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Multi-model seasonal forecasting service for meteorological droughts

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Drought indicators have been proven to be powerful tools to improve drought awareness and decision-making, being a key information source for water resource management in many countries and regions over the world. However, the integration of meteorological drought indicators and seasonal forecasts is not fully explored yet, since most of the drought prediction and early warning services (e.g. European Drought Observatory, Climate Prediction Center) offer limited information on drought forecasting at the seasonal scale.

This contribution presents a multi-model seasonal forecasting service of selected meteorological drought indicators, developed in the context of the WATER4CAST project, for the Jucar River Basin (Spain). This service offers seasonal forecasts (up to 6-7 months in advance) of SPI and SPEI indicators with time aggregations of 6, 12, 18 and 24 months. Input meteorological forecasts to compute them are obtained from the Copernicus Climate Change Service (C3S) for the ECMWF-SEAS5, MétéoFrance-System8, DWD-GCFS21 and CMCC-SPSv35 forecasting systems. These forecasts are post-processed against ERA5 reference data to ensure they are tailored to the climatic patterns of the Jucar River Basin, employing artificial intelligence algorithms (fuzzy logic) trained for the 1995-2014 period. Reference evapotranspiration for the calculation of SPEI indicators is estimated using the Hargreaves method. Once meteorological forecasts are post-processed and upscaled to the monthly scale, aggregated forecasts required to compute SPI and SPEI are made by combining them with past data from ERA5 (e.g. an SPI12 forecast for the next month would require 12-month aggregated precipitation forecasts made up by combining precipitation predictions for the next month with past precipitation records for the last 11 months). Finally, aggregated forecasts of precipitation (for SPI) and precipitation less reference evapotranspiration (for SPEI) are transformed into SPI and SPEI by standardizing them using the gamma (SPI) and the loglogistic (SPEI) probability functions, fitted for each ERA5 point using reference data for the 1973-2022 period. All the calculation process is coded in Python, and it is automatically launched as soon as new seasonal forecasts are available in the C3S.

The resulting service offers seasonal forecasts at the monthly scale, from 1 to 6/7 months in advance (depending on the forecasting system), of SPI and SPEI for the aggregations given at each point of the ERA5 grid overlapping the Jucar River Basin. These forecasts are uploaded into a web

platform (<https://water4cast-app.upv.es/>) that offers information both for a given point (in with the ensemble of SPI and SPEI forecast is displayed using box-whisker plots) and with a general picture (depicting the probability of being in a dry ($\text{index} \leq -1$), normal ($-1 < \text{index} < 1$) or wet ($1 \leq \text{index}$) period.

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