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# Identifying and quantifying the impact of non-climatic effects on the water cycle in a semi-arid environment

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In a context of climate change, the stakes surrounding water availability and use are getting higher, especially in semi-arid climates. Human activities such as irrigation and land cover changes impact the water cycle, raising questions around the effects it could have on regional atmospheric circulation and how to separate the impact of climate change from the impact of anthropogenic activities to better understand their role in the historical records. The ORCHIDEE Land Surface Model from Institut Pierre Simon Laplace (IPSL) simulates global carbon cycle and aims at quantifying terrestrial water and energy balance. It is being developed at regional scale but does not include satisfying hypothesis to account for human activities such as irrigation at such scale so far.

We propose a methodology to semi-empirically separate the effect of climate from the impact of the changing catchment characteristics on river discharge. It is based on the Budyko framework and allows to characterise the annual river discharge of over 363 river monitoring stations in Spain. The Budyko parameter is estimated for each basin and represents its hydrological characteristics. Precipitations and potential evapotranspiration are derived from the forcing dataset GSWP3 (Global Soil Wetness Project Phase 3) – from 1901 to 2010 –. Two methods are used to estimate evapotranspiration : the first uses evapotranspiration from the ORCHIDEE LSM outputs while the second deduced evapotranspiration from river discharge observations and the water balance equation. The first method only accounts for the effects of atmospheric forcing while the other combines, through the observations, climatic and non-climatic processes over the watersheds. We then study the evolution over the Budyko parameter fitted with these two estimates of evaporation. Studying the watershed parameter allows us to free ourselves from some of the climate interannual variability compared to directly looking at changes in the river discharge and better separate anthropogenic changes from the effect of climatic forcing.

Our results show that for most basins tested over Spain, there is an increasing trend in the Budyko parameter representing increasing evaporation efficiency of the watershed which can not be explained by the climate forcing. This trend is consistent with changes in irrigation equipment and land cover changes over the studied period. However changes of the basin characteristics can not be fully quantified by this variables. Other factors as glaciers melting which derails the water

balance over our time of study.

The methodology needs to be extended to other areas such as Northern Europe to see if the differences in response of the catchments to anthropogenic changes quantified by our methodology corresponds to known contrasts. Balance between climatic and anthropogenic changes of basin characteristics are different in semi-arid climate than in northern more humid regions.