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Quantifying the impact of non conservative processes on Rossby wave packets using local finite amplitude wave activity.

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Upper tropospheric Rossby wave packets (RWPs) are often associated with weather systems and can thus have a strong influence on surface weather. They sometimes act as precursors to blocking or intense extratropical cyclones and are, in this sense, connected with severe weather episodes. Therefore, understanding the dynamics of RWPs is of fundamental importance in the context of predictability.

This contribution presents a novel diagnostic for RWPs based on local finite amplitude wave activity (LWA) in the primitive equations/isentropic coordinates framework. LWA (which is an extension of the finite amplitude wave activity of Nakamura and Solomon) is proportional to the local meridional displacement of contours of potential vorticity (PV) from zonal symmetry. The advantage of using LWA consists in the fact that its formulation does not make any small amplitude assumption; it is able to faithfully identify nonlinear phenomena such as Rossby wave breaking, blocking, PV streamers, or cutoffs. The new diagnostic is applied to a specific episode containing large amplitude RWPs and compared with a more traditional one based on the envelope of the meridional wind. Overall, the LWA diagnostic provides a more coherent picture of the RWPs and their zonal propagation.

Furthermore, LWA has an exact conservation relation which allows one to formulate a budget equation for its evolution and to quantify the impact of non-conservative processes as a residuum from the LWA budget. In order to test this, the budget equation is used to estimate the magnitude of the nonconservative term in a simulation of Rossby wave packet decay using a barotropic model in spherical coordinates. A challenge in this context is the enstrophy cascade to the smaller scales, which results in an unavoidable sink term in the LWA budget due to diffusion of vorticity. Preliminary results from this simulation show that LWA diagnostic is able to quantify the impact of non-conservative processes in the propagation of RWPs, suggesting that its use can be extended also to atmospheric data such as reanalysis or operational models.