Operational ensemble forecasts of floods in Austria

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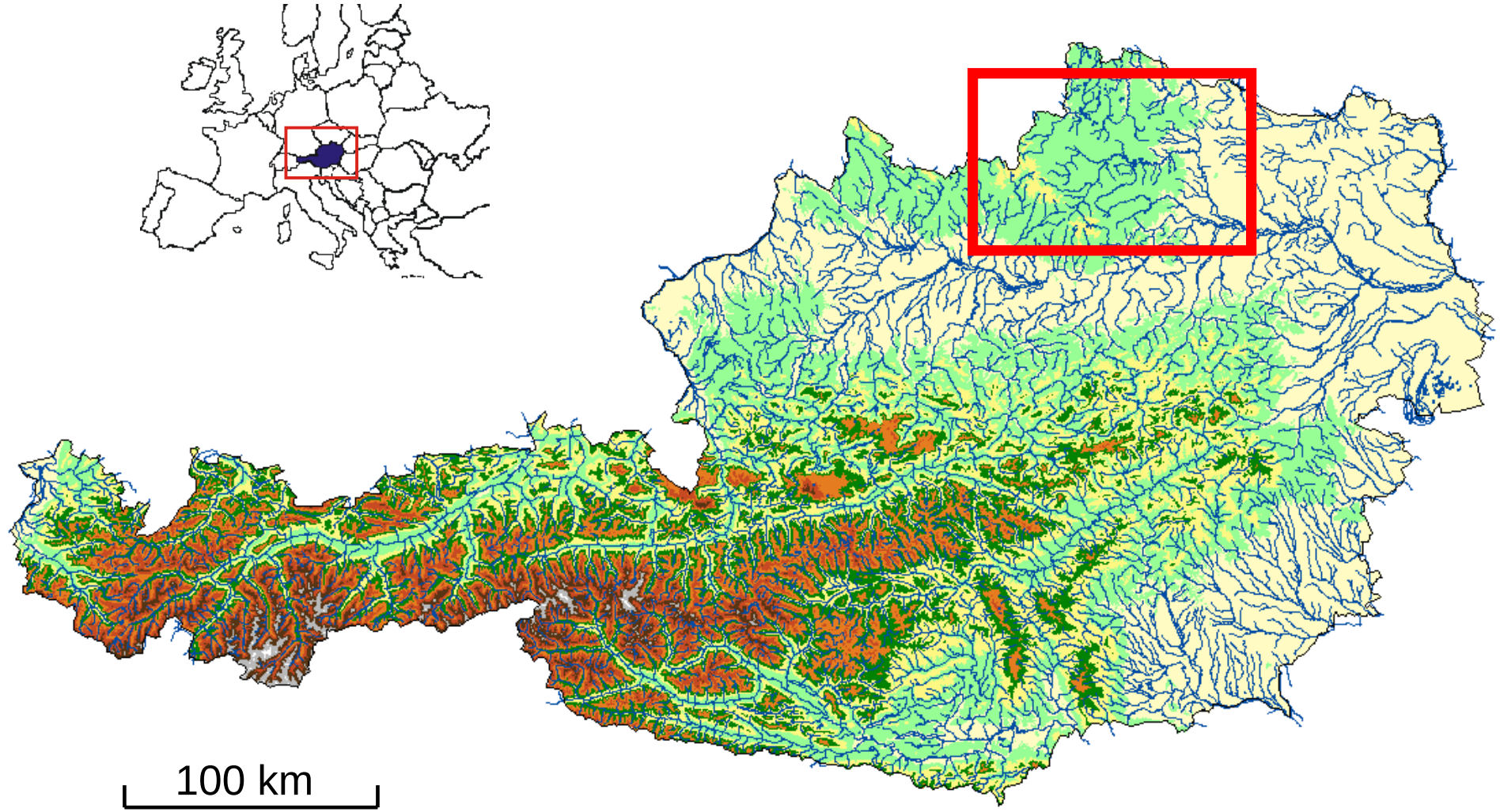
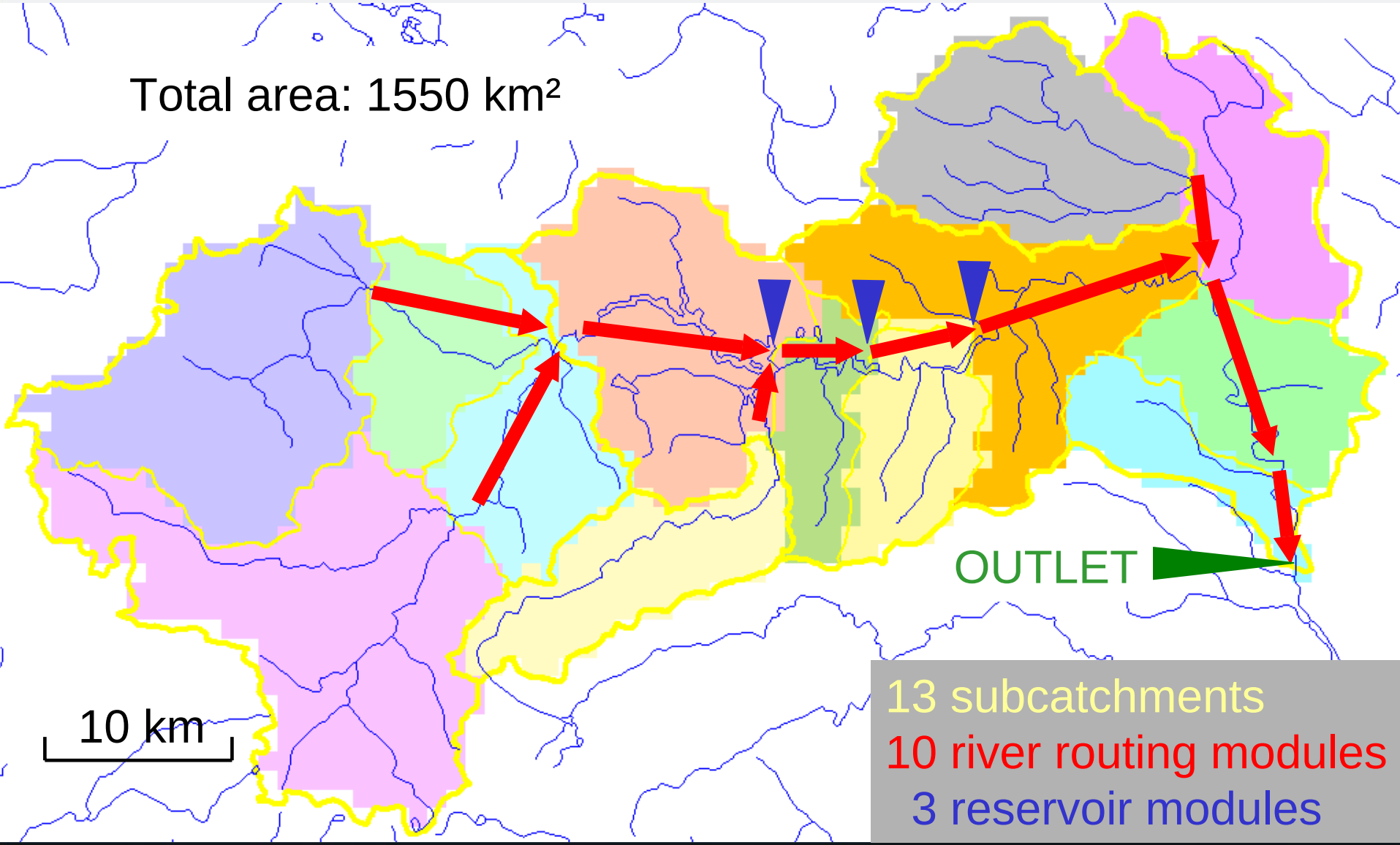
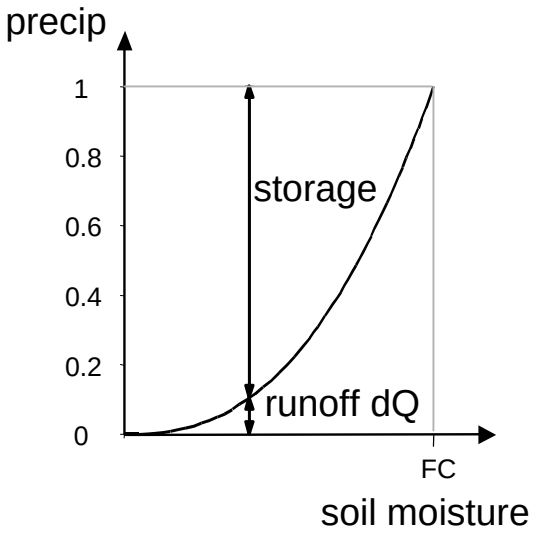
The Kamp catchment

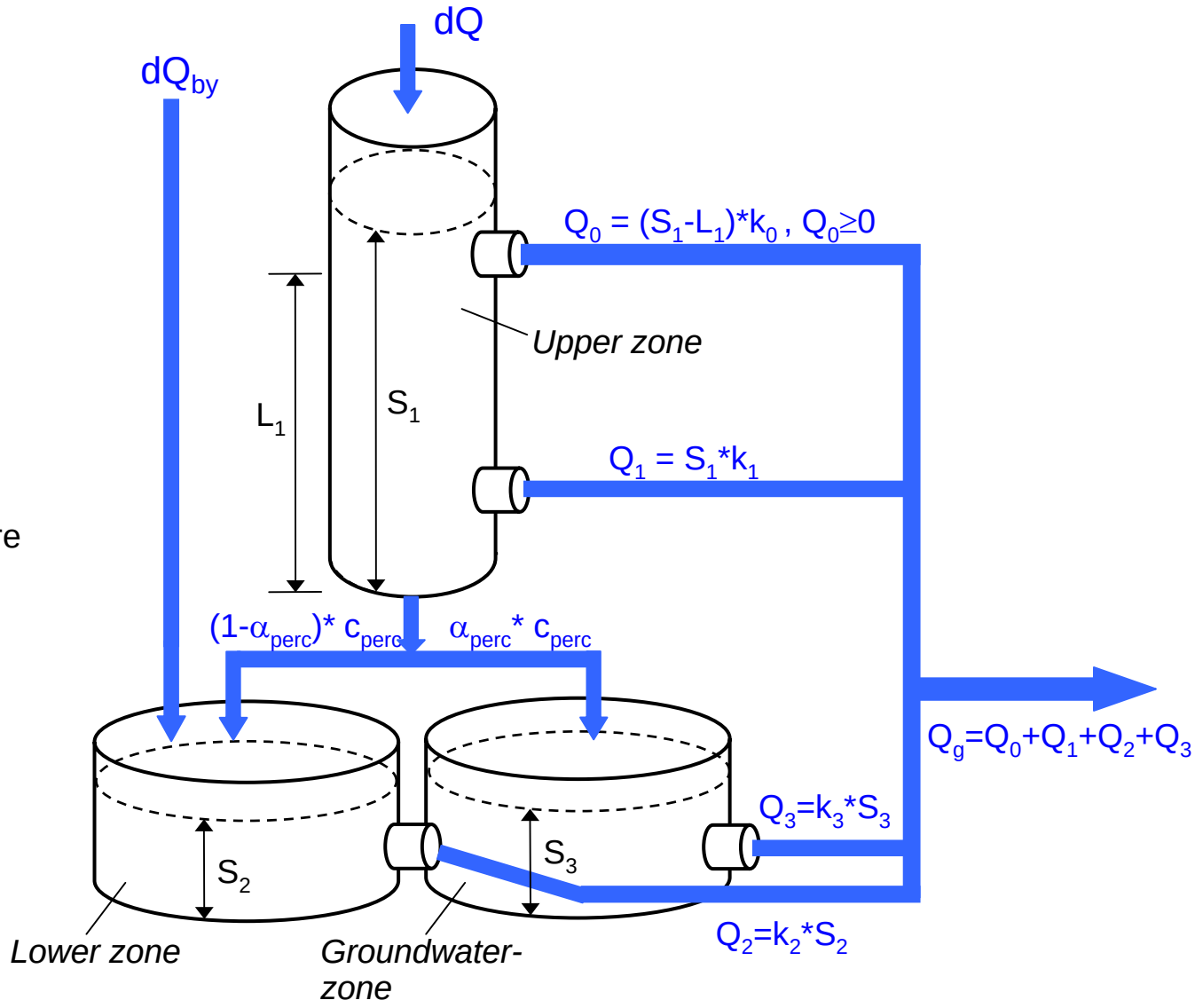


Runoff model – spatial structure

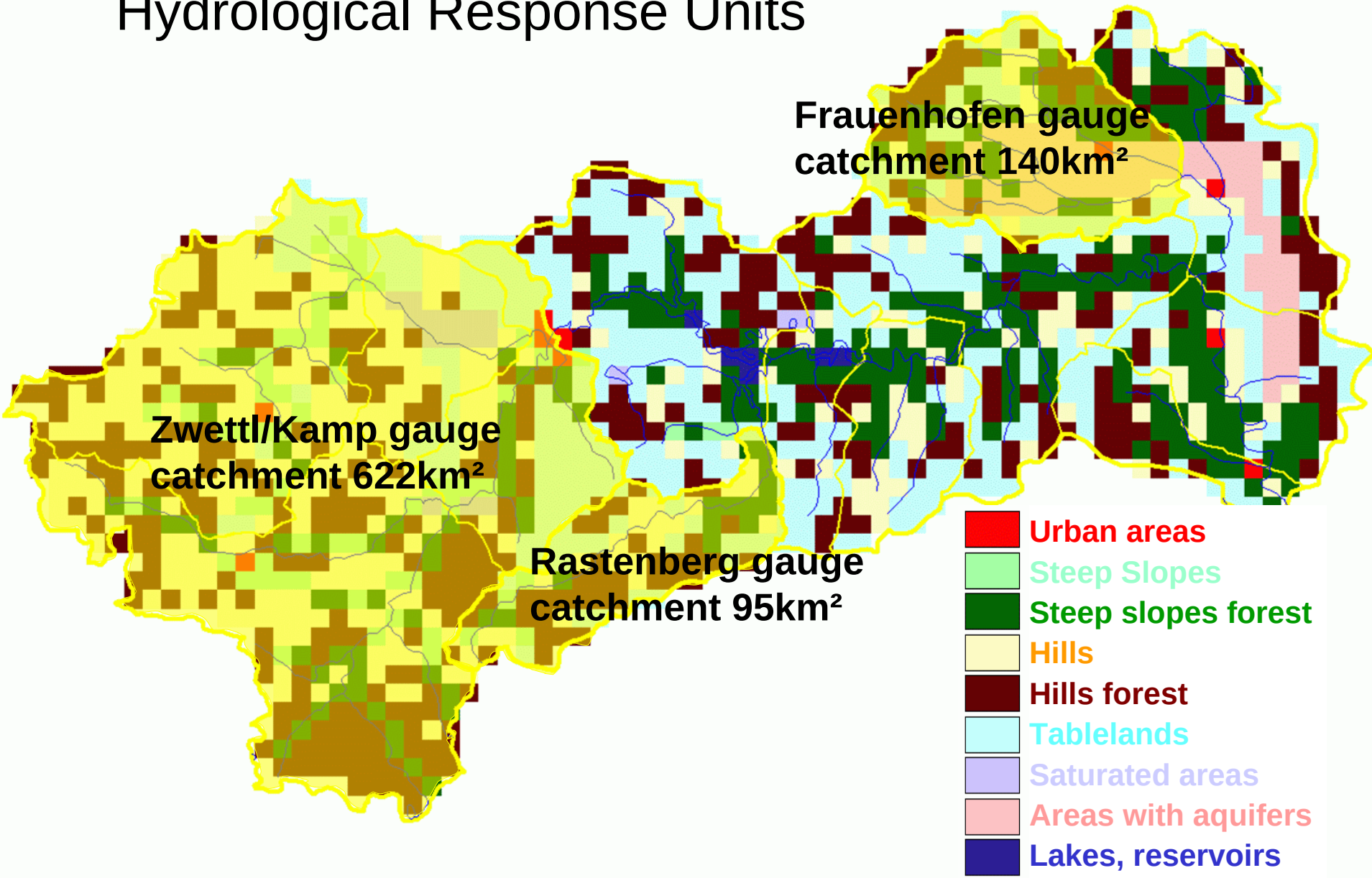


Runoff model - structure at pixel scale



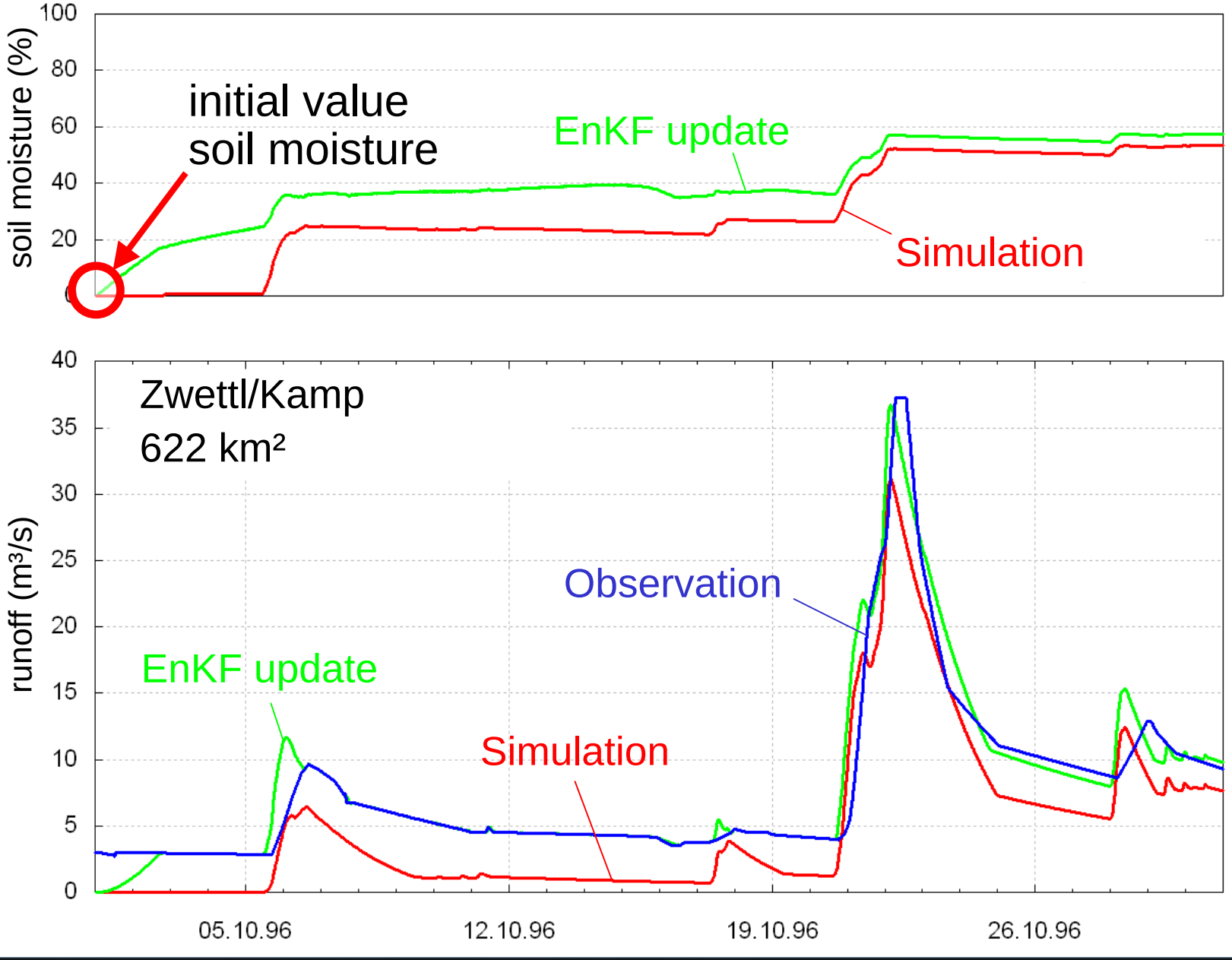


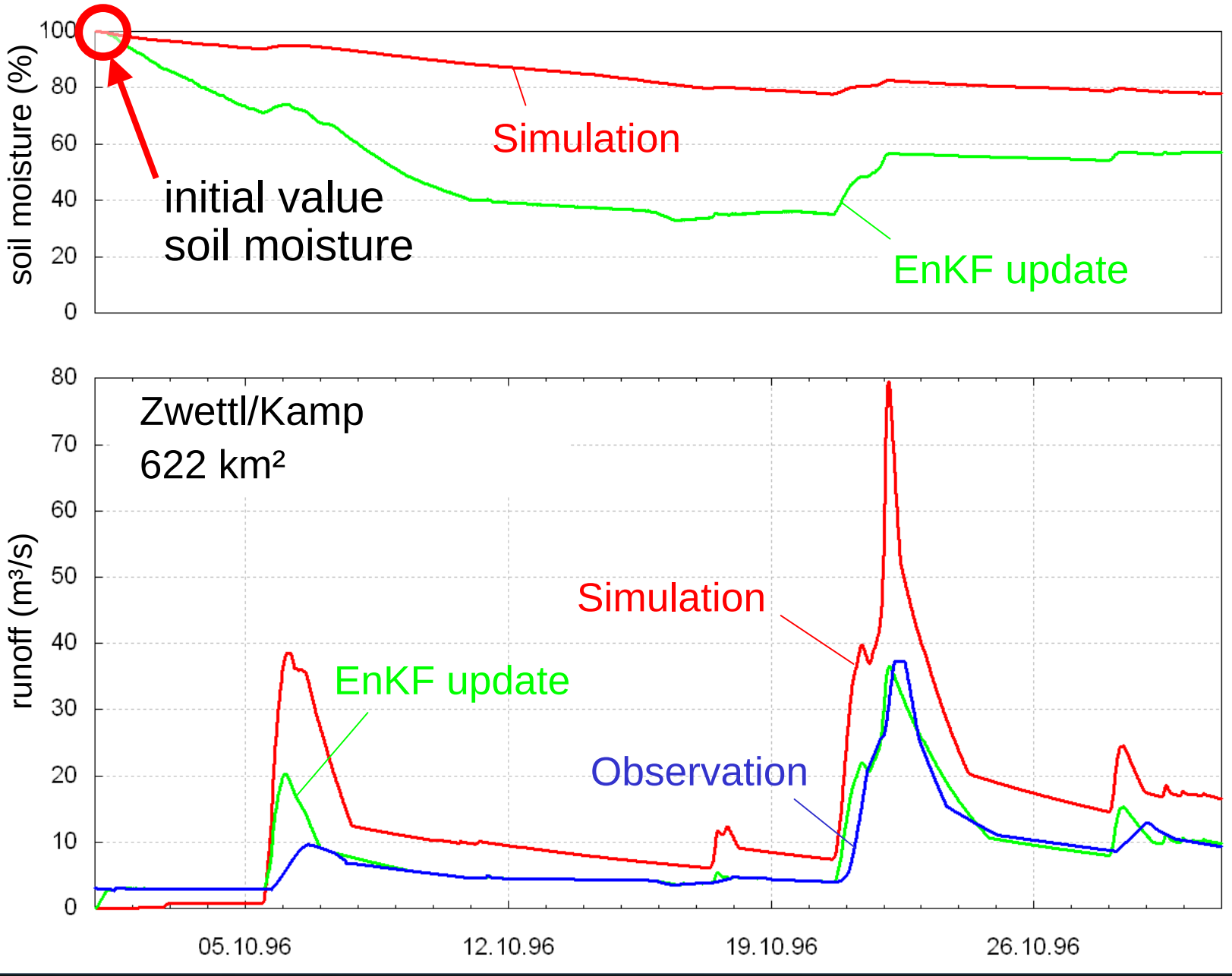
Hydrological Response Units



Updating procedure

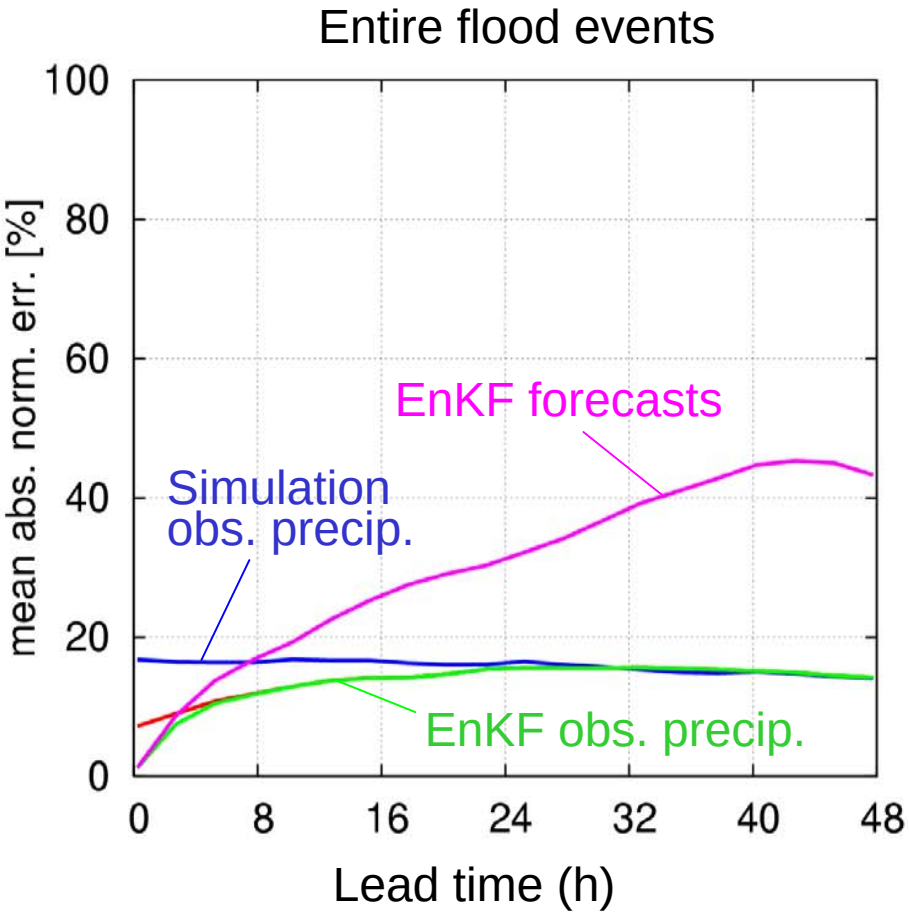
- Reduction of uncertainties of flood forecasts
  → using observations of runoff in real time
- Non-linear model - Ensemble Kalman Filter (EnKF)
- Observation uncertainties → runoff
- Model uncertainties → uncertainties in input (precipitation, evaporation) and its impact on the soil moisture state
- To estimate antecedent soil moisture

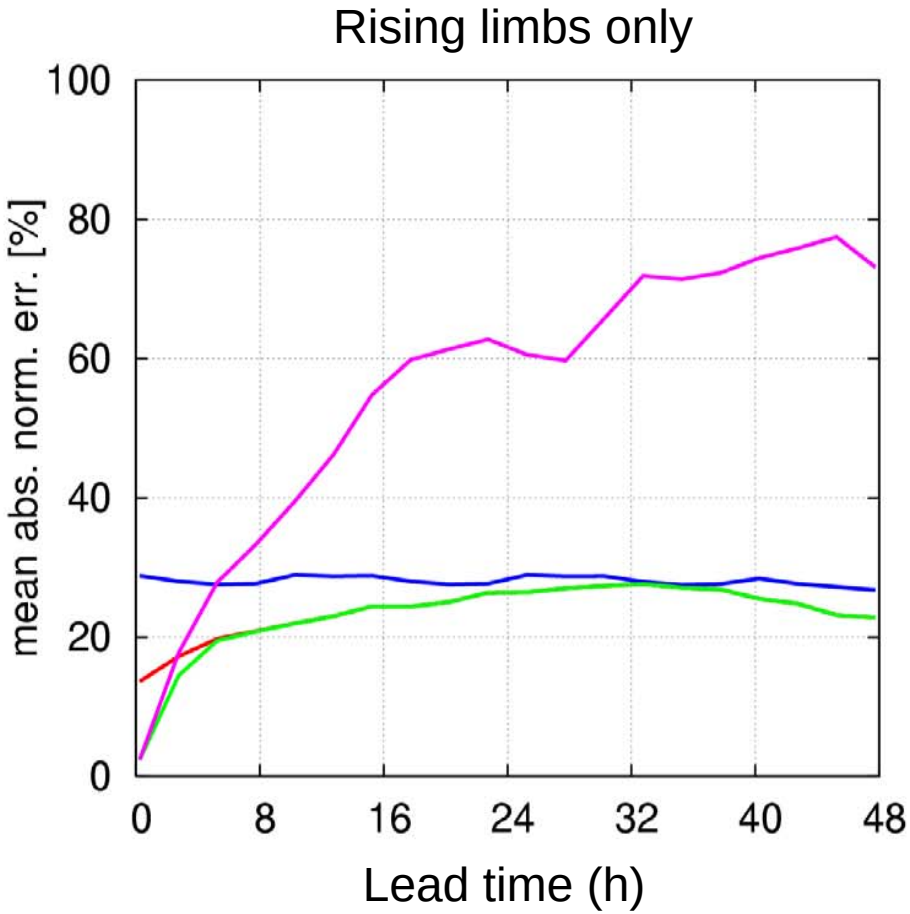

soil moisture (%)
100
80
60
40
20
0
initial value
soil moisture
EnKF update
Simulation
runoff (m³/s)
40
35
30
25
20
15
10
5
0
Zwettl/Kamp
622 km²
Observation
EnKF update
Simulation
05.10.96
12.10.96
19.10.96
26.10.96


soil moisture (%)
100
80
60
40
20
0
Simulation
initial value
soil moisture
EnKF update
runoff (m³/s)
80
70
60
50
40
30
20
10
0
Zwettl/Kamp
622 km²
Simulation
EnKF update
Observation
05.10.96
12.10.96
19.10.96
26.10.96

Error analyses

5 events - gauge **Zwettl/Kamp (622 km²)**

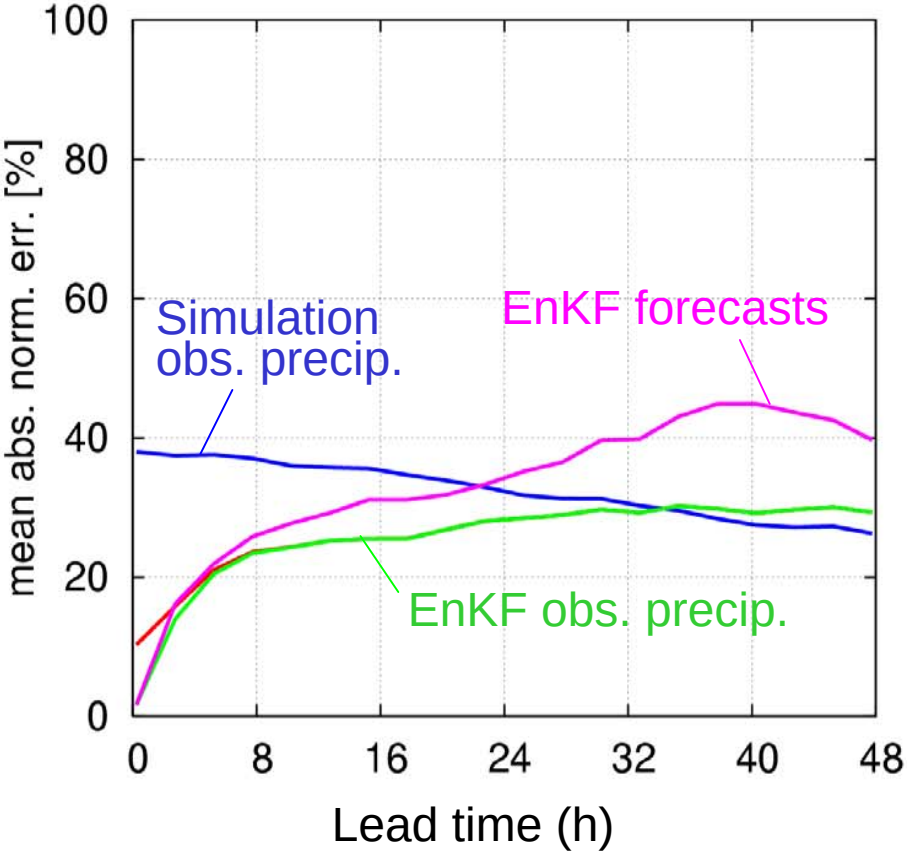




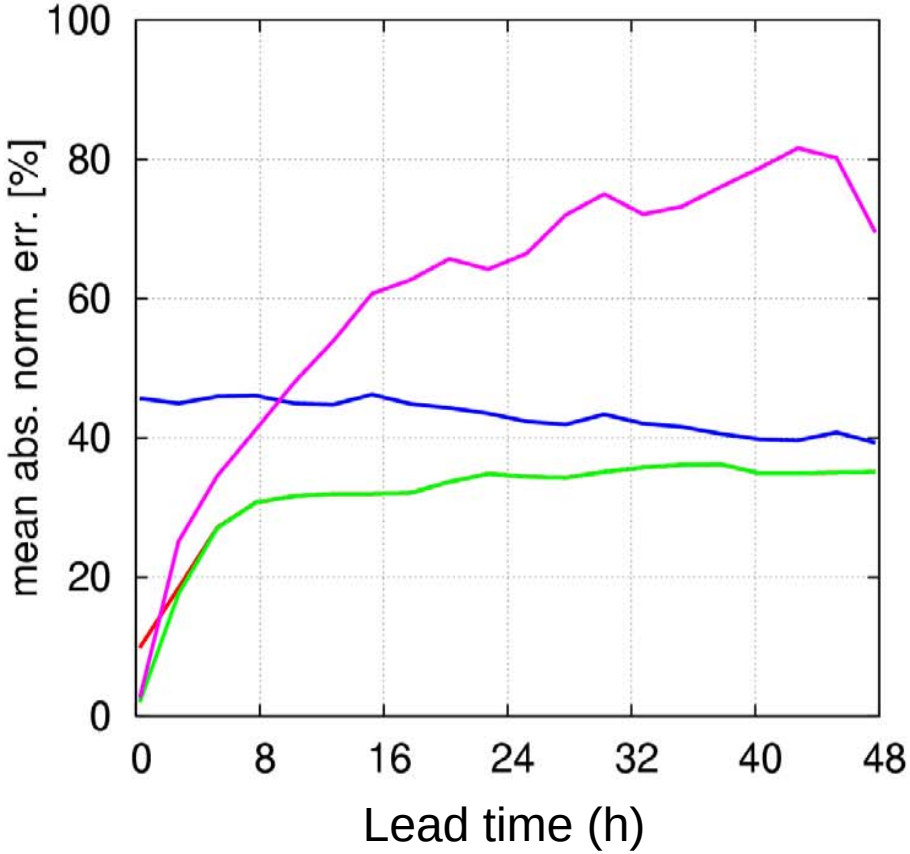
Error analyses

5 events - gauge **Rastenberg/Purzelkamp (95 km²)**

Entire flood events



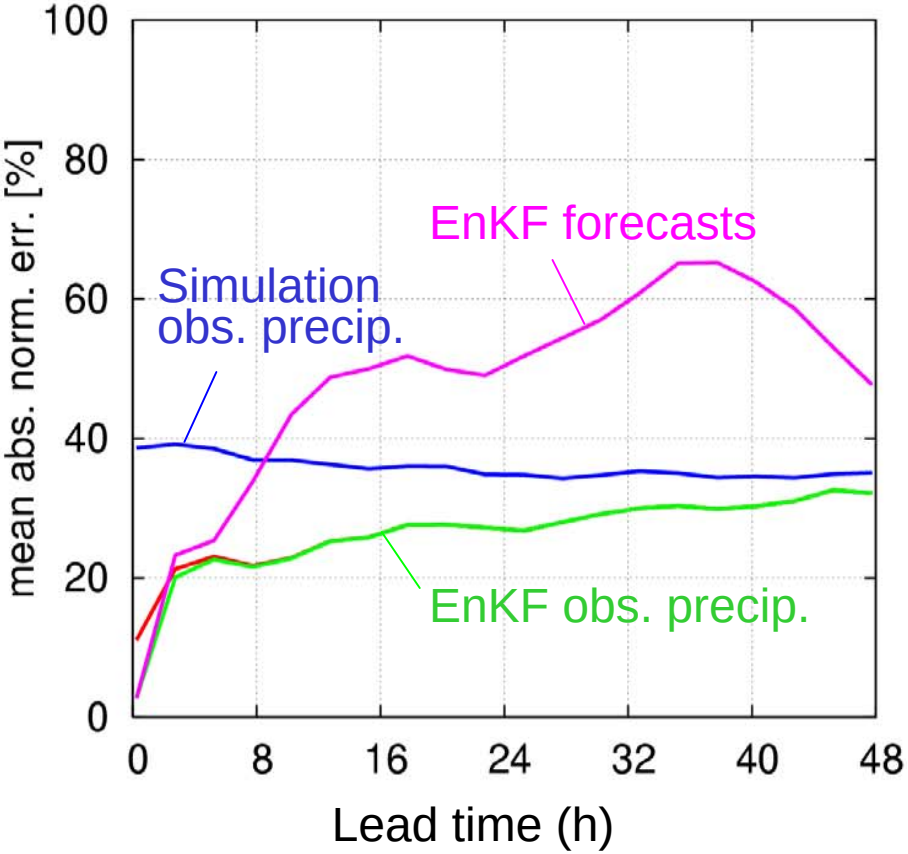
Rising limbs only



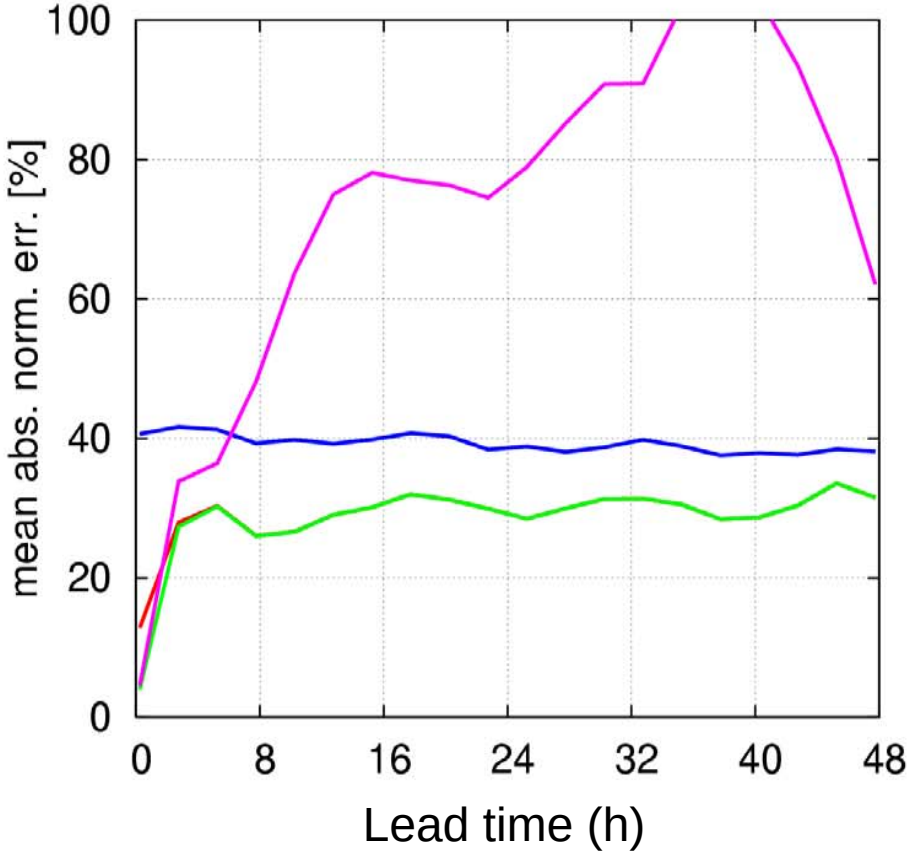
Error analyses

5 events - gauge **Frauenhofen/Taffa (140 km²)**

Entire flood events



Rising limbs only



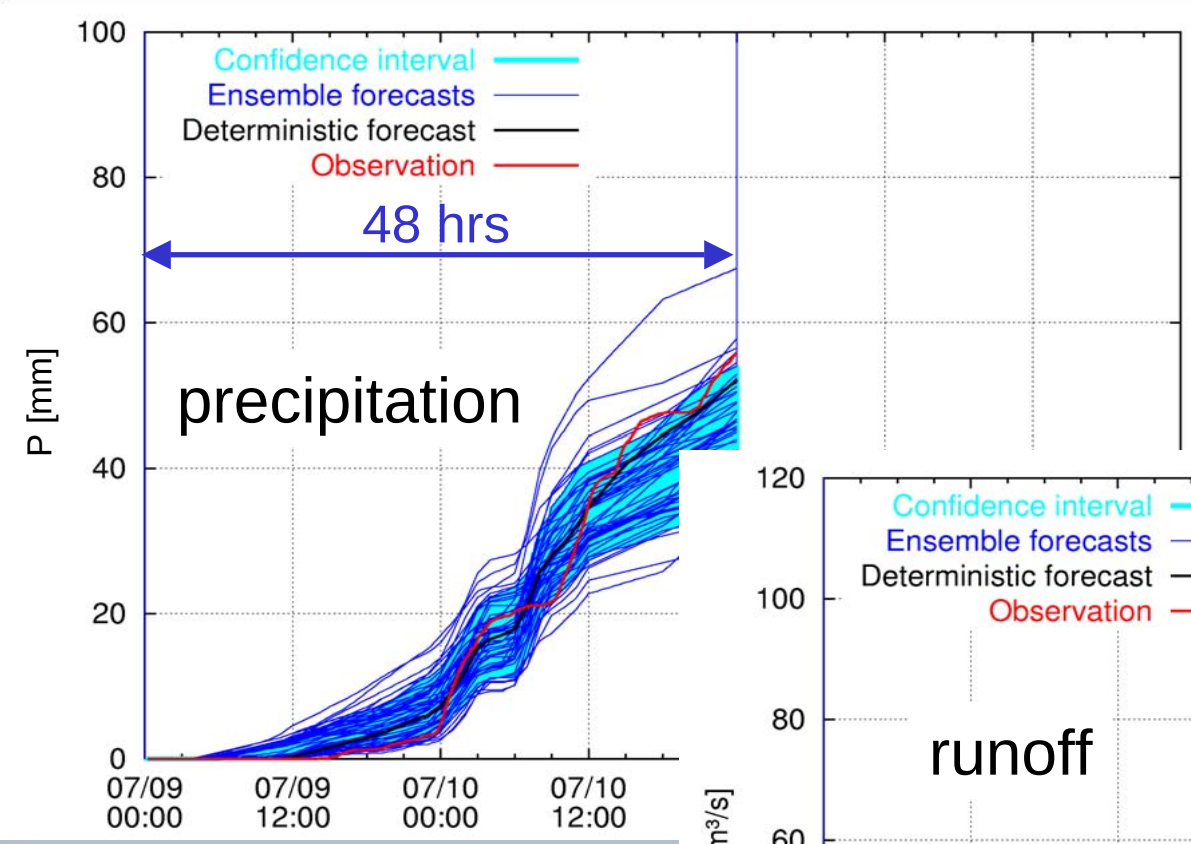
Ensembles

- using precipitation ensembles of Central Institute for Meteorology: combination of ECMWF realisations and LA-model ALADIN

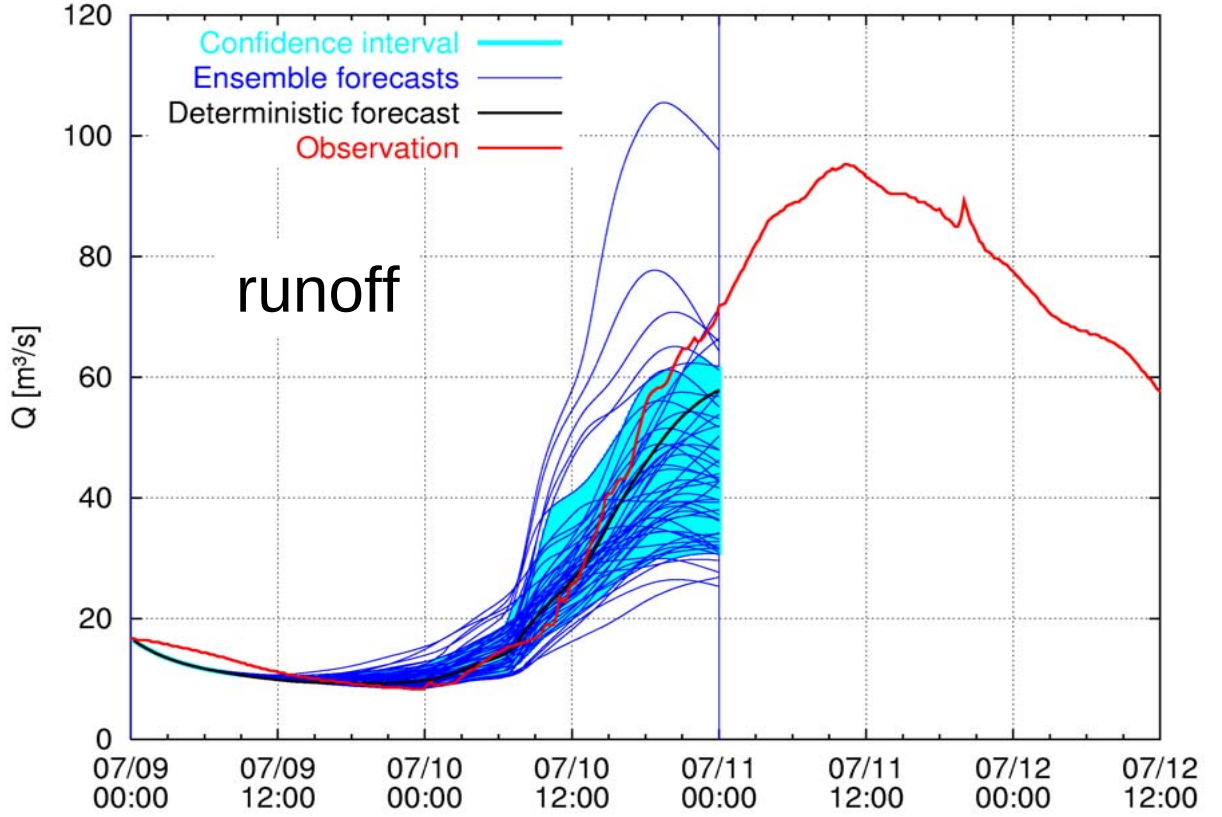
  (see presentation of Georg Pistotnik)

- downscaling of precipitation fields to a 1x1km² grid

- assuming main forecast uncertainty is due to uncertainties in precipitation forecasts
  → no perturbation of state variables or parameters of hydrological model



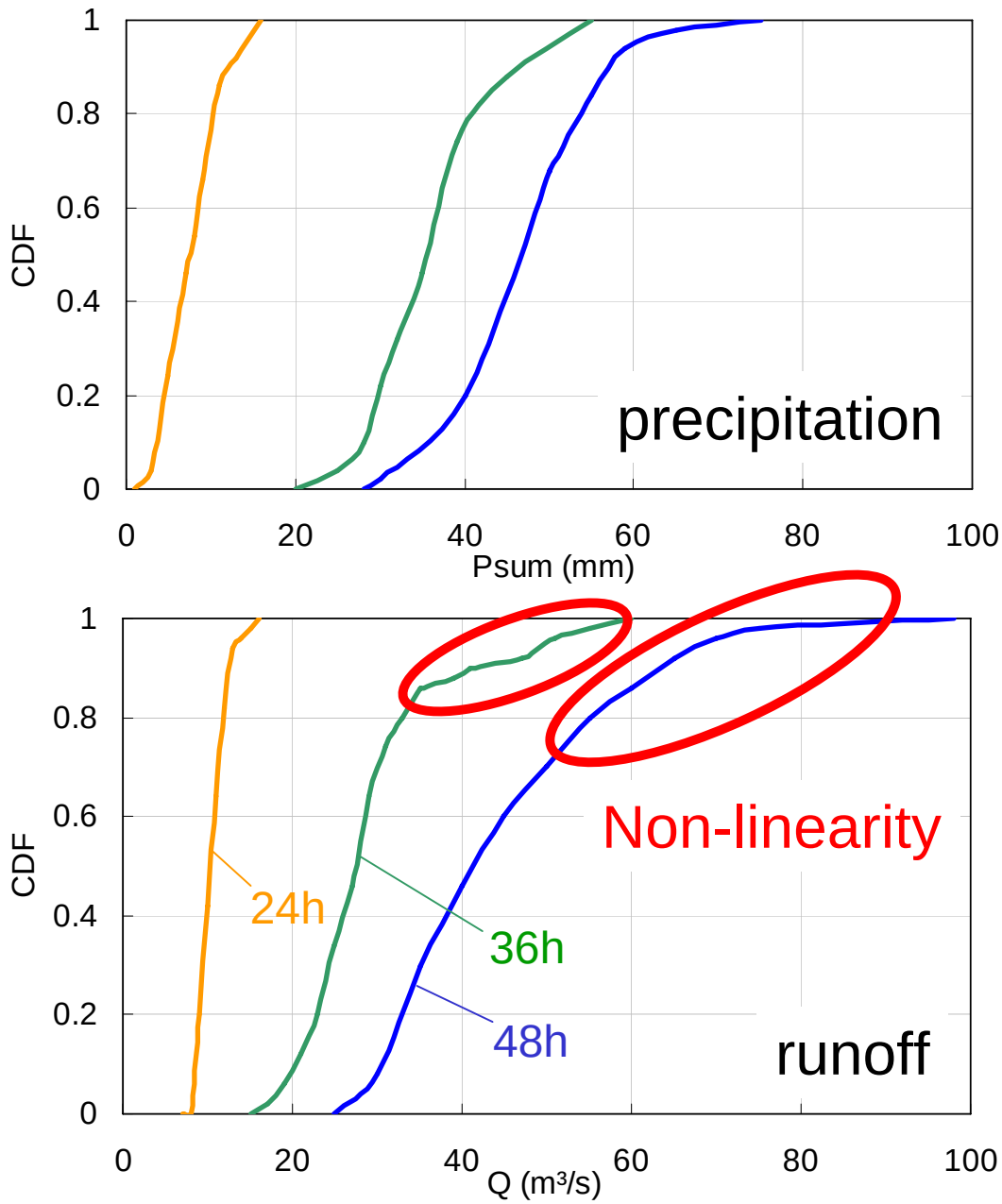
Zwettl/Kamp
July 9, 2005
00:00

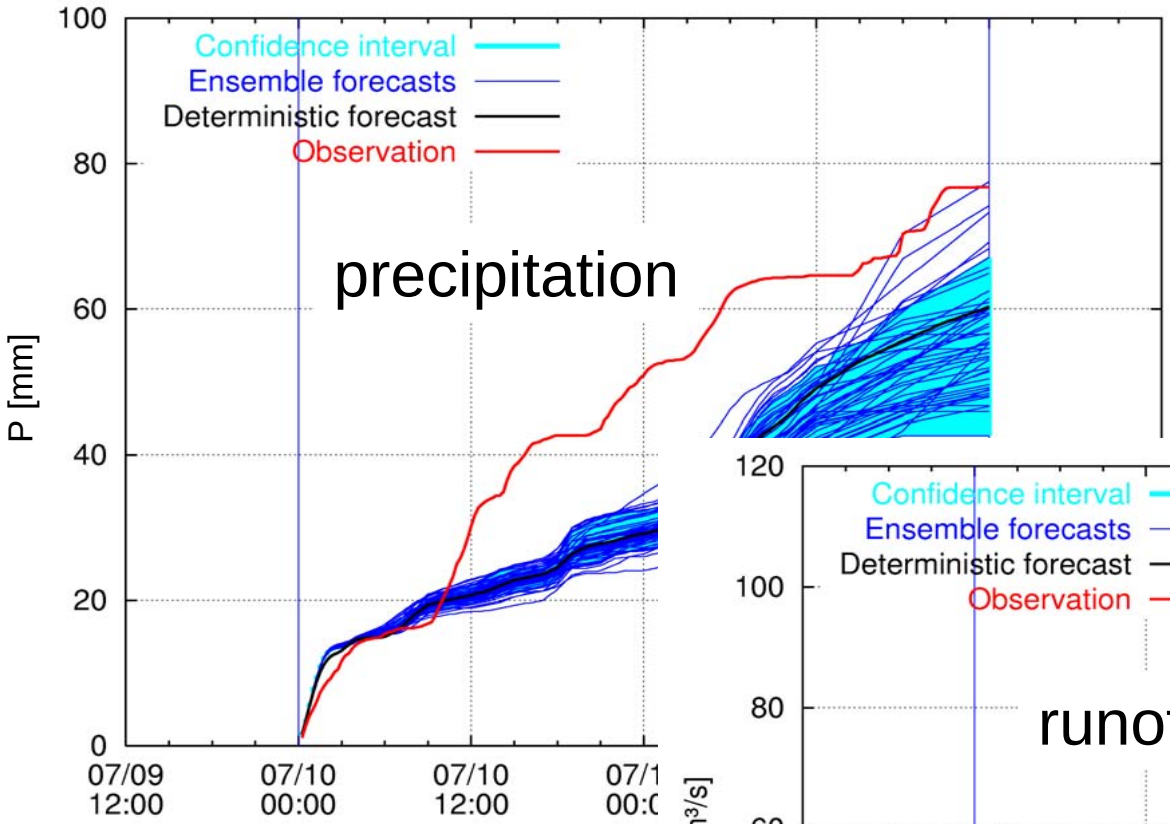


Ensemble spread

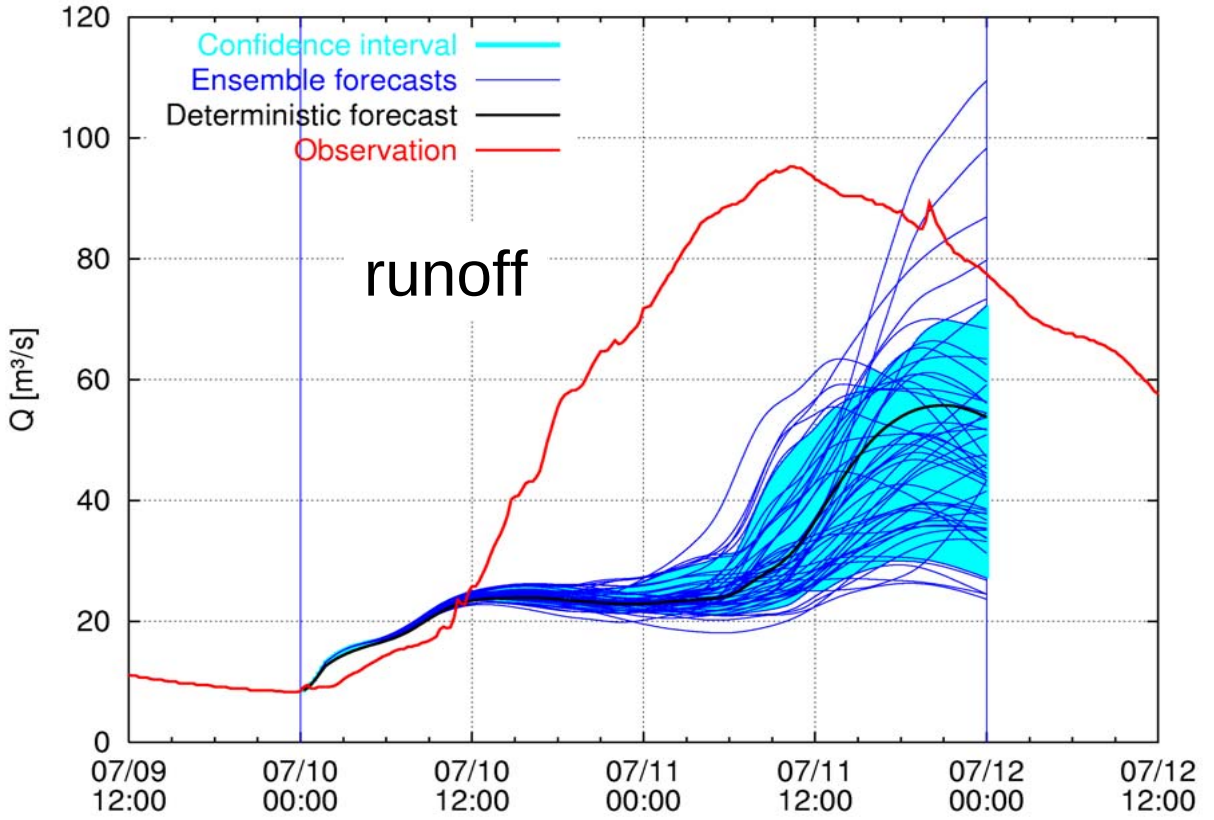
for Δt = **24h**, **36h**, **48h**

Zwettl/Kamp
July 9, 2005
00:00





Zwettl/Kamp
July 10, 2005
00:00



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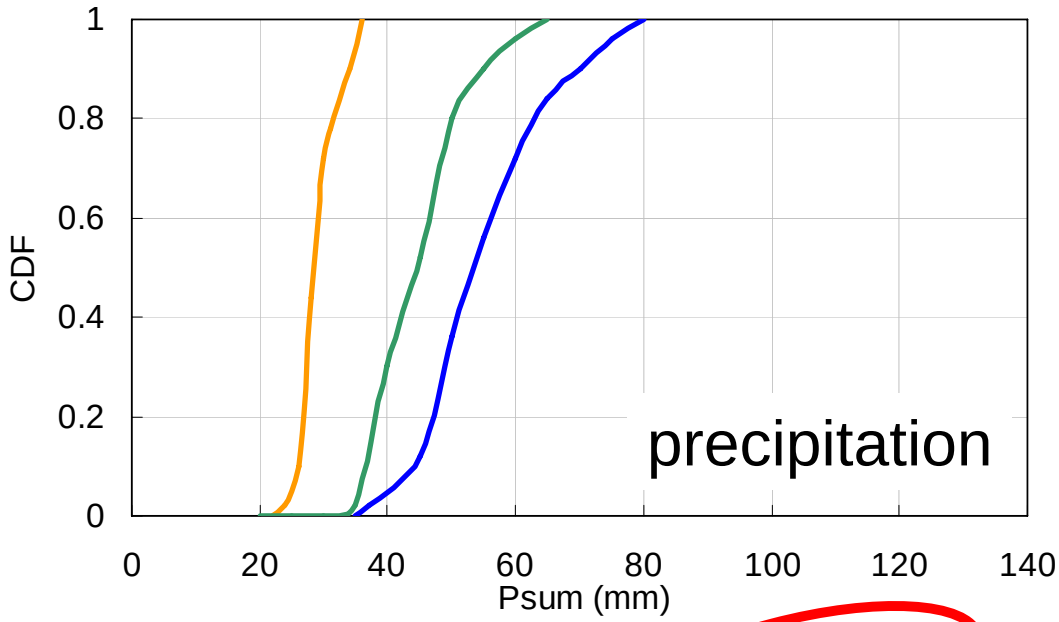
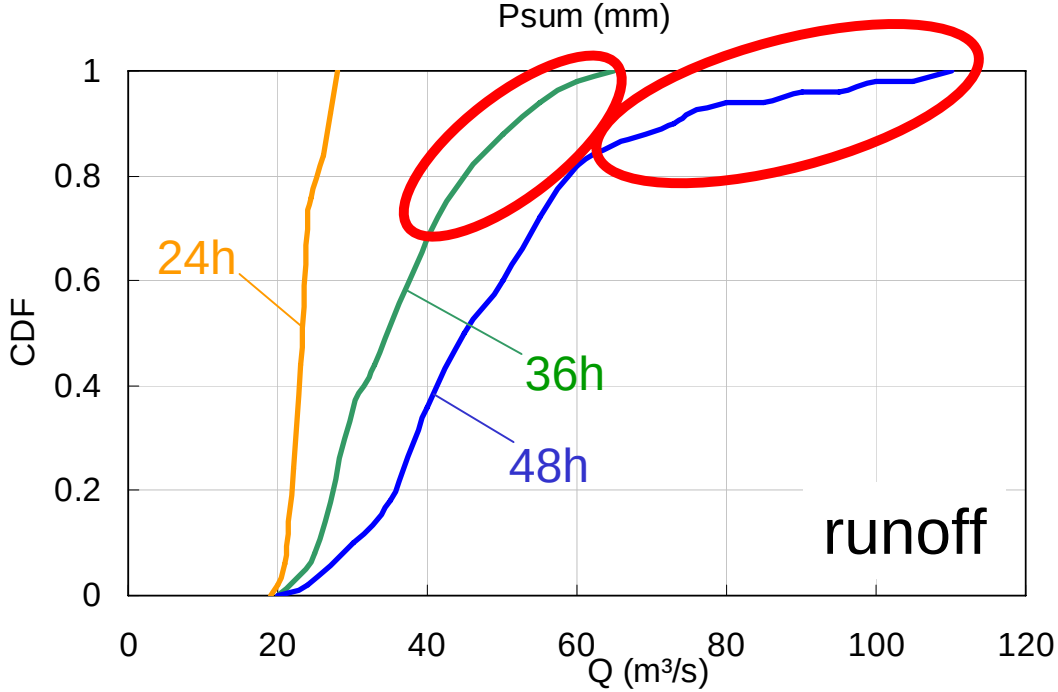
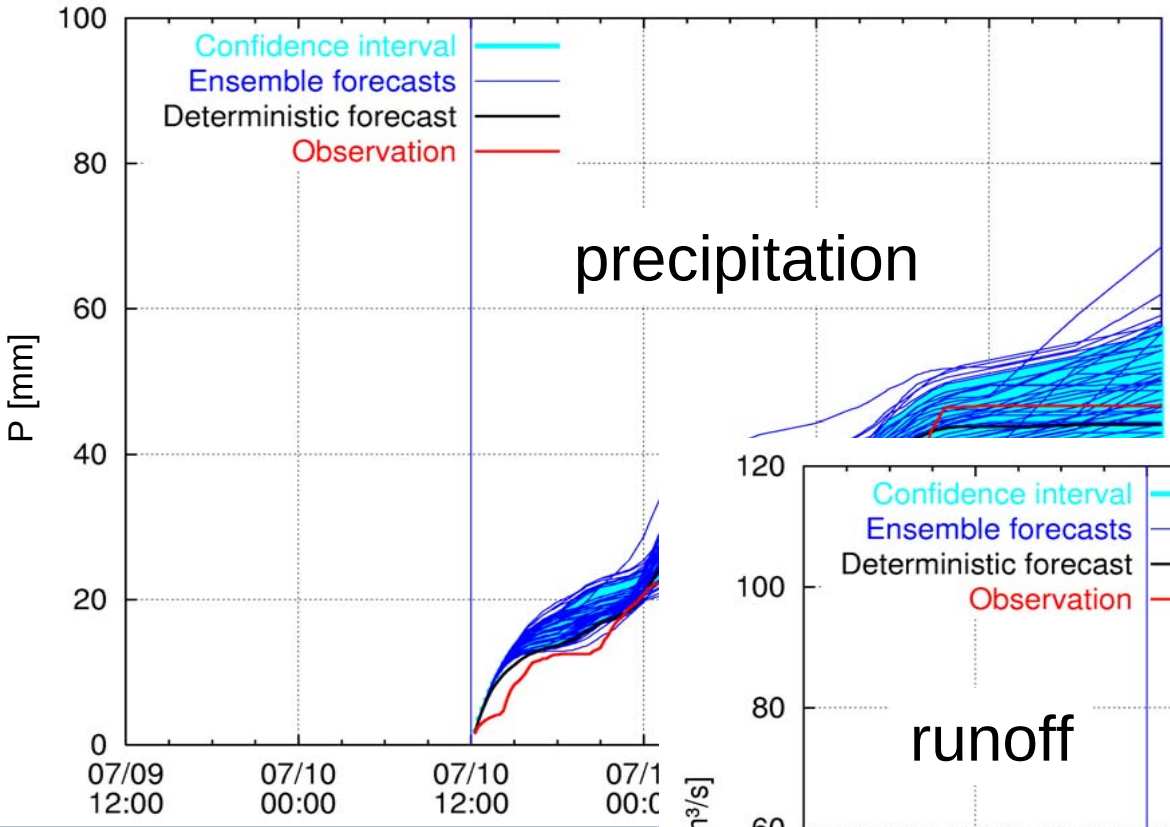
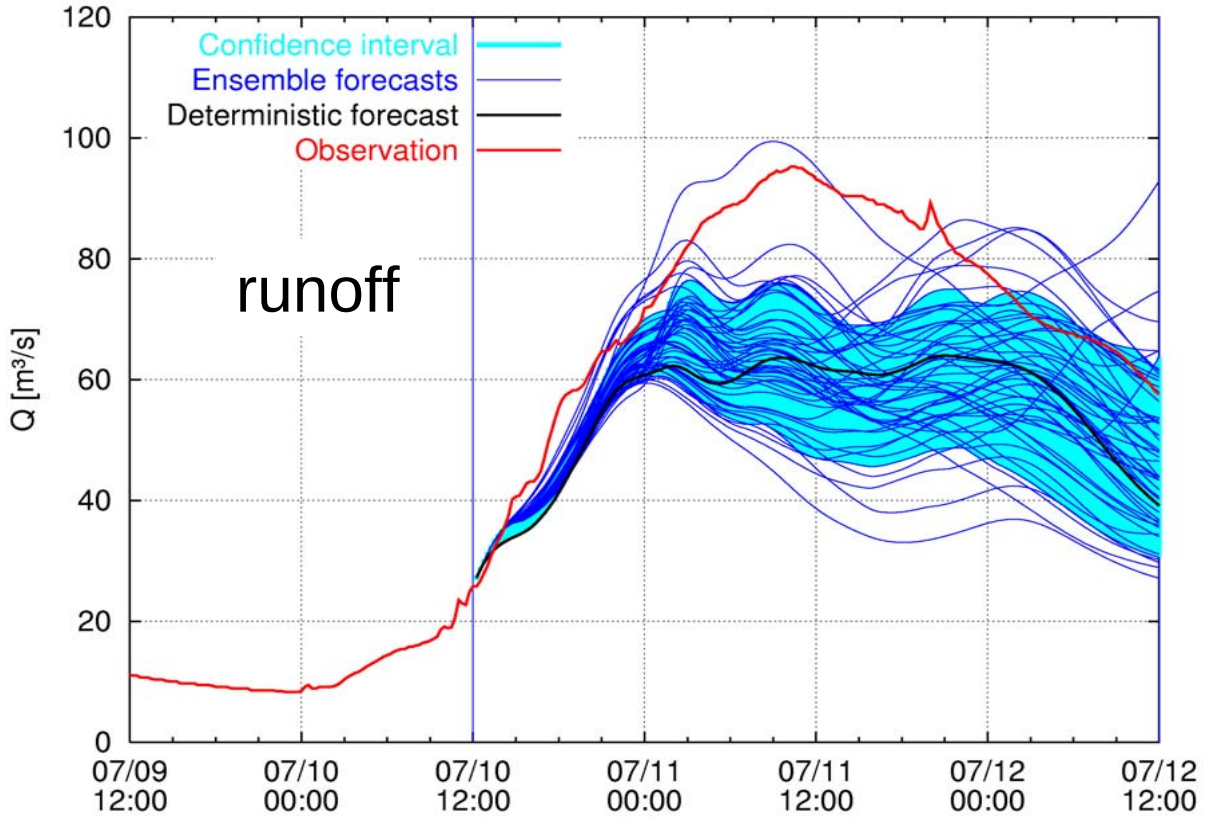
July 10, 2005
00:00







Zwettl/Kamp
July 10, 2005
12:00

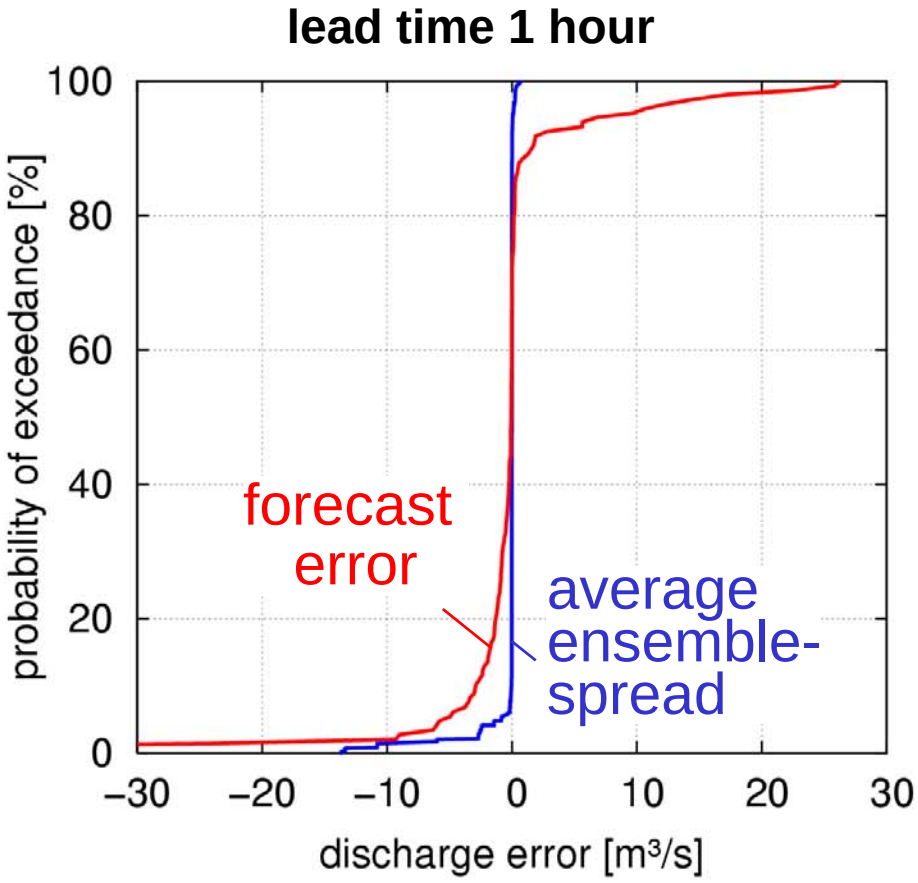


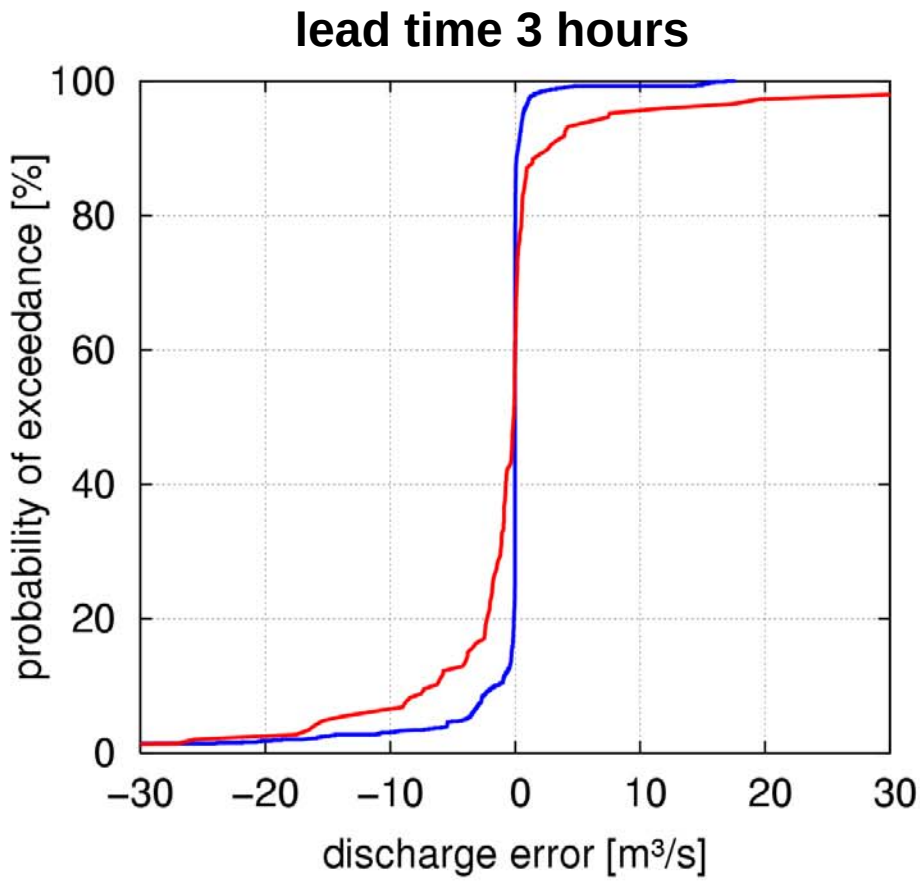
Error distributions

Gauge Zwettl/Kamp
(622 km²)

Assumptions:

- ensemble represents all error sources
- all ensemble members equally probable





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- ensemble represents all error sources
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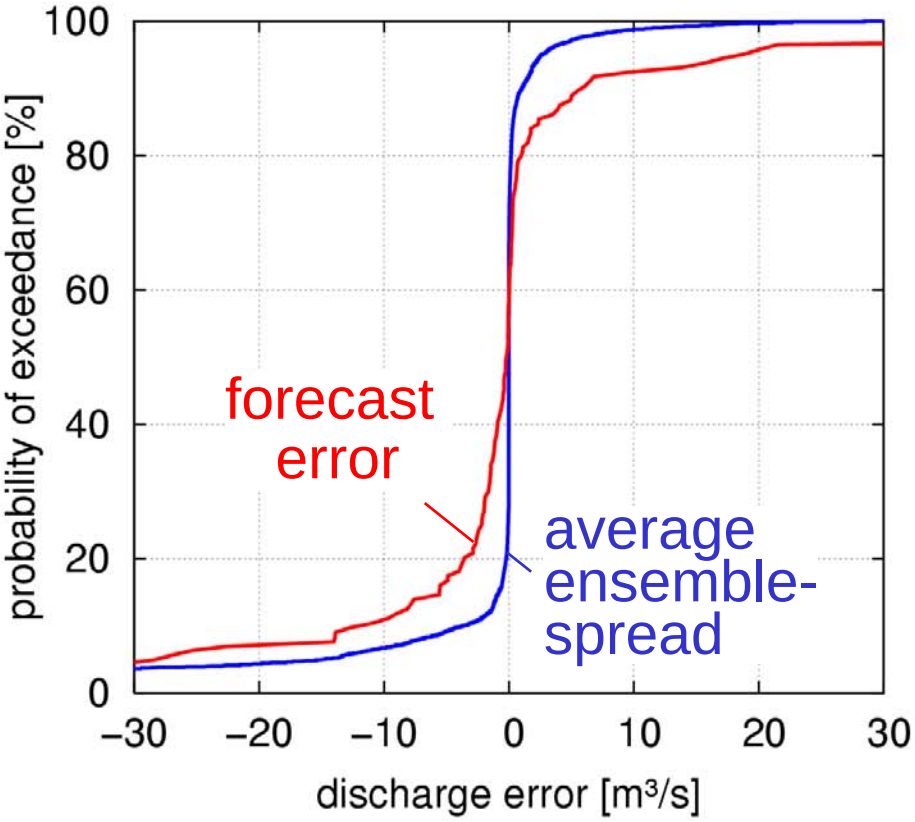
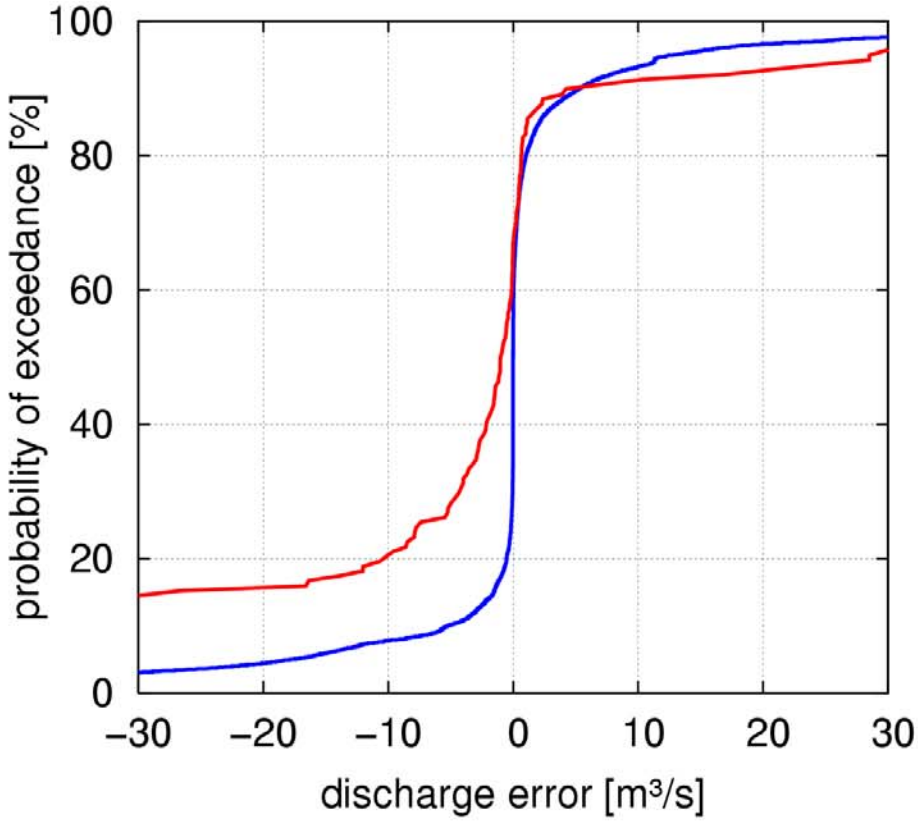
lead time 6 hours



lead time 12 hours



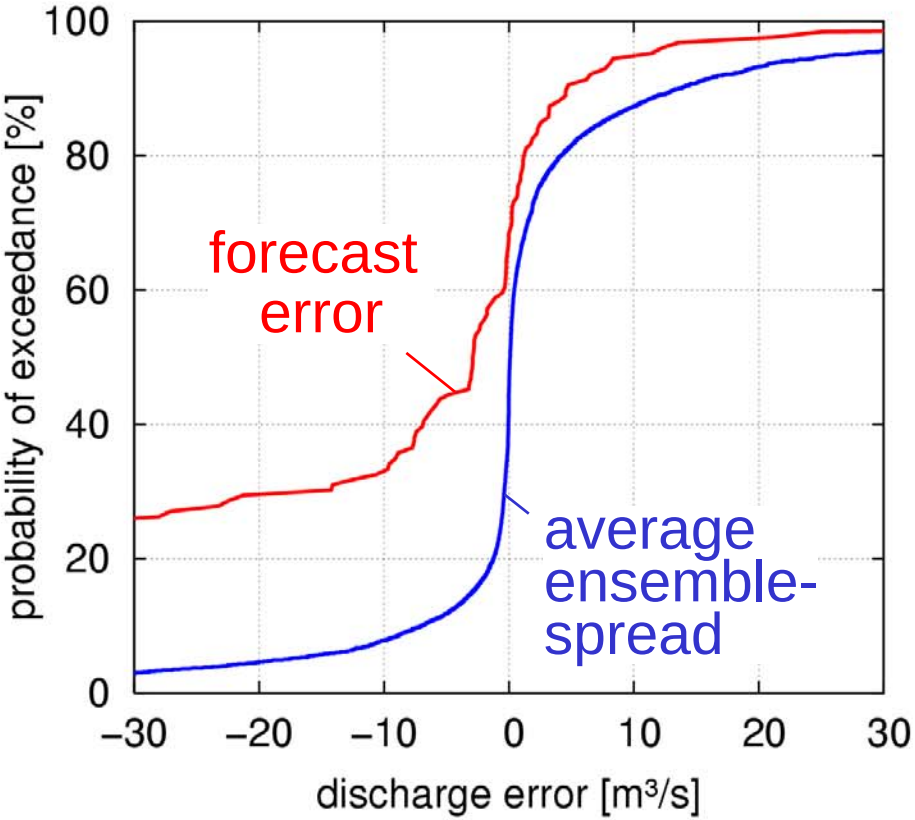
Error distributions

Gauge Zwettl/Kamp
(622 km²)

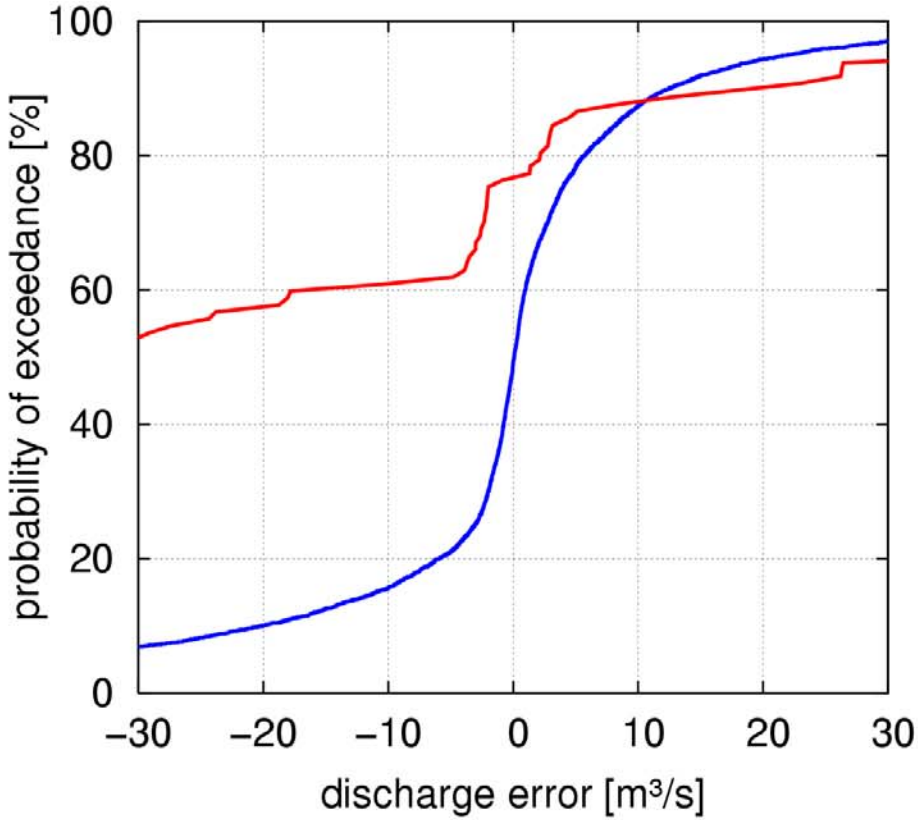
Assumptions:

- ensemble represents all error sources
- all ensemble members equally probable

lead time 24 hours



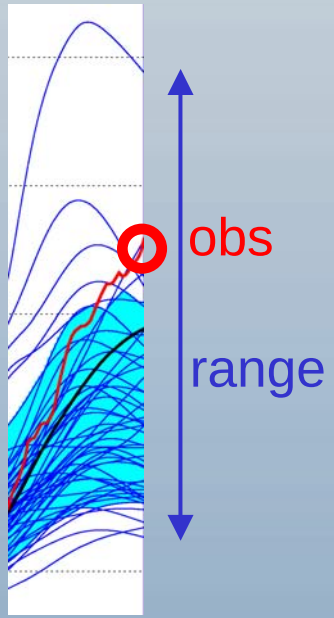
lead time 48 hours

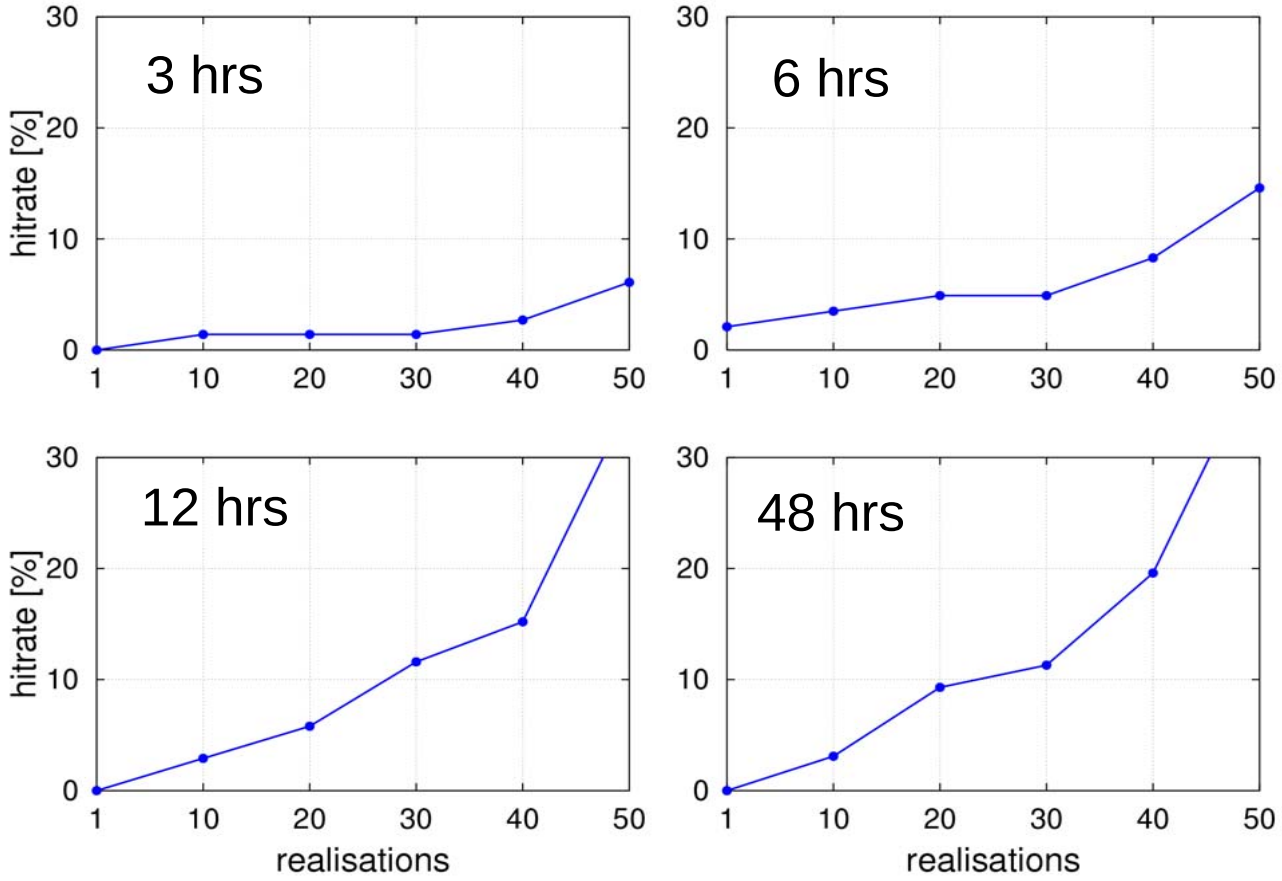


Percentage of forecasts, for which ensemble range overlaps with observed runoff

Additional uncertainties: - small scale precipitation
- runoff model structure and parameters

Gauge Zwettl/Kamp
(622 km²)





Conclusions

- Forecast accuracy depends on response time of catchment
- Real time updating of soil moisture based on Ensemble Kalman Filter using runoff data improves forecasts
- Ensembles as indicators of possible flood occurence
  → early flood warning
- Probabilistic interpretation of ensembles – comparison with error distributions
- Operational as of January 1, 2006
  … gaining experience with the forecasting system

THANK YOU !