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# Physical factors of influence in the interactions between rainfall, evapotranspiration and soil moisture driving the spatio-temporal evolution of drought patterns in the Ebro Basin (NE Spain).

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Droughts in the Iberian Peninsula are a natural hazard of great relevance due to their recurrence, severity and impact on multiple environmental and socioeconomic aspects. The Ebro Basin, located in the NE of the Iberian Peninsula, is particularly vulnerable to drought with consequences on agriculture, urban water supply and hydropower. This study, performed within the Project HUMID (CGL2017-85687-R), aims at evaluating the influence of the climatic, land cover and soil characteristics on the interactions between rainfall, evapotranspiration and soil moisture anomalies which define the spatio-temporal drought patterns in the basin.

The onset, propagation and mitigation of droughts in the Iberian Peninsula is driven by anomalies of rainfall, evapotranspiration and soil moisture, which are related by feedback processes. To test the relative importance of such anomalies, we evaluate the contribution of climatic, land-cover and geologic heterogeneity on the definition of the spatio-temporal patterns of drought. We use the Köppen-Geiger climatic classification to assess how the contrasting climatic types within the basin determine differences on drought behavior. Land-cover types that govern the partition between evaporation and transpiration are also of great interest to discern the influence of vegetation and crop types on the anomalies of evapotranspiration across the distinct regions of the basin (e.g. forested mountains vs. crop-dominated areas). The third physical characteristic whose effect on drought we investigate is the impact of soil properties on soil moisture anomalies.

The maps and time series used for the spatio-temporal analysis are based on drought indices calculated with high-resolution datasets from remote sensing (MOD16A2ET and SMOS1km) and the land-surface model SURFEX-ISBA. The Standardized Precipitation Index (SPI), the EvapoTranspiration Deficit Index (ETDI) and the Soil Moisture Deficit Index (SMDI) are the three indices chosen to characterize the anomalies of the corresponding rainfall (atmospheric), evapotranspiration (atmosphere-land interface) and soil moisture (land) anomalies (components of the water balance). The comparison of the correlations of the indices (with different time lags) between contrasting regions offers insights about the impact of climate, land-cover and soil

properties in the dominance, the timing of the response and memory aspects of the interactions. The high spatial and temporal resolution of remote sensing and land-surface model data allows adopting time and spatial scales suitable to investigate the influence of these physical factors with detail beyond comparison with ground-based datasets.

The spatial and temporal analysis prove useful to investigate the physical factors of influence on the anomalies between rainfall, evapotranspiration and soil moisture. This approach facilitates the physical interpretation of the anomalies of drought indices aiming to improve the characterization of drought in heterogeneous semi-arid areas like the Ebro River Basin.