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Forcing mechanisms of the wintertime subtropical jet over Africa

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The subtropical jet over Africa exhibits large variability both in its strength and its longitudinal extent during the winter months. We aim to understand this variability on synoptic to seasonal time scales. The subtropical jet is co-located with a zone of strong upper-level baroclinicity, a steep increase in the height of the dynamical tropopause from the north to the south, and a zone of strong potential vorticity (PV) gradients that demarks the transition from tropical tropospheric low PV air to extratropical stratospheric high PV air. This PV gradient is dynamically linked to the strength of the jet, the stronger the PV gradient is, the faster is the jet.

We look at synoptic and planetary scale forcing mechanisms of the subtropical jet over Africa during the winter of 2005 and 2006 focusing i) on processes that increase the PV gradient in the vicinity of the jet and ii) on the angular momentum budget of air that ends up in the subtropical jet with the aim of linking the two perspectives. To this end we calculated trajectories backwards out of the jet and backwards from areas of low PV to the south of the jet; tracing diabatic processes and the angular momentum along the pathways of the air parcels and gathering information on the three dimensional motion of these air parcels prior to their arrival in the jet.

Besides the classical Hadley cell forcing, Rossby waves and Rossby wave breaking in the extratropics and the subtropics can substantially affect the subtropical jet. Breaking waves can destabilize the subtropical and tropical atmosphere and trigger convection and thereby influence the upper-level PV distribution. Strong diabatic heating associated with uplift through the area results in a depletion of the upper-level PV. From an angular momentum point of view (breaking) Rossby waves are effective in transporting air from the tropics towards the subtropics, thereby potentially accelerating the subtropical jet. At the same time the zonal pressure gradients associated with the waves affect the conservation of angular momentum.