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Seasonal zonal asymmetries in the Southern Annular Mode and their impact on regional temperature anomalies

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The Southern Hemisphere Annular Mode (SAM) is the dominant mode of climate variability in the extra-tropical Southern Hemisphere. Representing variations in pressure and the corresponding changes to the circumpolar zonal flow, it is typically thought of as an 'annular' or ring-like structure. However, on seasonal timescales the zonal symmetry observed in the SAM in monthly or annual mean data is much less marked. This study examines the seasonal changes in the SAM structure, and explores temperature signals across the Southern Hemisphere that are strongly tied to the asymmetric SAM structure.

Time anomaly sea level pressure composites for strong positive and negative SAM events identify differences between the two phases, which result in differences in the surface temperature signal in some regions, particularly during austral winter and spring. Asymmetries in the SAM are investigated by removing the zonal mean from these composites. We find asymmetries are most marked in the Pacific sector and in austral winter and spring, related to changes in the jet entrance and exit regions poleward of 30oS. Depending on the season, the asymmetric SAM structure explains up to 35% of the variance in the overall SAM structure and has strong connections with ENSO or zonal wave number 3. In austral summer and autumn the SAM has been becoming more zonally symmetric, especially after 1980, perhaps tied to changes in anthropogenic forcing.

Using correlation analysis to investigate the SAM-temperature signal, we find that across the Pacific sector, including the Antarctic Peninsula, temperature variations are strongly tied to the asymmetric SAM structure, while temperatures across East Antarctica are more strongly tied to the zonally symmetric SAM structure. The results suggest that studies examining the climate impacts of the SAM across the Southern Hemisphere need to consider the seasonal variations in the SAM structure as well as varying impacts between its positive and negative polarity in order to adequately describe the underlying relationships.