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Primary Atmospheric Drivers of Dry and Wet Periods over the U.S. Great Plains within CMIP5 Models

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Precipitation variability is critical to the economic and ecosystem health of the United States Great Plains (GP). Whether from wet or dry extremes, changes in annual precipitation can lead to impacts on the health of the ecosystem and overall crop yield in a given year. To this end, wet and dry extremes have been investigated using the ERA-20C and CMIP5 dataset on an annual timescale to determine the ability of climate-scale simulations to resolve atmospheric drivers of precipitation variability. Results from the ERA-20C analysis show that specific atmospheric circulation anomalies can be detected which relate eddy geopotential height (EGH) anomalies to dry or wet annual precipitation anomalies in the GP domain. Using a similar method of defining dry and wet years, CMIP5 model simulations were examined to determine their ability to resolve these drivers and the associated precipitation variability in the GP. After filtering the different models based on their depiction of GP precipitation variability, the model simulations were categorized as Tier 1 and Tier 2 models, where Tier 1 yielded overall strong similarities and Tier 2 with overall weaker similarities. Both the Tier 1 and Tier 2 models were subsequently analyzed using the same atmospheric fields investigated within the ERA-20C dataset. The results demonstrated that both the Tier 1 and Tier 2 model ensembles were able to resolve the atmospheric anomalies associated with dry and wet years over the GP. However, specific differences exist between the Tier 1 and Tier 2 ensembles, namely that the Tier 2 model composites show larger magnitude anomalies. This result likely means that the Tier 2 model composites produce too many years in which the atmospheric anomalies are the primary cause of the precipitation anomalies when compared with known observational cases of GP dry or wet years. Overall, however, the CMIP5 models were able to satisfactorily reproduce GP precipitation variability, while the root of the variability appears to be forced by processes that are not widely evident in reanalysis datasets.

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