Allowing human expertise on meteorological ensemble forecasts

Does human expertise on clusters affect the statistical properties of ensemble forecasts?

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CNR in short

Since 1934

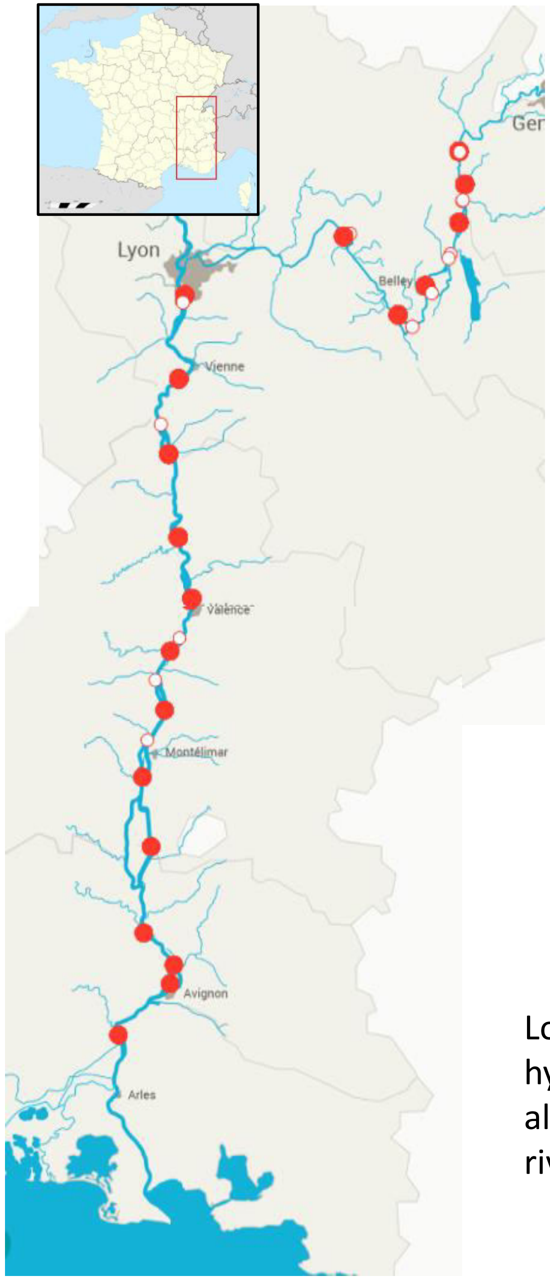
Producing **hydroelectricity**

Developing inland **navigation**

Facilitating **irrigation** for agriculture

CNR in 2023

- 1st French electricity producer in 100% renewable energy sources
- 2nd French electricity producer
- 25% of French hydropower generation



Location of hydropower plants along the Rhône river

Short term ensemble forecasting at CNR

The ensemble forecasting chain is currently in development

Stakes

- Hydropower production forecasting and optimization
- Hydraulic Safety

Particularities

- Succession of tools (meteorology, hydrology, hydraulics)
- Expertise at every stage of the chain
- Work scale: catchment
- Statistical processing to ensure reliability of ensemble forecast

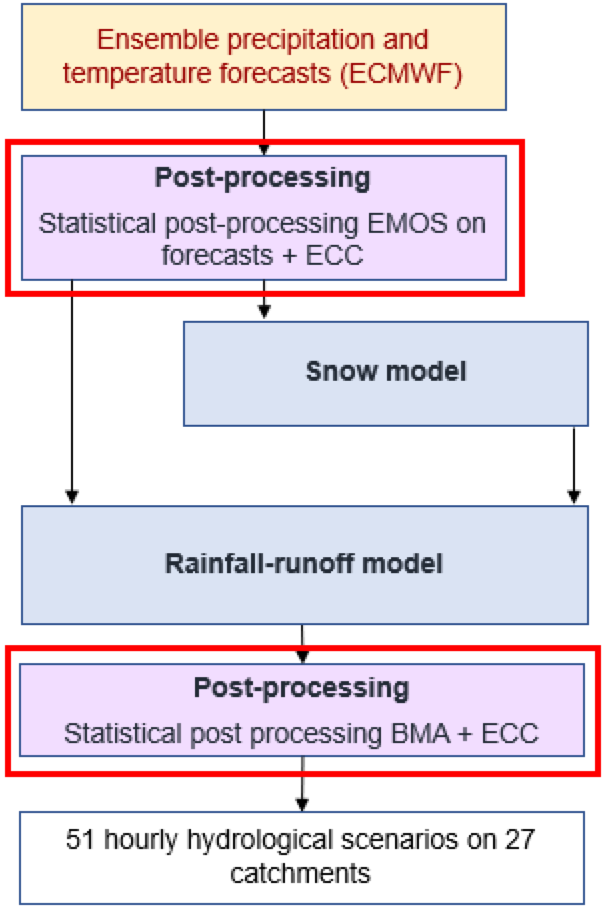
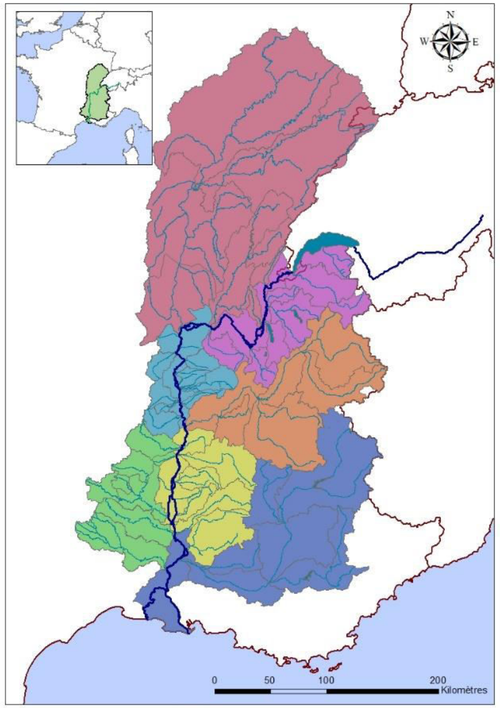


Diagram of the short-term ensemble forecast chain



Expertised catchments on the Rhône river

Context and issues

Context:

- Recent developpement of an ensemble hydrometeorological forecast chain at CNR
- Purpose: get the best estimate of **forecast uncertainty** while **allowing human expertise**

New issues:

- Use of “ensemble" models, used in meteorology, but little used in other fields
- Finding ways of **presenting** and **summarising ensemble information**
- Defining ways to expertise ensemble forecast
- Evaluate the **impact of expertise on the statistical properties** of the ensemble, especially its **reliability**

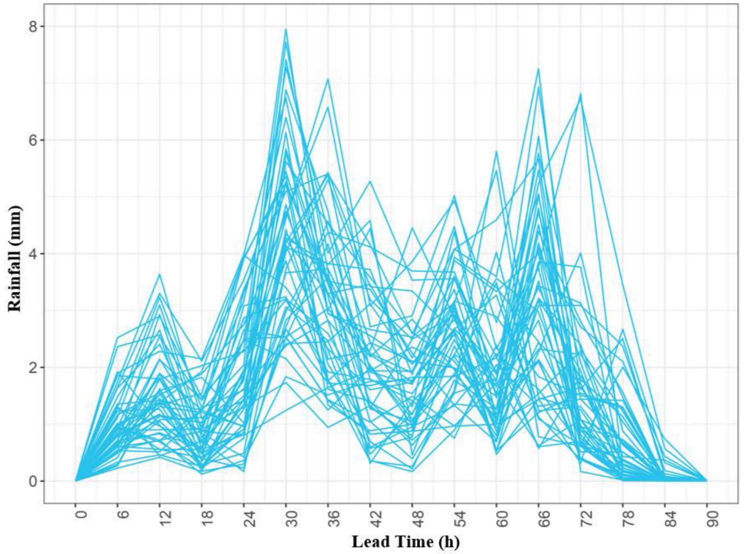
Summarising information through clustering

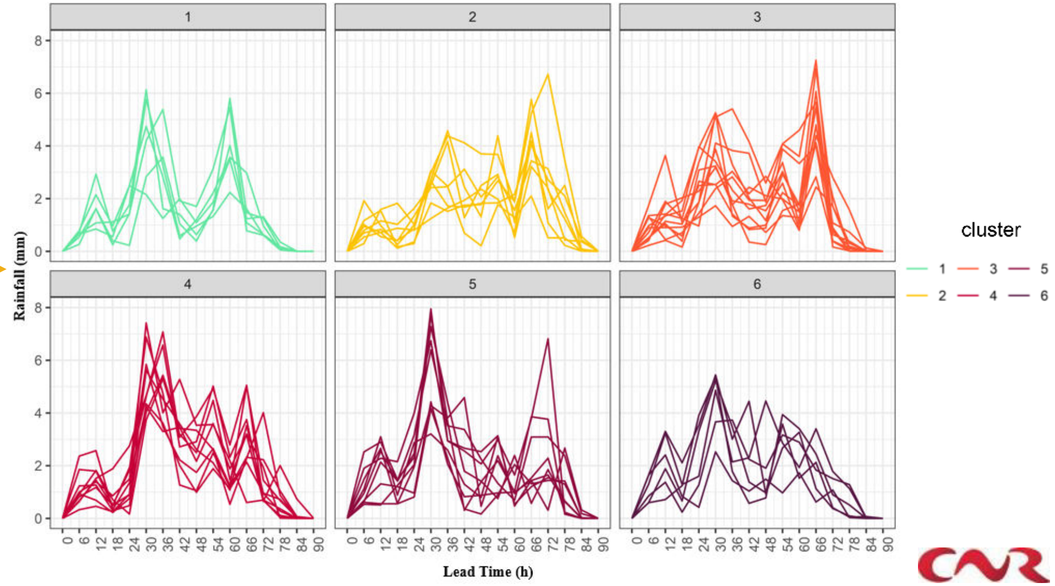
Clustering on forecast precipitation values: weighted K-means

- Space and time clustering
- Unsupervised clustering algorithm

Forecast precipitation → Data spatial aggregation → EOF → 1st component → K-means → Clustered precipitation

Data | Data processing | Clustering | Results





Types of human expertise assessed

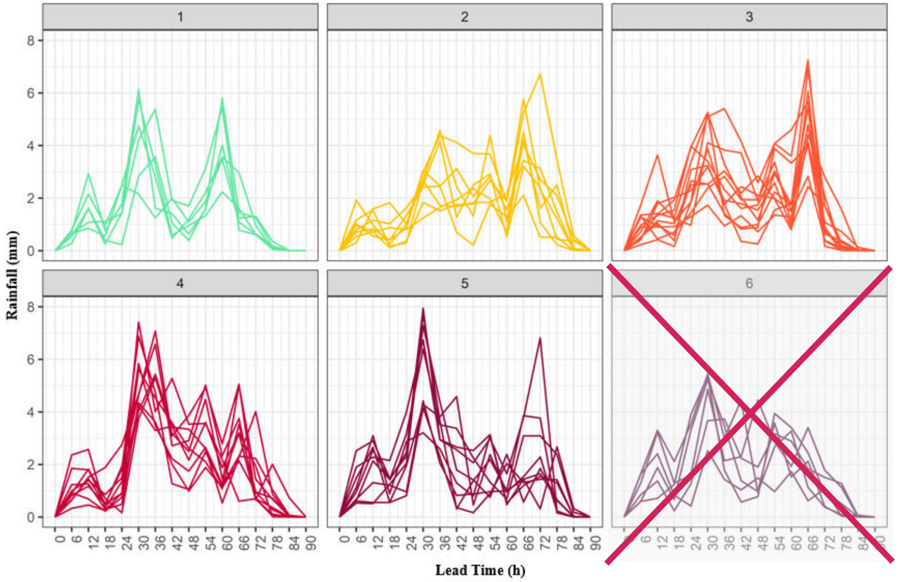
Suppression of an isolated cluster

Definition: "cluster whose median precipitation value is furthest from the median precipitation value of all its members".

Cluster median different by at least 10% from the medians of the other clusters.

2 archives generated:

1. Isolated cluster: maximum 20% of members
2. Isolated cluster: 20 to 40% of members

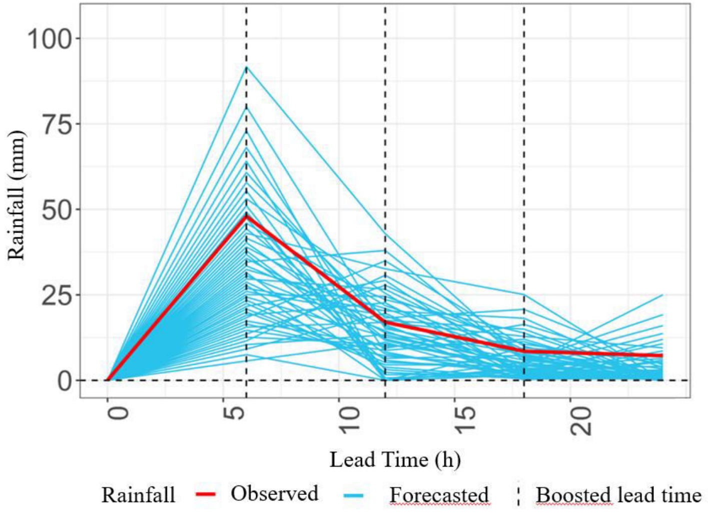


Boost on rain values

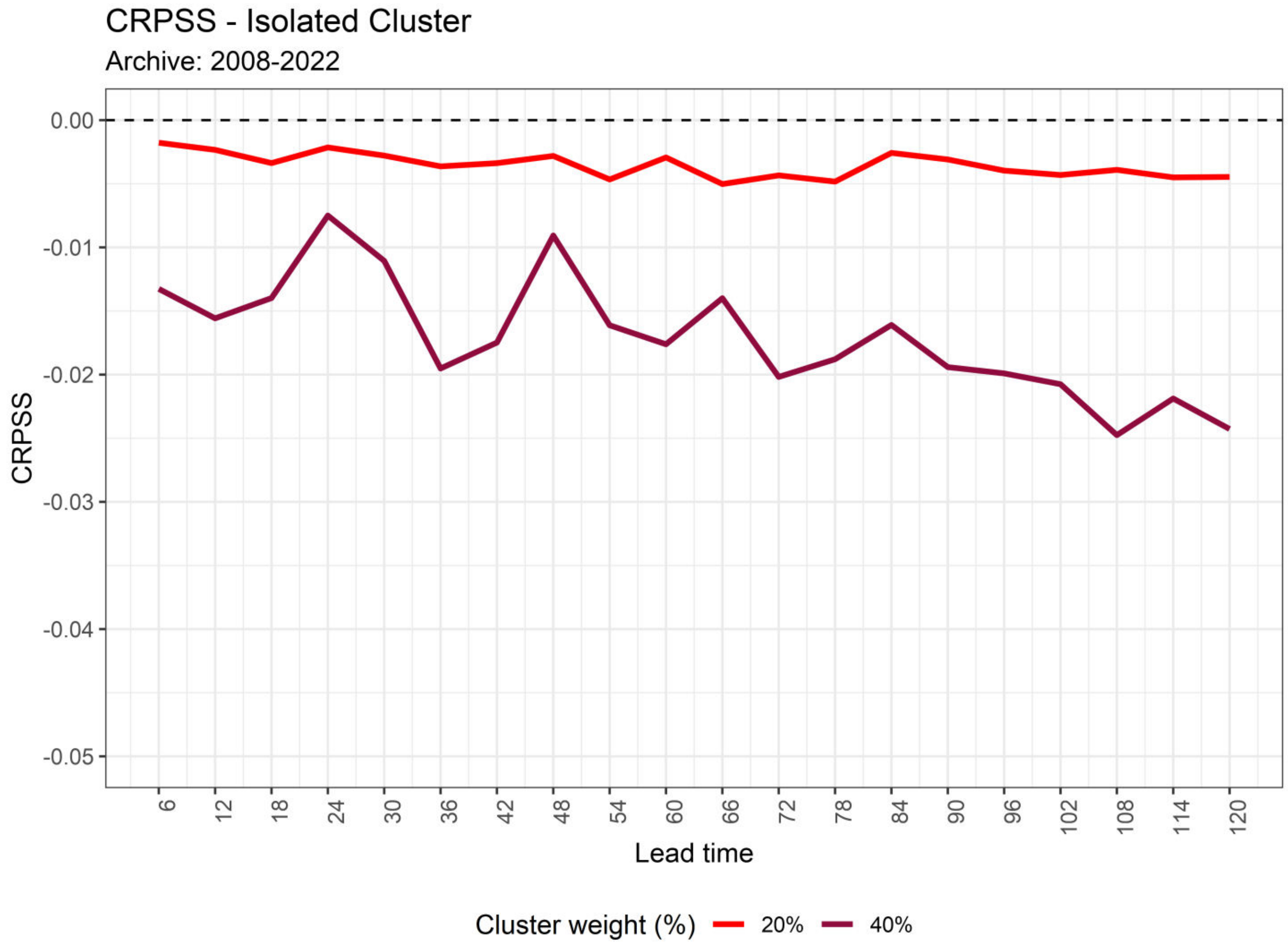
Definition: application of a multiplicative coefficient to precipitation values

1. Boost applied on precipitation values over that exceed a calculated threshold
2. Boost applied on selected catchment and lead times
3. Archive of "perfect" boost values (based on observations)
4. Application of normal noise on boost values
5. Boost varies between 0.5 and 2

Archives generated: 20, 50, 100, 200% error around the exact correction.



Suppression of an isolated cluster: results

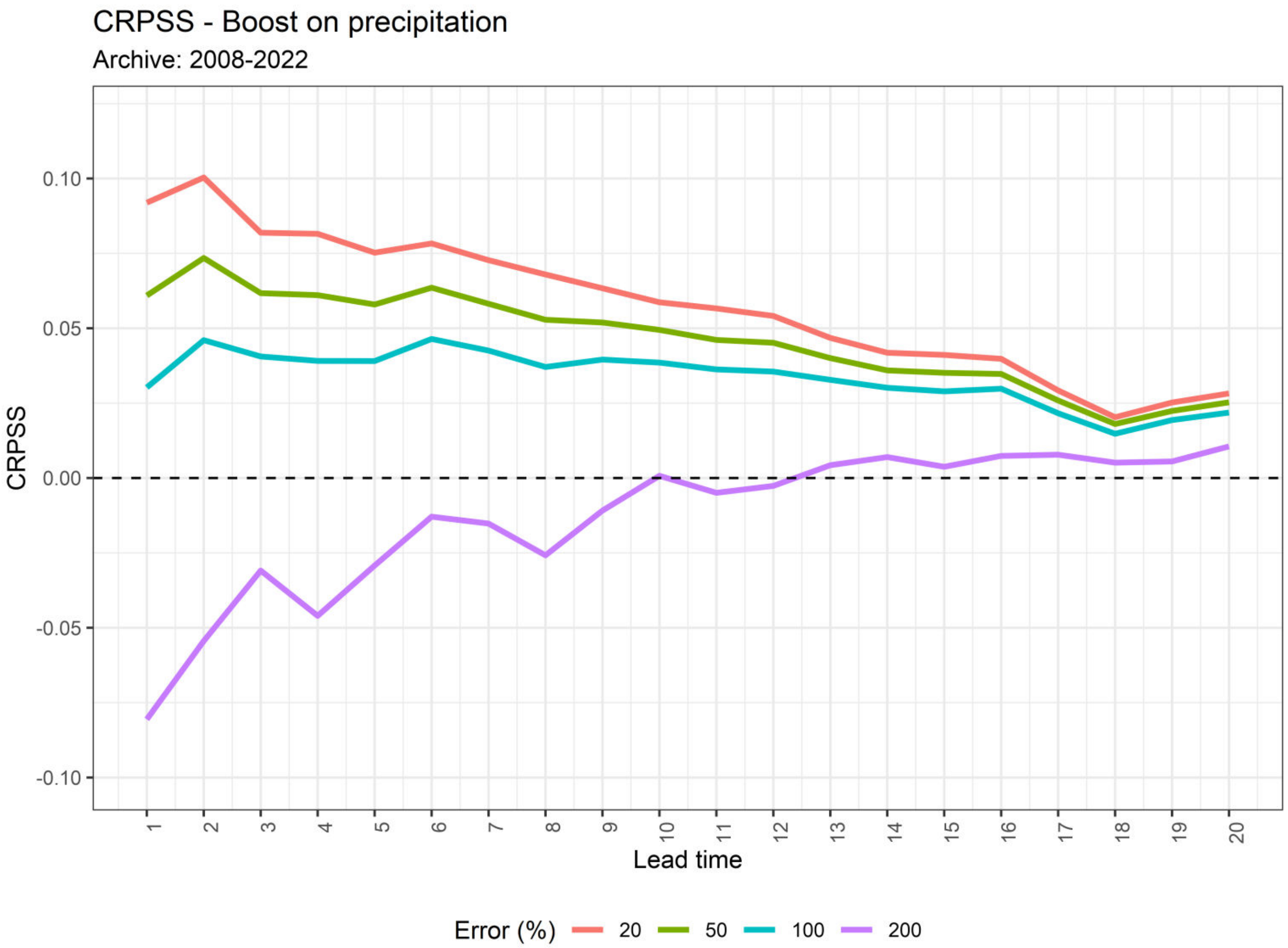


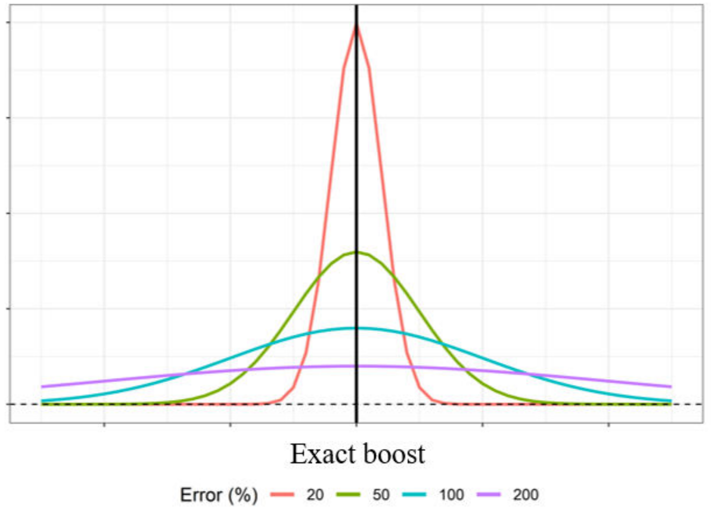
Reference CRPS: unmodified ensemble

- Low degradation of CRPSS due to reliability
- Almost no decline in performance up to a cluster size of 20%
- Acceptable loss of performance for a cluster size up to 40%

- **Suppressing an isolated cluster is possible without strongly degrading the reliability**

Boost on precipitation values: results





Errors simulated around the exact boost value

- Visible improvements on the CRPS up to an error of 100%
- Low degradation of reliability, large gain of potential CRPS (not shown)

- **Applying a boost coefficient for selected cases improves performances as long as expertise is enough accurate**

Conclusion

Results:

- Clusters facilitate **the expertise process**
- Assessed types of expertise appears **possible without degrading performances**
- **Limits need to be set** : maximum number of members in the isolated cluster, bounds for the boost values

Perspectives:

- Study the impact of **combined expertises**
- Study the impact of **new expertise types**
- Implementation of these methods in the operational chain
- Propagation of human **expertise on hydrological simulations**

Thank you for listening!

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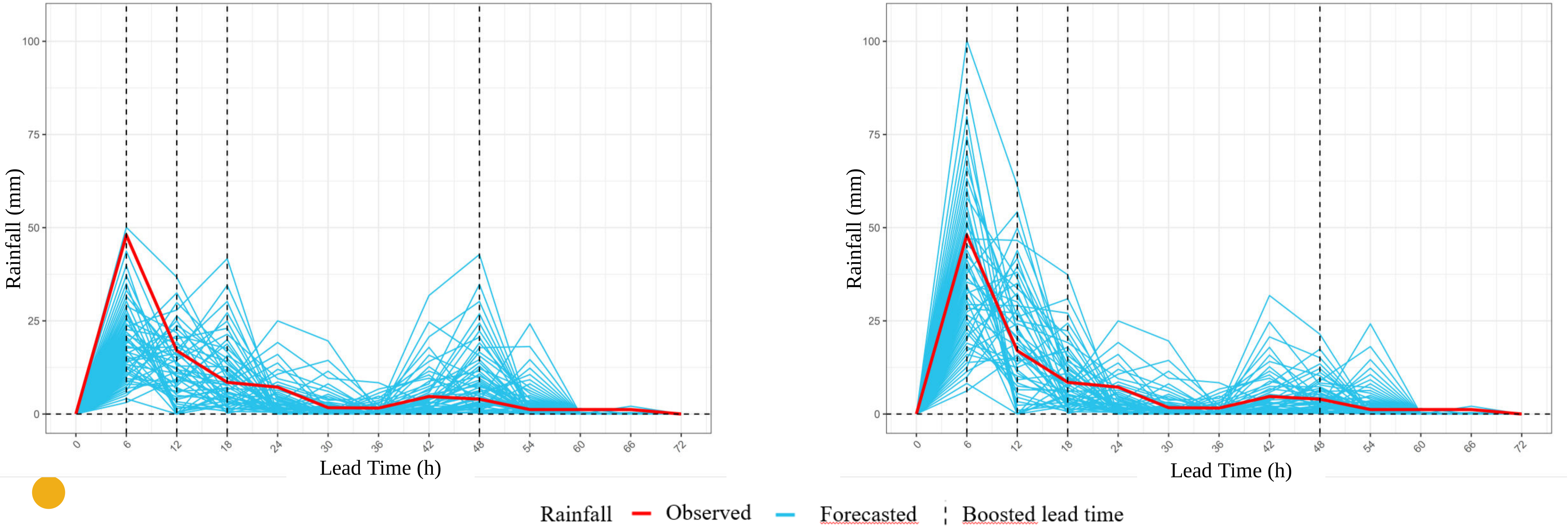
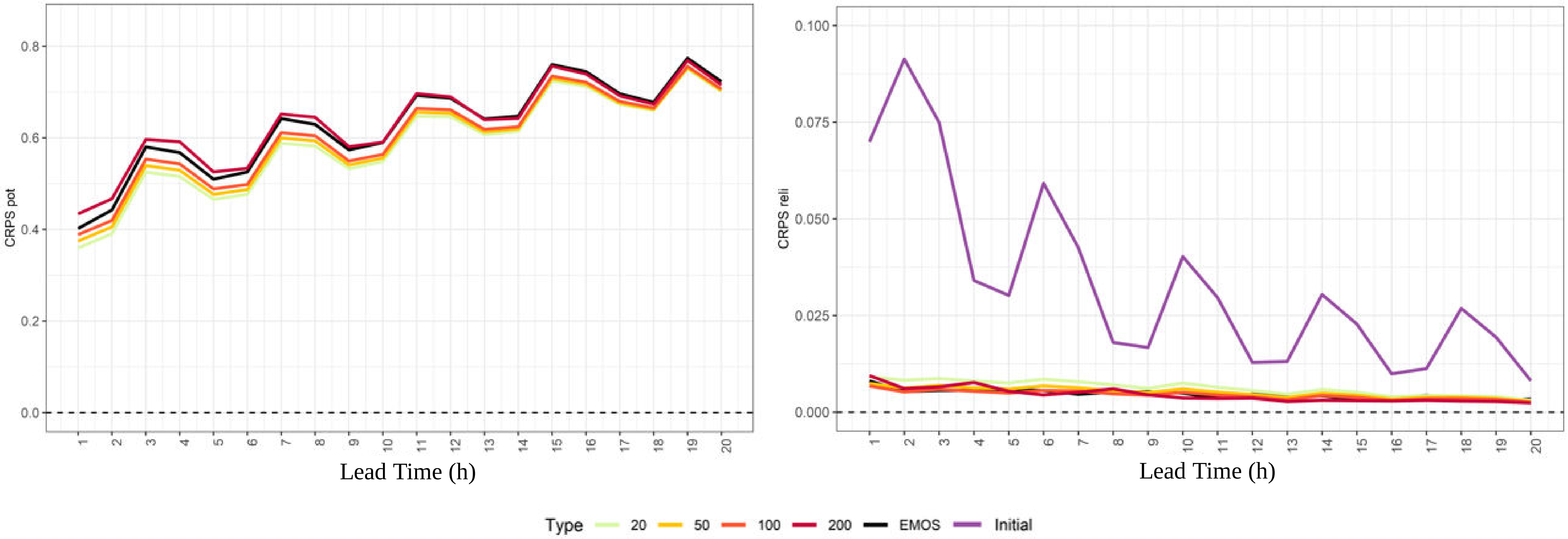
Boost on rain values - methodology



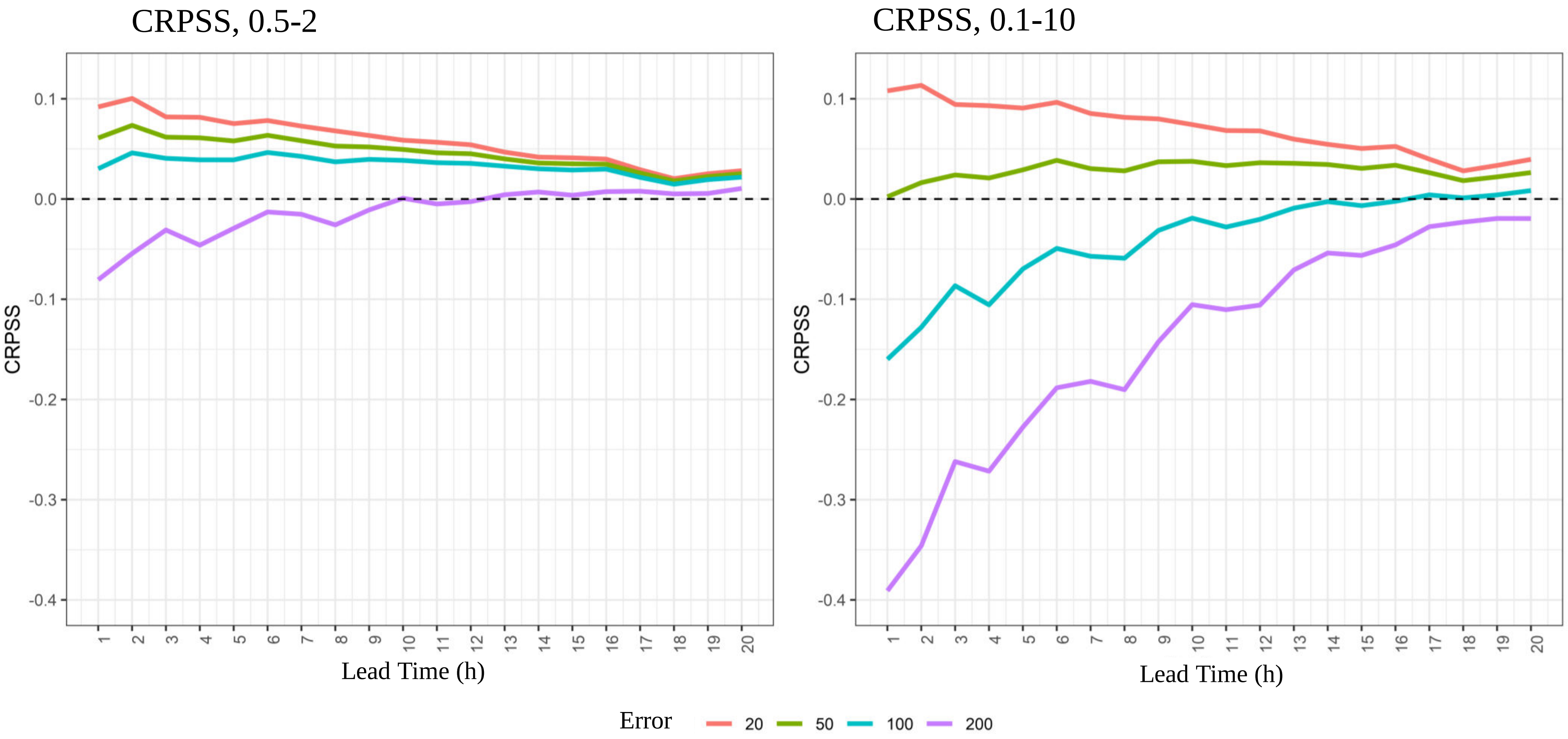
Boost on rain values - results

CRPS potential

CRPS reliabilty



Boost on rain values – bounds and limits



Deleting a cluster - limits

Deletion of a random number of clusters per threshold of remaining members