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Tropical cyclone – mature baroclinic wave interaction: Wave activity diagnostic and bifurcation point behaviour

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Rossby wave trains are fundamental to the synoptic-scale dynamics of the midlatitudes. It is well known that these wave trains play an important role in the development of midlatitude weather systems and associated weather events. One particular process that may significantly modify a Rossby wave train is the interaction with a tropical cyclone undergoing extratropical transition. Previous studies have shown that such an interaction often produces enhanced uncertainty of medium-range weather predictions. Our understanding of the physical processes of this interaction and the causes of the reduced predictability is still incomplete.

This presentation will examine an idealized scenario of extratropical transition, in which a tropical cyclone interacts with a mature baroclinic wave. The impact of the tropical cyclone is quantified as a source of wave activity for the upper-level wave pattern using piecewise inversion of potential vorticity complemented by a Helmholtz decomposition and an estimate of diabatic terms. In contrast to many previous studies, a consistent (further) amplification of the mature wave pattern is not diagnosed in this scenario. In fact, the interaction with the tropical cyclone initiates wave breaking and thus a weakening of the wave pattern.

The impact on the midlatitude wave is sensitive to the phasing of the wave pattern and the tropical cyclone, as found in previous studies. Sensitivity experiments reveal three distinct scenarios: a no-transition scenario, in which the tropical cyclone passes to the south of the upstream trough, and two scenarios that have been dubbed previously “northeast” and “northwest” pattern, respectively. Examination of the topology of the quasi-stationary steering flow reveals two bifurcation points that separate the three distinct regimes. Thus, uncertainties in the modification of the midlatitude wave train can be attributed to a large extent to the bifurcation behaviour of the tropical cyclone track.