EMS Annual Meeting Abstracts,
Vol. 6, EMS2009-55, 2009
9th EMS / 9th ECAM

9th EMS Annual Meeting
9th European Conference on Applications of Meteorology
High resolution meteorology
- applications and services

A Lagrangian Climatology of Tropical Moisture Exports to the Northern Hemispheric Extratropics

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Many case studies have shown that heavy precipitation events and rapid cyclogenesis in the extratropics can be fueled by moist and warm tropical air masses. Often the tropical moisture export (TME) occurs through a longitudinally confined region in the subtropics. Here a comprehensive climatological analysis of TME is constructed on the basis of daily five-day forward trajectories started from the tropical lower troposphere using 6-hourly ERA-40 data from the 23-year period 1979–2001. The objective identification procedure retains only those trajectories that reach a water vapor flux of at least 200 g kg–1 m s–1 somewhere north of 35°N. The results show four distinct activity maxima with different seasonal behavior: (I) The “pineapple express”, which connects tropical moisture sources near Hawaii with precipitation near the North American west coast, has a marked activity maximum in boreal winter. (II) TME over the West Pacific is most frequent in summer and autumn and is partly related to the East Asian monsoon and the Meiyu-Baiu front. This region alone is responsible for a large portion of TME across 35°N. (III) The narrow activity maximum over the Great Plains of North America is rooted over the Gulf of Mexico and the Caribbean Sea, and has a clear maximum in summer and spring. (IV) TMEs over the western North Atlantic show the smallest annual cycle with a maximum in winter and autumn. Interannual variability in this and region I is significantly influenced by El Niño. Over the African-European-Asian region, high orographic barriers impede TME. Typical TME trajectory evolutions are quasi-horizontally poleward in the subtropics and then more eastward and upward in the southern midlatitudes, where they contribute significantly to precipitation.