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Non-stationary analysis of extreme precipitation over Spain

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Changes in the climate system can affect the magnitude and frequency of hydrological extreme events, causing non-stationarities in their behavior. In this study, the Annual Maximum Daily Precipitation (AMDP) series extracted from the most recent gridded precipitation product developed by the Spanish Meteorological Agency (AEMET) were used to investigate whether AMDP over peninsular Spain and the Balearic Islands is experiencing non-stationary behavior. The Pettitt test was applied to identify abrupt changes, and the Mann-Kendall test was used for trends. Field significance was taken into account when applying the tests. In order to identify potential explanatory variables for AMDP, a teleconnection analysis was carried out with the climate indices corresponding to the North Atlantic Oscillation (NAO), East Atlantic (EA) pattern, East Atlantic-Western Russia (EAWR) pattern and Scandinavian (SCA) pattern. Non-stationary frequency analysis of the AMDP series was performed under the Generalized Additive Models for Location, Scale and Shape (GAMLSS) modeling framework, employing six candidate probability distributions. The results of the Pettitt and Mann-Kendall tests suggest the existence of significant change points and trends in part of the Spanish territory. The non-stationary modeling revealed problems such as equifinality and uncertainty in AMDP predictions derived from extrapolation into the future when using the climate indices projected under the ssp585 climate change scenario. This raises the question of further investigating AMDP non-stationarities that tests and models have suggested exist, with the aim of finding the physical cause-effect mechanism that explains these non-stationarities.