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On the Relationship between Tropical Moisture Exports and Extratropical Cyclones

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Tropical moisture export (TME) events are an important element of the global circulation and contribute significantly to regional precipitation. They are defined here on the basis of trajectories starting in the tropical troposphere and reaching a water vapor flux of at least 100 g kg-1 m s-1 poleward of 35° latitude. TME frequency shows four marked occurrence maxima in both hemispheres with varying seasonal cycles. In some cases TMEs can be linked to similar phenomena of atmospheric flow such as Warm Conveyor Belts (WCBs) or Atmospheric Rivers (ARs). For example, 90% of all ARs affecting the US West Coast during December–May are connected to TME events, but the tropical moisture source is less important during the more active AR season June–November.

In addition to these climatological TME characteristics we discuss two aspects of their relationship to extratropical cyclones: Case studies indicate that (i) cyclones traveling along the southern fringes of the midlatitude storm track can instigate the export of tropical moisture ahead of their cold fronts, and (ii) the tropical moisture can fuel latent heat release in the cyclone and therefore contribute to its intensification. A long-term statistical analysis of passages of TME trajectories through areas with closed isobars surrounding active cyclones in the northern hemisphere reveals a surprisingly small number of encounters, particularly in winter. The majority of hits occur south of 40°N and there is no statistically significant relationship with cyclone intensification. The results suggest that TMEs often pass relatively far from cyclone centers where vertical motions tend to be moderate. This prevents an early rainout of the tropical moisture and allows the export into higher latitudes. For the same reasons we expect TMEs to “avoid” WCBs with roots at low latitudes. This interpretation is consistent with the fact that most TME maxima are located along the western flanks of subtropical high-pressure systems.