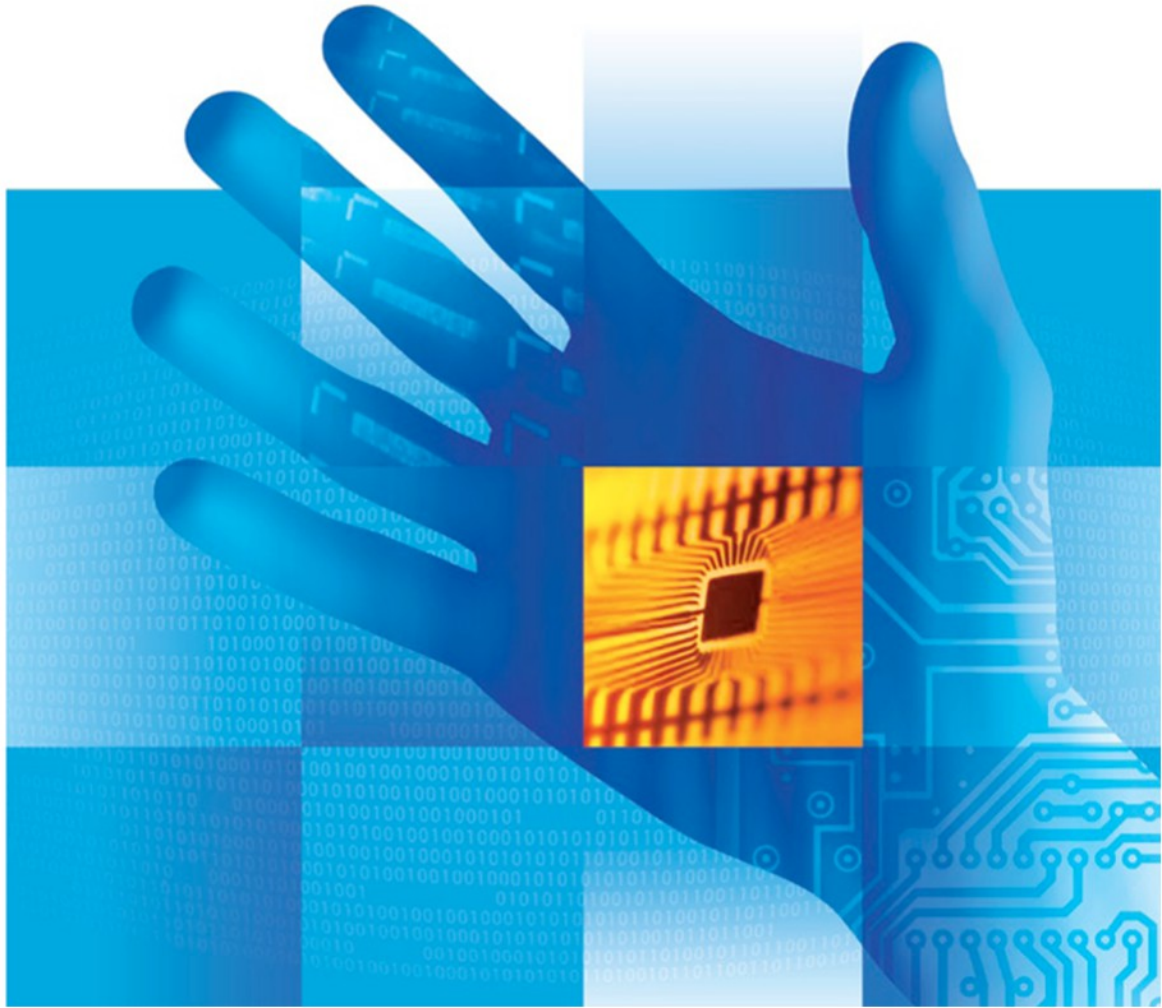


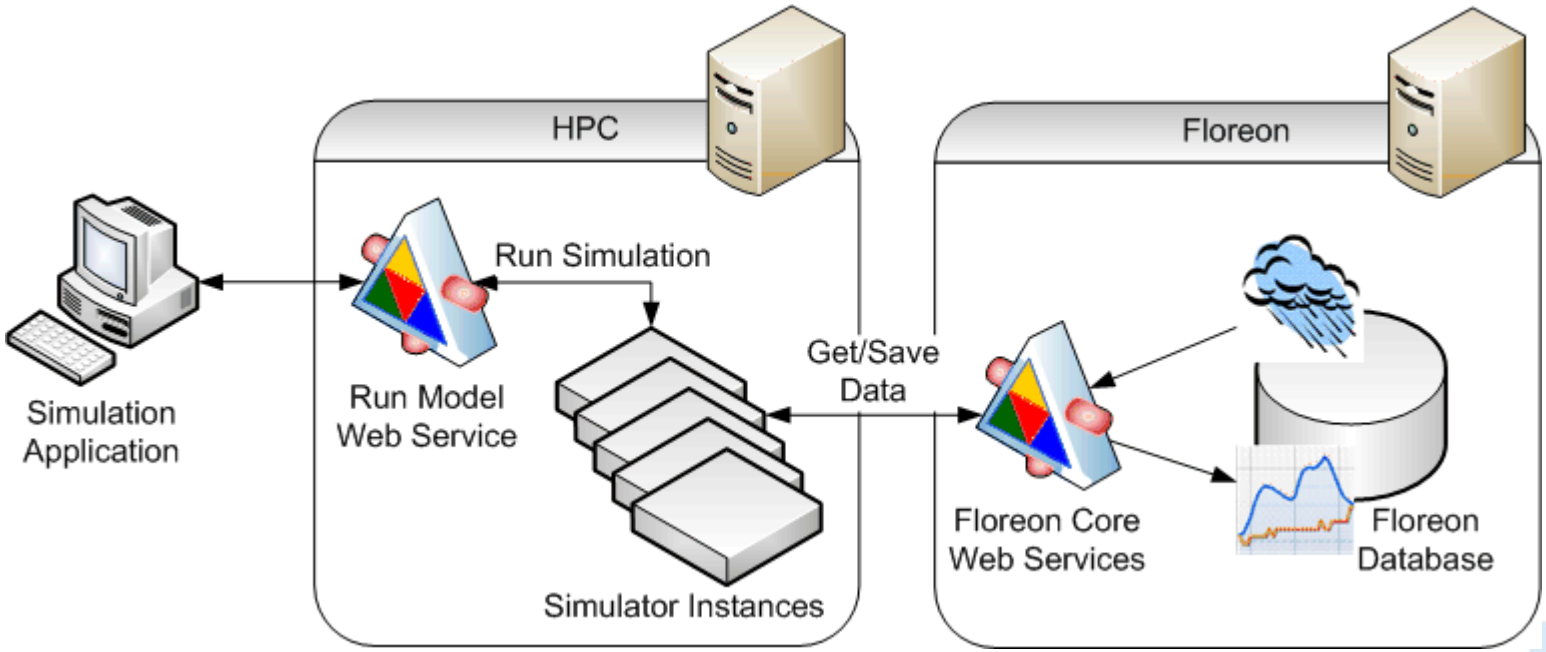
FLOREON+ System

- FLOods REcognition On the Net
- Modular web-based system for environmental risks modelling and simulation in the Moravian-Silesian region, Czech Republic
  - Flood risk
  - Transportation risk
  - Water and air pollution risk
- Results should simplify the process of disaster management and increase its operability and efectiveness

Hydrology simulations and HPC environment

- HPC parallel environment can be used for running many simulations concurrently or parts of one simulation on multiple computing nodes
- Shortens waiting times for simulation results even during critical situations
- Very useful for calibrating models – running independent simulations with different parameters
- Comes with an implementation cost to ensure connected parallel environments

Hydrology simulations and HPC environment

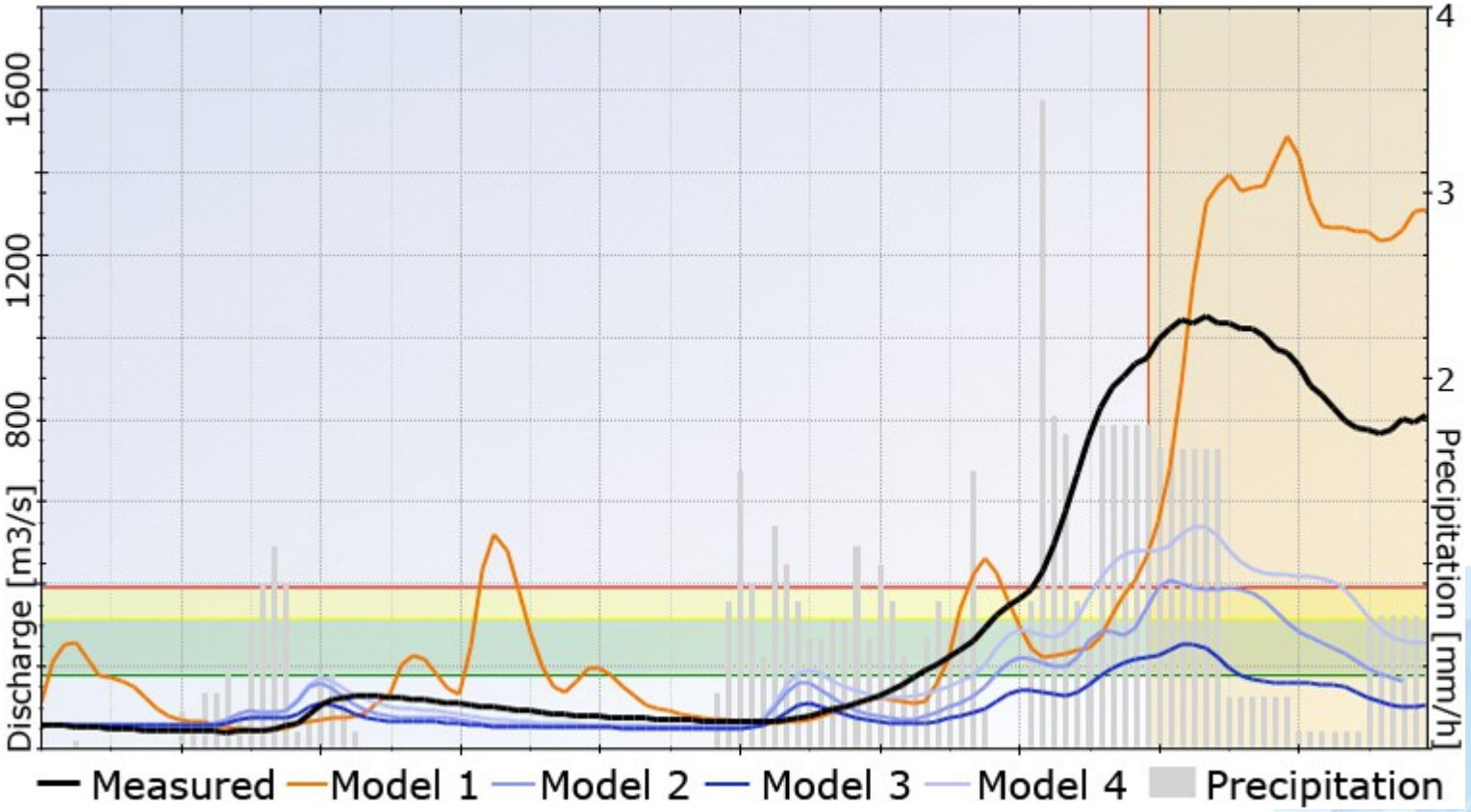


Rainfall-Runoff Model Verification

- Process of demonstrating that model is capable of making „sufficiently accurate“ simulations
- Comparison of predicted discharge volumes with actual measured discharge volumes
- Visual and statistical techniques used for verification

Visual Verification

- Hydrograph



Statistical Verification

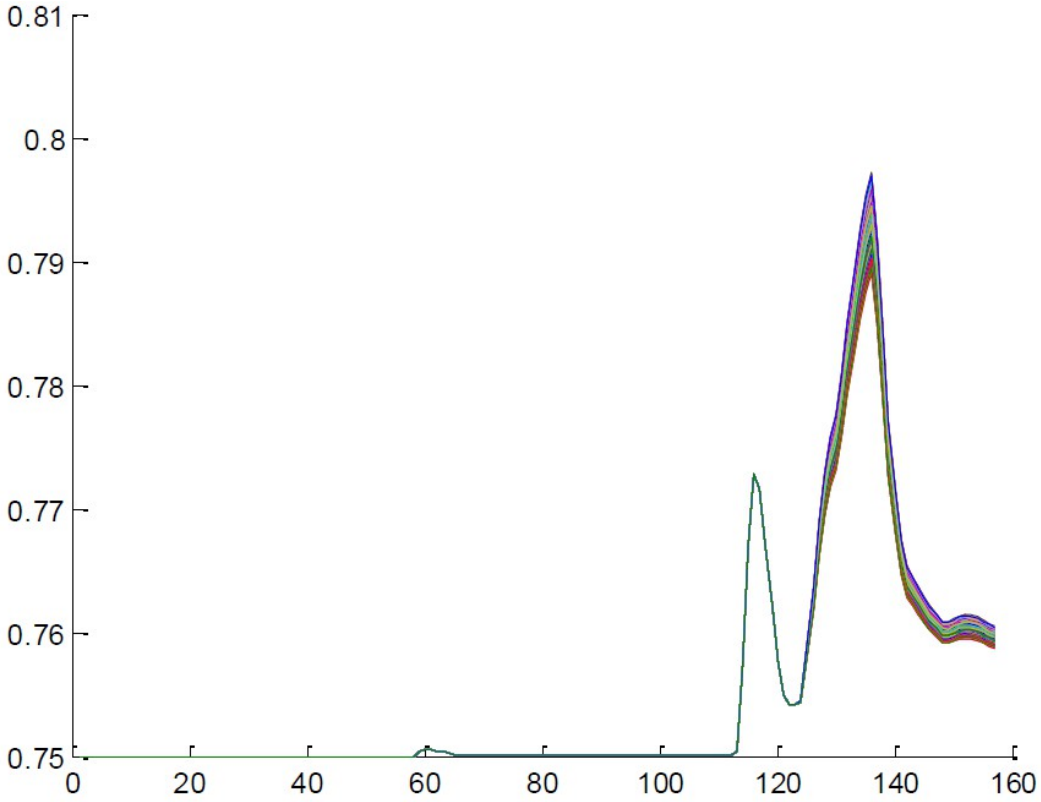
- Analysis of statistical indicators
- Commonly used error indicators
  - mean estimate error (ME), root mean square error (RMSE), mean absolute error (MAE), mean percentage error (MPE), mean absolute percentage error (MAPE), relative error in volume (VE), relative error for peak (MF)
- They indicate error in units or as percentage
- Low error indicators signify precise model, individual models can be easily compared

Uncertainty Modelling

- Some input model parameters are not specified exactly but are also predicted approximately
  - e.g. precipitation forecast, soil infiltration, ...
- These imprecisions influence the whole prediction and can lead to bad decisions
- Monte-Carlo simulations can estimate possible situations and their probability

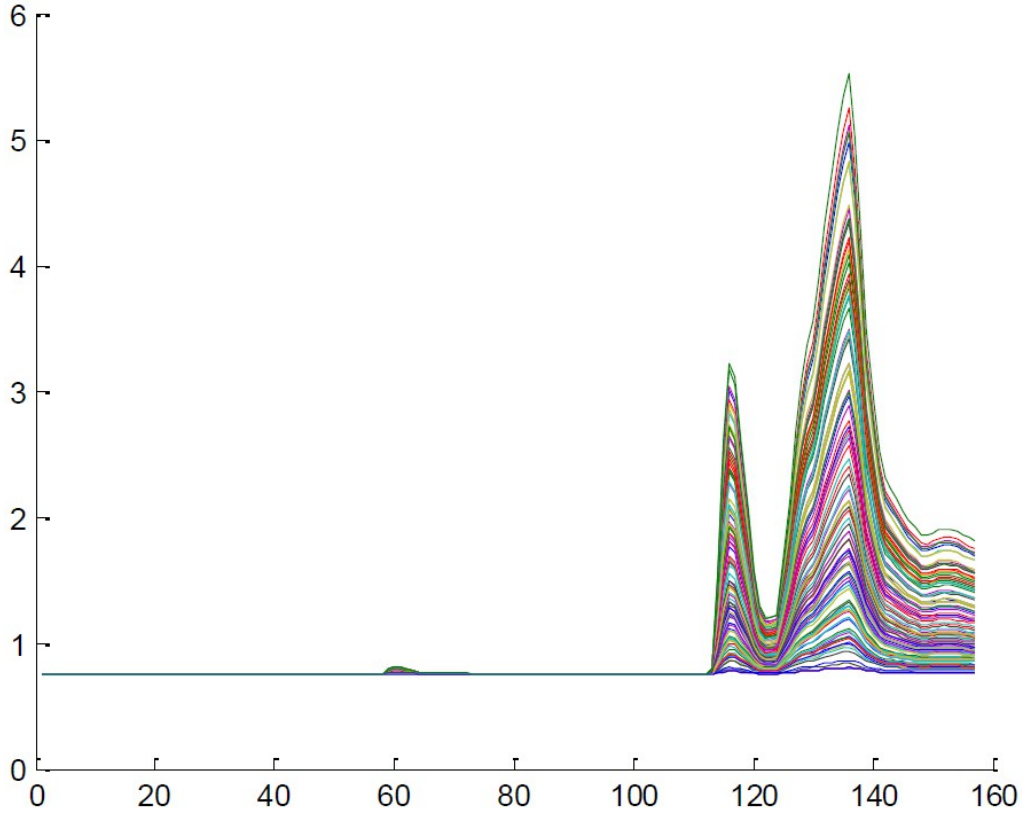
Monte-Carlo Simulations Example

- CN Curve = 55
- Predicted precipitations +/- 10%



Monte-Carlo Simulations Example

- CN Curve = <55;95>
- Predicted precipitations +/- 10%



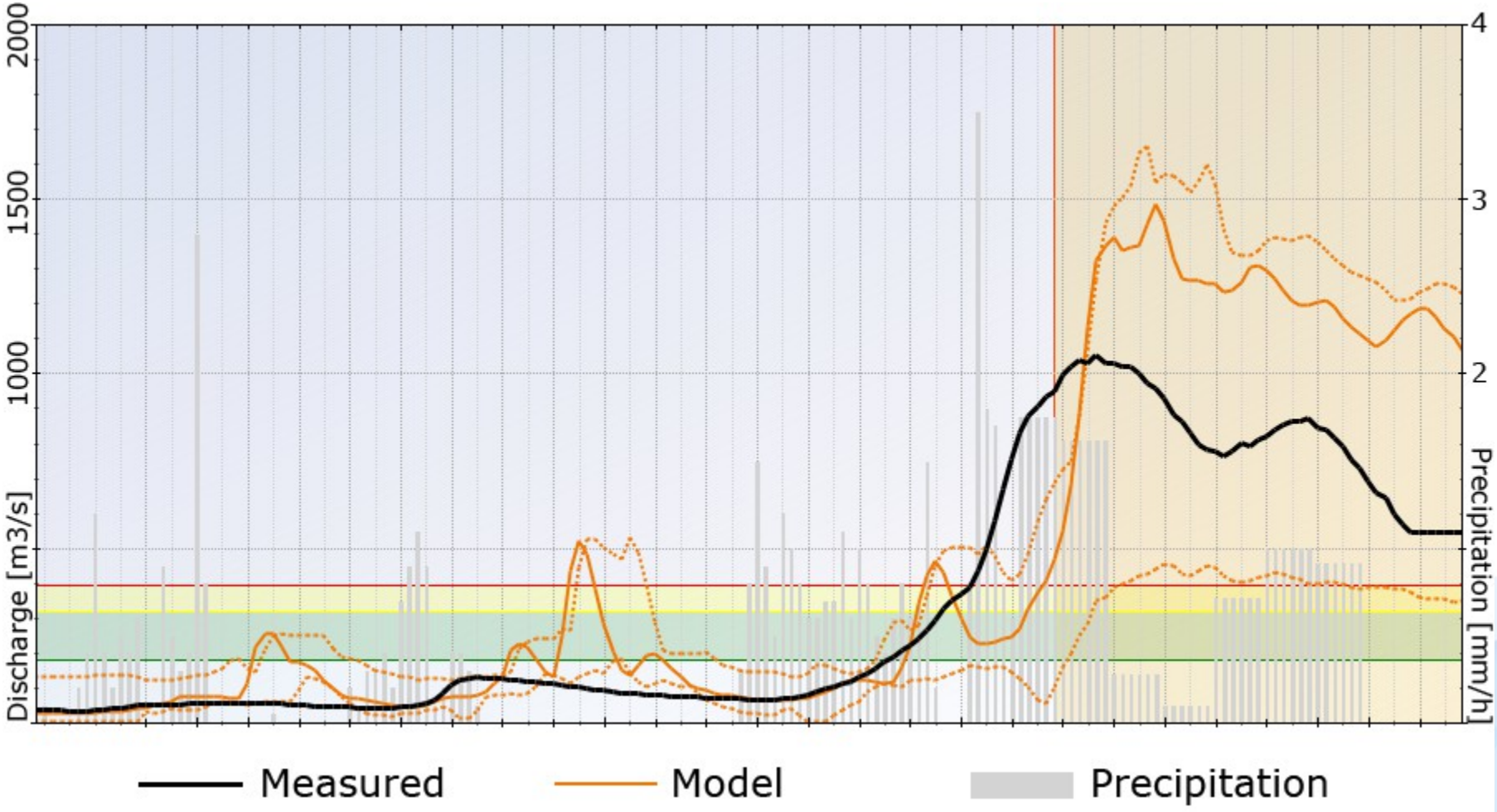
Integration to FLOREON+

- HPC environment is ideal for running Monte-Carlo simulations
- Uncertainty values for chosen parameters had to be defined
  - CN Curve
    - Pre-calibrated from previous simulations
    - Normal distribution with small variance
    - 3---$\frac{5}{8}$ 5% of pre-calibrated value
  - Precipitation Prediction
    - Uniform distribution +/- 10%

Confidence Intervals

- Individual simulations are collected from HPC but only significant results are stored
- Significant results:
  - 5%, 15%, 25%, 75%, 85% and 95% percentiles
  - These percentiles form 50%, 70% and 90% confidence intervals

90% Confidence Interval



Confidence Interval Evaluation

- Comparison of confidence interval percentage with the percentage of measured values inside the interval

Confidence interval	Values inside	Values outside	Interval Success	Is Successful
90%	45	3	93.75%	YES
70%	26	22	54.17%	NO
50%	4	44	8.33%	NO

Confidence Interval Evaluation

- Visual and statistical verification of rainfall-runoff models in the FLOREON+ system presented
- Monte-Carlo method used to model uncertainty of input parameters in the rainfall-runoff models
- Uncertainty simulations demonstrated and evaluated using confidence intervals

Thank You for Your Attention