Reliable estimates of predictive uncertainty for an Alpine catchment using a non-parametric methodology [EGU2017-13500]

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0 Goal

Test the Generalized Pareto Uncertainty (GPU) method as a postprocessor of predictive uncertainty. Learn about the validity of the deterministic prediction.

1 The model

Concept (a)

The **Generalized Pareto Uncertainty (GPU)** method [1,2] is **a way of optimizing an ensemble of deterministic models** so that:

1) each model's **probability of exceedance is known**, and
2) for each probability of exceedance, the optimized model's **errors as small as possible**.

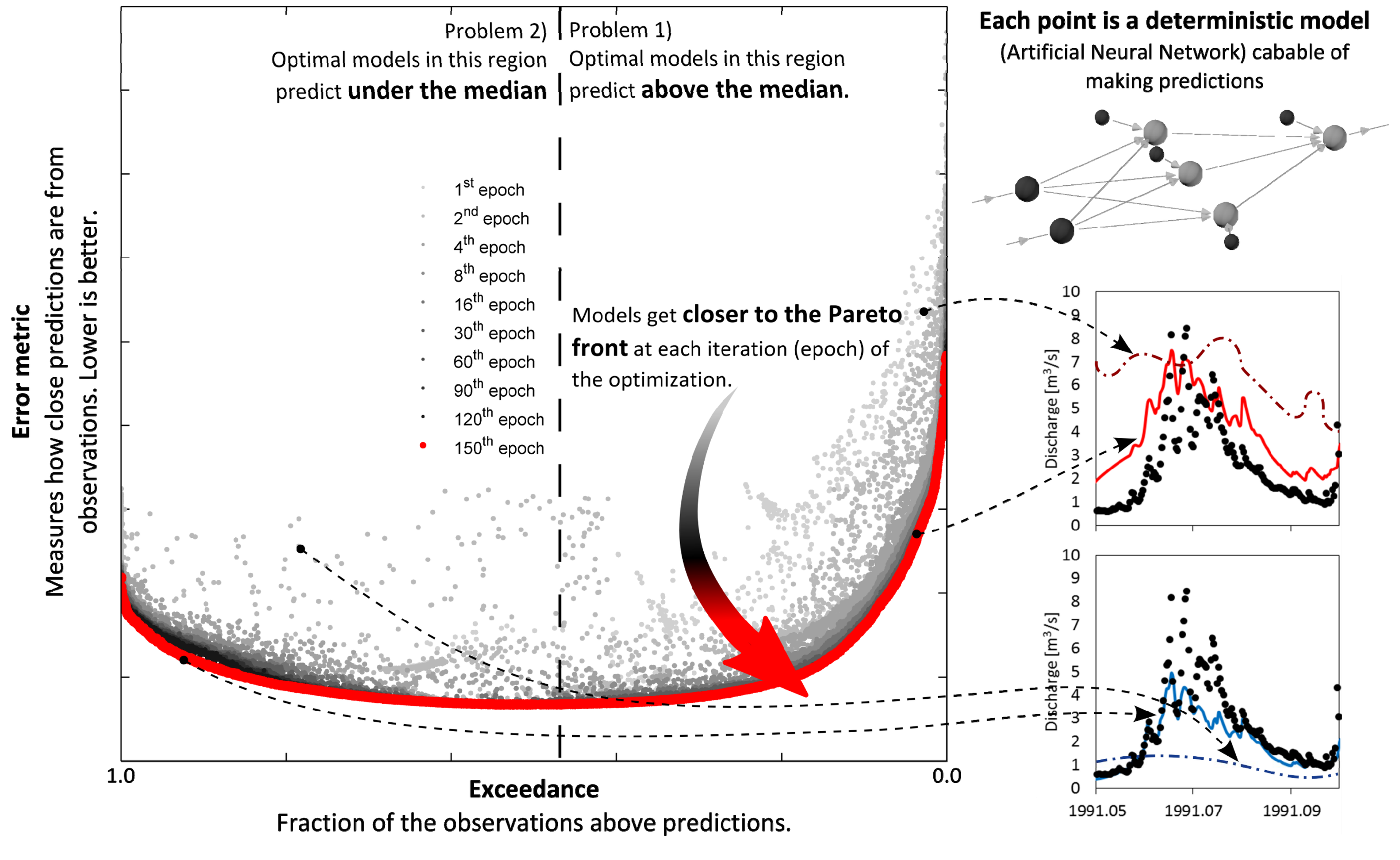
- **Any deterministic model** can be used. Better fast and flexible (e.g. Artificial Neural Networks).
- **Is not specialized** (e.g. predicts water levels, streamflows, runoff volumes, SSC, model errors).
- **Adapts to any input data** (estimates are conditioned on it).
- **Data-driven**: better with long time series for calibration.

Implementation (b)

The essence of GPU lies on **how to find the optimal parameters $\boldsymbol{\theta}_i$**. To do so, GPU solves simultaneously two multi-objective optimization problems :

1) one searches the Pareto front of **low probabilities of exceedance and low errors**;
2) the other searches the Pareto front of **high probabilities of exceedance and low errors**.

A custom multi-objective evolutionary algorithm was developed.

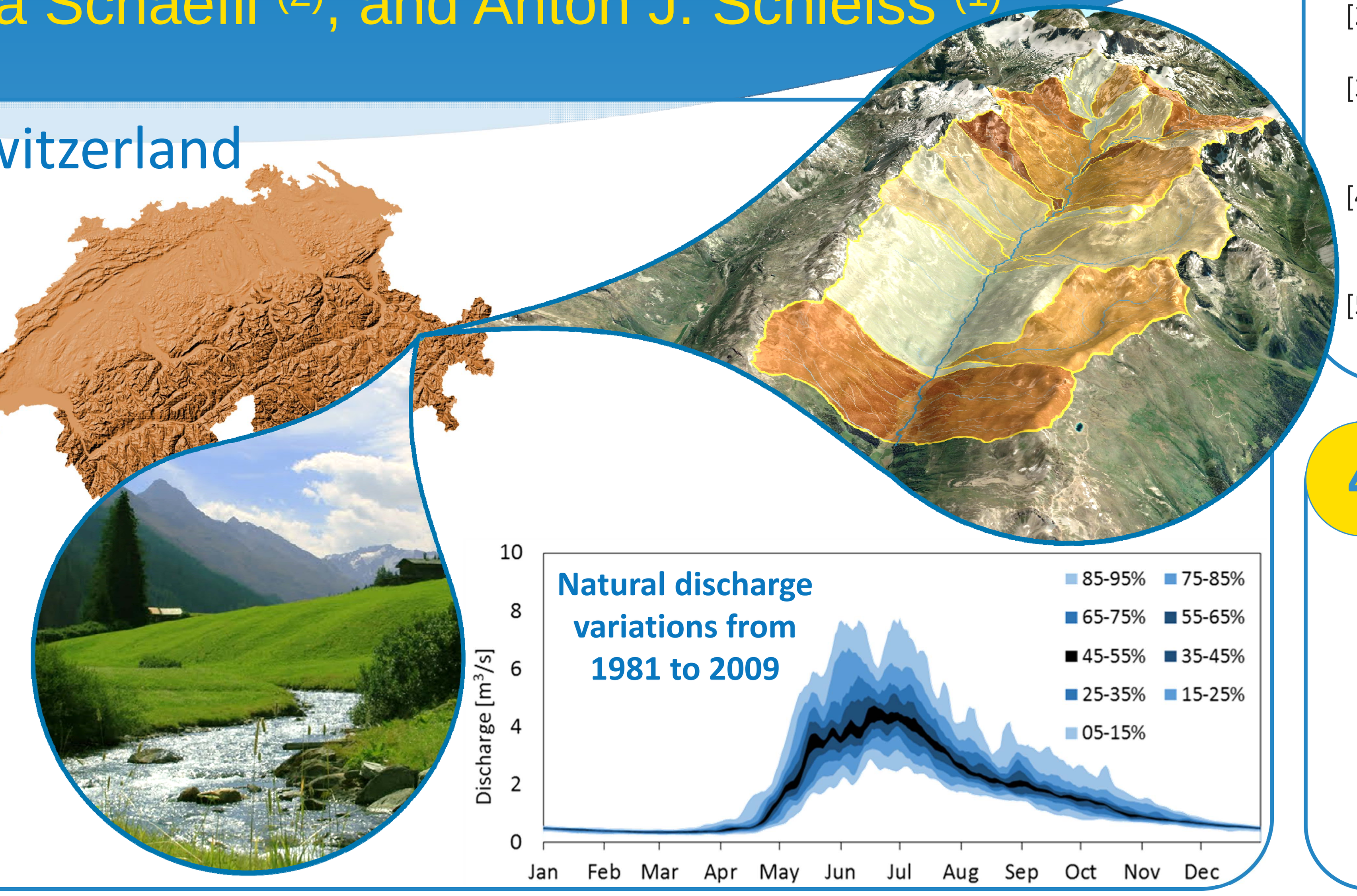


Uncertainty bands obtained after averaging outputs of models in the vicinity of a chosen probability of exceedance.

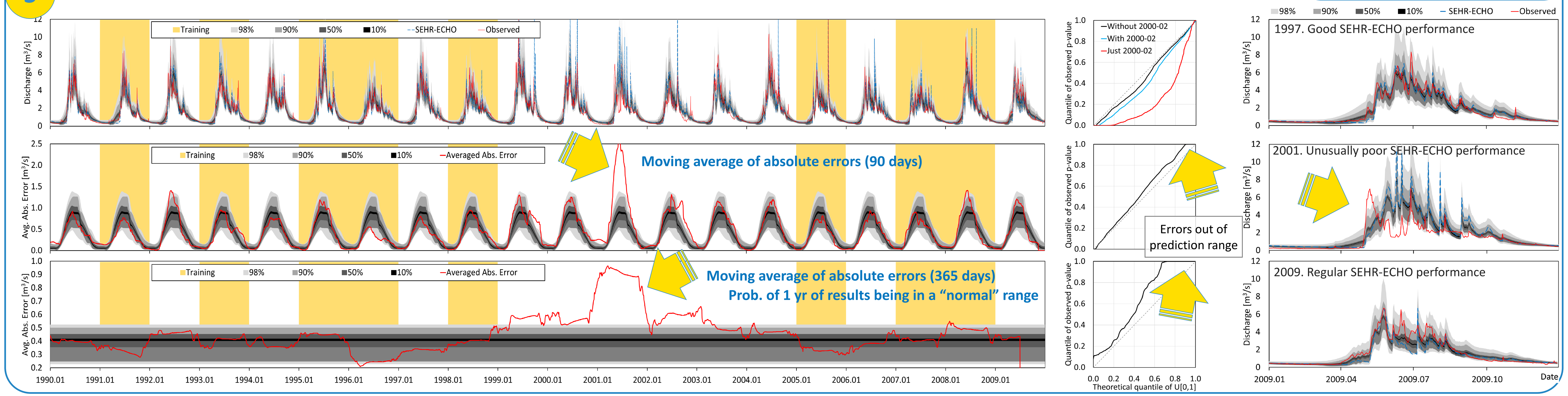
$$\hat{F}^{-1}_{Y|D}(p) = \sum_{i=1}^{n} \frac{g_i(\mathbf{d}|\boldsymbol{\theta}_i)}{n}, \forall g_i : |\eta(g_i) - p| < \beta$$

2 Case study: Dischmabach, Switzerland

- 43.3 km² catchment, elevation range of 1668 to 3146 m.a.s.l., 2.1% glacier cover.
- Strong seasonal discharge pattern due to **accumulation and melting of snow**.
- Discharge simulation available from **SEHR-ECHO model** [4]:
  - a) **deterministic spatially explicit process-based** model;
  - b) input: air temperature, precipitation, and potential evaporation data;
  - c) **12 parameters** calibrated with simple Monte Carlo generation within a priori ranges.
- Relevance of the case study: **strong mismatches between model simulations and observed discharges** hint towards:
  - i. strong system modification during observation period (1981 to 2009);
  - ii. problems with observed discharge data [5].



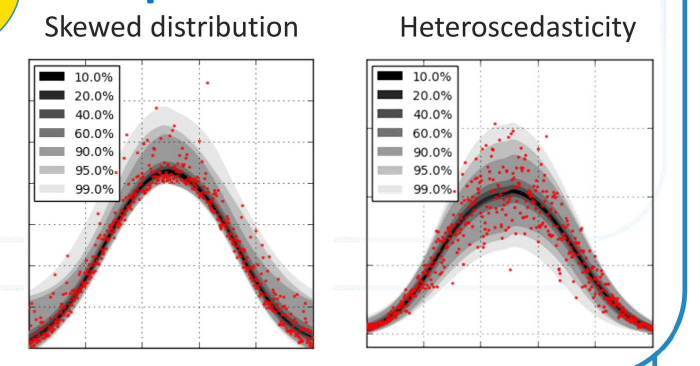
3 Results



4 Conclusions

- **GPU works well as an uncertainty postprocessor** for process-based hydrological models.
- Copes well with **heteroscedasticity, skewness, and dependency.**
- **Can model uncertainty of many variables** without adaptations or extra assumptions (e.g. SSC [1] or absolute model errors).
- **Can check model adequacy and quantify it statistically** how much a deterministic model's simulations depart from historical records.

3.1 Capabilities



5 References

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