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Implications of semi-geostrophic dynamics for Rossby wave packet detection

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Upper troposheric Rossby wave packets have received increased attention recently, partly because of their potential role in triggering heavy weather downstream. In most studies wave packets are detected by computing the envelope of the meridional wind field using either complex demodulation or a Hilbert transform technique. The latter requires less choices to be made and appears, therefore, preferable. However, the Hilbert transform technique is fraught with a significant problem, namely a tendency which makes a single wave packet to fragment into several parts. The problem arises because Rossby wave packets feature substantial deviations from the almost plane wave paradigm — owing to the semi-geostrophic nature of the underlying dynamics. As a consequence higher harmonics are included into the reconstructed envelope. A possible way out lies in additional smoothing, e.g. by means of a filter, or resorting to complex demodulation (which implies some smoothing anyways). Another possibility lies in applying the Hilbert transform technique in semi-geostrophic coordinate space.

In this presentation we first illustrate the problem using sythetic wave packets. Thereafter we investigate observed Rossby wave packets using ERA-interim data. It is shown that the technique involving the semi-geostrophic coordinate transformation often works well. However, it sometimes fails in cases when the wave packet travels on a low wave-number background flow. The reasons are discussed and examples are given.