Since the late 1960’s, southwest Western Australia (SWWA) has experienced a substantial drying trend with a winter rainfall decrease of some 15-25%. Previous studies have identified a range of factors as potential or likely contributors to the rainfall decrease, including natural variability, land-use changes, the Indian ocean temperatures and atmospheric circulation changes including the Southern Annular Mode (SAM) and a monsoon-like southwest Australian circulation (SWAC). In this work, we investigate relationships among the SWAC, the SAM, and SWWA winter rainfall (SWR).

It is found that the influence of the SWAC on SWR is largely independent of fluctuations in the SAM, although the SAM has a moderate link to the SWAC with a correlation coefficient of −0.46. This correlation is found to be mainly induced by the component of SWAC that has a minor influence on SWR. We show that the seasonal shift of planetary-scale thermal convection is the prerequisite for the existence of the SWAC, which leads to a seasonal shift in the subtropical high, resulting in the reversal of surface winds over SWWA. The land–sea thermal contrast across the wider SWWA is the secondary driver of the SWAC. Our results suggest that these external forcings of the SWAC are independent of the SAM. Thus, the well-coupled SWAC-SWR relationship is not influenced by the SAM. The sensitivity analysis form a numerical model also supports to this argument. The strong coupling between the SWAC and SWR may provide another perspective for understanding the trend and variability in SWWA rainfall.