Geophysical Research Abstracts, Vol. 9, 03203, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03203

Moisture Conveyor Belts - A Possible Link between Tropical Moisture and Extratropical Precipitation

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In this study the term moisture conveyor belt (MCB) is defined as an elongated band of enhanced poleward water vapour fluxes (WVFs) above the planetary boundary layer (PBL) with roots in the Tropics. Case studies have shown that MCBs are usually related to slow-moving or quasi-stationary upper-level troughs or cut-off lows (COLs) in the subtropics. MCBs mostly consist of midlevel trajectories that curve anticyclonically away from the moist tropical easterlies and then move polewards and eastwards along the equatorward side of the upper-tropospheric baroclinic zone associated with a subtropical jet (STJ) streak. Closer to the COL centre frontogenetic circulations can lead to WVF convergence involving air from the midlevel subtropical troposphere. At later stages MCB trajectories can become involved in zones of strong uplift and precipitation associated with convective instability, quasi-geostrophic forcing associated with the COL and inertial instability along the anticyclonic shear side of the STJ. At the surface, cyclogenesis and thermal contrasts are generally weak, and trade winds prevail polewards of the Intertropical Convergence Zone (ITCZ). The absence of significant surface features clearly distinguishes MCBs from classical warm conveyor belts (WCBs) that ascend ahead of the surface cold front of extratropical cyclones. Other important differences are the high elevation of the WVF maximum (ca. 700 hPa as compared to ca. 925 hPa for the WCB), as well as the quasi-horizontal track and origin above the PBL of most MCB trajectories.

The new terminology introduced above is illustrated through an exemplary case study of a MCB over the northeastern Pacific during 09-13 November 2003 that provides the moisture for a significant precipitation event in the dry southwestern USA. The analysis of the associated moisture transports and dynamics is based upon output from

a simulation with the University of Wisconsin-Nonhydrostatic Modeling System, as well as analysis data, surface observations and satellite images. During the late stages of this case an elongated tropical cloud plume developed to the east of the involved subtropical COL in association with a marked flare-up of ITCZ convection. A remarkable feature of this case is that close to the COL centre, moist tropical air was overrun by the dry slot, resulting in convective instability and extreme hail in the Los Angeles area. In addition to the case study, first results of a climatological investigation of MCBs using trajectory ensembles calculated from ECMWF re-analysis data will be presented. The analysis will be based on trajectories that (I) originate in the Tropics, (II) reach the subtropics and (III) reveal WVFs above a certain threshold. In the long run this climatology is meant to elucidate typical characteristics of MCBs such as geographical distribution, annual cycle, level of maximum WVF, relation to precipitation etc. and to give insight into dynamical aspects like vorticity or potential vorticity balances and diabatic processes along the trajectories.