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Uncertainty on evapotranspiration formulation and its hydrological implication under climate change over France

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Climate change might cause regional modifications of precipitation regimes and increase of air temperature and evaporative demand. As a consequence, the potential increase in evapotranspiration has been determined as a key risk, which could lead to a decrease in runoff and water resources. In many hydrological models, evapotranspiration is determined by a preliminary computation of the evaporative demand, potential evapotranspiration (PET). Estimating PET for future climate is still subject to extensive research, due to the multiplicity of PET formulations and the uncertainties associated with the climatic variables used within these formulations. Physically-based PET formulations use several climatic variables whose simulations come with large uncertainties, while more simple empirical PET formulations rely on limited climatic variables. However, their empiric development questions their robustness for transient climatic conditions.

In this work, we examined the evolution of PET under future climate conditions. We also investigated to what extent seven different classical PET formulations could modify the partitioning of uncertainty associated with climate projections.

The importance of PET formulation on the total uncertainty of the potential evapotranspiration changes was evaluated within a multiscenario multimodel ensemble (Euro-CORDEX climate projections from CMIP5 experiment) over the whole France. This approach was used to account for the uncertainty on the unknown future greenhouse gas emissions trajectories, and differences coming from climate models (GCMs and RCMs). An analysis of the variance (ANOVA), allowed us to determine the contribution of each modelling step to the total uncertainty of PET estimates over entire France. The ANOVA was applied on an ensemble completed by a Bayesian process, to have a balance set of projections to analyze.

The results showed that the relative importance of PET formulations was found to be minor compared with other uncertainty sources (GCMs and RCMs) in the future. We also found that divergences of PET among the different formulations were highly dependent on the temperature anomaly. Based on our experimental design, we concluded that the choice of PET formulation might not constitute a major element of uncertainty reduction for hydrological projections.