

Operational Hydrologic Ensemble Forecasts in Small Catchments – Implementing New Products for Precipitation Estimation and Seamless Predictions

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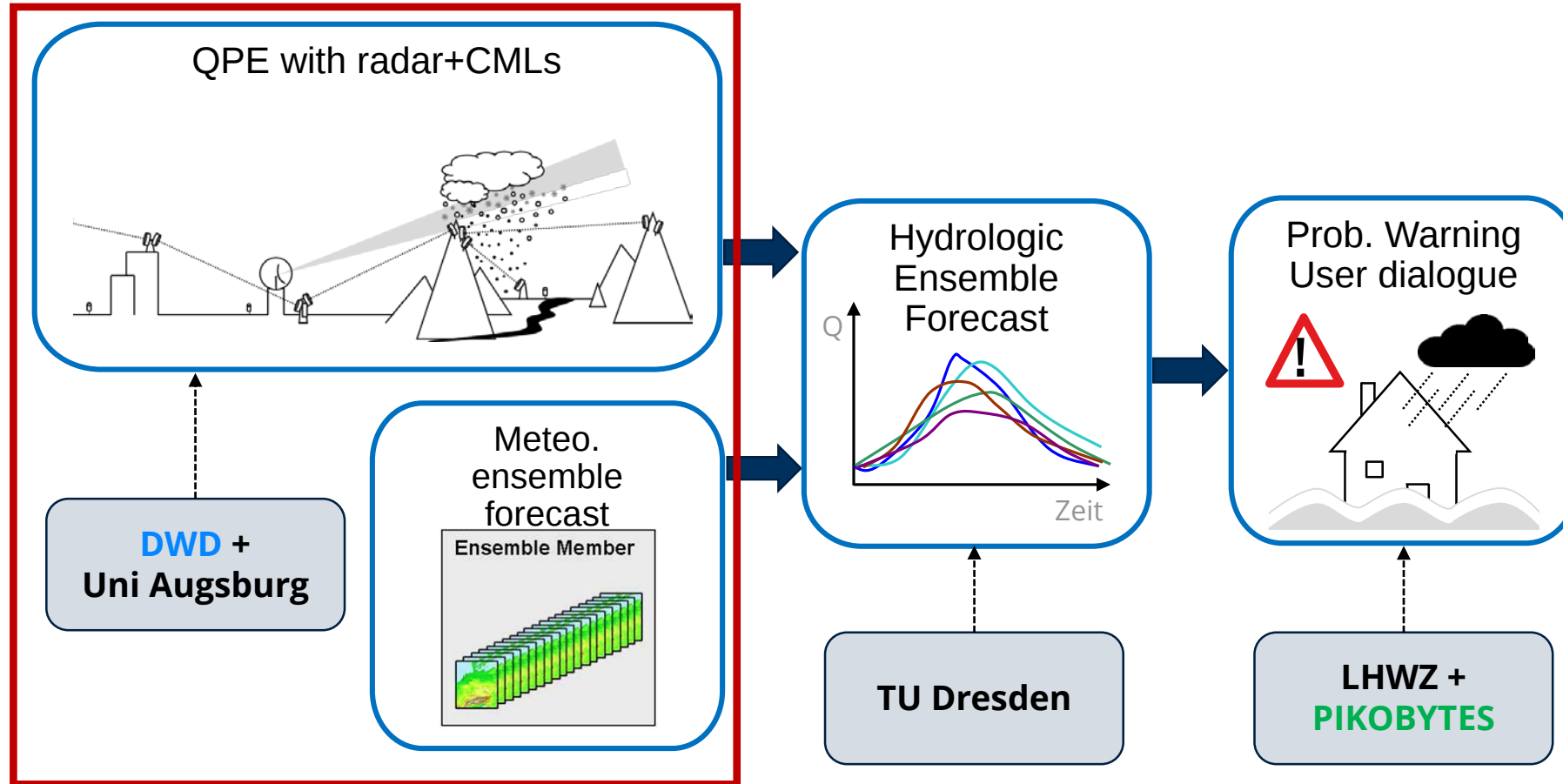
TU Dresden, Chair of Hydrology

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Introduction: HoWa-PRO

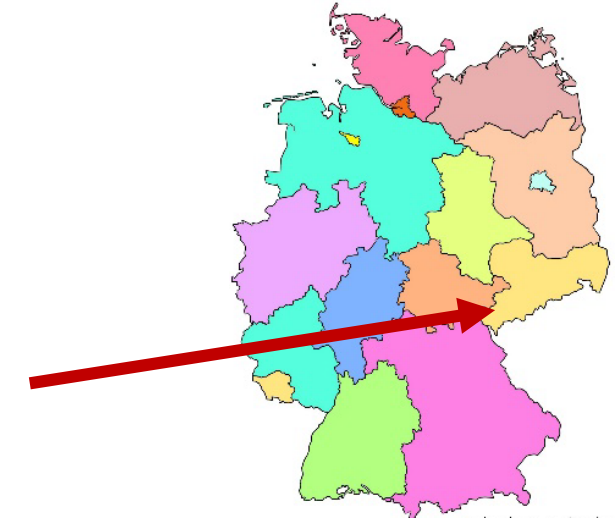


Small catchments and voluntary flood defence forces

- Benefit?
- Communication of uncertainties?
- Suitable warning products?

Is there a benefit of upcoming new data products?

Introduction: Saxony and pilote regions



Vogtland Weiße Elster

- Oelsnitz (328 km²)
- Adorf 1 (170 km²)
- Bad Elster (47,7 km²)

Osterzgebirge Rote Weißeritz

- Hainsberg 5 (160 km²)
- Reichstädt (12.7 km²)
- Dippoldiswalde (77.4 km²)
- Schmiedeberg (53.7 km²)
- Bärenfels (6.77 km²)

Lockwitzbach

- Kreischa (22.9 km²)

Müglitz

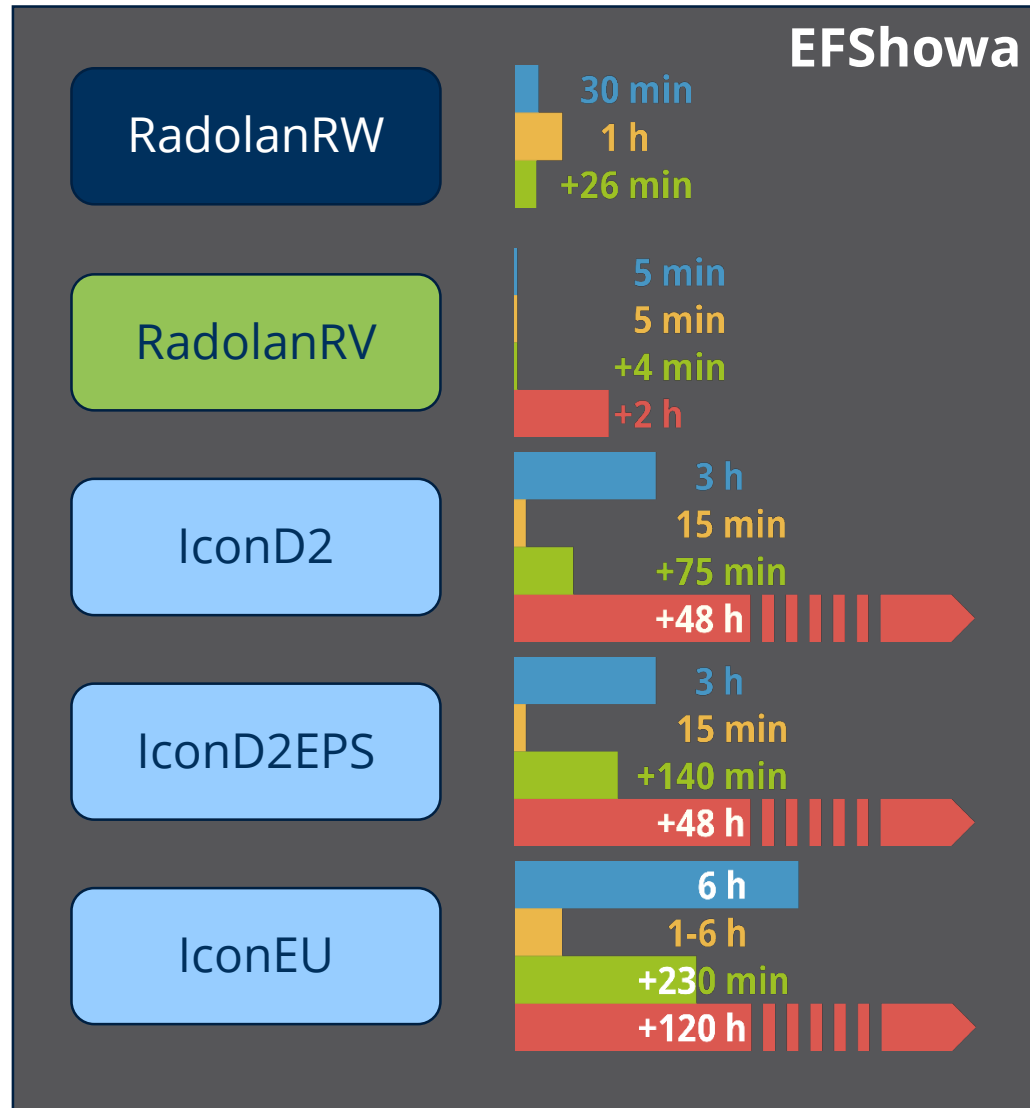
- Dohna (200 km²)
- Lauenstein 4 (75.4 km²)
- Geising (26.2 km²)

Oberlausitz Mandau

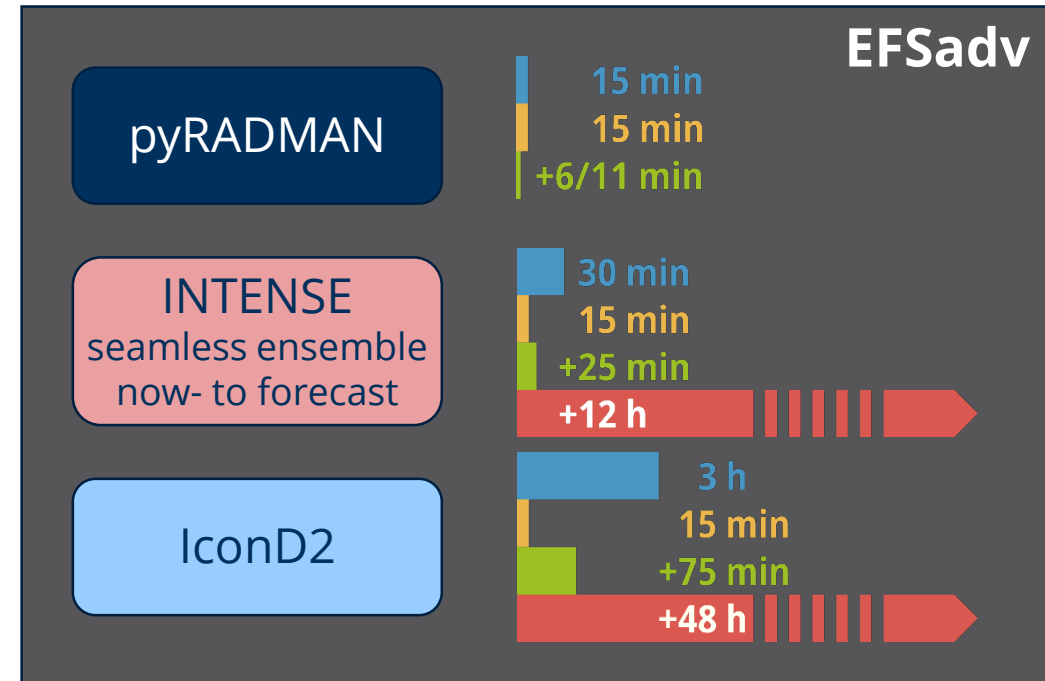
- Zittau 6 (277 km²)
- Großschönau (161 km²)
- Seifhennersdorf (74.9 km²)
- Niederoderwitz (28.8 km²)

Used data products of DWD for demonstrators

Established Data



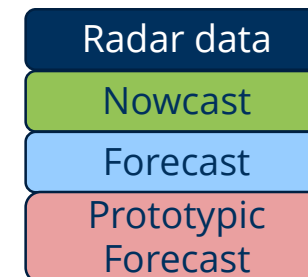
EFSadv



Prototypic Data

Legend

Data type



Properties

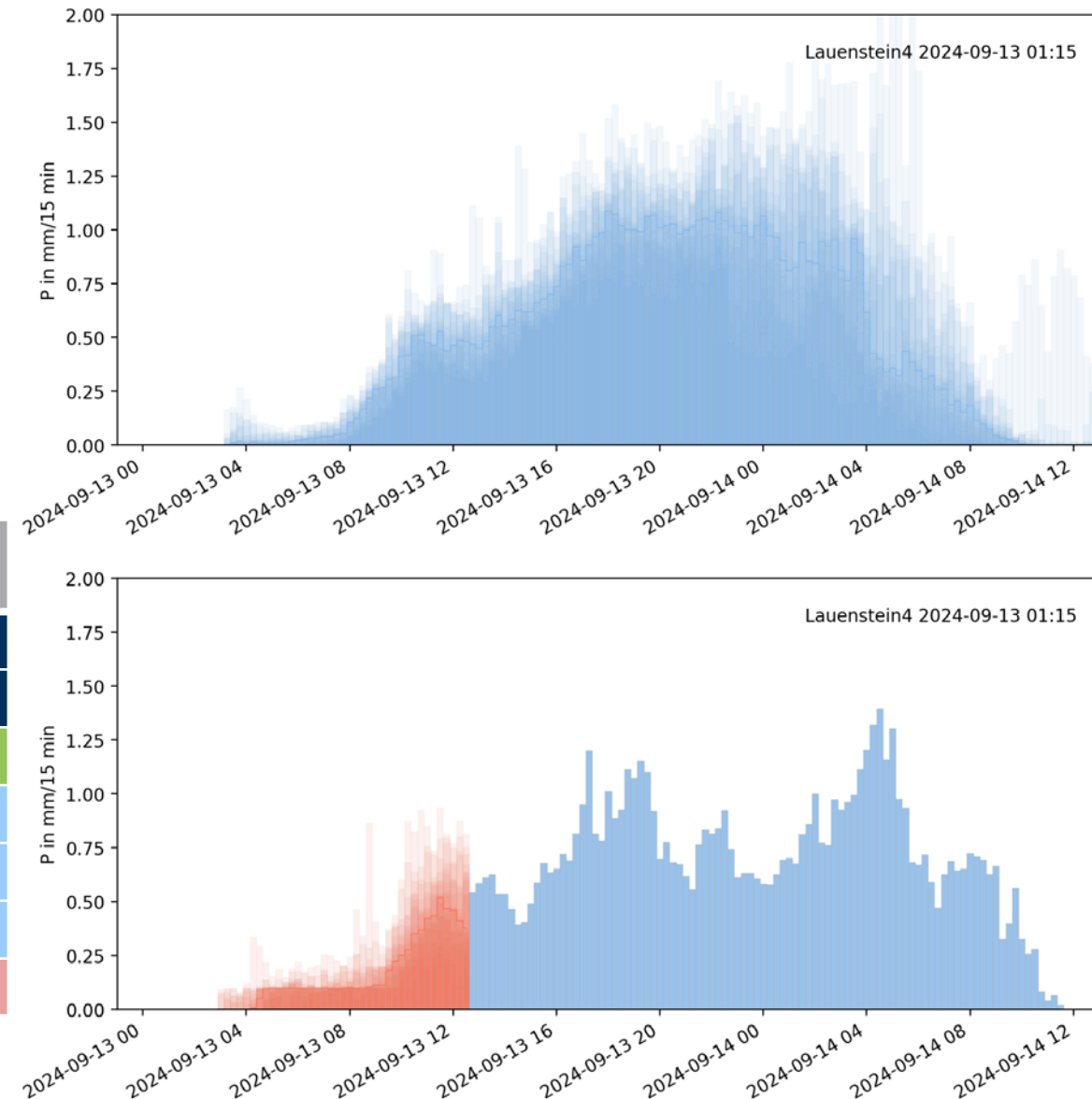


Used data products of DWD for demonstrators

- Example Lauenstein@Müglitz (Osterzgebirge)
- **EFShowa** (radRW, radRV, IconD2EPS)
 - radRW, updated each 30 min
- **EFSadv** (pyRADMAN, INTENSE, IconD2)
 - pyRADMAN, updated each 15 min

Product	Dx	dt	Update	Forecast horizon	Delivery offset
RadolanRW	~1 km	1 h	30 min	-	26 min
pyRADMAN	~1 km	15 min	15 min	-	6/11 min
RadolanRV	~1 km	5 min	5 min	2 h	4 min
IconD2	~2 km	15 min	3 h	48 h	75 min
IconD2EPS	~2 km	15 min	3 h	48 h	140 min
IconEU	~4 – 7 km	1 – 6 h	3 – 6 h	48 – 120 h	230 min
INTENSE	~2 km	15 min	0.5 – 2 h	12 h	25 min

blue	Measured values
green	Nowcast
blue	Forecast
red	seamless forecast

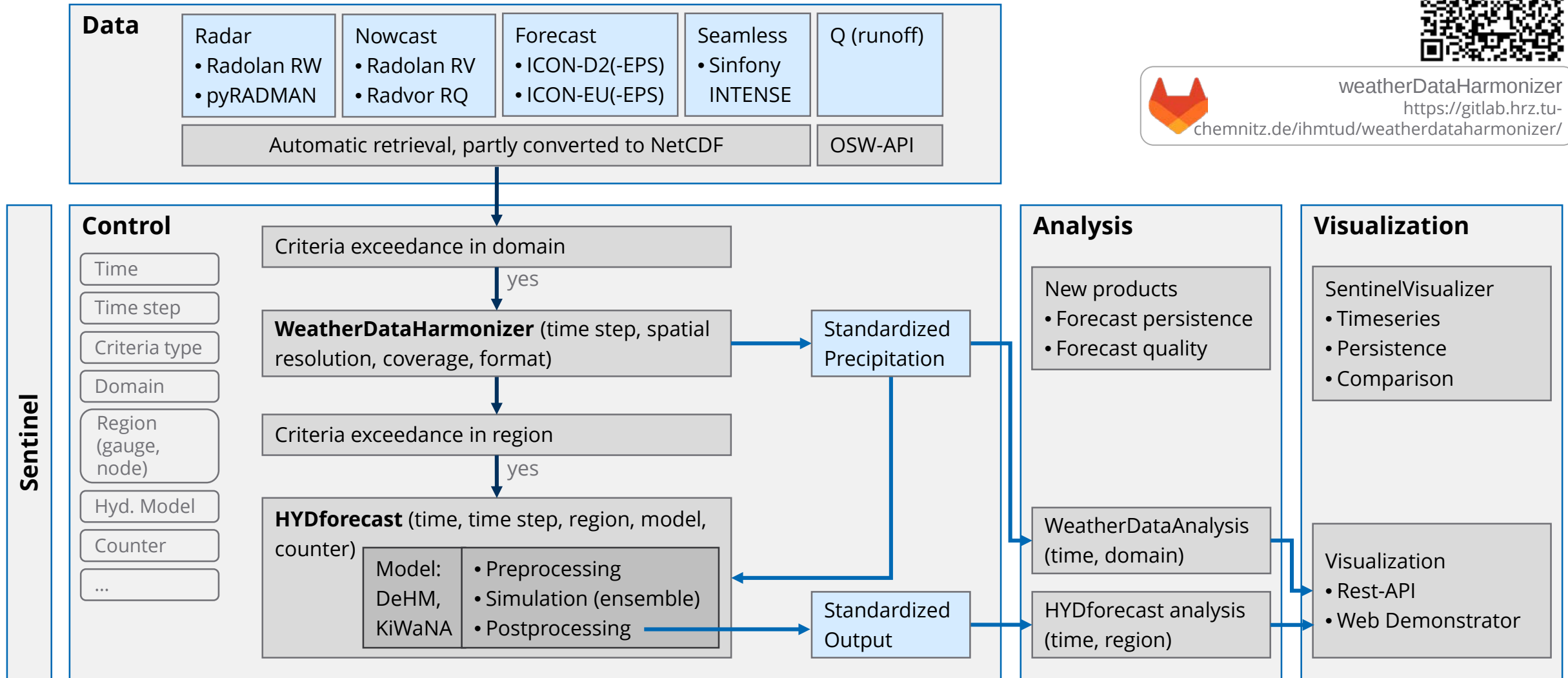


Operational hydrologic Ensemble Forecast System (hydEFS)

FloodSentinel



weatherDataHarmonizer
<https://gitlab.hrz.tu-chemnitz.de/ihmtud/weatherdataharmonizer/>

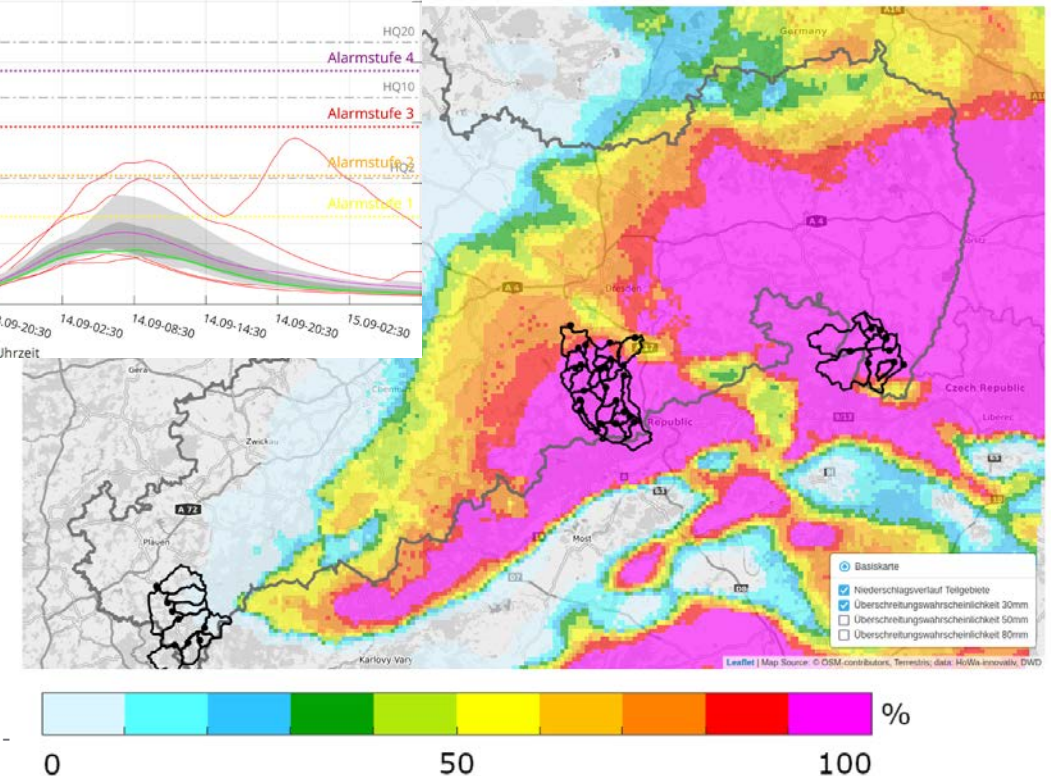
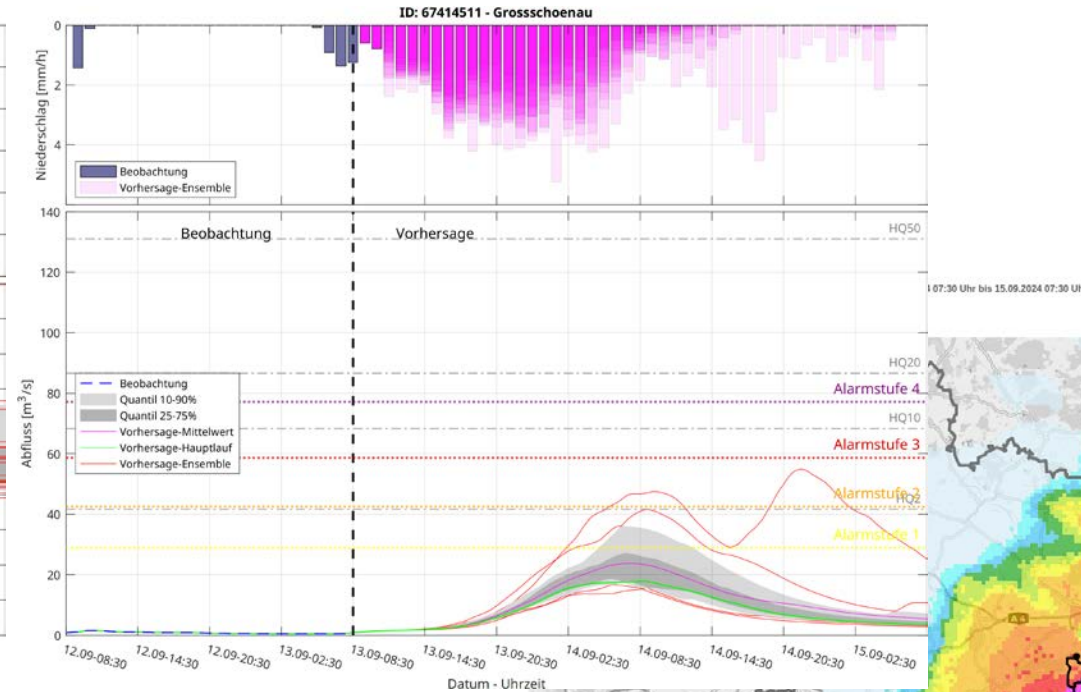
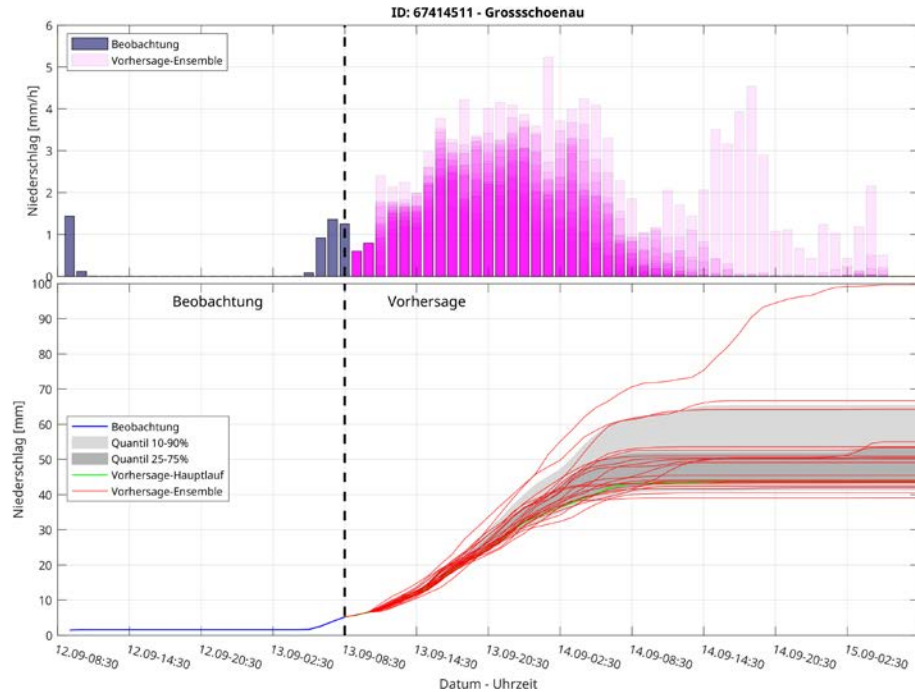


Web-demonstrators – EFShowa & EFSadv

EFSadv



<http://howa-innovativ.hydro.tu-dresden.de/WebDemoEFSadv/>



Web-demonstrators

- Rainfall exceedance probability
- Rainfall amounts (quantiles)
- Expected runoff (quantiles & thresholds)
- Easy to read flood warning

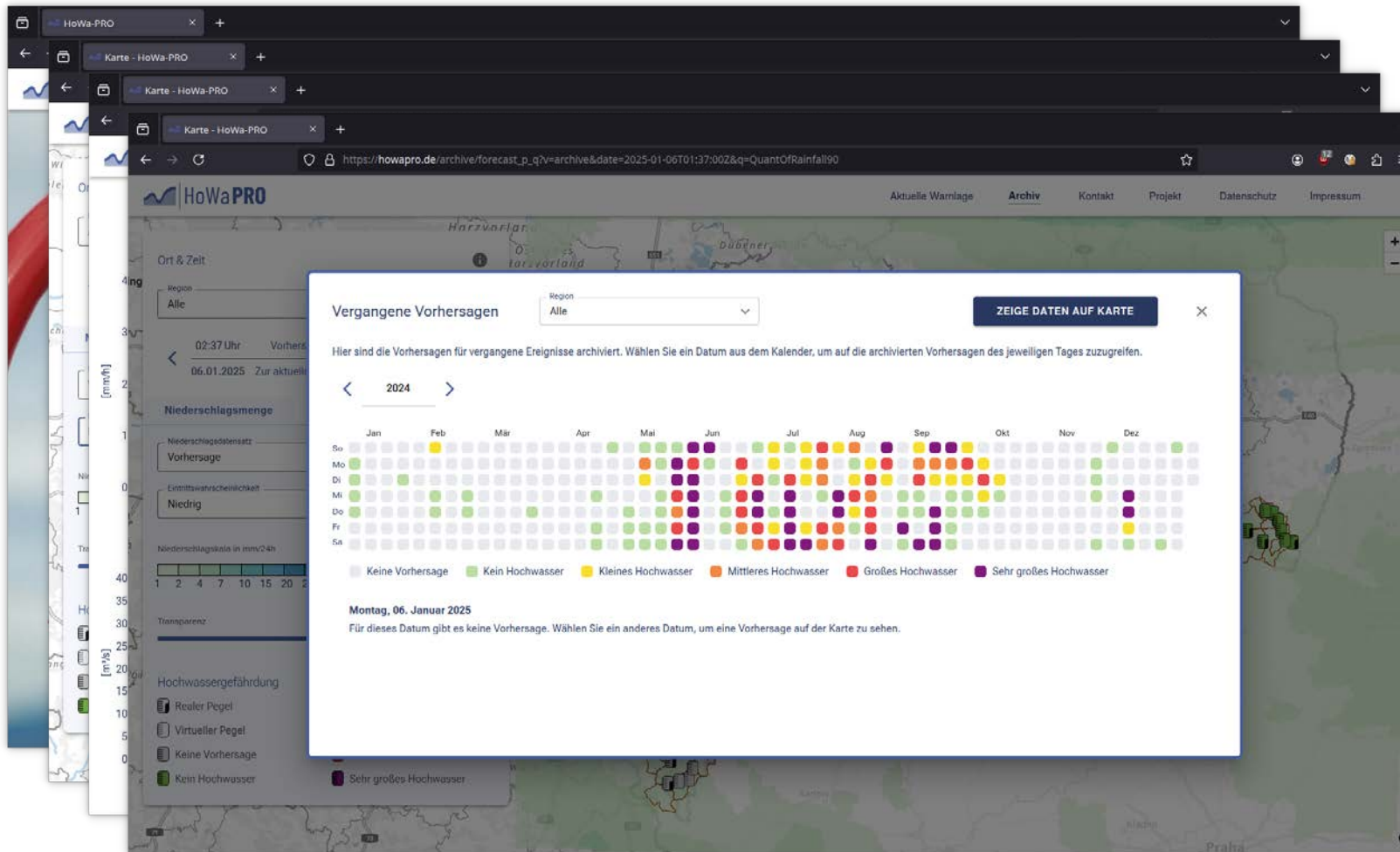
EFShowa



<http://howa-innovativ.hydro.tu-dresden.de/WebDemoLive/>



Demonstrator – howapro.de



Warning application

<https://howapro.de>

- More modern design and UI
- Regional overview
- Hydrographs for real and virtual gauges
- Archive and API
- Used for trainings
- Useable on smart phones

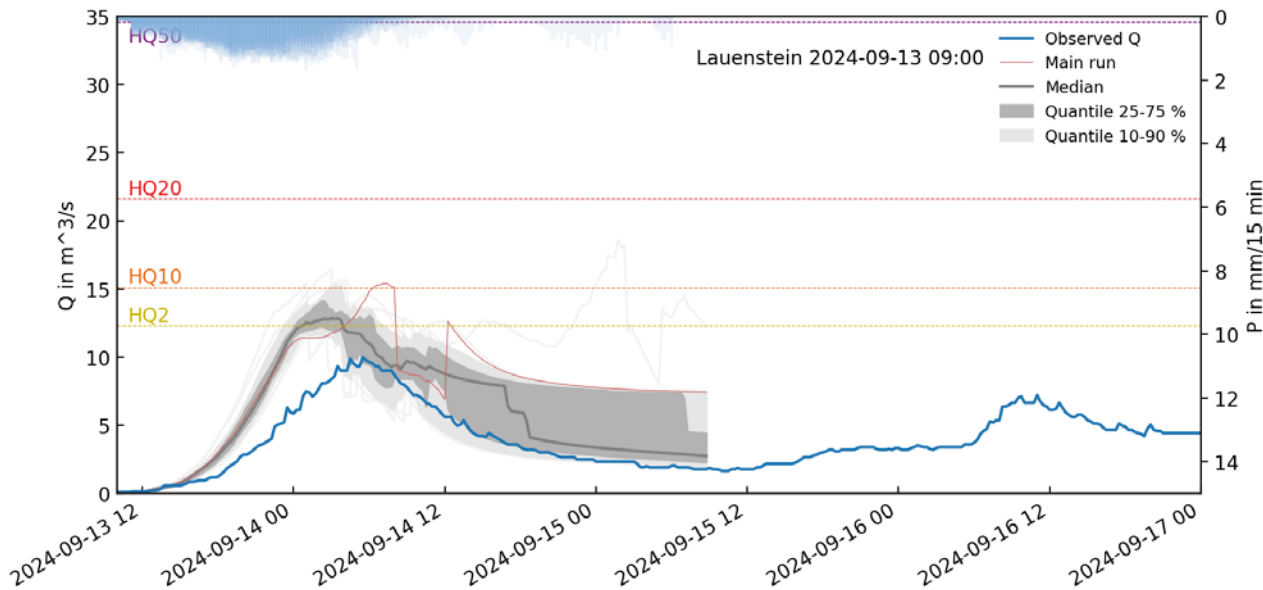


<https://howapro.de>

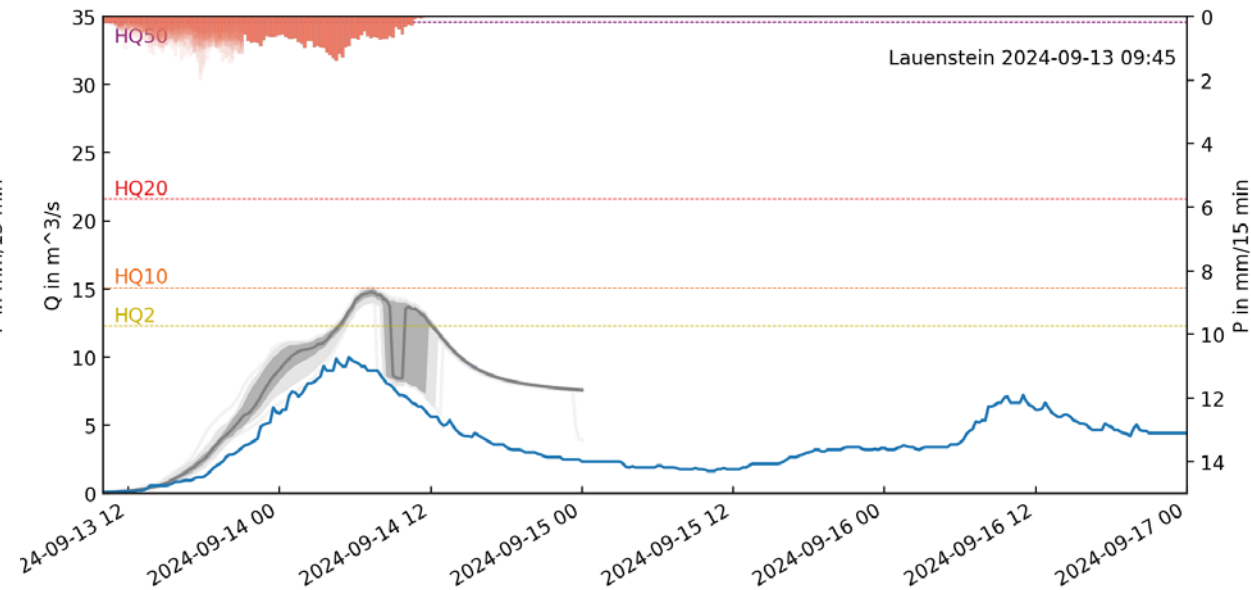
Evaluation

- Operational ensemble forecast: 13.09. – 16.09.2024 in Lauenstein@Müglitz
- Impact of controlled flood reservoir

EFShowa

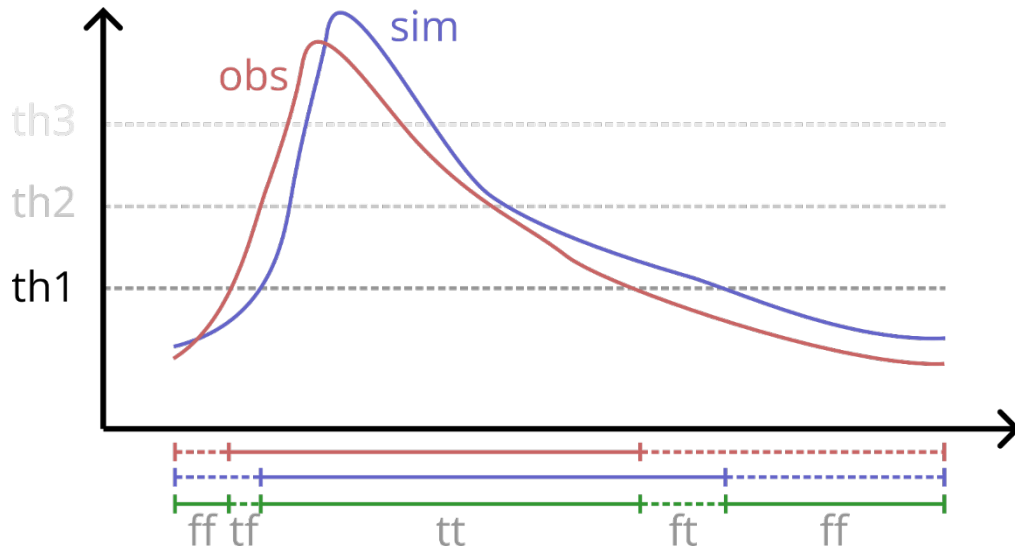


EFSadv



Evaluation

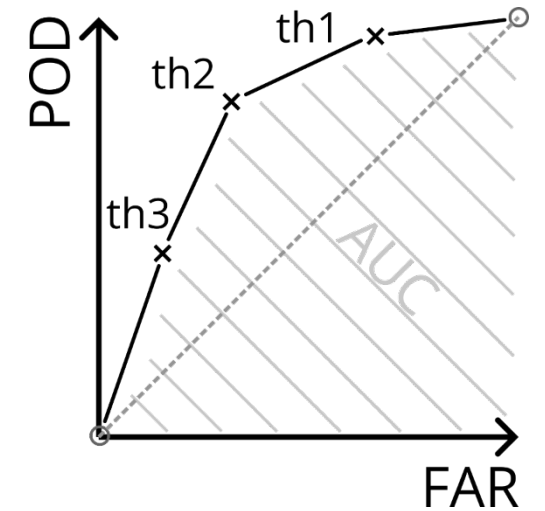
Area Under Curve (AUC) – Theorie



		sim	
		true	false
obs	true	tt	tf
	false	ft	ff

$$POD = tt / (tt + tf)$$

$$FAR = ft / (ft + ff)$$



POD: probability of detection

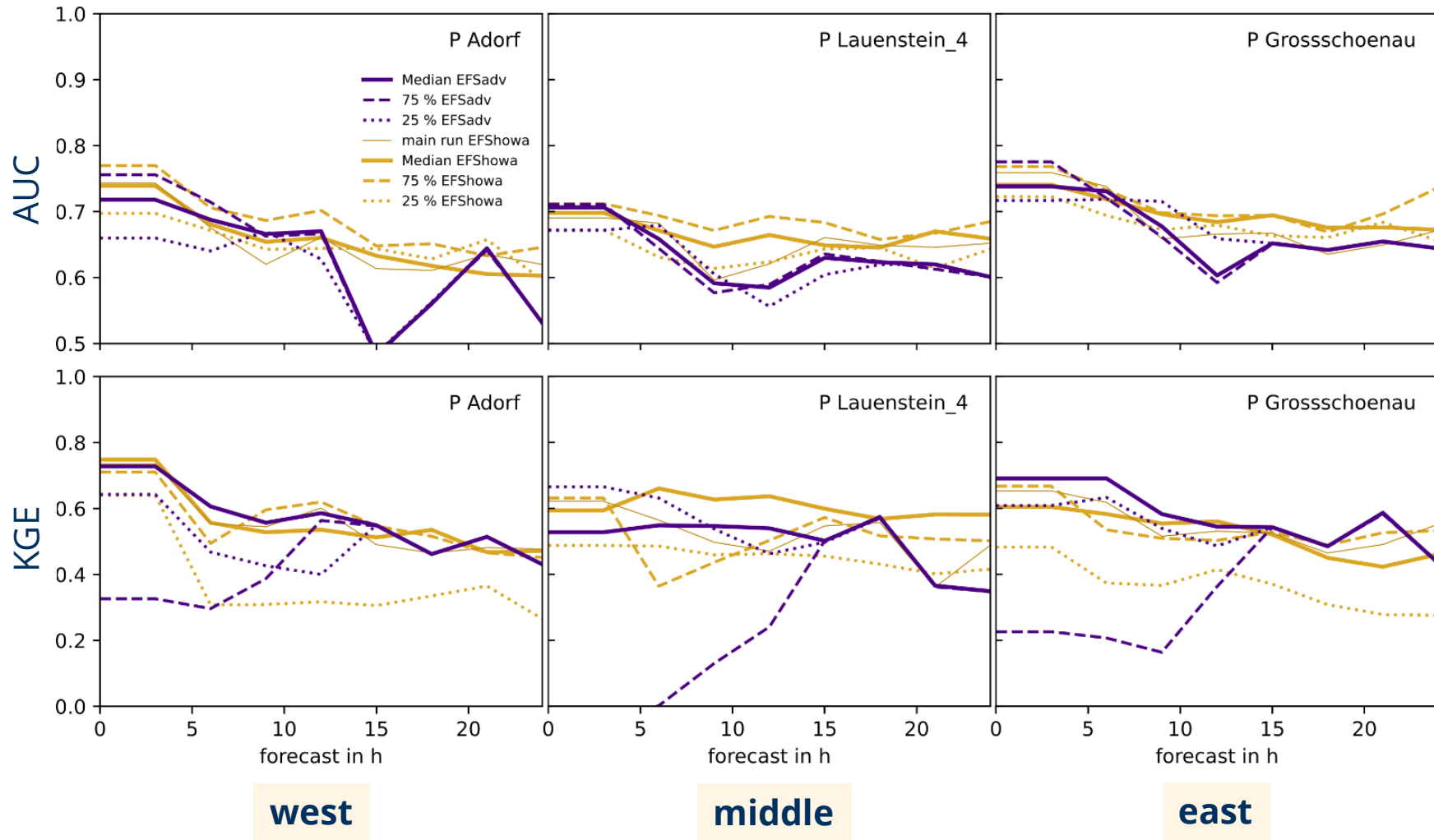
FAR: false alarm ratio

+ other metrics based on contingency table (e.g. ACC, CSI, f1, ...)
and goodness-of-fit indicators (e.g. KGE, NSE, nRMSE, ...)

Runoff at gauges & mean areal rainfall of catchments → quantiles and forecast horizons

Evaluation – Ensemble over period (01.12.2023 – 31.12.2024)

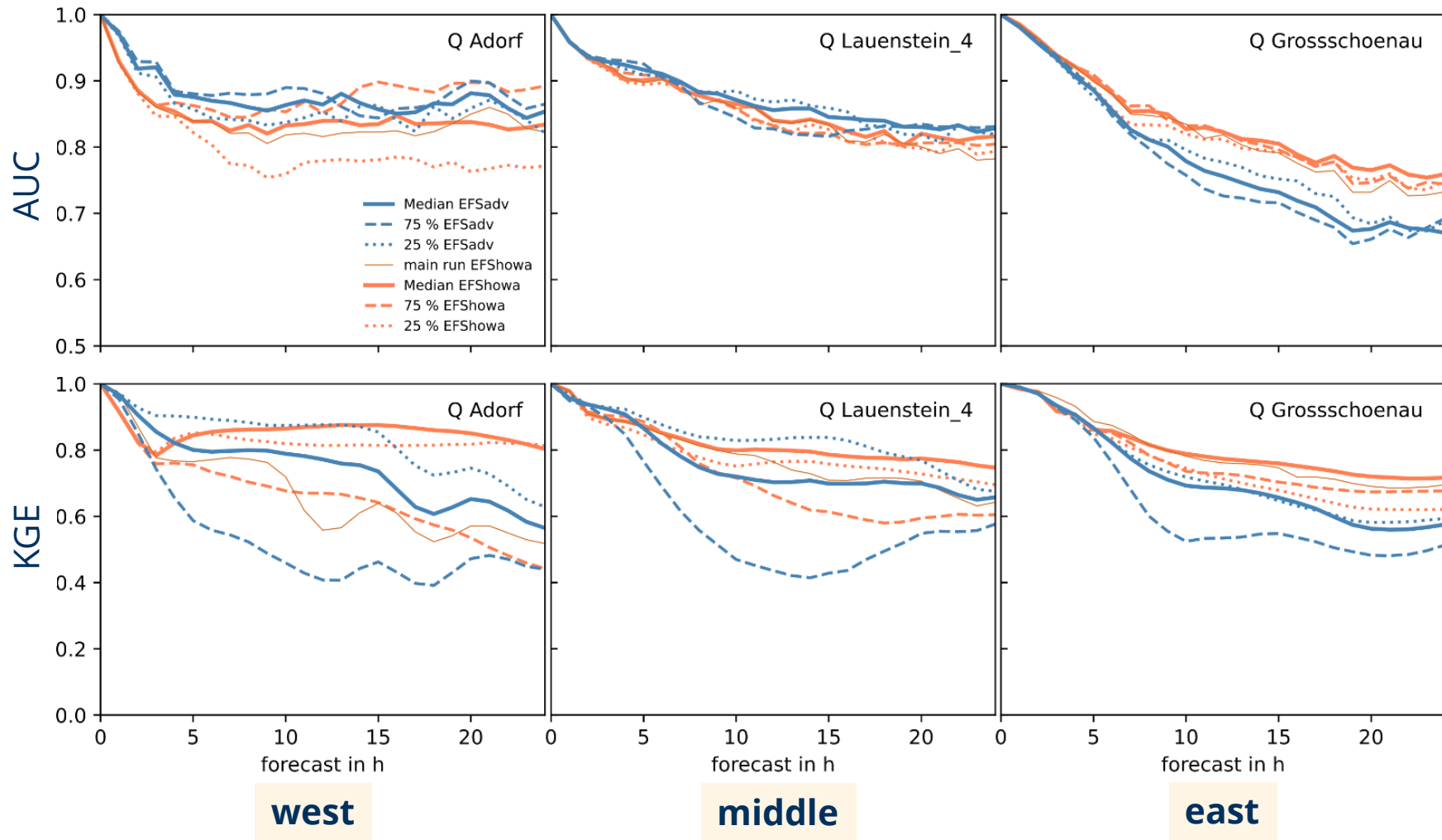
Mean areal rainfall of catchments



- EFShowa: 5152 forecasts
- EFSadv: 5032 forecasts
- ~29 % of potential forecasts
- Mean areal rainfall
 - Observation: RadolanRW
 - dt = 3 h sum
 - main run, median, 25%-, 75%-quantiles

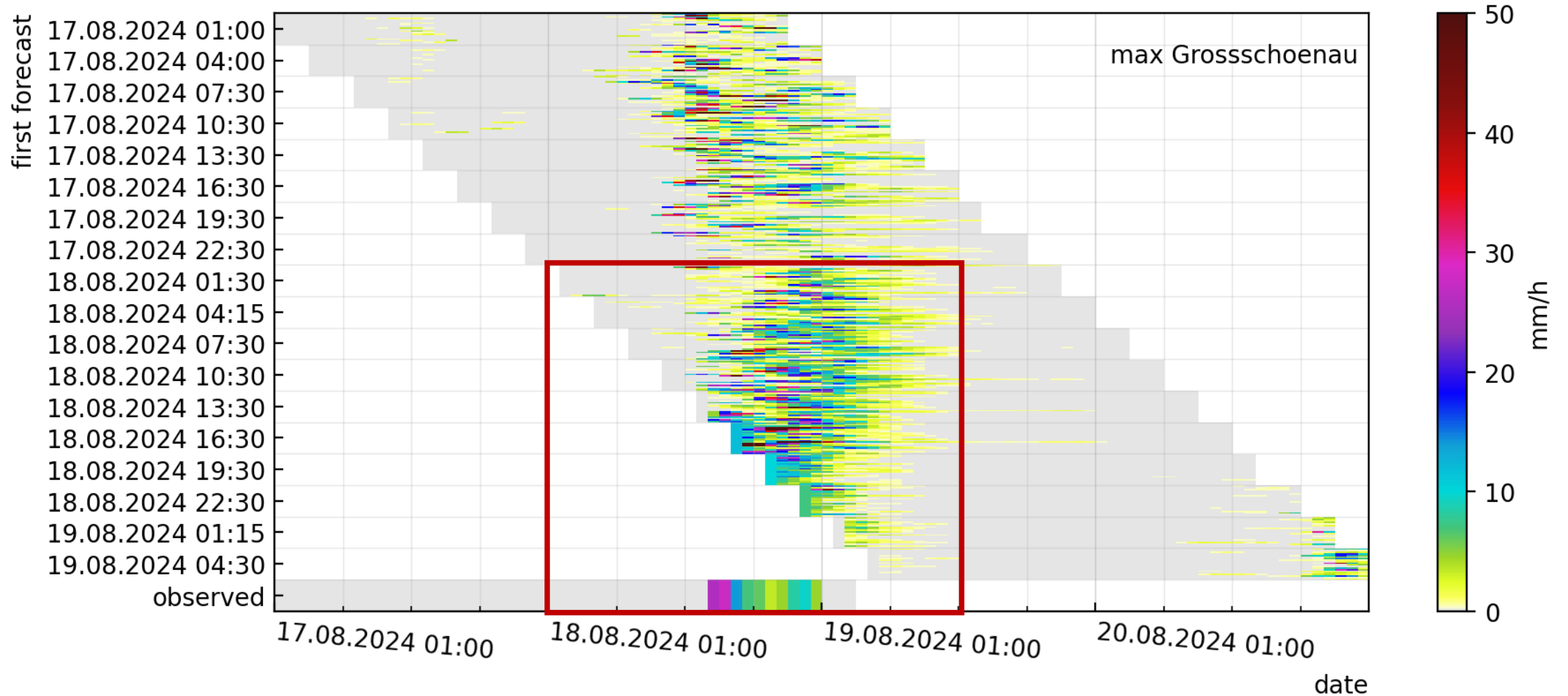
Evaluation – Ensemble over period (01.12.2023 – 31.12.2024)

Runoff at gauge stations



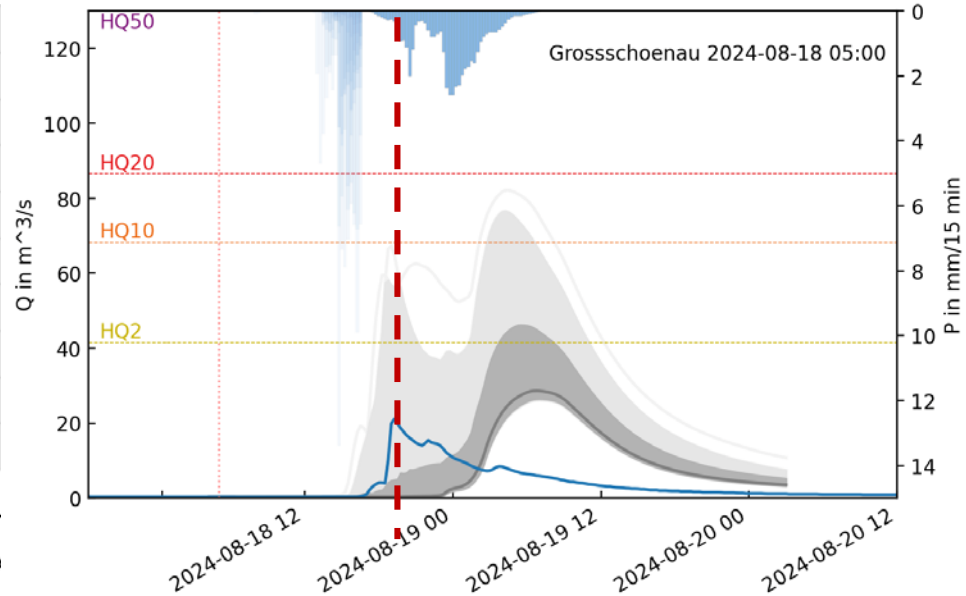
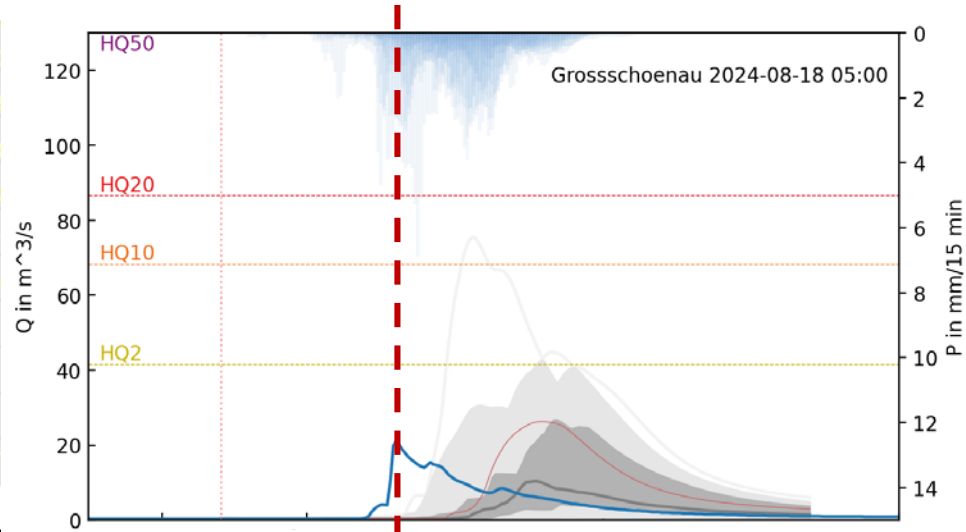
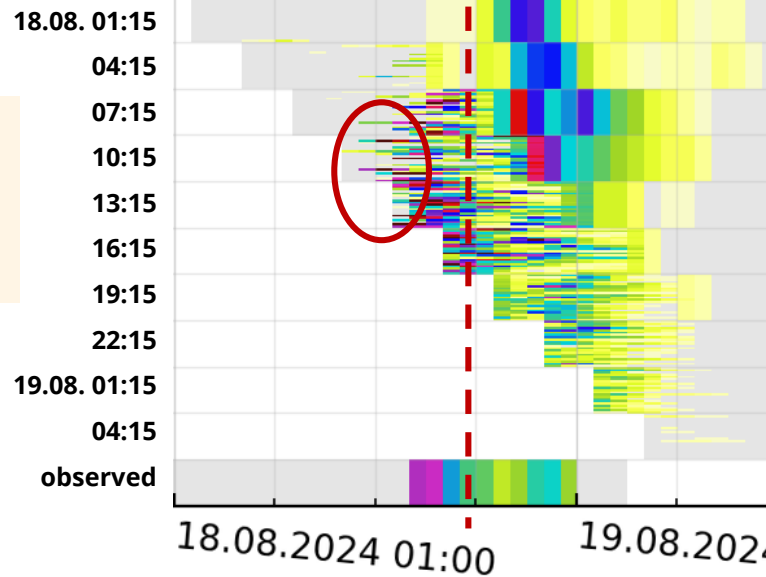
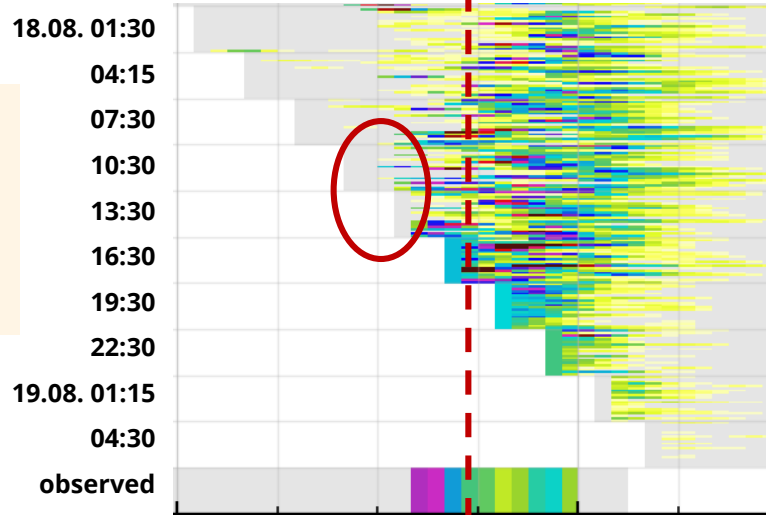
- EFSHowa: 5152 forecasts
- EFSadv: 5032 forecasts
- ~29 % of potential forecasts
- Runoff
 - Observation: Gauge
 - dt = 1 h
 - main run, median, 25%-, 75%-quantiles

Evaluation – Event based (17.–21.8.2024)

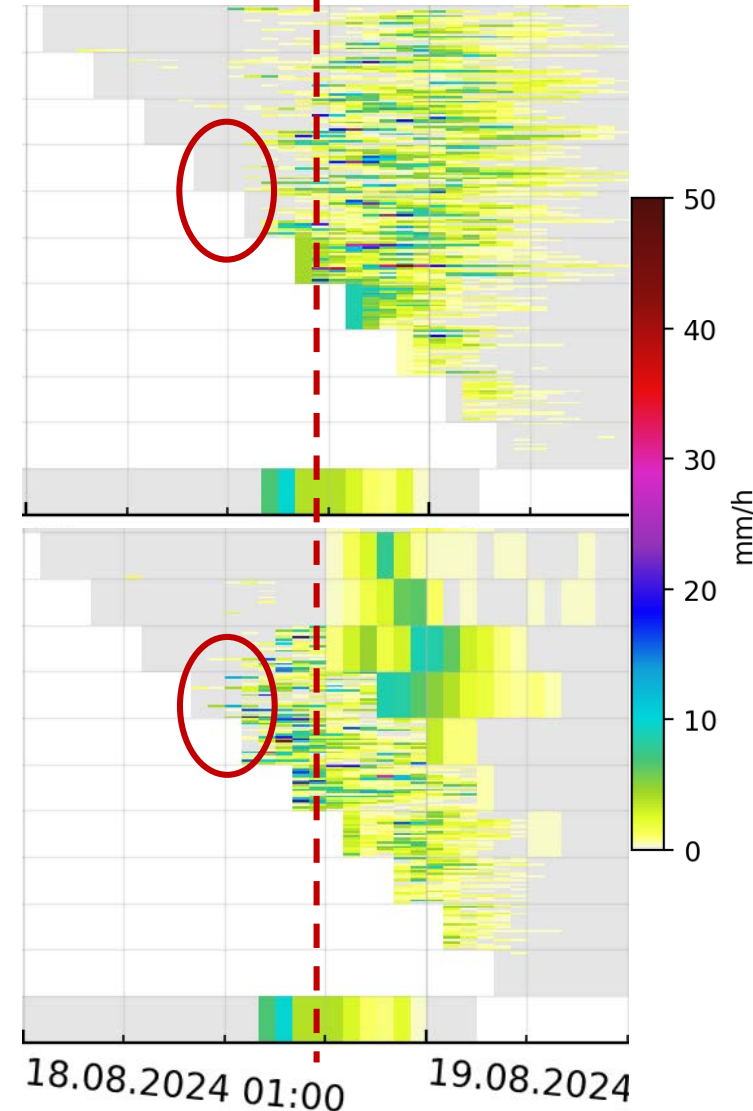


Evaluation – Event based (17.–21.8.2024)

Max intensity



Mean areal rainfall



Conclusions

- Hydro-meteorologic ensemble forecasts allow for flood early warning
- FloodSentinel: scalable ensemble forecast system for small catchments
- Web-demonstrators with established and prototypic precipitation data of DWD since mid/end 2023 (ESFhowa & ESFadv)
- EFSadv: earlier delivery, frequent updates, forecasts starts with ensemble
- Evaluation over period: benefits of EFSadv for first forecast hours depending on region (decreasing from west → east)
- Evaluation event based: better timing of EFSadv visible
- Evaluation of runoff forecasts depends on quality of hydrologic model
→ check with regional AI-model

Next Steps

- Evaluation: longer period with more extremes, additional metrics e.g. CRPS(S)
- Combination of INTENSE with IconD2EPS – longer forecast horizon

