

18th Cyclone Workshop

A climatological analysis of Rossby wave initiation on the Northern Hemisphere extratropical jet

Matthias Röthlisberger¹, Olivia Martius^{1,2} and Heini Wernli³

¹ Oeschger Centre for Climate Change Research and Institute of Geography, University of Bern, Bern, Switzerland

² Mobiliar Lab for Natural Risks, University of Bern, Bern, Switzerland

³ Institute for Atmospheric and Climate Science, ETH Zürich, Zürich, Switzerland

Abstract

In this study we investigate dynamical mechanisms leading to and occurring during the initiation of synoptic-scale Rossby waves (RWI) in the mid-latitudes. A novel all season climatology of RWI events on the Northern Hemisphere extratropical jet is compiled by applying an objective RWI identification algorithm to ERA-Interim data. In winter, RWI events occur most frequently over the northwestern Pacific and, less frequently, over the North Atlantic. In summer, the total number of RWI events is lower than in winter and they occur most frequently over the Himalayas.

A composite analysis of the large-scale flow prior, during and after winter North Pacific RWI events reveals the presence of an upstream wave train propagating across Asia on the arctic waveguide prior to RWI. The newly forming wave exhibits a baroclinic structure, and is also amplified by diabatic processes occurring in the warm conveyor belt of a deepening surface cyclone. Moreover, the composite wave develops in a region of large-scale upper-level deformation, upstream of a pre-existing ridge. Further it is shown that active tropical convection can act as a geographical anchor for the RWI events, by strengthening the subtropical anticyclone to the north of the tropical convection and thus favoring a zonal and straight jet, which is a prerequisite for RWI.

By analyzing the frequency of occurrence and co-occurrence of these composite features during individual RWI events we find that not all features occur in each RWI event. Rather, they occur in preferred combinations: A strong surface cyclone tends to co-occur with strong diabatic heating and a strong positive PV anomaly aloft. The occurrence of these features is, however, independent from the presence of a downstream ridge, active tropical convection and a strengthened subtropical anticyclone, which themselves tend to occur in concert.