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Investigating the interactions between data assimilation and post-processing in hydrological ensemble forecasting

François Bourgin, Maria-Helena Ramos, Guillaume Thirel, and Vazken Andréassian
Hydrosystems and Bioprocesses Research Unit, Irstea Antony, France (Contact: francois.bourgin@gmail.com)

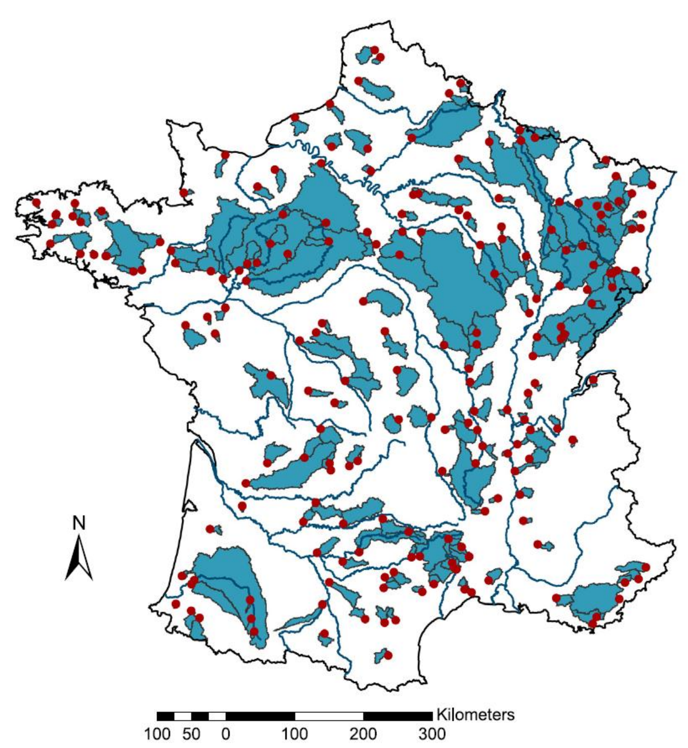
1. Aims

Statistical post-processing and data assimilation (also called real-time model updating in the engineering community) can be intrinsically related in the hydrological forecasting framework.

They represent techniques that may be used in a forecasting system to improve the quality of the forecasts (i.e., to provide more accurate and reliable forecasts) and to, ultimately, enhance the usefulness of the forecasts in decision-making.

- How does data assimilation impact hydrological ensemble forecasts?
- How does post-processing impact hydrological ensemble forecasts?
- How does data assimilation interact with post-processing to improve the quality and skill of hydrological ensemble forecasts over the forecast lead times?

2. Data and methods



- 202 unregulated catchments in France.
- Potential evapotranspiration, precipitation, and discharge data at hourly time steps over 1997–2006 (source: Météo-France and Banque HYDRO).
- PEARP: short-range meteorological ensemble prediction system by Météo-France (runs once a day at 18:00 UTC; 11 members, a 60 h forecast range, and a 25-km grid resolution. Spatial disaggregation to an 8 km 8 km grid, which includes bias correction, was applied).
- GRP hydrological model: continuous, parsimonious lumped storage-type model designed for flood forecasting.

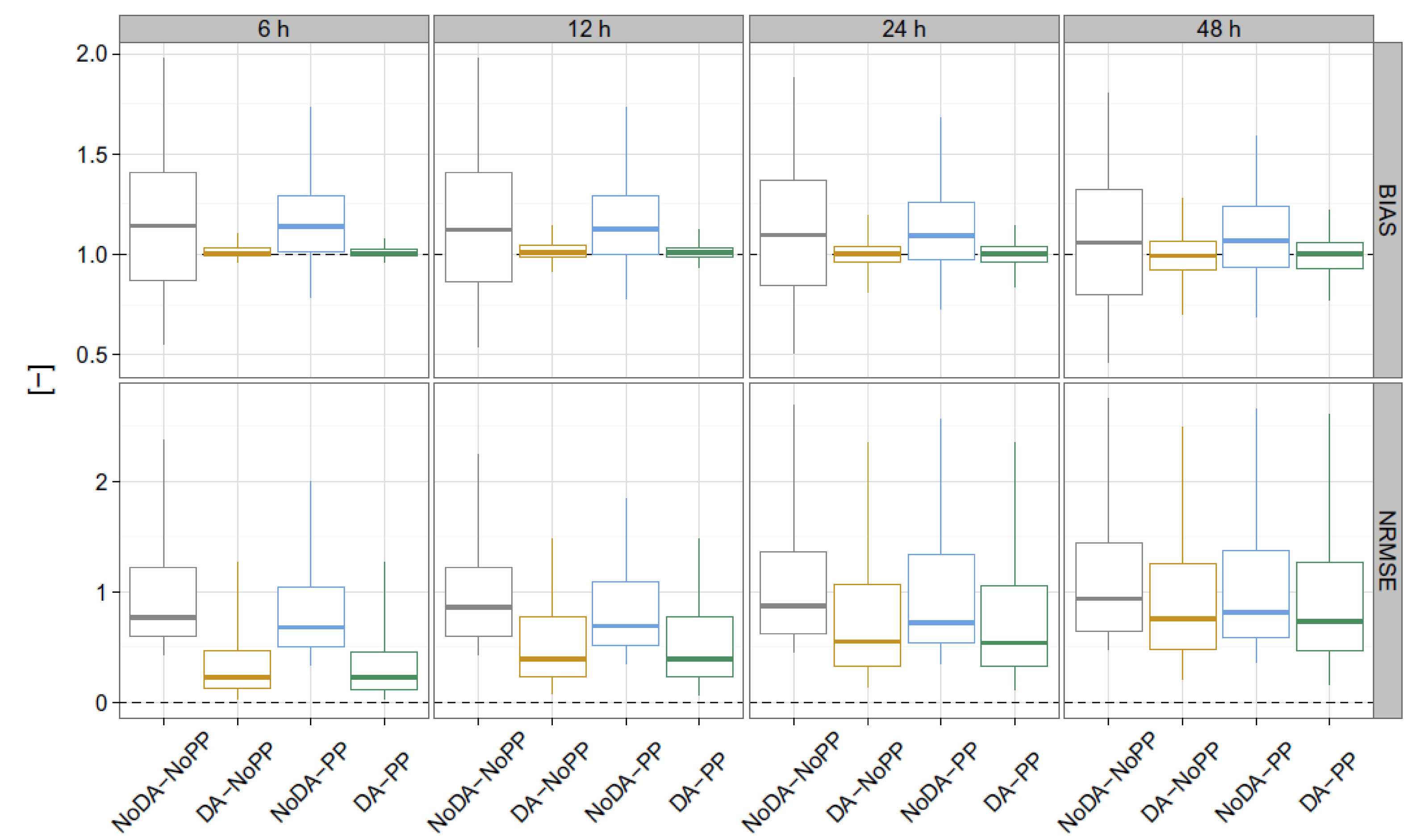
- **Data Assimilation -** two procedures for flood forecasting:
  - last available observed discharge is used to directly update the routing store state, and
  - last relative error is used to correct the model output with a multiplicative coefficient.
- **Post processing -** a hydrological uncertainty processor (HUP) is used to estimate the conditional errors of the hydrological model (model is run with observed weather data)
  - Data-based and non-parametric method to assess model simulation uncertainties.
  - Empirical quantiles of relative errors estimated (stratified by different flow groups).
  - HUP trained during the period used for calibrating the parameters of the hydrological model.

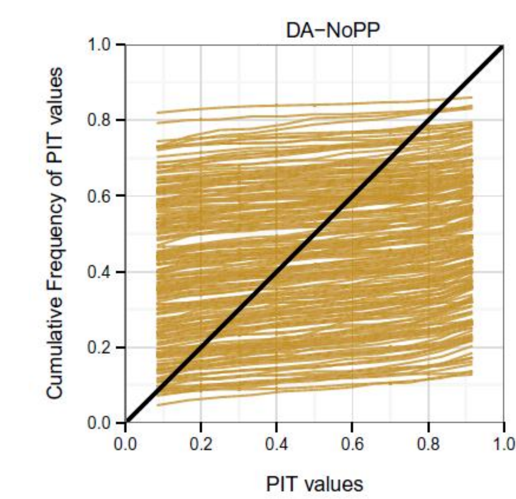
Acronyms used for the different experiments used in this study.

	Without data assimilation	With data assimilation
Without post-processing	NoDA-NoPP	DA-NoPP
With post-processing	NoDA-PP	DA-PP

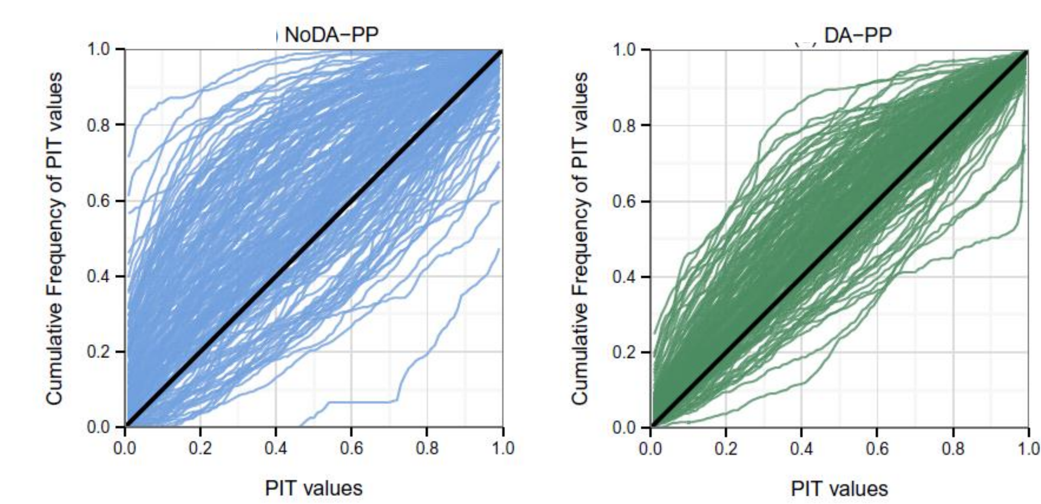
3. Results for ensemble streamflow forecasts (lead times 6 h, 12 h, 24 h and 48 h)

Distributions of two deterministic scores, the relative bias (BIAS) and the normalized root-mean-square error (NRMSE)

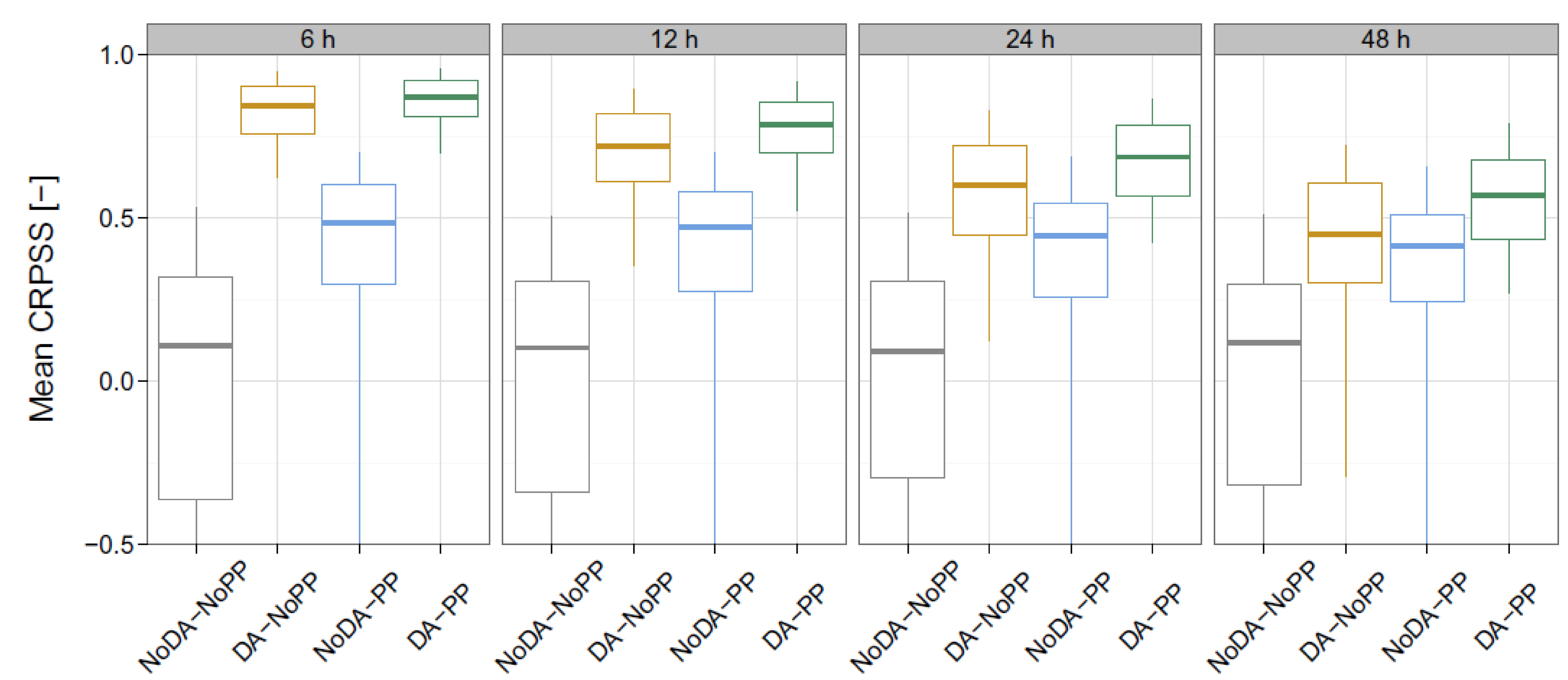




PIT diagrams of the 24h ahead streamflow ensemble forecasts. Each line represents one of the 202 studied catchments



Distributions of the mean CRPSS. Perfect score is 1.0



Boxplots (5th, 25th, 50th, 75th and 95th percentiles) summarise the variety of scores over the 202 catchments

For more info

Bourgin, F., Ramos, M.H., Thirel, G., Andreassian, V. (2014). Investigating the interactions between data assimilation and post-processing in hydrological ensemble forecasting, *Journal of Hydrology*, 519, Part D, 2775-2784.

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4. Conclusions

- Data assimilation has a strong impact on improving the quality of the ensemble mean, and a much lesser effect on the variability of the ensemble members (i.e., their spread). Post-processing has a strong impact on forecast reliability.
- The benefits of the combined use of data assimilation and post-processing are clearly shown: both contribute to achieve reliable and sharp forecasts, with impacts acting differently according to the target lead time.
- The stronger impact on forecast reliability comes from the use of post-processing. Adding data assimilation to the system helps in improving sharpness and reliability at all lead times, with higher gains in performance at shorter lead times.

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