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Method to identify and quantify the effect of climatic and non-climatic drivers on river discharge in Europe

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To predict and manage the evolution of water resources is a high stake for society in the context of climate change and largely managed rivers. A first step in this endeavour is to be able to determine in the past records which of both processes has dominated changes.

We propose an innovative way to detect and quantify the changes in river discharge due to climate processes or to non climatic factors over the past century for European catchments. The Land surface model (LSM) ORCHIDEE forced with a century long climate data set is used to simulate the complex hydrological response of natural catchments to change in climatic variables. The Budyko framework is applied with a time-moving window to decompose the direct discharge response to changes in precipitation P and potential evapotranspiration PET and the indirect response due to climate induced changes in the evaporation efficiency of the watersheds. We then apply the same methodology to discharge observations from gauging stations over Europe. It enables to highlight the areas where the model misrepresents (or omits) important catchment processes and where non-natural changing factors impacting the watershed's apparent evaporation efficiency significantly contribute to trends in the observed discharge over the century. Results over Europe show that long-term changes and variability in discharge due to climate processes are dominated by changes in P . The second main climatic driver is PET except over the Mediterranean area where water is more limiting and where intra-annual changes in the distribution of P outweigh the effect of PET trends on discharge changes. Over most catchments however and mostly in southern Spain, the changes due to factors not accounted for in the "natural" system dominate over the century. When the focus is on decadal periods, the effect of non-climatic factors is still significant but small compare to the high effect of climate variability. Attempts to attribute non-climatic changes in the catchments evaporation efficiencies are presented. For instance, good correlations are found between changes in the evaporation efficiency of Spain catchment with the evolution of water stored in dams showing that it is a reliable indicator of the effect of human activities on the hydrological changes of watersheds in that area. Adding the effect of land-use and land-cover changes in the current implementation of the LSM has no significant effects on the hydrological behaviour of the watersheds at the studied scale of this study. Many processes especially related to human factors impact the watershed's apparent evaporation efficiency, often with complex and inter-correlated feedback effects and further studies are needed to better attribute the non-climatic trends detected. Further developments in LSM would allow to better include these factors.

