Vertical aerosol stratification above the Caribbean Sea near Barbados

B. Wehner[1], F. Ditas[1], H. Wex[1], I. Serikov[2], A. Wiedensohler[1], and H. Siebert[1]

[1]Leibniz Institute for Tropospheric Research (TROPOS), 04318 Leipzig, Germany
[2]Max-Planck-Institute for Meteorology, 20146 Hamburg, Germany
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Presenting author email: birgit@tropos.de

Shallow cumulus clouds are widespread in the trade wind regions and play an important role for the vertical transport of moisture, momentum, and heat as well as for the earth's radiation budget. The influence of aerosol particles on the formation and life cycle of these clouds is controversially discussed in the literature.

Therefore, one major topic of the CARRIBA (**C**loud, **A**erosol, **R**adiation, and Tu**R**bulence in the trade w**I**nd regime over **BA**rbados) campaigns in November 2010 and April 2011 was to investigate the temporal and spatial variability of aerosol particles near the Caribbean Island Barbados (Siebert et al., 2012). More than 30 research flights with the helicopter-borne platform ACTOS have been performed in that region.

For measuring the total particle number concentration a commercial CPC (model 3762, TSI Inc., St. Paul, USA) has been implemented on ACTOS to measure the total particle number concentration *N* with a time resolution of 1 s. The aerosol particle number size distribution (PNSD) from 6 nm to 2.5 µm was measured using an SMPS (designed by TROPOS) and an OPC (Model 1.129, Grimm Aerosol Technik, Ainring, Germany) with a time resolution of 120 s. Furthermore, ACTOS contains various instruments to measure cloud properties and thermodynamic parameters, such as temperature, humidity and 3D-wind vector. Continuous measurements of a Raman-Lidar located at Deebles Point at the East Coast of Barbados were also used to detect distinct aerosol layers.

Results

Figure 1 shows the profile of potential temperature Θ, specific humidity r and particle number concentration N measured on April 18, 2011. In the well-mixed sub-cloud layer (SCL < 500 m) Θ, r, and N are nearly constant. Above that height N increases slightly except for a short dip due to a cloud contact in around 700 m. Between 800 and 1200 m N reaches its maximum of this profile of ~ 1000 cm^{-3} and decreases above to values between 400 and 600 cm^{-3}. Above the SCL, the profile of N can be divided into strongly separated aerosol layers: e.g. Layer 1 from 800 to 1200 m and Layer 2 from 1200 to 1700 m.

Figure 2 shows PNSDs measured below 500 m (SCL), in Layer 1 (800 – 1200 m), and Layer 2 (1200 – 1700 m). The shape of the individual PNSDs is similar but the number concentration is highest in Layer 1 corresponding to the profile of N.

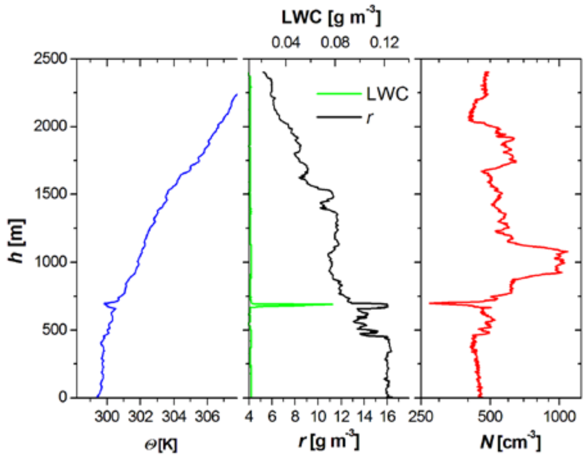

Figure 1. Vertical profiles of potential temperature Θ, specific humidity r and particle number concentration N measured on April 18, 2011 by ACTOS.

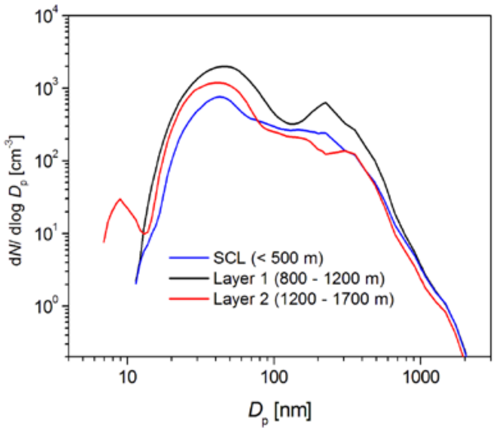

Figure 2. Particle number size distributions in selected layers: SCL (below 500 m), Layer 1, and Layer 2 on April 18, 2011.

The existence of such narrow aerosol layers has been observed on several days throughout the campaign. Obviously there are no efficient mixing processes to balance such concentration gradients immediately. The continuous Lidar data will be used to detect aerosol layers during the day and may give some information about their optical properties.

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Siebert, H., et al. (2012), The fine-scale structure of the trade wind regime over Barbados - An introduction to the CARRIBA project -, *Atmos. Chem. Phys. Discuss., 12,* 28609 - 28660.