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A Lagrangian Climatology of Moisture Conveyor Belts that Link Tropical Moisture Sources and Precipitation in the Extratropical Northern Hemisphere

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Many case studies have revealed that extratropical precipitation events can be fed by tropical moisture sources. Often the poleward transport occurs through a longitudinally confined region in the subtropics that has been termed a moisture conveyor belt (MCB). Here we present first climatological results based upon an objective MCB identification from 6-hourly European Centre for Medium-Range Weather Forecasts (ECMWF) re-analysis data for the period 1995-2001. The identification procedure consists of two steps: (a) For every day of the entire period 5-day forward trajectories are started at 00 UTC from the 3-D box 0-20°N and 1000-490 hPa. Every trajectory represents an atmospheric volume of 100 by 100 km and 30 hPa in the vertical and thus a mass of ca. 3x10ˆ12 kg. (b) From all trajectories only the ones are retained that reach a moisture flux of at least 200 (g/kg)*(m/s) somewhere north of 35°N, i.e. transport significant moisture from the Tropics into the extratropical Northern Hemisphere. For these MCB trajectories different meteorological parameters such as specific humidity, wind and potential vorticity are saved.

The results show several distinguished regions with enhanced occurrence of MCB trajectories. (I) The “pineapple express” that connects the Tropics near Hawaii with the North American west coast has a distinct activity maximum in boreal winter and is absent in summer. (II) In contrast MCBs rooted in the West Pacific warm pool are most frequent in summer and autumn, when the maximum shifts westward to about 130°E. This region alone is responsible for almost half of the MCB moisture transport

across 35°N. (III) The only continental activity maximum occurs over the Great Plains of North America with roots over the Gulf of Mexico. This region is active all year round with a clear maximum in summer and spring. (IV) A forth maximum is located over the Gulf Stream region along the east coast of North America from Florida to Newfoundland. This maximum shows the smallest annual cycle with a maximum in autumn. Over the African-European-Asian region MCBs are practically non-existent, most likely due to the high orographic barriers in the subtropics and southern mid-latitudes in this part of the world. On average the MCB trajectories move eastward and upward with latitude. Particularly between 40 and 50°N trajectories rise significantly and lose a lot of their moisture. In the long run this climatology is meant to elucidate other characteristics of MCBs and to give insight into dynamical aspects like vorticity or potential vorticity balances and diabatic processes along the trajectories.