Multi-year soil moisture predictability in the Community Earth System Model-Decadal Predication-Large Ensemble (CESM-DP-LE) Experiments

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Year-2 to 10 soil moisture potential predictability is investigated in the Community Earth System Model-Decadal Predication-Large Ensemble (CESM-DP-LE) experiments. Statistically significant prediction skill (signal to noise ratio) for the root zone soil moisture (0-1m) anomalies are analyzed using 36 initialized forecast experiments from the year 1980 to 2015. The initialized forecast consists of a 40-members ensemble forecast that employs: (a) same observed ocean condition, (b) same reference (model simulated) soil moisture condition, but (c) slightly perturbed initial atmospheric conditions on November 1st of the given year. For example, November 1st, 1979, initialization will provide a 10-years forecast from 1980 to 1989. Hence, the second objective of this research is to quantify contributions of the land and ocean sources to the total predictability. The local anomaly correlations between the reference soil moisture anomalies averaged over the past 12-months before the initialization day, and average ensemble forecast anomalies at the given lead-time were employed as a metric to quantify the contribution of the land sources. Finally, the land area with statistically significant skills is computed for North America. The statistical significance is computed at the 95% confidence level.

The majority of the land area (68% of North America) shows statistically significant skill in year-2 of the initialized forecasts. By the year-10, the forecast skill remains statistically significant and found in 37% land area. A total of 45% of land area shows significant skill averaged over the year-2 to year-10 forecasts. The spring season show the highest skill (51%), followed by the summer (50%), winter (46%), and the fall (36%). Locally, land-memory contributes to one-third of total predictability. Contributions of the reference soil moisture anomalies are statistically distinguishable from that of the random soil moisture anomalies for the winter, spring, and fall seasons.