Using climate services to evaluate projected changes in the operation of hydropower reservoirs

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USING CLIMATE SERVICES TO EVALUATE PROJECTED CHANGES IN THE OPERATION OF HYDROPOWER RESERVOIRS

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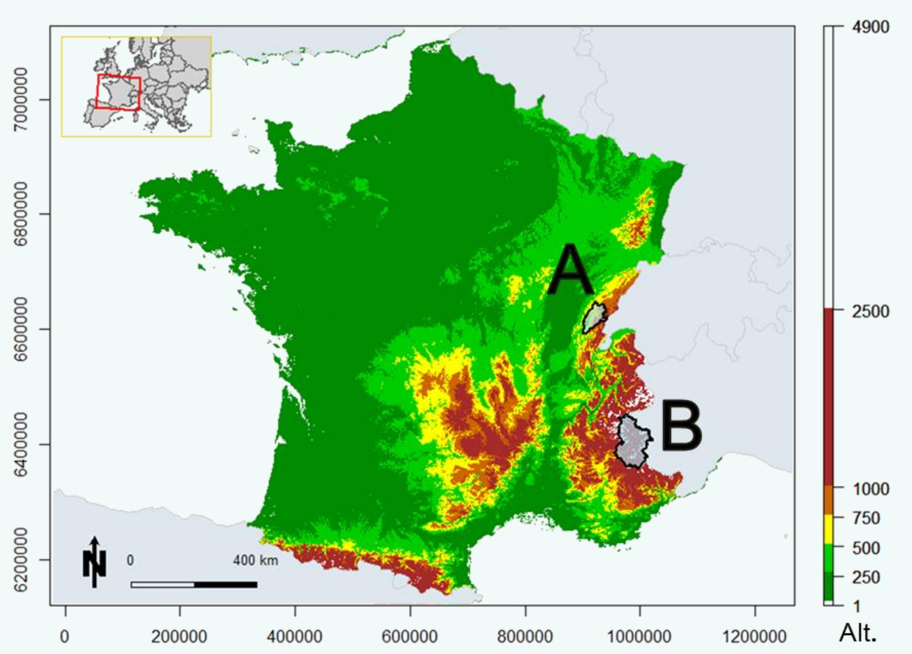
The hydropower sector is sensitive to climate variables as these affect energy generation and consumption. Reservoir-based hydropower can better cope with climate variability in space and time and offers possibilities to regulate production. Climate services give key information to optimize reservoir operations and manage water storage. They provide guidelines for climate change adaptation and climate resilience strategies.

➢ Our aim is to develop indicators for the energy sector based on climate services in order to facilitate decision-making on energy production and planning at the regional and local levels in a context of climate change.

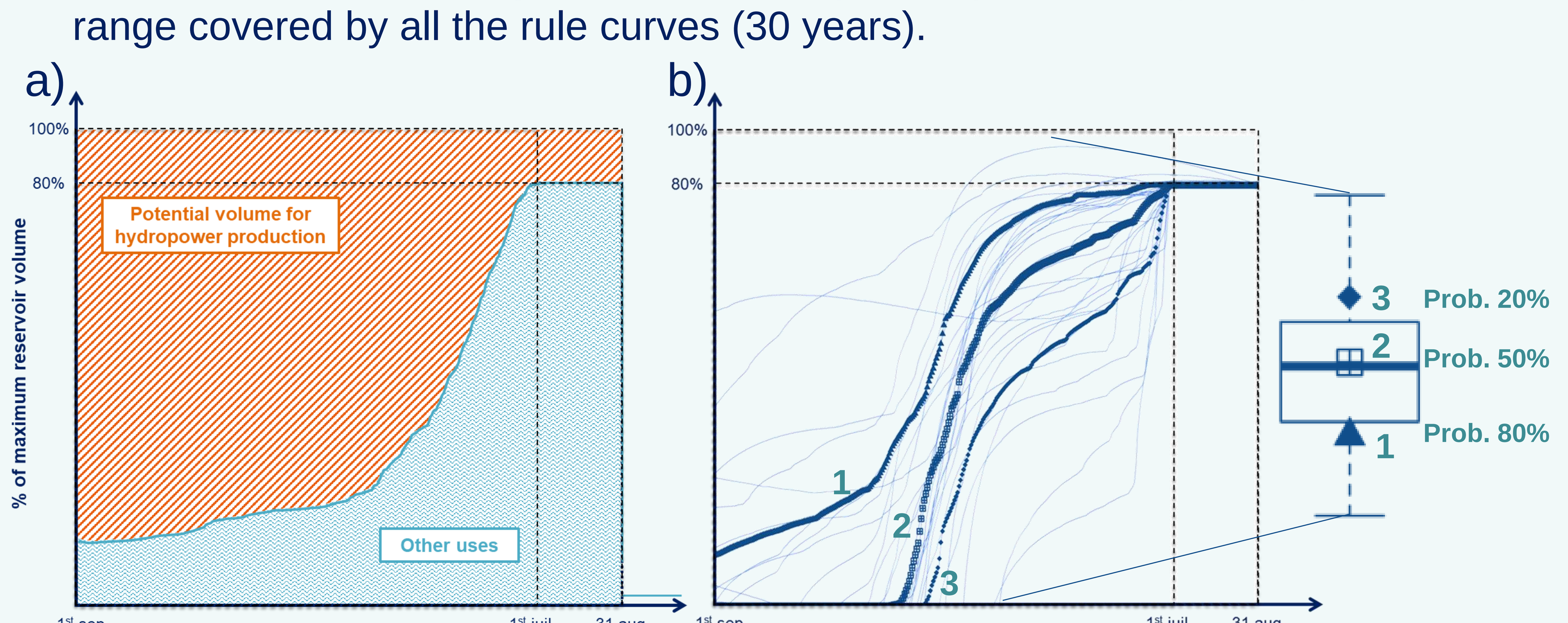
1. Data



- Two catchments:
  - **A**: Ain in Jura (pluvial regime).
  - **B**: Durance in Southern Alps (nival regime).
- **Drias** portal of climate services:
  - http://www.drias-climat.fr
  - 6 GCM/RCM (EURO-CORDEX with RCP 8.5).
  - Climate projections of temperature and precipitation used in GR6J hydrological model to simulate riverflow.
- Flow observations from the French HYDRO database.

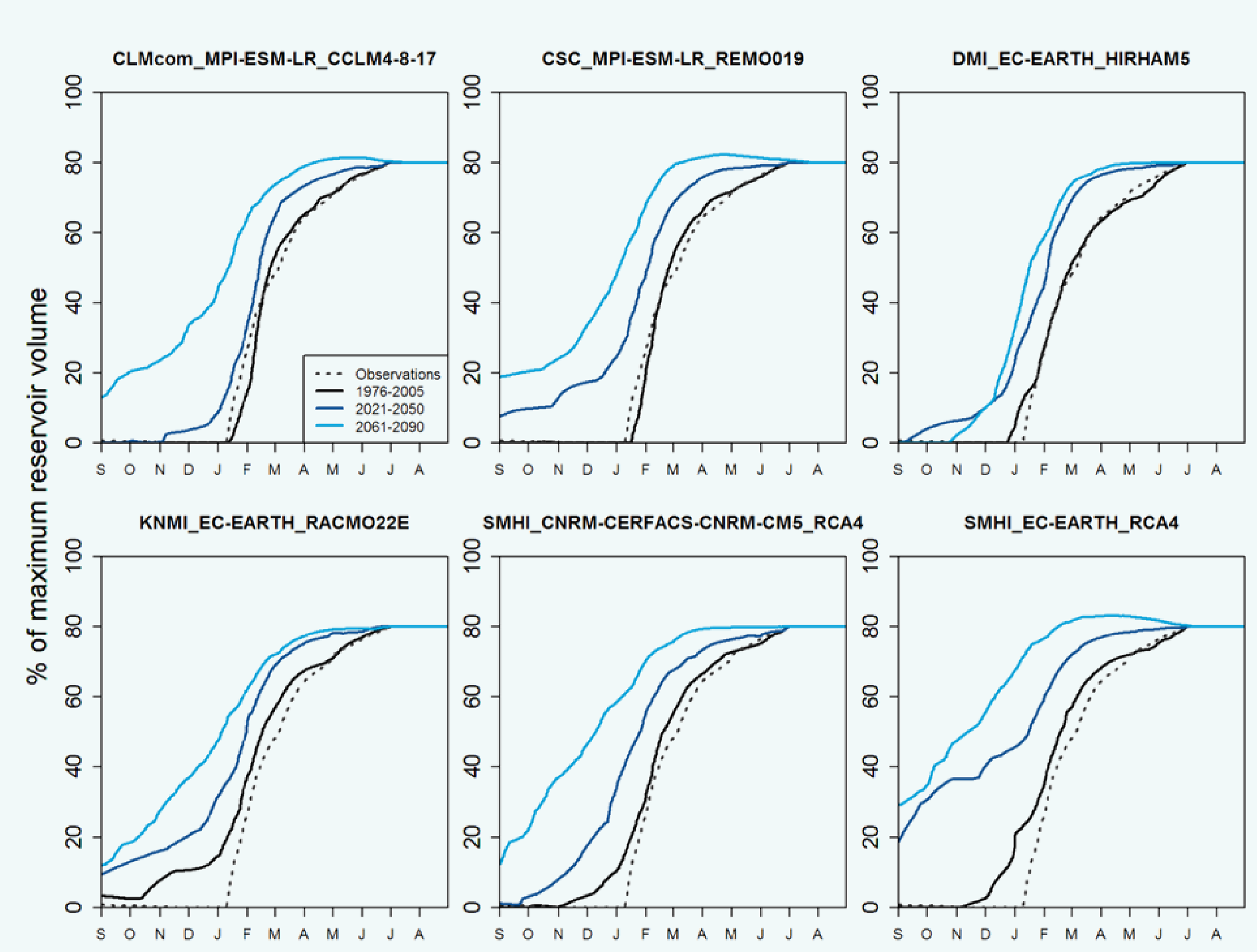
2. Methods: operating guide curves

- They represent how to manage the reservoir levels (figure a) in order to reach the system's objective or constraint (here, the minimum volume/level in the reservoir during summer).
- On figure b, each blue line represents the rule curve for a given year, given its inflows and the minimum releases required. Triangular markers (1) show the 80% guide curve. It indicates the minimum water level required at each day so that the constraint is achieved 8 years out of 10. Squares (2) and Diamonds (3) are for 50% and 20% guide curves, respectively. The boxplot represents the range covered by all the rule curves (30 years).



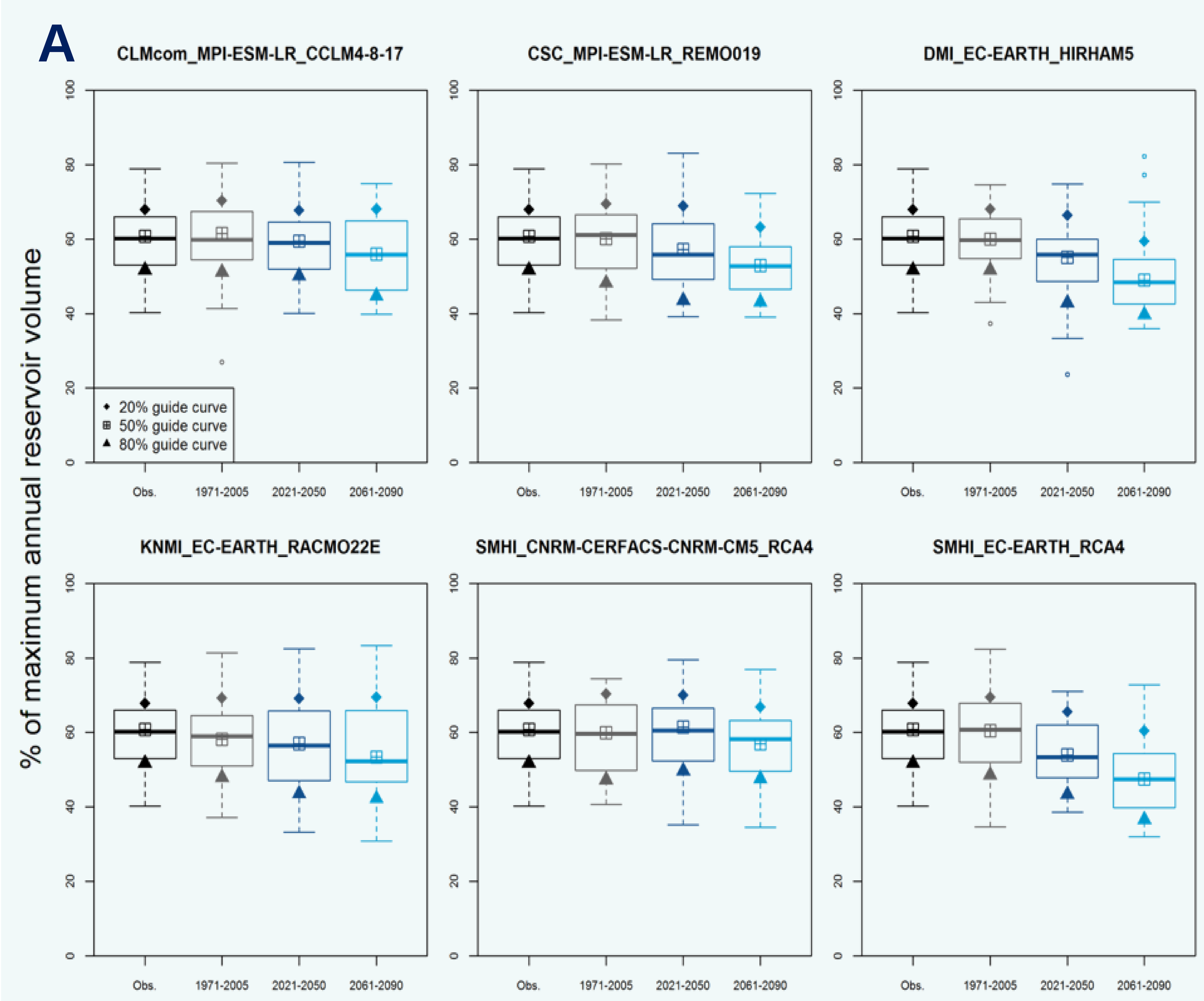
- This study uses conceptual reservoirs whose dimensions are defined as a function of the mean monthly riverflow over a reference period (1976-2005).

3. Results: example of guide curves

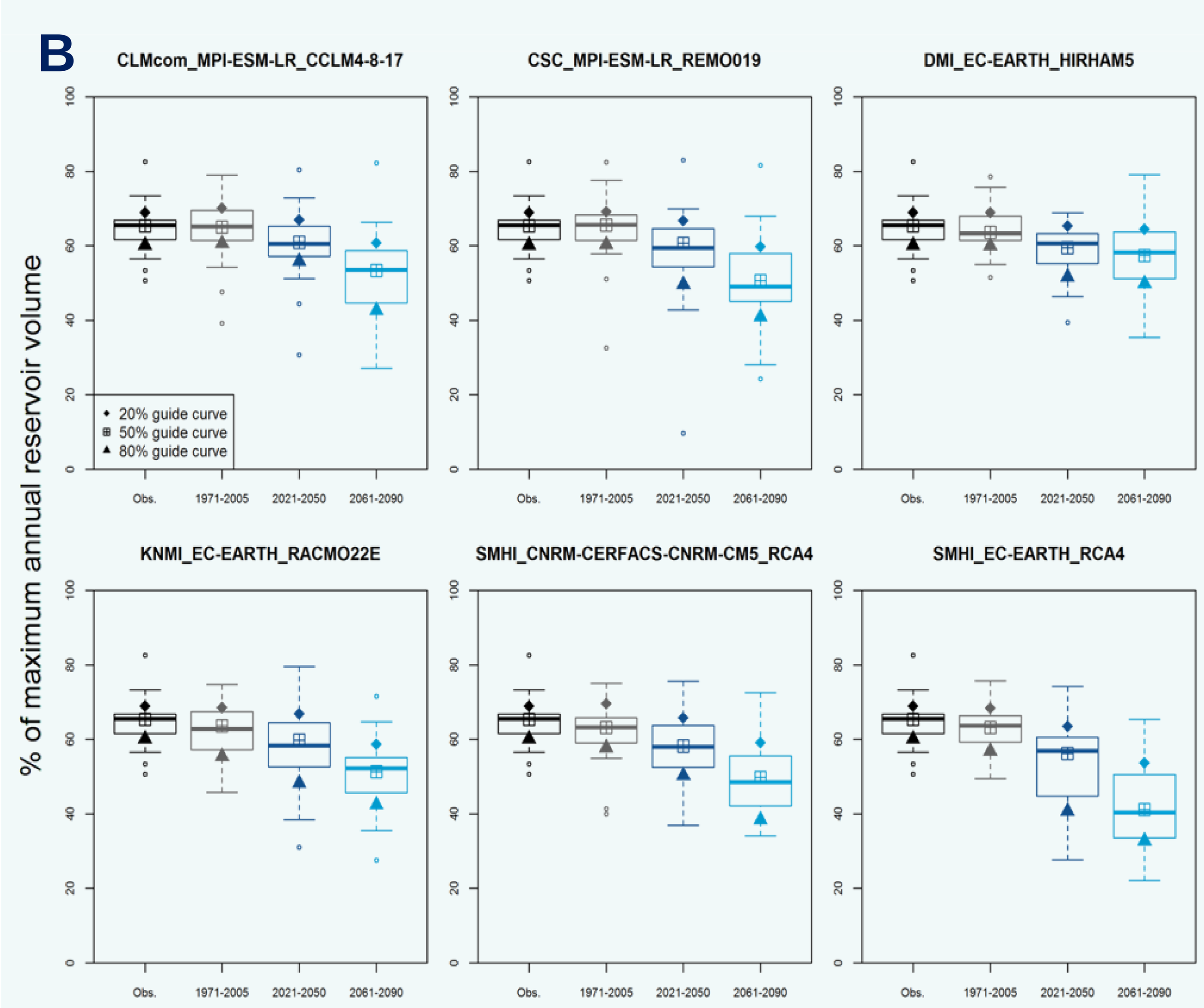


- Guide curves for 6 GCM/RCM.
- 3 periods :
  - *Historical* (1976-2005)
  - *Near future* (2021-2050)
  - *Far future* (2061-2090)
- Location B: Durance in Southern Alps.

4. Results: volume for hydropower production



- Location A: Ain in Jura.
- Results from projections over the historical period (1976-2005) represent well the observations (Obs).
- Most GCM/RCM projections for the future indicate a downward trend in the % of maximum volume that can be potentially used for hydropower optimization.



- Location B: Durance in Southern Alps.
- Similar general conclusions.
- Under this regime, more influenced by snowmelt, all GCM/RCM indicate a more significant decrease of the maximum volume that can be potentially used for hydropower optimization (comparatively to location A).
- The variability among annual guide curves increases in the future (wider boxes).

5. Conclusions

- The use of guide curves is necessary for reservoir management in order to respect different constraints inherent to multi-purpose systems.
- Climate services provide information and variables that allow the construction of guide curves under different scenarios of future climate.
- We showed how an indicator can be obtained based on these guide curves to characterize the maximum volume that can be potentially allocated to hydroelectric production. It highlights the flexibility of water-energy systems under future climate.
- The two catchments studied showed a general downward trend in the maximum volume available for optimization in the future, with the higher impact observed in the catchment with a nival hydrological regime.
- It might be necessary to consider a modification of the reservoir management rules or to adapt constraints in the future in order to guarantee the same volume for production as in the historical (reference) period.

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