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Austral Summer Droughts and their Driving Mechanisms in Observations and Present-day Climate Simulations across Malawi

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The societal relevance of droughts in Africa underscores the need for improved understanding of the atmospheric processes that drive them. This study examined drought characteristics across Malawi, and the associated atmospheric circulation patterns, in observations, reanalysis and global climate models. Droughts were identified using the Standardised Precipitation and Evapotranspiration Index (SPEI) for the period 1965 to 2018. Atmospheric circulation patterns during droughts were examined and the main moisture fluxes into Malawi were identified. Despite differences in the frequency, and events being asynchronous at times, droughts exhibited characteristics that were statistically similar between northern and southern Malawi. Droughts in both regions were associated with anomalous circulation that typically worked to diminish moisture advection and thus convection. Differences in the structure of the anomalies were indicative of differences in mechanisms associated with droughts in the north and south of Malawi. Three main moisture flux pathways were identified, and categorized as northeasterly, southeasterly, and northwesterly, each with a unique correlation structure with precipitation and global SSTs. Positive and negative biases of varying magnitudes were noted for drought and rainfall characteristics across the range of CMIP5 models. Such biases can be attributed to biases in moisture fluxes whose variability was found to be a key driver of summer precipitation variability across Malawi. Despite biases in moisture fluxes and their influence on precipitation biases, the majority of models exhibited moisture flux-precipitation correlations consistent with observations and reanalysis. Results from the study highlight the extent to which climate models are reliable in simulating droughts and therefore of value in developing narratives of climate variability essential for long-term development planning.