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The driving of baroclinic anomalies at different time scales and its role for self-maintenance

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Latitudinal jet shifts represent the dominant form of internal variability for the zonal wind in the extratropics. Previous diagnostic studies have shown that this variability tends to occur on longer time scales than the characteristic scale (synoptic) of the eddy momentum fluxes that displace the jet, which might be partly due to a positive eddy feedback. A self-maintenance mechanism has been proposed for this positive feedback, through which enhanced baroclinicity, eddy generation and eddy-driven zonal acceleration follow the initial displacement of the jet.

In this study, we assess the feasibility of this mechanism by analyzing the lagged relation between the barotropic and baroclinic components of the zonal-mean zonal wind using deseasonalized Southern Hemisphere NCEP reanalysis data. For both components, the dominant mode of variability can be described as a latitudinal shift. The principal components for the modes are very highly correlated, with the barotropic variability leading the baroclinic variability by roughly a day.

We then study the characteristic lifecycles of baroclinic anomalies by regressing the various forcing terms in the governing equations. A very different picture is found depending on the frequency range considered. While for high frequencies the baroclinicity essentially responds to the transient eddy heat flux, at low frequency the baroclinic anomalies tend to be generated by adiabatic heating by the mean meridional circulation and damped by the diabatic heating and transient eddy heat flux. A similar study for the zonal-mean baroclinic wind shows that low-frequency anomalies for this term are generated by friction and the eddy momentum flux, and damped by the Coriolis torque of the mean meridional circulation. This leads to a sequence of events in good agreement with the self-maintenance mechanism.