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Predictability and skill of large-scale extreme droughts using global bias-corrected seasonal forecasts (SEAS5-BCSD)

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Devastating large-scale droughts are increasing in frequency and severity under climate change, posing major challenges for preparedness and mitigation. Reliable information on the timing, extent, and intensity of droughts is therefore crucial. Seasonal forecasts with lead times of up to twelve months offer potential for early drought warning, but raw model output is often affected by substantial biases and temporal drifts relative to reanalysis products such as ERA5, limiting its direct applicability.

Here, we assess the skill of a global bias-corrected ECMWF SEAS5 seasonal forecast dataset (SEAS5-BCSD, DOI: in preparation), processed using the Bias Correction and Spatial Disaggregation (BCSD) method, for predicting extreme drought events at multiple time scales. For the period 1981–2024, we analyze 36 major droughts selected based on spatial extent and mean Standardized Precipitation Evapotranspiration Index (SPEI), representing the two most severe events per continent (excluding Antarctica) and accumulation period (1-, 3-, and 6-month SPEI).

Forecast performance is evaluated using probabilistic skill metrics including the Continuous Ranked Probability Skill Score (CRPSS) and the Brier Skill Score (BSS). Results show positive CRPSS skill relative to climatology for all analyzed droughts, with SEAS5-BCSD consistently outperforming uncorrected forecasts across all metrics. One-month droughts exhibit the highest predictability, while three- and six-month droughts show comparable but slightly reduced skill. Predictability varies regionally, with African droughts showing the highest skill and North American droughts the lowest. Forecast skill is highest for moderate drought thresholds (SPEI < −1) and decreases for more severe events (SPEI < −1.5 and −2), though remaining superior to climatology in most cases.

Overall, the results demonstrate that bias-corrected seasonal forecasts substantially enhance the predictability of extreme large-scale droughts and provide clear added value over both climatology and uncorrected seasonal forecasts.