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Quality assessment of subseasonal soil moisture forecasts for agricultural applications in Germany

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Rain-fed agriculture constitutes more than 95 % of cropland in Germany. It depends heavily on rainfall patterns and the water storage capacities of top soil layers. Intense summer droughts with long-lasting lack of precipitation leads to yield loss in wheat, corn and sugar beet production in the last years 2018, 2019, 2020 and 2022. Hence, these drought events increase the requirement of long-range forecasts for precipitation and soil moisture, which could provide useful predictions for agricultural applications.

Here a coupled modelling attempt is presented, that combines the extended-range ENS-forecasts from the European Centre for Medium-Range Weather Forecasts (ECWMF) with the soil-vegetation-atmosphere-transfer (SVAT) impact model AMBAV to simulate the top soil moisture for subseasonal forecasts on a downscaled 5x5 km grid in Germany. A quality assessment of forecast ensemble means from July 2022 to November 2022 has been done with the corresponding hindcasts for the preceding 20 years. The mean squared error skill score (MSESS) of weekly averages reveals a significant forecast skill up to 4-6 weeks for soil moisture in the upper 60 cm in comparison to an AMBAV analysis run based on gridded weather station data. In contrast, the precipitation forecast skill is much lower and achieve only adequate forecast skill with lead times up to two weeks. Due to the low variability and persistence of soil moisture values, it is proposed, that this storage variable is well suited for climate services like agricultural drought predicting systems on subseasonal time scales. It could offer guidance with sufficient reliability for medium-term management adjustments like irrigation planning or reduced fertilizer usage in case of expected severe drought periods. Overall, the results of this study show the potential of subseasonal soil moisture forecasts for agricultural applications. Further research is needed to verify these findings and to extend the forecast analysis period to the entire year. Then the impact modelling system might contribute to the adaptation of agriculture to climate change in Germany.