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Comparing the impacts of climate modes of variability on coastal aquifers of Portugal and California

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Understanding the impact of climate variability on aquifer systems is important to improve future projections of groundwater availability, particularly in the context of increasing water scarcity. Coastal aquifers in Mediterranean regions are particularly sensitive to inter-annual and seasonal water storage fluctuations linked to climate forcing and climate-induced pumping. This comparative study examines the implications of climate variability modes on groundwater levels in coastal aquifers of California and Portugal. Piezometric levels in selected aquifers in Portugal (Leirosa-Monte Real and Campina de Faro) and California (Coastal Basins aquifers), spanning a period from 1988 to 2018, are analyzed using wavelet transform methods and principal component analysis. The methods expose not only the impact of the individual climate modes (AMO, PDO, ENSO, PNA in California and NAO, EA and SCAND in Portugal) but also the existence of complex transitive couplings among modes. Together, the climate modes are responsible for most (80%) of the inter-annual variability in groundwater storage in both Portugal and California coastal aquifers. However, our most important result is the recognition that transitive couplings greatly affect the hydrological responses both in Portugal and California. Coupled phases are linked to extreme piezometric levels and are associated with shifts in mode-interaction patterns. The authors would like to acknowledge the financial support FCT through project UIDB/50019/2020 – IDL.