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Comparison of H_2O-DIAL observations with operational ECMWF analyses in tropical regions

H. Flentje, A. Doernbrack, G. Ehret, A. Fix, and U. Schumann

Institut für Physik der Atmosphäre, DLR Oberpfaffenhofen, 82230 Wessling, GermanyHarald.Flentje@dlr.de / Fax: +49 8153 281271

Airborne differential absorption lidar (DIAL) measurements of tropospheric water vapor mixing ratio and aerosol backscatter ratio are presented, taken during the TROCCINOX campaign over south Brazil and on the transfer flight from Brazil to Europe in March 2004. Complex advection and rapid vertical transport associated with meso- and synoptic scale dynamical processes reflect in inhomogeneous water vapor distributions along the flight paths. The DIAL H_2O sections are compared to operational analyses of the European Center for Medium Range Weather Forecast (ECMWF) at T511/L60 resolution. The tropical (Hadley) circulation, baroclinic disturbances and humidity transitions between different air masses are analyzed by the ECMWF with remarkable accuracy. To determine the relative deviations, ECMWF data have been interpolated in space and time to the DIAL flight path, while the DIAL data were smoothed to fit the ECMWF resolution. The q-bias between both data fields, averaged over a tropospheric section of roughly 2000 km length, is below 10%. Locally however, relative shifts and differing shapes of structures, particularly those exhibiting large q-gradients and being subject to rapid temporal development (within the measurement plane) may cause considerable deviations. Obviously, the relevant transport processes are adequately represented in the ECMWF model as long as vertical and horizontal scales exceed roughly 0.5-1 km and few ten km, respectively. Smaller structures and larger gradients are smoothed out.

The origin of observed air masses is tracked with aid of backward trajectories allowing the identification of the dominating dynamical processes in the different campaign regions: tropical continent, tropical/sub-tropical Atlantic and mid-latitudes. Over (subtropical) south Brazil, the H_2O vertical profile is determined by transport either from the convective Amazonian region or less convective mid-latitudes. While the former

exhibit pronounced humidity maxima of 0.2-0.3 g/kg H_2O between 8-12 km, the latter remain on average well below 0.1 g/kg above 8 km. The DIAL q-values agree closely with balloon-borne in situ measurements. The Atlantic transfer (5°S–37°N) starts from the tropical regime dominated by the Hadley circulation and reaches into the storm-track influenced mid-latitudes. A deep stratospheric intrusion is associated with the cyclonic shear along a trough from the Canary Islands towards Gibraltar. In the dry subsidence layer north of the Hadley cell and inside the intrusion, H_2O mixing ratios $q \approx 0.01$-0.1 g/kg are measured while $q > 0.5$ g/kg is found in lower tropospheric air lifted convectively to UT levels. At mid-latitudes UT/LS intrusions contain filaments of enhanced particle backscatter, the H_2O signature of the tropical circulation is not correlated with aerosol.