SESSION: (B1) Mechanisms of S2D predictability

(B1-13)

Projected Changes in S2D Hydroclimate Predictability in North America in CESM-LE

Dewes, Candida (1,2), Newman, Matthew (1,2), Kumar, Sanjiv (3)

Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder (1), Physical Sciences Division, NOAA/ESRL (2), School of Forestry and Wildlife Sciences, Auburn University (3)

Potential S2D predictability of North American hydroclimate anomalies, and its sensitivity to external forcing, is evaluated within the 40 climate realizations from the Community Earth System Modeling Large Ensemble (CESM-LE). Each ensemble member experiences the same external forcing scenario (observed + RCP8.5) over the years 1950 to 2070. The hydroclimate variables examined are soil moisture (0-1 m depth), Palmer Drought Severity Index (PDSI), and precipitation. As remote predictors, we consider the leading mode of Pacific sea surface temperature variability within three different domains: the Tropical Pacific (30°S-30°N; e.g., ENSO), the Indo-Pacific (20°S-70°N; e.g., the IPO), and the North Pacific (20-70°N; e.g. the PDO). We also include land surface memory by specifying soil moisture or PDSI state 12 months prior as a local source predictor. By performing simple and multiple linear regression analyses across successive 20-year periods, where the externally-forced signal represented by the ensemble mean is first removed, we can then evaluate the changing relative importance of Pacific forcing and land surface memory upon predictability, measured by a signal-to-noise (S2N) ratio between explained and unexplained variances. Comparison is also made with a similar analysis applied to the observational record over the years 1950-2015.

The relative importance of the remote Pacific and local memory predictors was found to have significant regional variation in the CESM-LE. The Pacific contribution was large across the southern tier of the United States, dominating predictability in the North American Southwest. In other regions, the land surface memory process was more important; in particular, soil moisture memory dominated central Canada predictability, yielding a S2N ratio of comparable magnitude (~0.5) as ENSO over the Southwest US. For some regions, such as the central US, the two sources were about equally important. We also assessed the relative importance of the three Pacific predictors, finding that ENSO yields the highest S2N ratios, with the IPO predictor yielding similar S2N patterns, though slightly weaker, and the PDO slightly weaker still. We also found that precipitation is very poorly correlated to the previous year's precipitation anomalies, while for annual soil moisture anomalies the memory has a more significant footprint. PDSI predictors show similar patterns as for soil moisture, albeit with slightly lower S2N ratios.

We found that for most North American regions, the CESM projects hydroclimate predictability to increase in the warmer climate, even though there is no significant change in overall hydroclimate variability. This is due primarily to a strengthening of the Pacific-related predictable component which coincides with a pronounced increase in the variance of tropical Pacific sea surface temperatures. In contrast, predictability due to land surface memory remains the same or slightly decreases over time. These findings suggest that interannual hydroclimate predictability over certain regions of North America could be improved by combining remote and local sources of hydroclimate predictability.