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Exploring the landscape heterogeneity and the hydrological diversity in three contrasted observatories of the French critical zone research infrastructure OZCAR

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The French OZCAR critical zone network offers the opportunity to conduct multi-site studies and to explore the critical zone functioning under contrasted climate, geology, vegetation and land use. In this study, an integrated modeling of the water cycle is performed with the ecohydrological model EcH$_2$O-iso in three long-term observatories: (1) the Naizin watershed characterized by an oceanic climate, a metamorphic bedrock and an intensive agriculture (north-west of France, AgrHyS observatory); (2) the Aurade watershed, a watershed with a warmer semi-continental oceanic climate, a sedimentary geological substratum and a crop cover with a wheat-sunflower rotation (south-west of France, Aurade observatory) and; (3) the Strengbach watershed characterized by a mountain climate, a granitic bedrock, and a beech-spruce forest cover (north-east of France, OHGE observatory).

Modeling robustness is evaluated by taking advantage of the large database for critical zone sciences including stream flow, water level in piezometers, and evapotranspiration fluxes measured from climatological stations and flux-towers located in the watersheds. Our comparative study brings these general outcomes: (1) the long term CZ evolution controlling the regolith thickness strongly impacts the total water storage in watersheds; (2) the Quaternary geomorphological evolution influences the current hydrological partitioning and the separation of

hydrologically active and inactive water storage; (3) Both internal watershed characteristics and external forcings, such as current atmospheric forcing and recent land use need to be considered to infer stream persistence and to understand hydrological diversity; and (4) the observed hydrological diversity cannot be fully understood without considering a continuum of time scales in CZ evolution.

Overall, this work illustrates the strength of critical zone networks, allowing a new level of multi-site and comparative studies that are crossing several observatories and encompassing a wide diversity of geology and climate.