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Tropical-extratropical interactions related to upper-level troughs at low latitudes

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Intrusions of upper-level extratropical disturbances into low latitudes are prominent examples of tropical-extratropical interactions. They are often associated with enhanced tropical convection and the formation of an east- and poleward stretching cloud band on the eastern side of the trough. Generally these situations enable tropical moisture transport towards the subtropics and may lead to extreme precipitation events. In the present work a new algorithm has been developed to identify and track upper-level disturbances at low latitudes in the ERA40 reanalysis data over the period 1980-2001. In contrast to previous studies only intense intrusion events with the absolute value of the 400-100 hPa averaged potential vorticity (PV) exceeding 2 PVU equatorward of 17 degrees are detected. Intrusion episodes are defined by tracking the intrusion systems in time.

The resulting climatology for the boreal winter reveals two well-defined regions with high intrusion frequencies in the Northern Hemisphere (NH), respectively, over the eastern parts of the North Pacific (120°-150°W) and North Atlantic (10°-40°W). In the Southern Hemisphere (SH) two maxima are located within nearly the same longitudinal bands. These regions are characterised by mean upper westerly winds in the Tropics. In the most active regions intrusion systems are detected at 20% of all analysis times and on average 20 episodes occur per ocean basin per winter half year (Oct.-March) with a mean duration of almost two days. In the summer the intrusion frequencies are generally reduced. Only over the central North Pacific the intrusion activity increases due to the monsoon circulation and the related upper-level high. Interannual variations of intrusion frequencies show a clear association with the El

Niño-Southern Oscillation (ENSO), particularly in the NH. The correlation to ENSO during NH winter in the North Pacific of -0.83 is opposite of the correlation in the North Atlantic of 0.78. The dependence on ENSO can partly be explained by differences in the mean tropical background flow. Whether there are differences due to ENSO in the generation of the disturbances in the extratropics has to be investigated. The intrusion activity over the North Atlantic also shows a significant positive correlation to the North Atlantic Oscillation of +0.5. In order to investigate different hydrological processes related to intrusions, system-relative composites are examined. The analysis reveals enhanced convection, northward moisture transport and precipitation anomalies along the eastern flank of the intrusion systems. It is also shown that these processes are more pronounced for disturbances with a larger vertical extension.