High resolution measurements of water vapor and aerosol fields with UHOH scanning DIAL system at Hornisgrinde

Sandip Pal, Andreas Behrendt, Max Schiller, Andrea Riede, and Volker Wulfmeyer

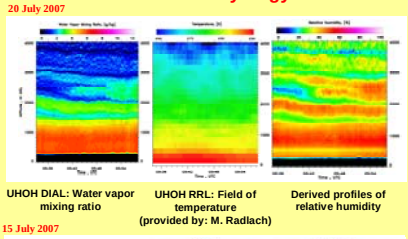
Institute of Physics and Meteorology, University of Hohenheim, 70593 Stuttgart, Germany. Email: sandip@uni-hohenheim.de

Introduction

Within this contribution, we present measurements of the fields of water vapor mixing ratio and aerosol backscatter made with the UHOH water vapor DIAL system during COPS from June to August 2007 on top of Hornisgrinde (highest peak in the Northern Black Forest, at an elevation of 1161 m above sea level).
Differential absorption lidar (DIAL) allows to profile the atmospheric water vapor number density with higher resolution and accuracy than any other remote sensing technique.
The UHOH DIAL system provides the profiles of water vapor number density with temporal and spatial resolution of 10 s and 15 m, respectively. For the data presented here, the signals of two telescopes with a diameter of the primary mirror of 80 and 20 cm, respectively, have been used.

Fig. 1: View to the COPS supersite on Hornisgrinde. The water vapor DIAL is seen in the foreground. A larger suite of other remote sensing instruments was collocated at this site.

Instrument synergy



UHOH DIAL: Water vapor mixing ratio | UHOH RRL: Field of temperature (provided by: M. Radlach) | Derived profiles of relative humidity

UHOH DIAL: Water vapor mixing ratio | IMK Doppler lidar: vertical velocity (Courtesy of: K. Traeumner. A. Wiesser, FZK, Karlsruhe) | Measured latent heat flux profiles

Fig. 2: Synergetic measurement of of ABL key parameters with lidars at supersite Hornisgrinde. Estimation of relative humidity with the data obtained by UHOH DIAL and RRL on 20 July 2007 (upper panel) and latent heat flux with the data obtained by UHOH DIAL and IMK Doppler lidar on 15 July 2007 (lower panel).

16 July 2007 (EUFAR activity)

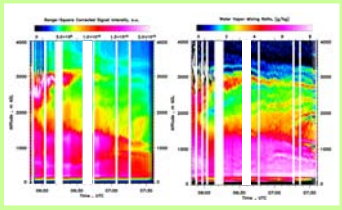


Fig. 3: Time-height cross section of particle backscatter (left panel) and water vapor mixing ratio (right panel) measured with the UHOH DIAL on 16 July 2007.

Intercomparison: UHOH DIAL and RS

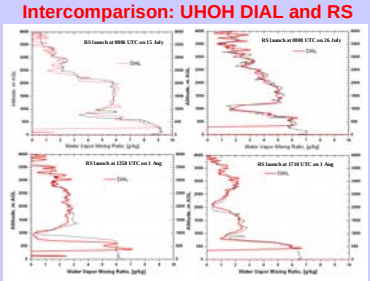


Fig. 4: Comparison of the profiles of water vapor mixing ratio obtained by the UHOH DIAL and collocated RS lauches on three different IOP days

Acknowledgement

Within three inter-linked projects of Deutsche Forschungsgemeinschaft (DFG) coordinated by University of Hohenheim this scanning water vapor DIAL has been developed which yields presently the largest power-aperture product of such systems. The platform development was managed by the Institute of Tropospheric Research, Leipzig, a high-power pump laser was developed by University of Potsdam, the frequency-converter, a Titanium Sapphire laser, was built by University of Hohenheim, and the seeders to stabilize the transmitter were set up by Deutsches Zentrum für Luft- und Raumfahrt Oberpfaffenhofen.

Measurement examples during COPS 2007

IOP 8b (15 July 2007)

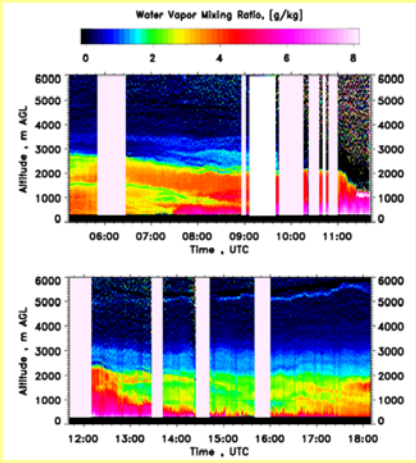


Fig. 5: Water vapor mixing ratio measured with the DIAL on 15 July 2007 (COPS IOP 8b) in vertical pointing mode

IOP 9c (20 July 2007)

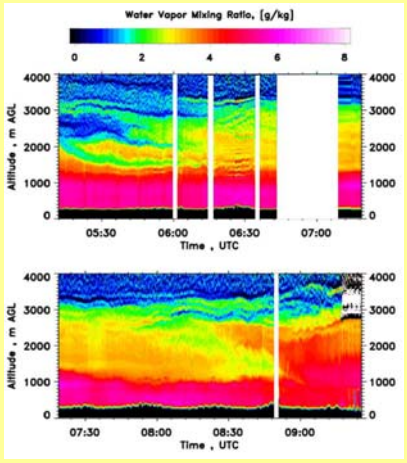


Fig. 6: Same as Fig. 5 but for 20 July 2007

IOP 11a (25 July 2007)

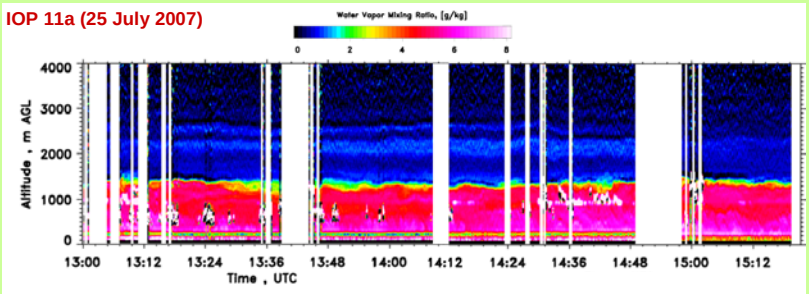


Fig. 7: UHOH DIAL measurements of the moisture field in a well mixed convective boundary layer on 25 July 2007 between 1300 and 1530 UTC Some thin dry layers were also observed above 1.2 km AGL. A very humid layer below 600 m most probably marks the CBL height.

IOP 11b (26 July 2007)

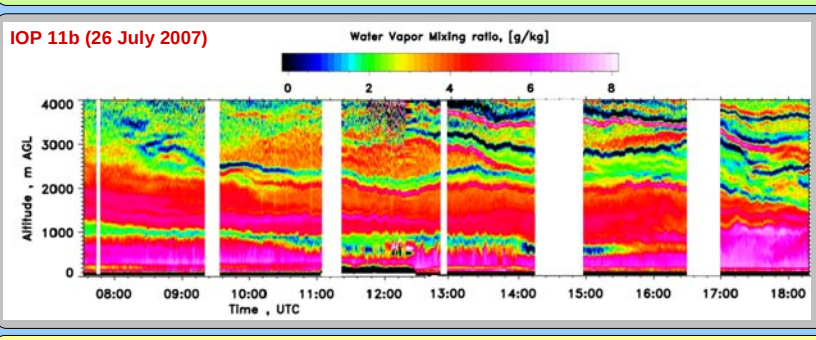


Fig. 8: Continuous development of the moisture field on 26 July 2007 between 0730 and 1830 UTC. Moist layers with both temporal and spatial variability throughout the day are observed. Penetration of dry layers are seen in various altitudes.

IOP 13 a-b (1-2 Aug 2007)

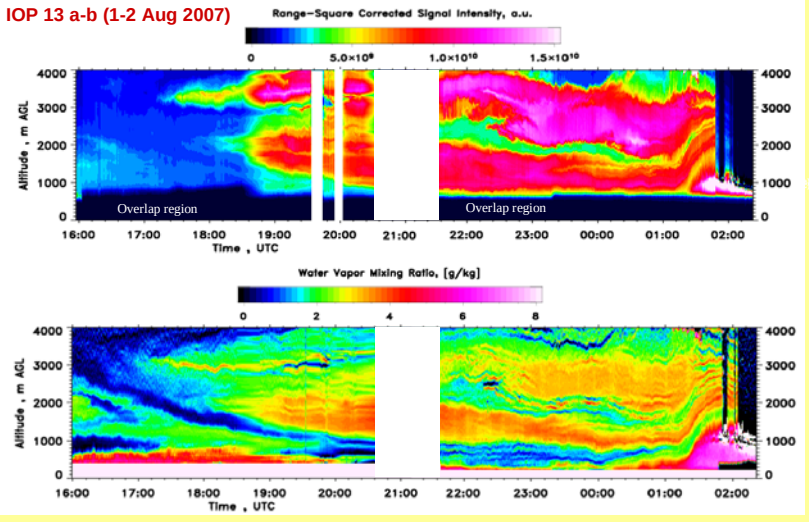


Fig. 9a: Relative particle backscatter field @ 820 nm measured on 1-2 Aug 2007. Range square corrected signal obtained with the big telescope are only shown here. Data gaps and overlap region are marked on the image. Very high particle backscatter were observed due to Saharian dust out-break on this day.

Fig. 9b: Field of water vapor mixing ratio dervied for the same time period as above. A quasi continuous devlopment of the moisture structures inside and above the boundary layer are seen. At the end of this measurement period the signatures of an approaching cold front are seen: cold and moist air is advected which causes an uplift of the air mass.