Ensemble Flood Forecasting in Switzerland: Selected case studies of extreme events

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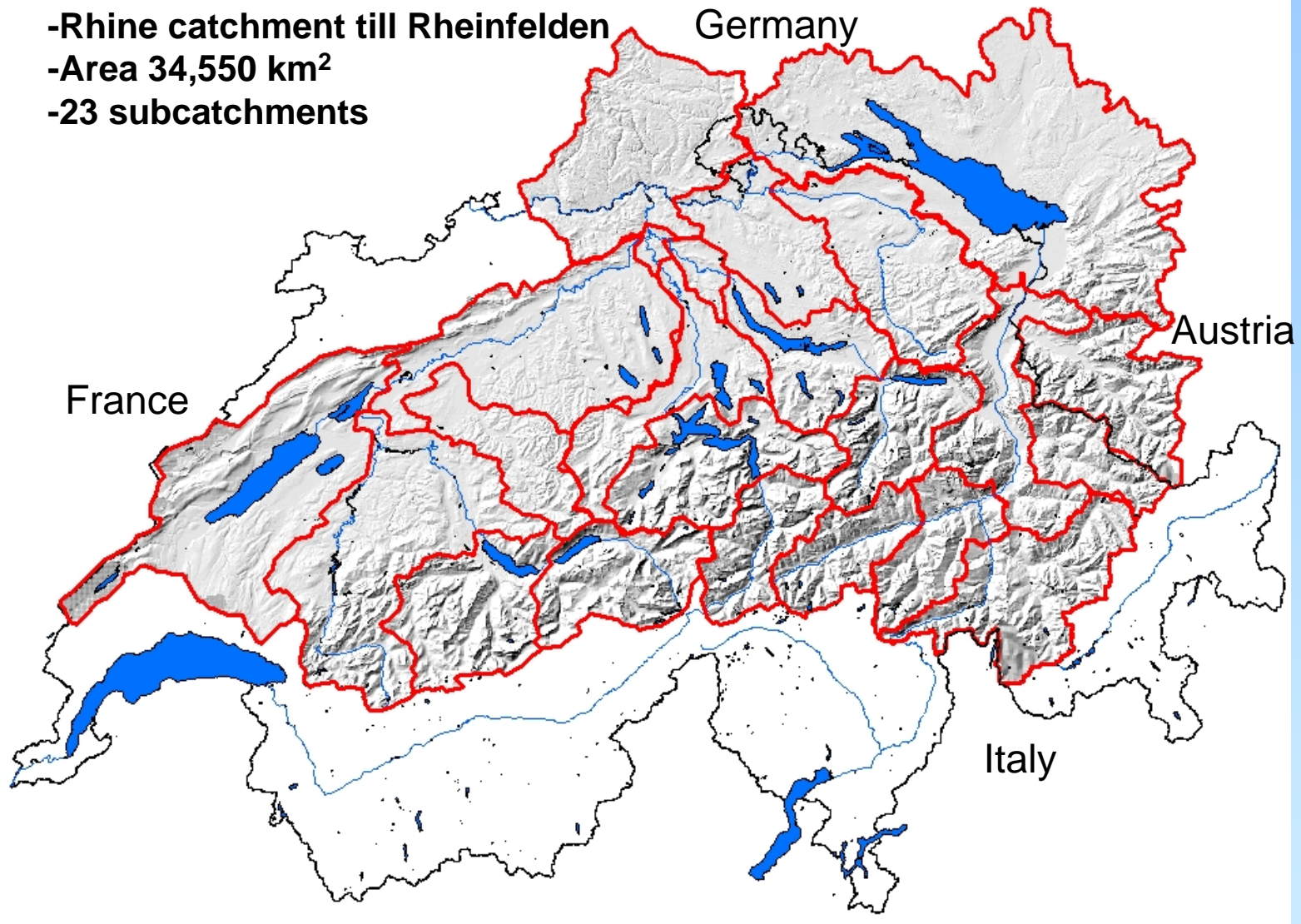[2]MeteoSwiss, Zurich, Switzerland
[3]ARPA-SIM, Regional Meteorological Service of Emilia-Romagna, Italy
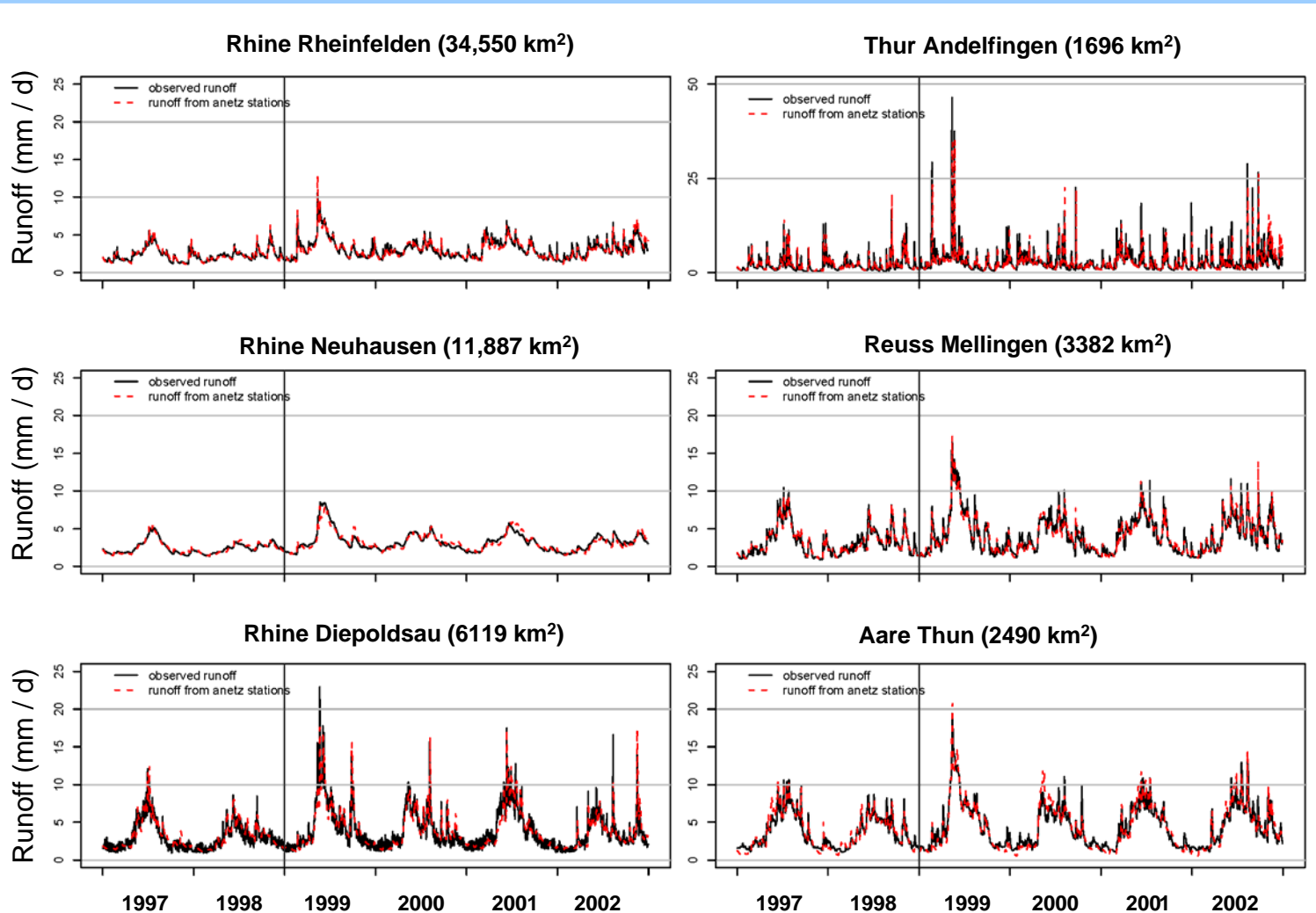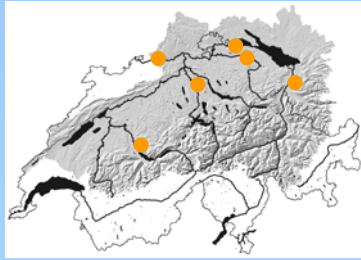
Aim

„To develop a probabilistic
runoff forecasting system
to quantify the forecast uncertainty"
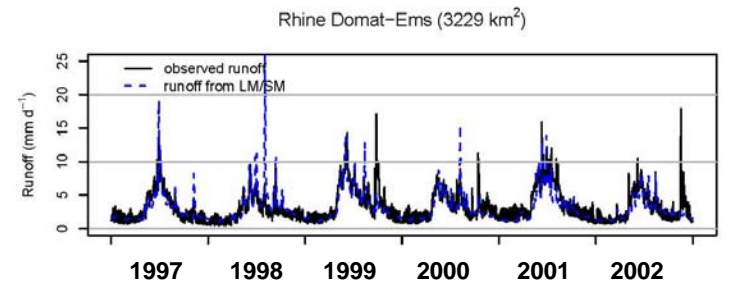
The investigated catchments

-Rhine catchment till Rheinfelden
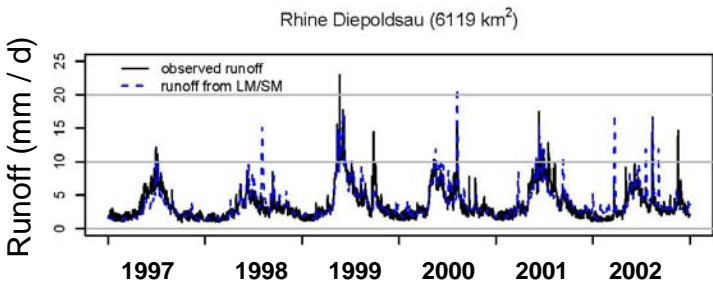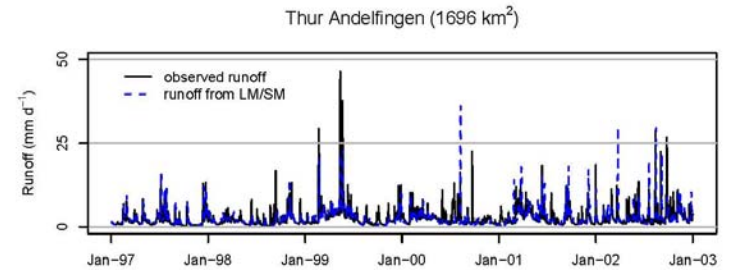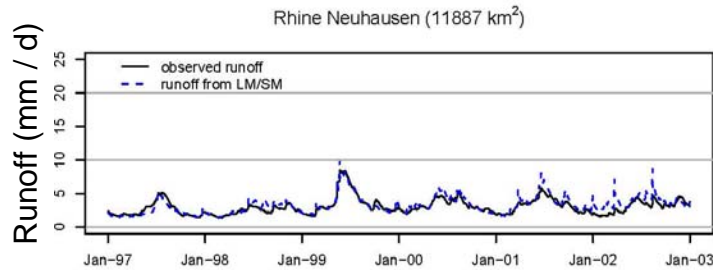-Area 34,550 km^2
-23 subcatchments

Hydrological calibration & validation

Rhine Rheinfelden (34,550 km²)

Thur Andelfingen (1696 km²)

Rhine Neuhausen (11,887 km²)

Reuss Mellingen (3382 km²)

Rhine Diepoldsau (6119 km²)

Aare Thun (2490 km²)

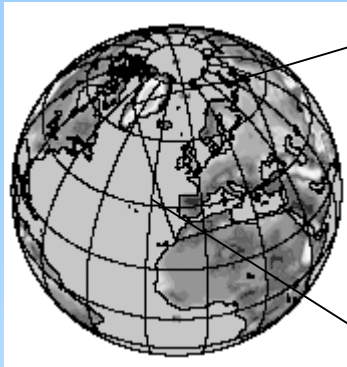# Verification of the Lokal Model (19-42 h)
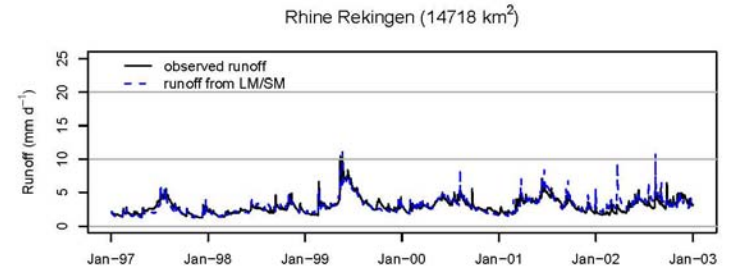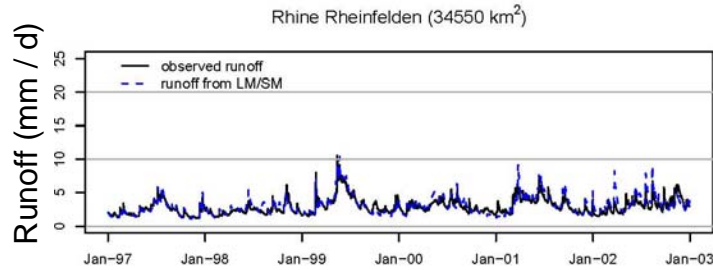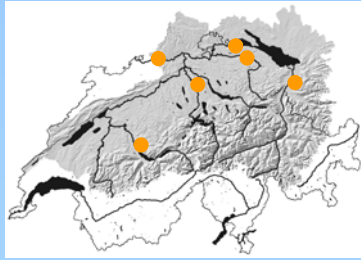
Probabilistic flood forecasting with the use of a Limited-area ensemble prediction system

- Weather forecasts contain considerable uncertainties.

- Information about uncertainty of flood forecasts is desirable.

- Provides a range of possible outcomes instead of a single value.
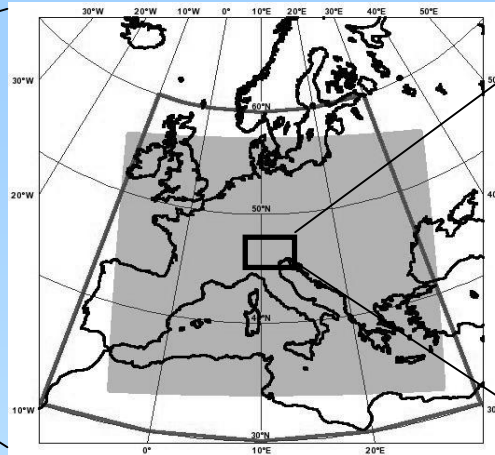
Model chain

1. (ECMWF-EPS)

-global
-resolution: 80 × 80 km
-ensemble members: 51
-40 vertical levels
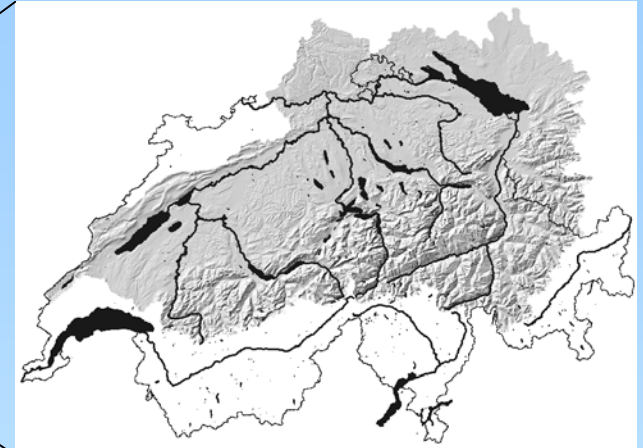-operational: 51 members

A. Montani, ARPA-SIM

2. COSMO-LEPS

-central and southern Europe
-resolution: 10 × 10 km
-ensemble members: 51
-40 vertical levels
-operational: 16 members

A. Walser, MeteoSwiss
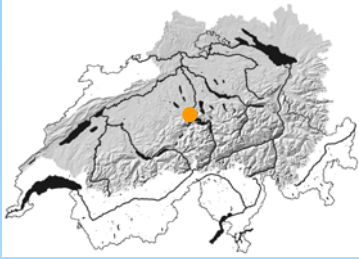
3. Hydrologic-EPS

-Rhine basin (Rheinfelden)
-resolution: 0.5 × 0.5 km
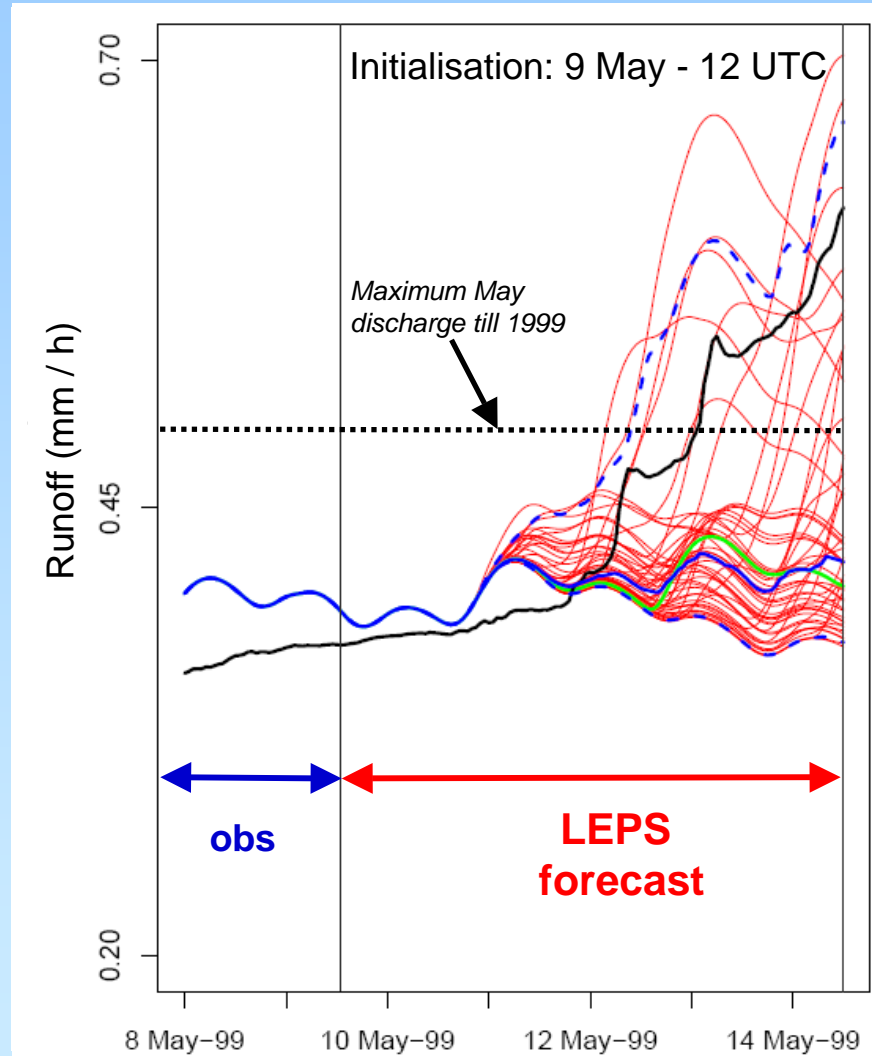-ensemble members: 51
-PREVAH
-operational: 0 members

M. Verbunt, ETH Zurich

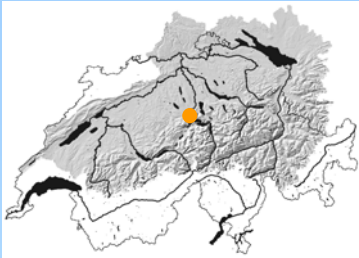# Deterministic versus Probabilistic Predictions

Reuss –Luzern (2251 km^2)

— observed runoff
— deterministic forecast
— ensemble members
— ensemble median
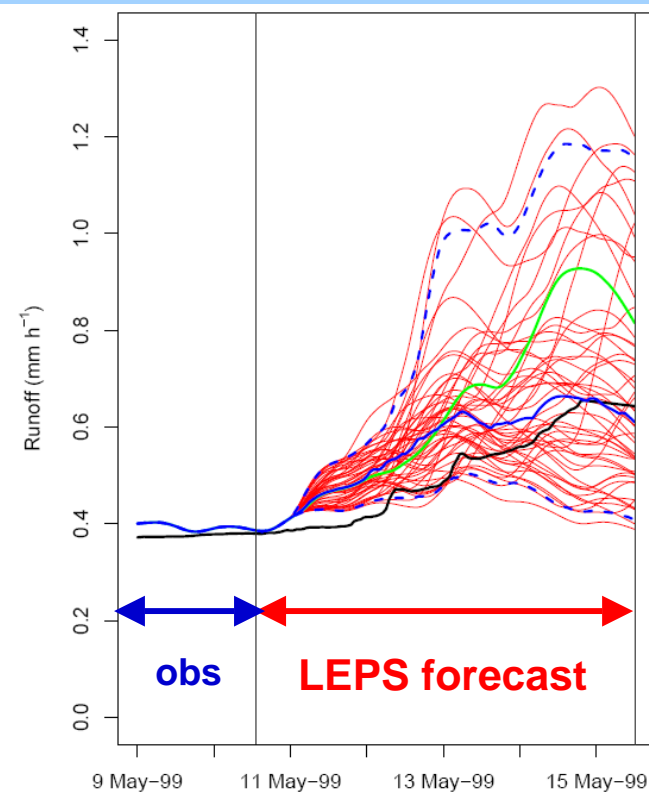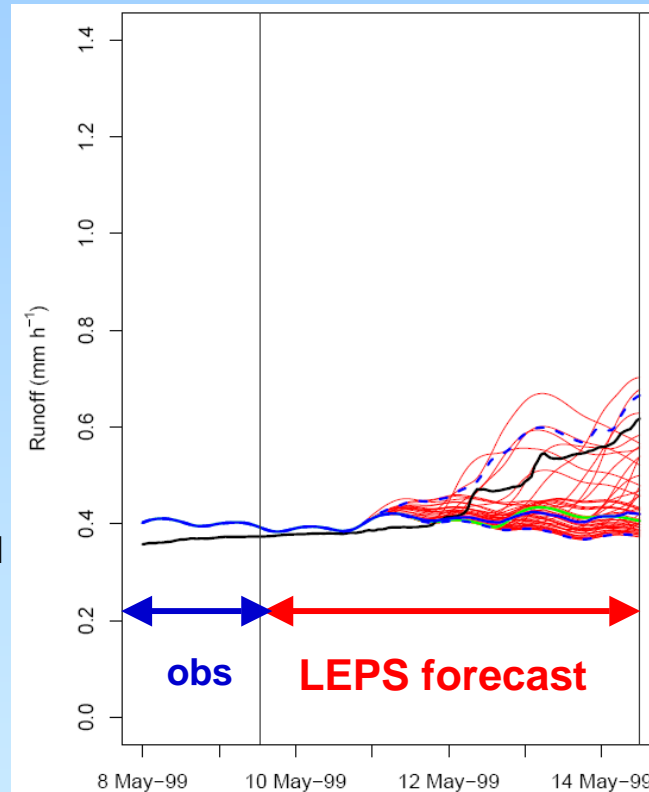-- - 95% confidence interval

Impact of a smaller lead time

Reuss –Luzern (2251 km²)

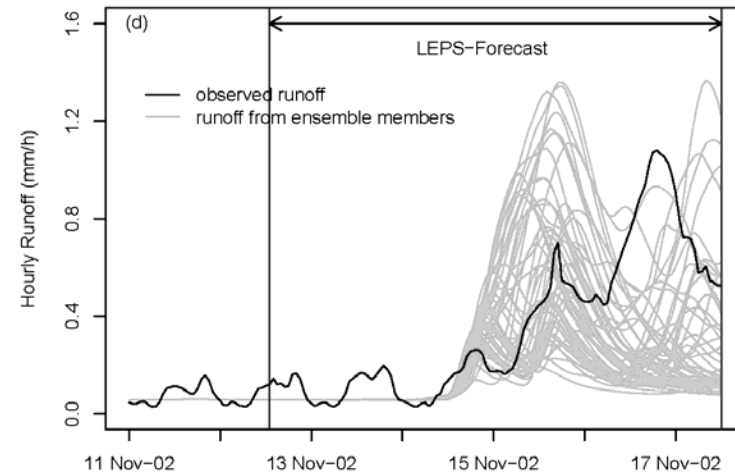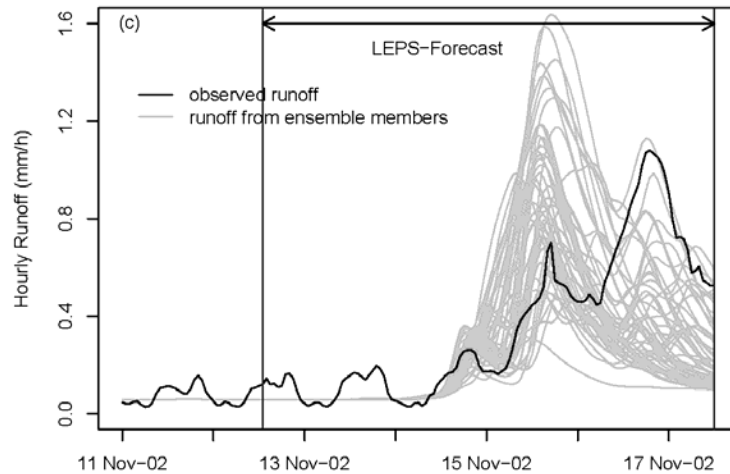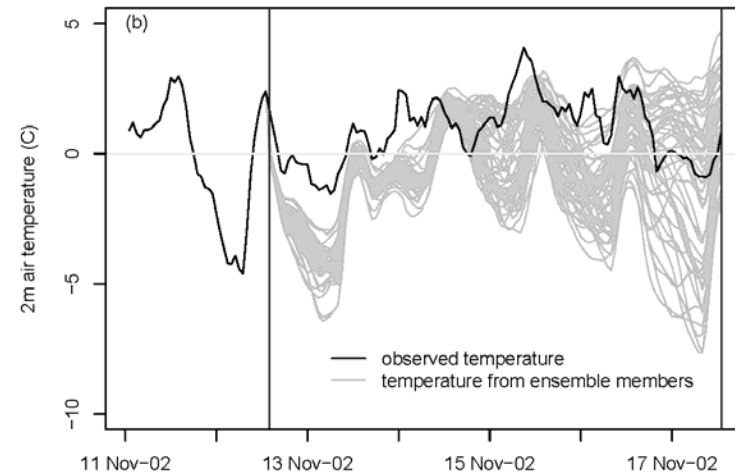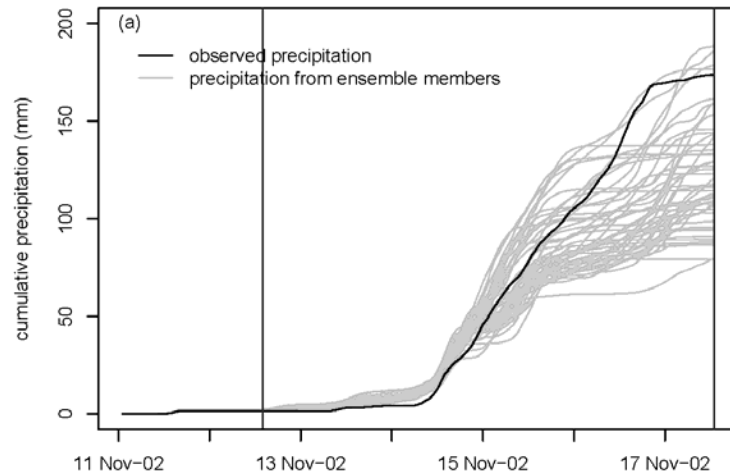observed runoff
deterministic forecast
ensemble members
ensemble median
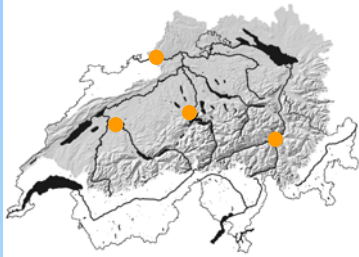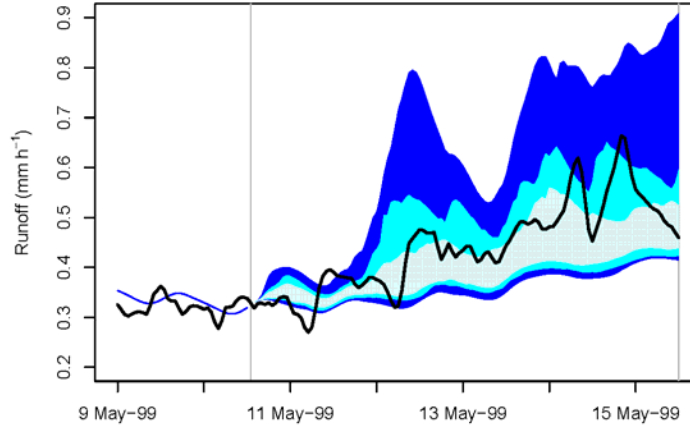95% confidence interval

9 May 12 UTC

10 May 12 UTC

Impact of temperature and precipitation

Rhine Domat-Ems (3229 km²)

Runoff Quantiles
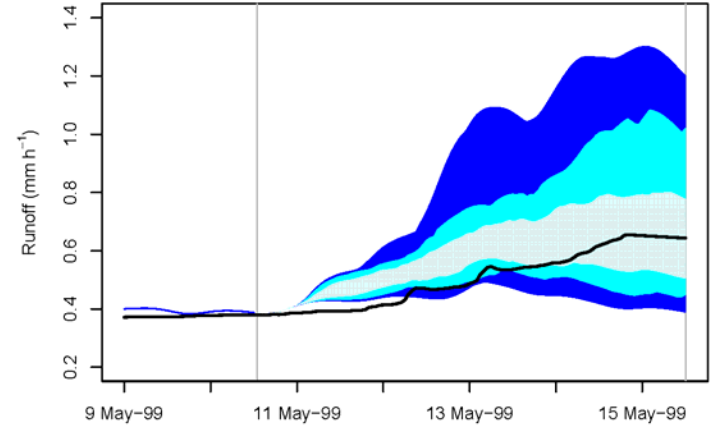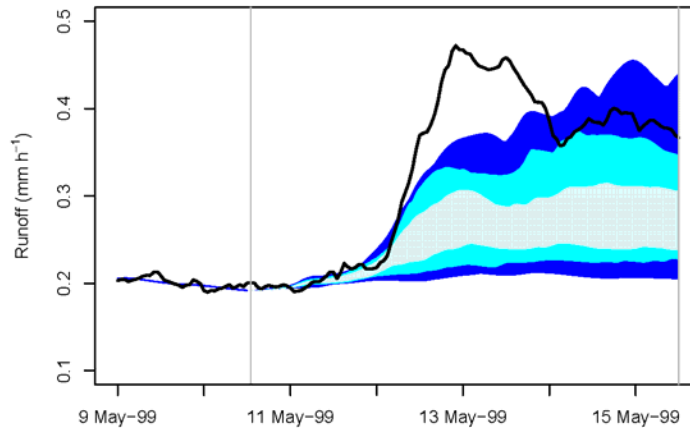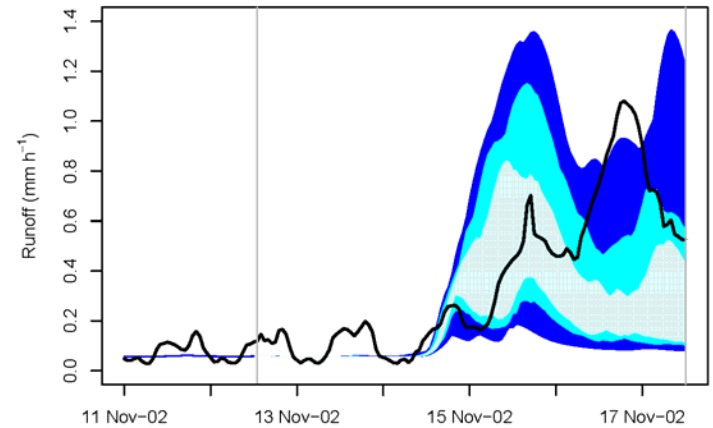
Probability map

Predicted probabilities exceeding the 80% level of the maximum May discharge
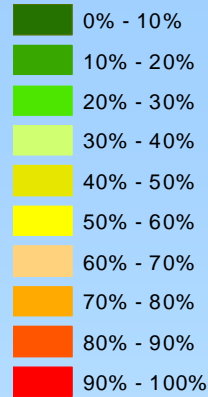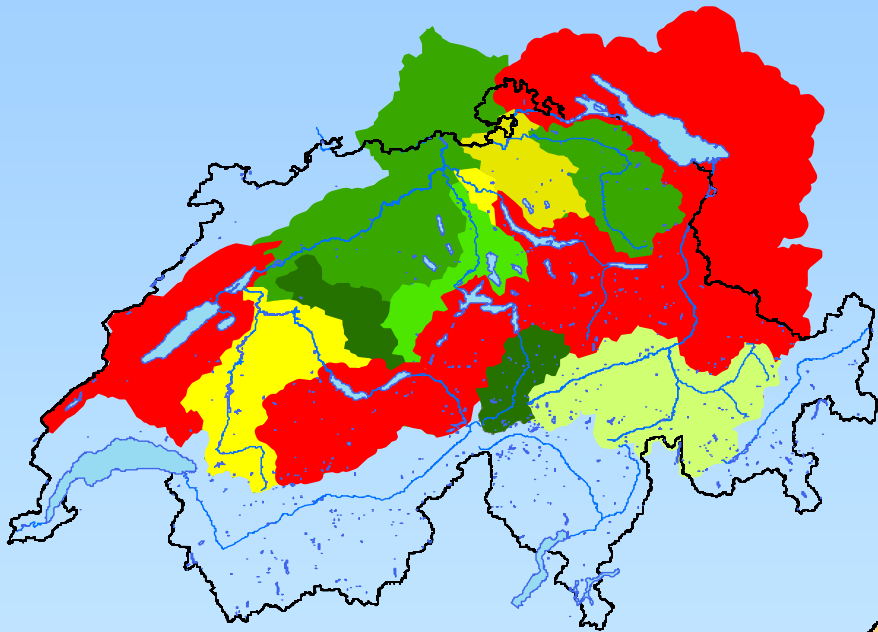
Observed discharges compared to the 80% level of the maximum May discharge

0% - 10%	
10% - 20%	
20% - 30%	
30% - 40%	
40% - 50%	
50% - 60%	
60% - 70%	
70% - 80%	
80% - 90%	
90% - 100%	

< -15%	
-15% - 5%	
-5% - 5%	
5% - 15%	
15% - 25%	
25% - 35%	
35% - 45%	
45% - 55%	
55% - 65%	
>65%	
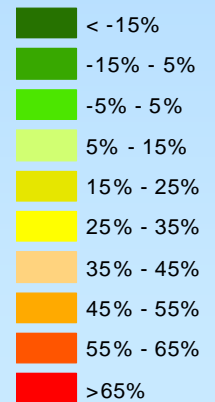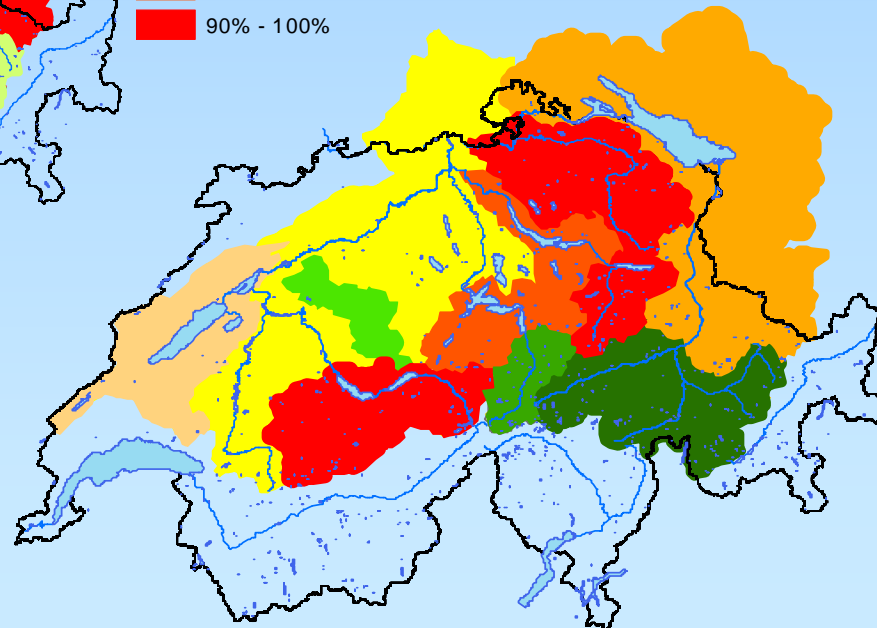
The clustering methodology

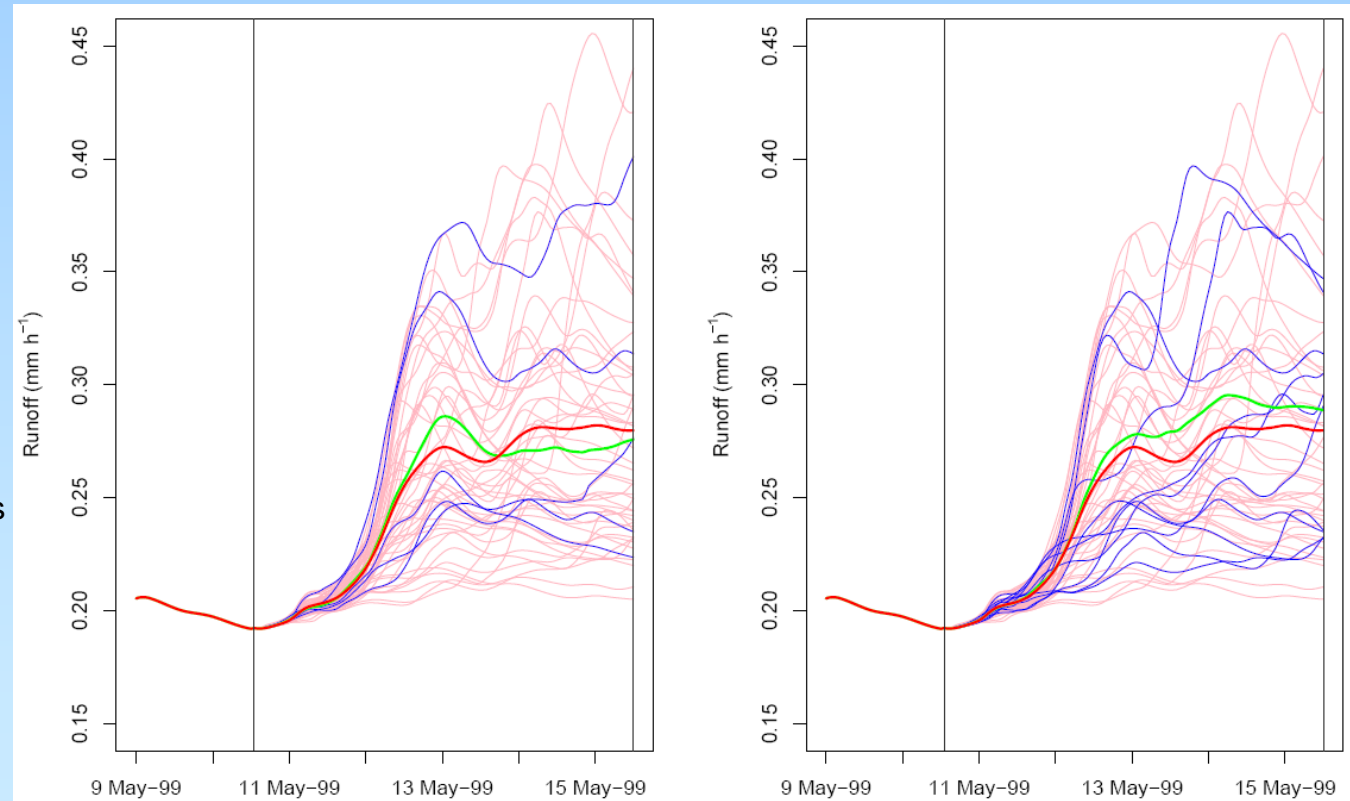- high demands of total ensemble regarding computer resources
- select representative members (*Molteni et al, 2001*)

Rhine – Rheinfelden (34,550 km^2)
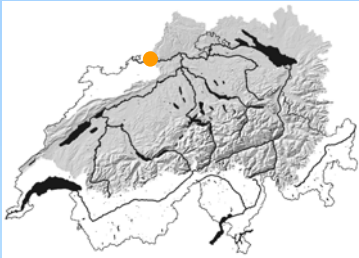
5 RMs

10 RMs

total ensemble (51)
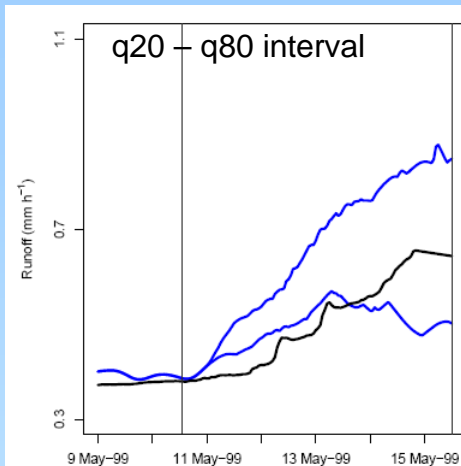representative members
mean of repres. members
mean of total ensemble

The clustering methodology
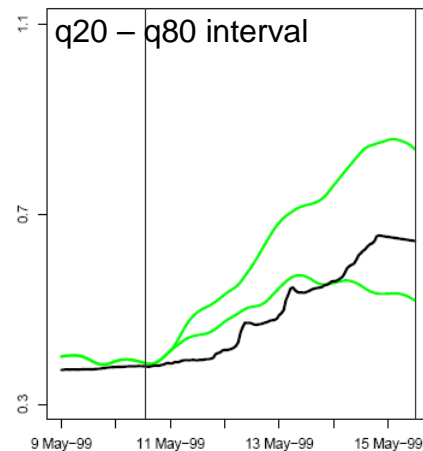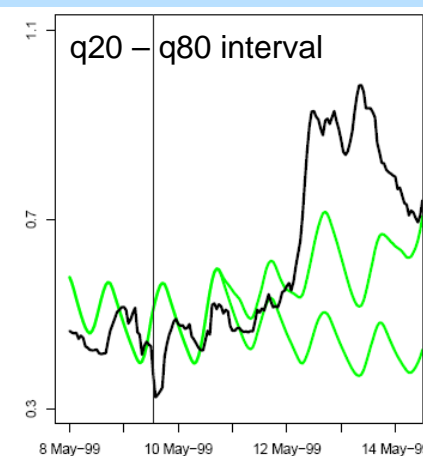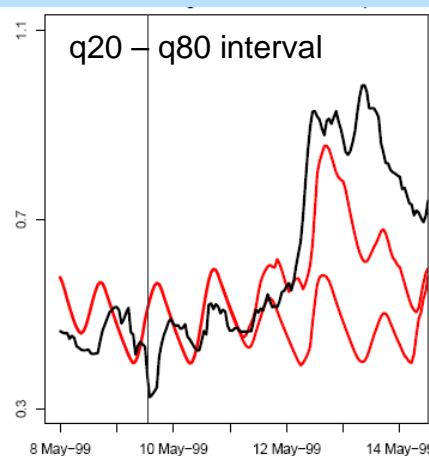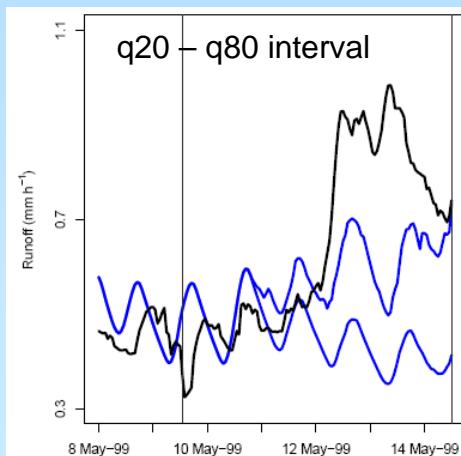
November 2002 Flood – Rhine Domat-Ems
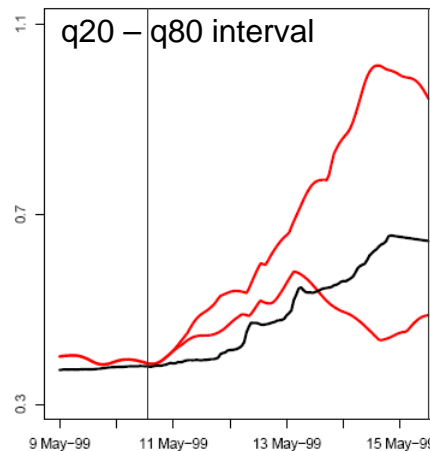
*120 h sum of total precipitation,
at 17 Nov 2002 12 UTC*

(A. Walser, MeteoSwiss)

August 2005 Flood - Aare Hagneck

Initialized at 20.08.2005 00.00 UTC

Legend:
- measured runoff
- initialisation curve
- aLMo runoff
- LEPS runoff
- LEPS IQR

(S. Jaun, ETH)

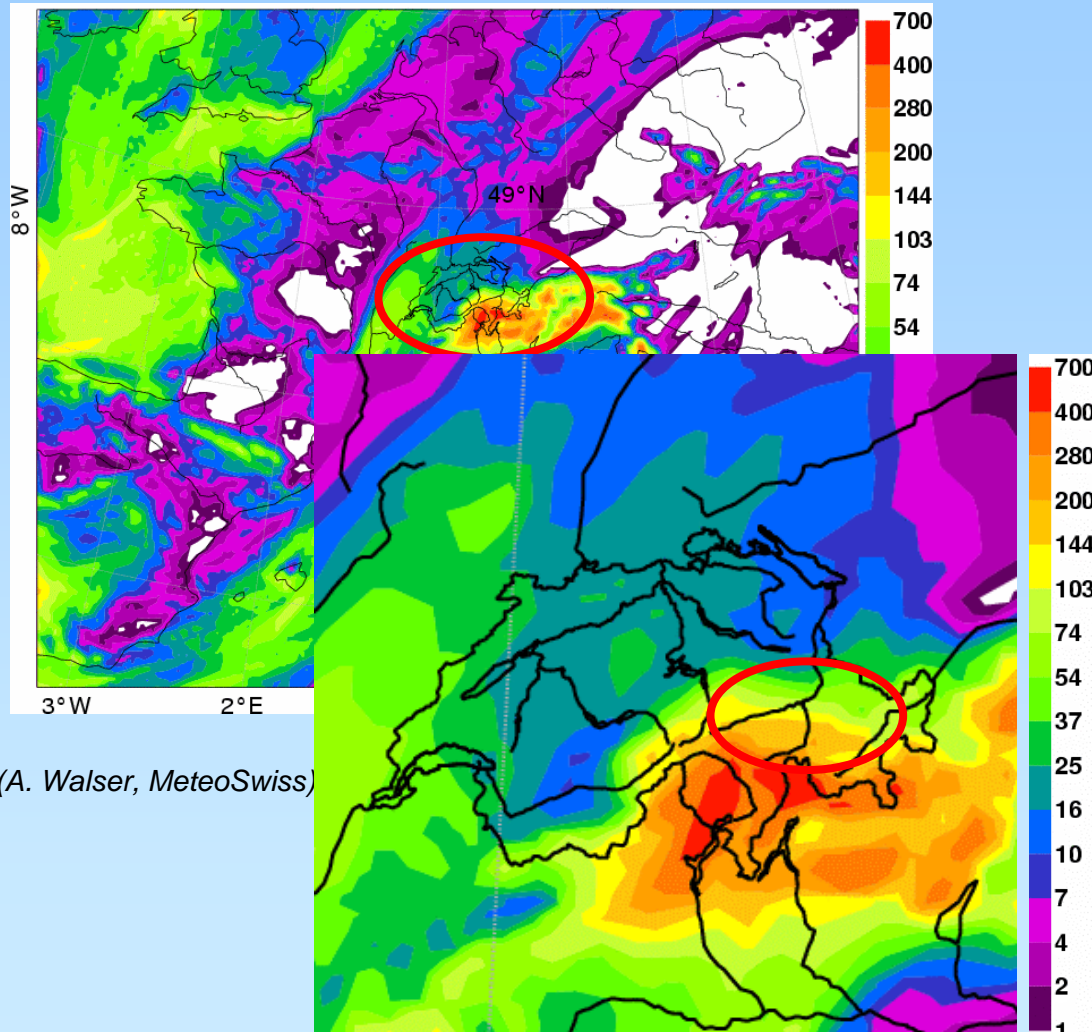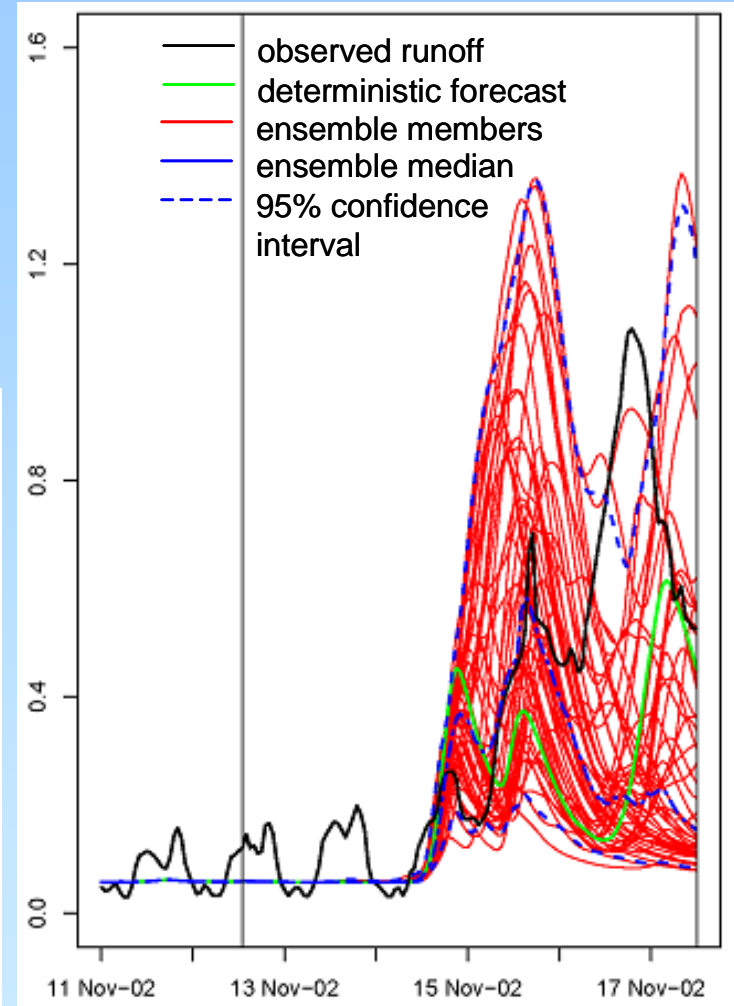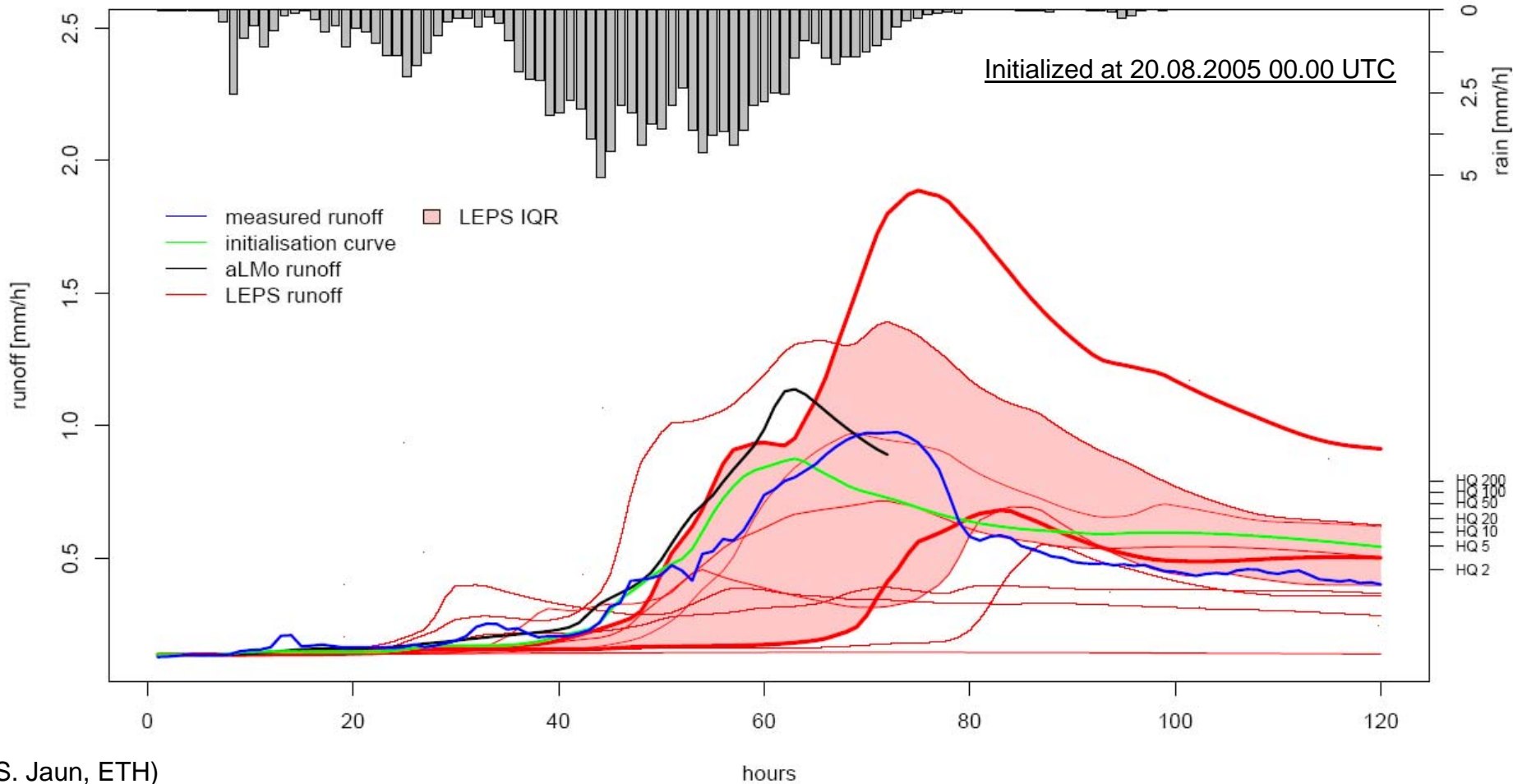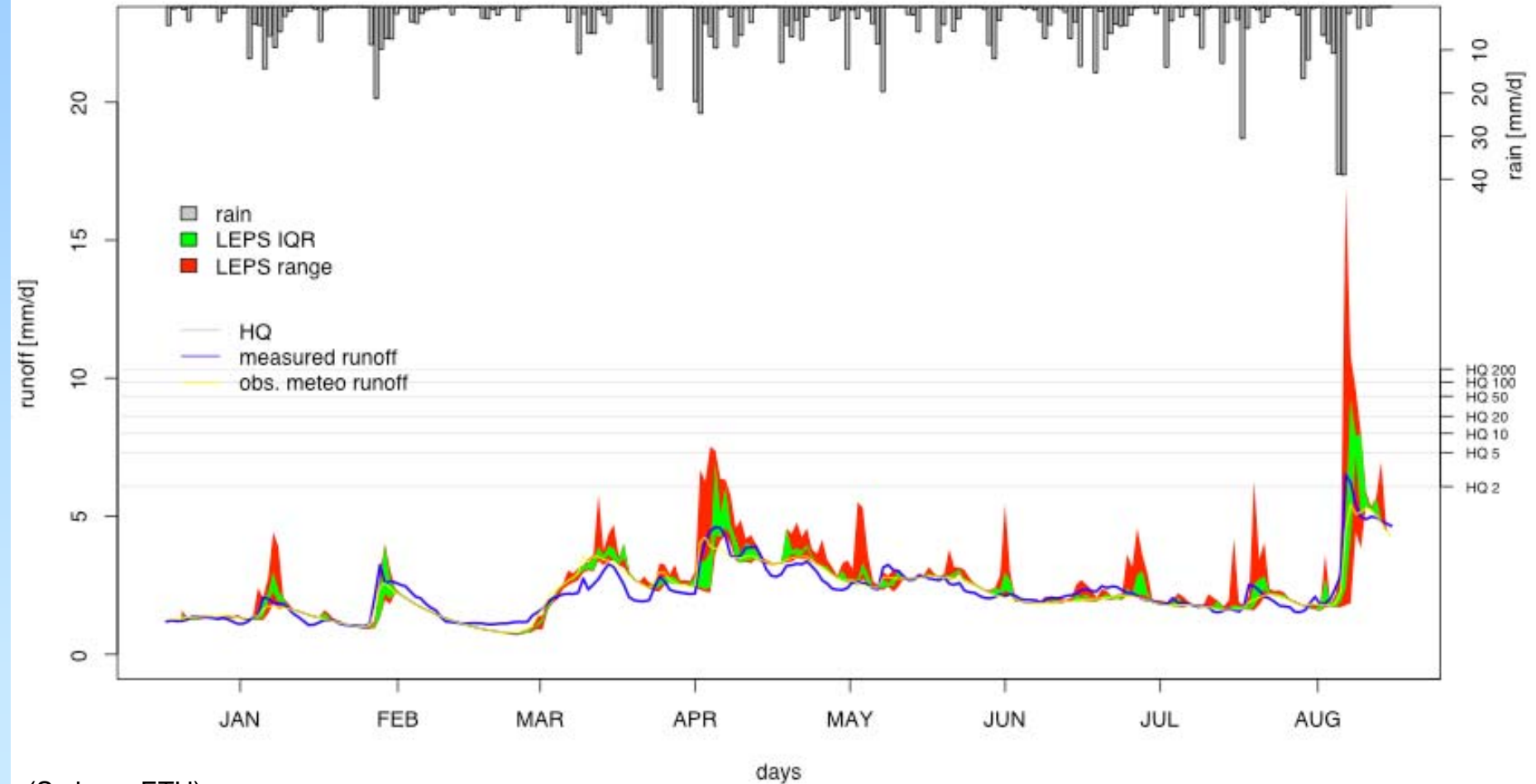Brugg (Aare), runoff forecast 2.1.2005–31.8.2005, range: 96hours

(S. Jaun, ETH)

Summary

• Probabilistic runoff forecasts show clear advantages and provide additional information compared to the deterministic forecast.

•The clustering technique does not reduce ensemble spread, while it reveals a larger range than randomly selected members.

• The coupled LEPS-hydrologic forecasts provide reliable forecast ranges and are a very promising tool to estimate uncertainties in flood forecasts.

•Time series of hydrological forecasts driven by ensemble data can be used as verification of the LEPS.