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Quantifying barotropic and baroclinic eddy feedbacks in the persistence of the Southern Annular Mode

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Understanding the persistence of the Southern Annular Mode (SAM) is important for the intraseasonal and decadal predictability of SAM. Using the ERA-40 and ERA-Interim reanalysis data, this study introduces a new method to quantify the relative roles of barotropic and baroclinic eddy feedbacks in the SAM persistence. Through a hybrid Eulerian-Lagrangian Finite Amplitude Wave Activity diagnostic, it is found that (i) transient wave activity is important in driving the SAM, but it provides a negative feedback to the SAM persistence. (ii) Irreversible potential vorticity mixing, through barotropic processes in the upper troposphere, plays an important role in driving and sustaining the SAM variability. Particularly, following the poleward shift of the eddy-driven jet, the reduction/enhancement in effective diffusivity on the jet's poleward/equatorward flank can be understood by a stronger/weaker zonal jet acting as a robust/leaky mixing barrier. (iii) Baroclinic eddy generation and vertical wave propagation mainly act to sustain the SAM variability.