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A centralized real-time controller for the reservoir's management on the Seine River using ensemble weather forecasting

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The reservoirs on the Seine River, upstream of Paris, are regulated with the objective of reducing floods and supporting low flows. The current management of these reservoirs is empirical, reactive, and decentralized, mainly based on filling curves, constructed from an analysis of historical floods and low flows. When inflows are significantly different from their seasonal average, this management strategy proves inefficient. Climate change is also a challenge, for the possible modification of future hydrologic conditions.

To improve such management strategy, in this study we investigate the use of Tree-Based Model Predictive Control (TB-MPC), a proactive and centralized method that uses all the information available in real-time, including ensemble weather forecasting. In TB-MPC, a tree is generated from an ensemble of weather forecast. The tree structure summarizes the information contained in the ensemble, specifying the time, along the optimization horizon, when forecast trajectories diverge and thus uncertainty is expected to be resolved. This information is then used in the model predictive control framework.

The TB-MPC controller is implemented in combination with the integrated model of the water system, including a semi-distributed hydrologic model of the watershed, a simplified hydraulic model of the river network, and the four reservoir models. Optimization takes into account the cost associated to floods and low-flows, and a penalty cost based on the final reservoir storages. The performances of the TB-MPC controller will be simulated and compared with those of deterministic MPC and with the actual management performances.

This work is part of the Climaware European project (2010-2013) set up to develop and to assess measures for sustainable water resources management regarding adaptation to climate change.