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Impacts of forced sub-tropical waves on extra-tropical flow: Theory and Model Simulations

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The study is built around two linked aspects. First that events of intense localized convective activity in the sub-tropics (such as the MJO) can constitute a large-amplitude coherent flow feature in an otherwise comparatively quiescent ambient environment. Second that such sub-tropical synoptic-scale perturbations can play a major role in the initiation of Rossby wave trains in the extratropics, and in particular trigger downstream development along the PV wave-guide.

In this study the influence of such subtropical/tropical forcing upon extra-tropical flow is studied using a mix of theoretical considerations and idealized model simulations.

Theoretical considerations indicate the sensitive dependence of latitudinal wave-transmission to the ambient atmospheric state and zonal structure of the forcing. Lateral propagability is drastically reduced in stronger shear flow. For realistic atmospheric settings meridional propagation is expected to be highly evanescent.

In addition numerical simulations, performed with the ECMWF Integrated Forecast System (IFS CY31R2), pinpoint further dynamical aspects of lateral wave propagation. The model was initialized with an idealized zonally symmetric, barotropic jet with variable strength. A mountain located at different, tropical and subtropical latitudes was used as a trigger for stationary waves. The impact on the extra-tropical flow can be separated into two regimes: Downstream development along the jet-steam (wave-guide) and Rossby wave propagation along great circles. First is evident for all experiments, whereas latter is highly dependent on jet-strength, location of forcing and time.

The results suggest that for medium range prediction (up to day 15) only downstream

development along the wave guide is of relevance, whereas wave propagation along great circles is limited to weaker jet settings and long lasting forcing events, hence becoming more relevant on seasonal time-scales.