Towards a seamless combination of short-term deterministic with mid-term probabilistic hydrological forecasts

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1. Introduction

CNR is the concessionary of the French part of the Rhône River, operating and managing the river in accordance with its three missions: electricity production, river navigation development, and irrigation supplying. To optimize the management operations, **two operational hydrological forecasting tools** – that have been developed internally – are used daily. These tools have different characteristics since they fulfill different needs. They provide, on the different sub-catchments:

- **Deterministic hourly** forecasts, up to 4 days ;
- **Probabilistic daily** forecasts, up to 14 days.

2. Objectives

The results of these two tools are **independently assessed** by the forecasters, to deliver an optimized forecast for the management of the operations. The tools should **provide coherent forecasts** to avoid duplicated expertise, and they need to propagate the expertise in coherence. This work aims at providing an idea of the first attempts made to add some **coherence between the tools**.

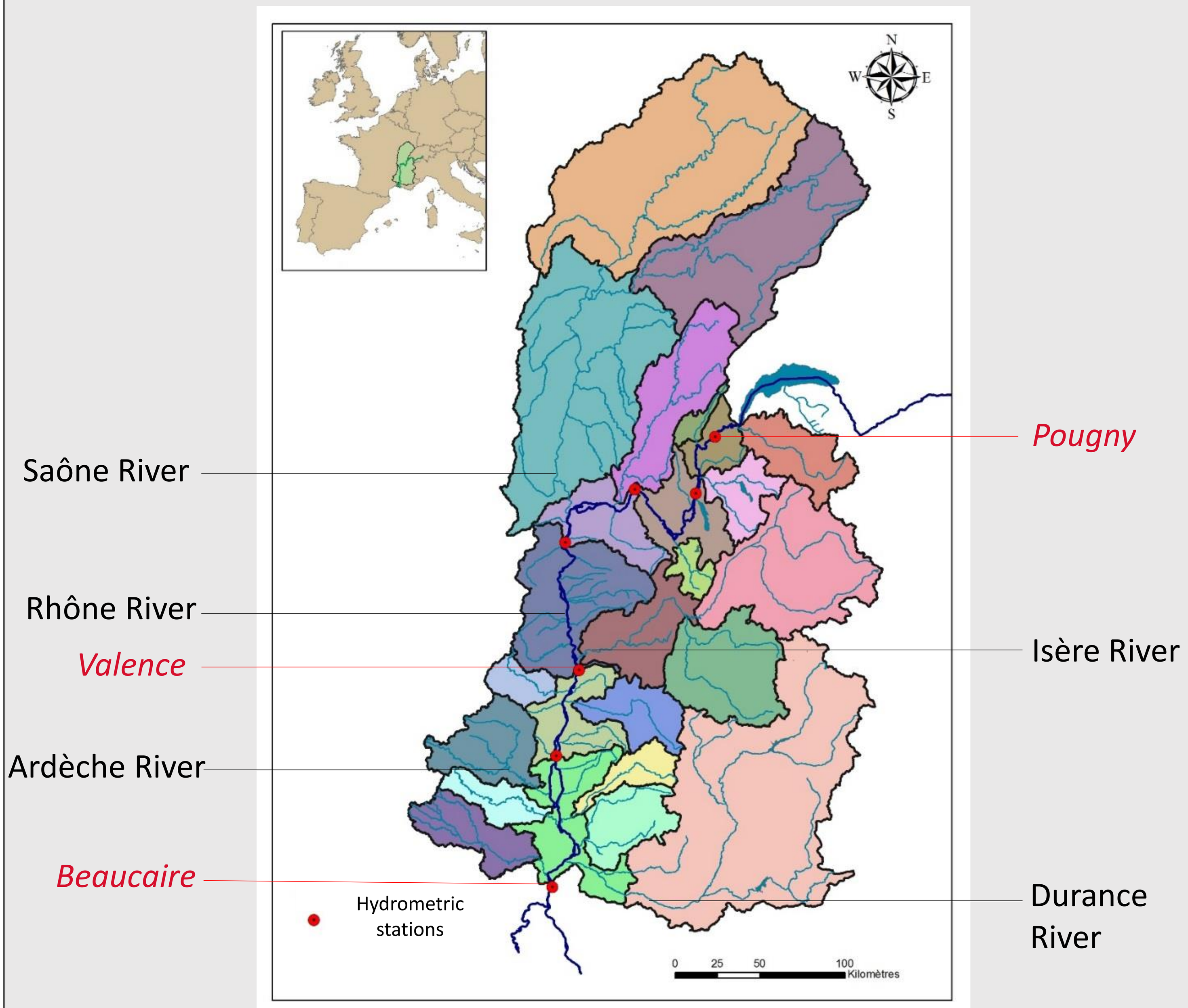

Figure 1 : Study area, with the main tributaries in black and some Rhône River stations in red

- French Rhône River watershed with sub-catchments.

3. Tools

Two operational hydrological forecasting tools are used in this study.

(1) Deterministic short-term chain [Bompart et al., 2008]

- Designed for short-term forecasting on 53 watersheds (lead times from day D to day D+4, hourly time steps).
- One expert meteorological forecasted scenario from CNR forecasters who gather different data sources (from Météo-France, GFS, ECMWF, …). A snowmelt model is run on specific watersheds.
- Hydrological forecasting with a conceptual hydrological model GRP [Berthet et al., 2009], and a statistical model ARX [Remesan and Mathew, 2015]. One year data assimilation scheme to initialise GRP reservoirs.
- Construction of an expert hydrological scenario for each tributary of the Rhône River and hydraulic propagation models on the Rhône River. These forecasts are named "Deterministic Hourly Forecasts" or **DHF**.

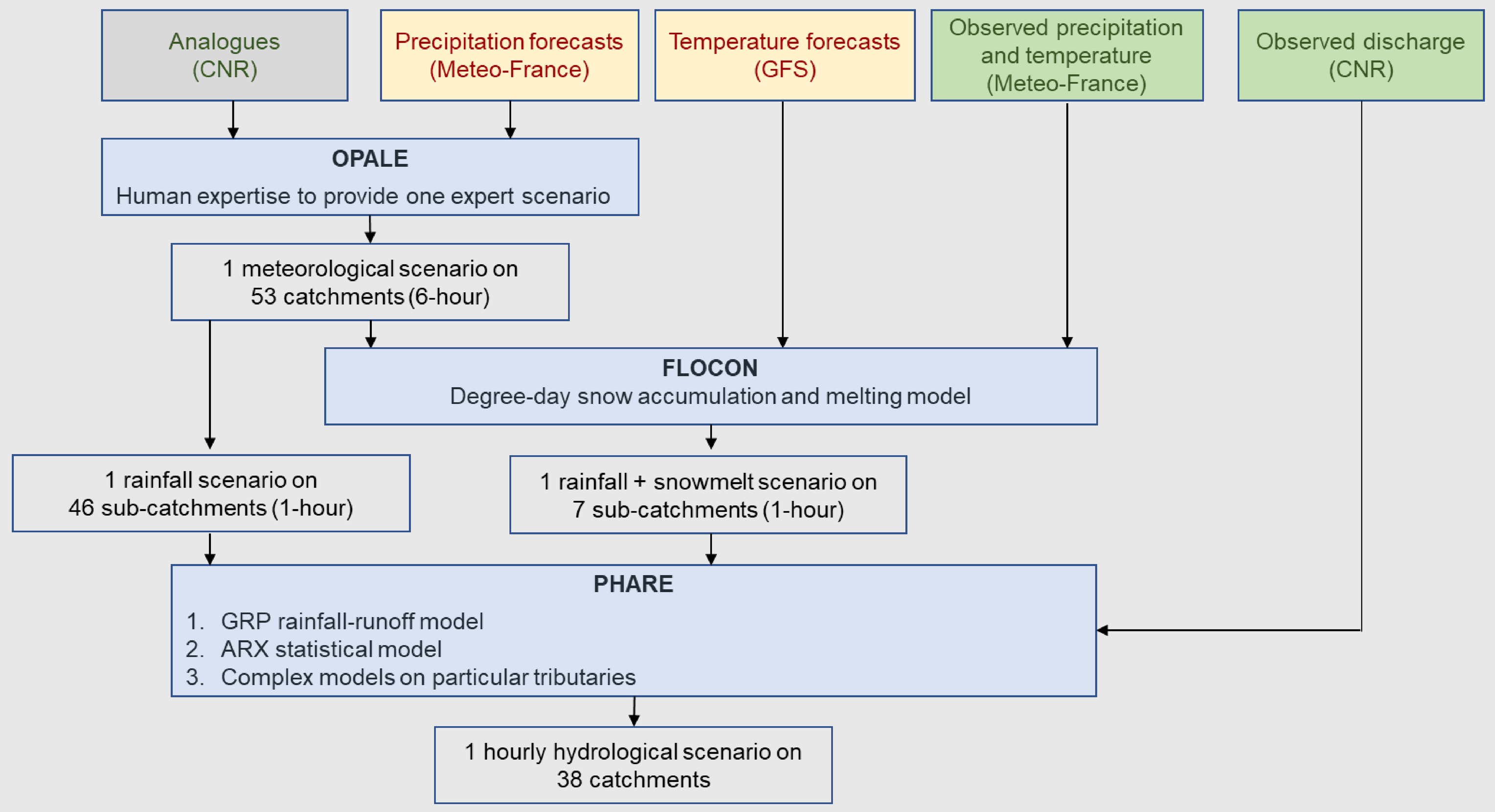

Figure 2 : Schematic description of the short-term deterministic forecasting chain

(2) Probabilistic mid-term chain

- Designed for mid-term forecasting on 24 watersheds (lead times from day D to day D+13, daily time steps).
- Meteorological forecasts from EPS used as inputs into a snowmelt model (CemaNeige) and a hydrological model (GRP). One year data assimilation scheme to initialise GRP reservoirs.
- Simple routing module to obtain forecasted flow at 7 gauging stations on the Rhône River.
- EMOS approach to post-process forecasted streamflow [Vannier, 2018]. These forecasts are named "Probabilistic Daily Forecasts" or **PDF**.

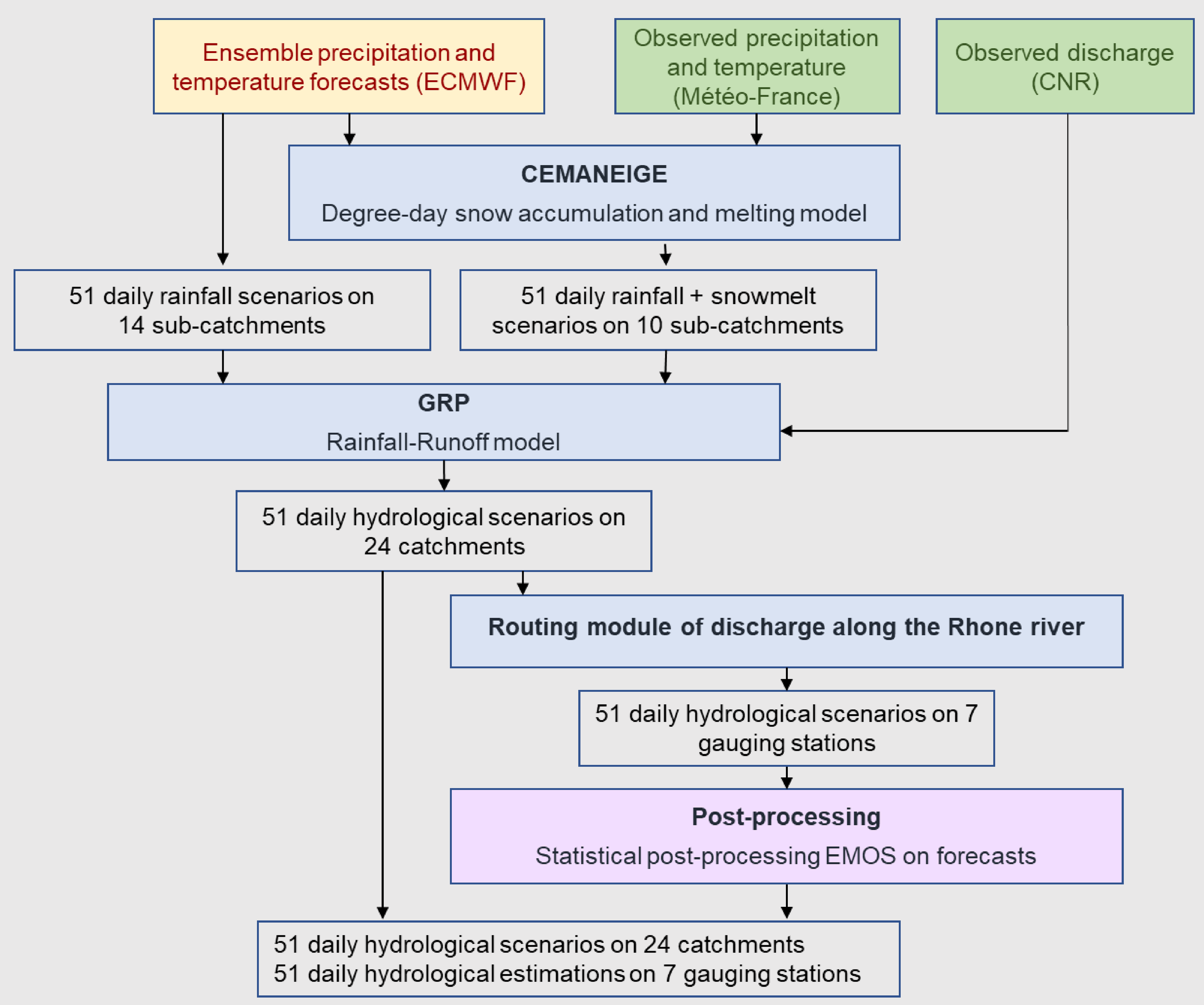

Figure 3 : Schematic description of the short-term deterministic forecasting chain

4. Method

A combination of DHF with PDF is currently developed, following these steps:

1. Creation of expert DHF on the tributaries with the short-term chain ;
2. Use of the expert DHF as observations between day D and day D+4 in the mid-term chain ;
3. Data assimilation through GRP reservoir initialisation in the mid-term chain until day D+4 and use of probabilistic forecasts from day D+5 to day D+13.
4. Human expertise on the PDF+DHF forecasts.

This combination is applied to the common watersheds between the two tools. It is then propagated over the Rhône River gauging stations.

The procedure has been implemented for operational testing. Figure 4 shows an example of the combination results (in orange) compared to initial PDF (in blue) for two stations. For this specific event, the PDF+DHF forecasts show a better accuracy than the PDF alone. This combination improves the coherence between the tools – and thus, lightens the forecaster's work.

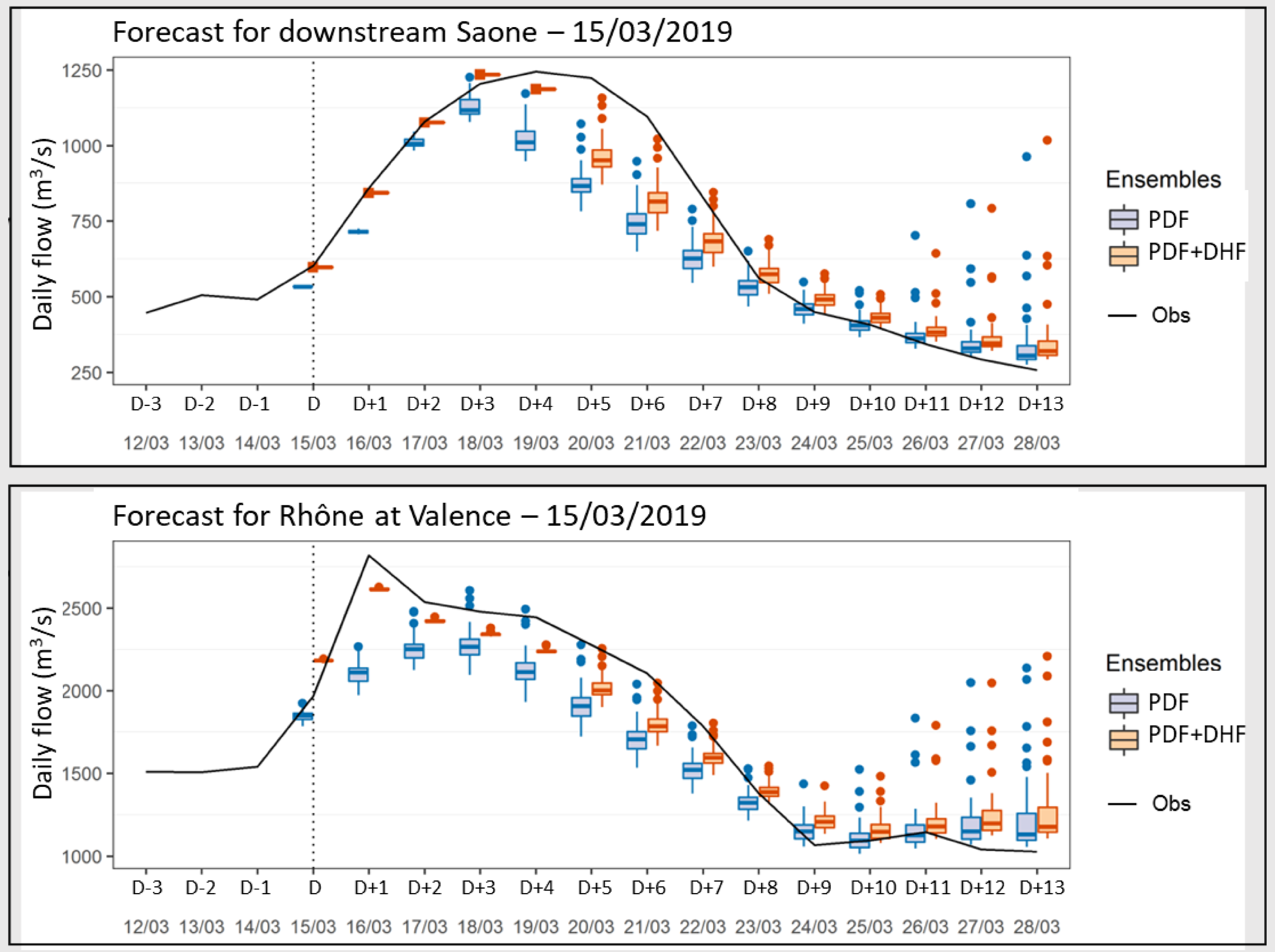

Figure 4 : Probabilistic Daily Forecasts (PDF) obtained for the 15th of March 2019, for two stations, with (orange) and without (blue) the integration of the Deterministic Hourly Forecasts (DHF).

5. Conclusion and perspectives

This implementation eases the work of the forecasters, as they do not need to adjust the PDF in accordance to their previous expertise on the DHF. As a result, operations for flow management are easier to optimize, including better flood predictions, scheduling of short-term maintenance operations, etc.

Several perspectives will be treated in the next months :

- Adding spread to the deterministic forecasts before the combination to take into account meteorological uncertainties and verify reliability ;
- Setting the EMOS post-processing on the PDF+DHF forecasts ;
- Computing quantitative scores to assess the performances of the combination ;
- Applying the same process to the others CNR tools (combination between mid-term and long-term tools).

References

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