



Changes in the Metastability of the Midlatitude Southern Hemisphere Circulation and the Utility of Nonstationary Cluster Analysis and Split-Flow Blocking Indices as Diagnostic Tools

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The authors examine changes in the metastability of the Southern Hemisphere 500-hPa circulation using both cluster analysis techniques and split-flow blocking indices. The cluster methodology is a purely datadriven approach for parameterization whereby a multiscale approximation to nonstationary dynamical processes is achieved through optimal sequences of locally stationary fast vector autoregressive factor (VARX) processes and some slow (or persistent) hidden process switching between them. Comparison is made with blocking indices commonly used in weather forecasting and climate analysis to identify dynamically relevant metastable regimes in the 500-hPa circulation in both reanalysis and Atmospheric Model Intercomparison Project (AMIP) model datasets. The analysis characterizes the metastable regime in both reanalysis and model datasets prior to 1978 as positive and negative phases of a hemispheric midlatitude blocking state with the southern annular mode (SAM) associated with a transition state. Post 1978, the SAM emerges as a true metastable state replacing the negative phase of the hemispheric blocking pattern. The hidden state frequency of occurrences exhibits strong trends. The blocking pattern dominates in the early 1980s then gradually decreases. There is a corresponding increase in the SAM frequency of occurrence. This trend is largely evident in the reanalysis summer and spring but was not evident in the AMIP dataset. Further comparison with the split-flow blocking indices reveals a superficial correspondence between the cluster hidden state frequency of occurrences and split-flow indices. Examination of composite states shows that the blocking indices capture splitting of the zonal flow whereas the cluster composites reflect coherent block AU1 formation. Differences in blocking climatologies from the respective methods are discussed.