Water Vapor Differenial Absorption Lidar Measurements at Hornisgrinde during COPS

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Introduction

Differential absorption lidar (DIAL) allows to profile the atmospheric water vapour number density with higher resolution and accuracy than any other remote sensing technique. Within three inter-linked projects of Deutsche Forschungsgemeinschaft (DFG) coordinated by University of Hohenheim a scanning water vapour 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.

In this contribution, we present measurements which were made with the system during COPS from June to August 2007 on top of Hornisgrinde, the highest peak in the Northern Black Forest, at an elevation of 1161 m above sea level.

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.

System Setup Overview

This water vapor differential absorption lidar has been developed within a DFG-funded project in which four research institutes cooperated (Fig. 2):

- Institute of Physics and Meteorology (IPM), University of Hohenheim
- German Aerospace Center (DLR), Oberpfaffenhofen
- Chair of Photonics, University of Potsdam
- Institute for Tropospheric Research, Leipzig

Overall coordination was with the IPM of the University of Hohenheim.

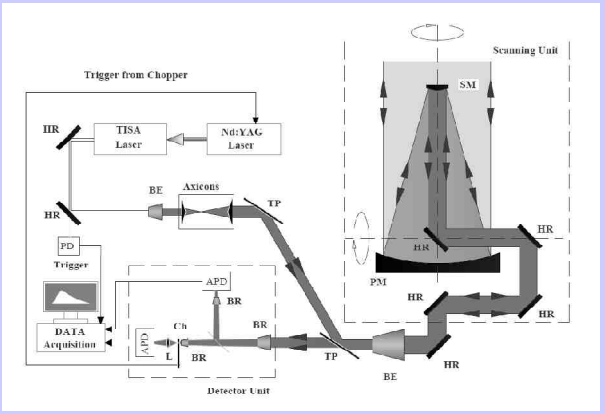

Fig. 2: Schematic of the UHOH DIAL system. HR: high reflection mirror, BE: beam expander, TP: thin film polarizer, PD: photodiode, APD: avalanche photodiode, L: lense, BR: beam reducer, Ch: chopper, PM: primary mirror, SM: secondary mirror.

Fig. 3: Mobile platform of the reference system.

The mobile platform (Fig. 3) arrived in Hohenheim in October 2006. After all components were installed, system tests started to specify the overall performance. First water-vapor DIAL measurements were performed in January 2007. COPS in summer 2007 was the first field deployment of the instrument.

Fig. 4: IPM diode laser-pump high-power Nd:YAG laser system.

Fig. 5: Set up of TISA system in trailer.

Measurement examples during COPS 2007

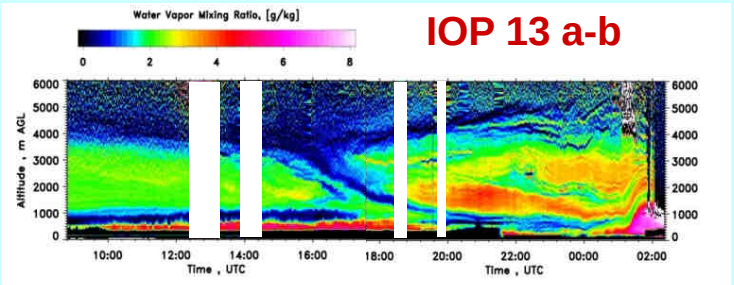

Fig. 6: Water vapor mixing ratio measured with the DIAL on 1 and 2 August 2007 (COPS Intensive Observations Period number 13a) in vertical pointing mode. At the end of this measurement period the signatures of an approaching cold front are seen: cold and moist air is advected which causes an uplift of the air mass.
For these data, the signals of two telescopes with a diameter of the primary mirror of 80 and 20 cm, respectively, have been used.

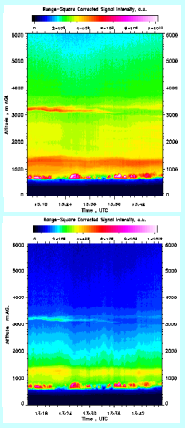

Fig. 8: Same as Fig. 7 but for the online signal. Higher extinction is due to water vapor absorption.

Fig. 7: Range-square corrected offline backscatter signal detected by the large 80-cm telescope.

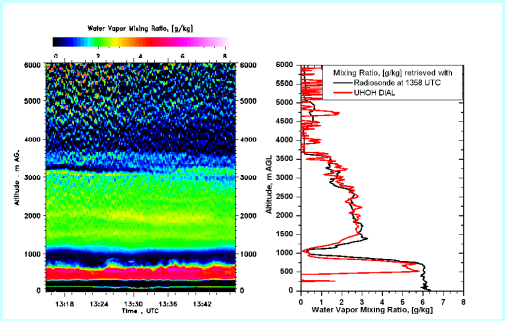

Fig. 9: Water vapor mixing ratio derived for the signals shown in Figs. 7 and 8 (left panel) as well as the same type of signals detected with a small telescope with 20 cm diameter. Comparison with a radiosonde launched at the lidar site (right panel). The radiosonde type used is Vaisala RS 92.

IOP 8b

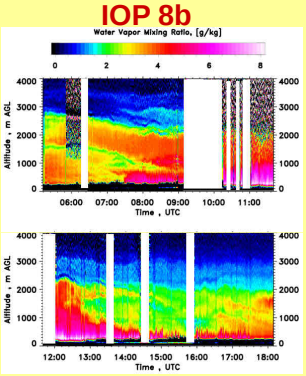

Fig 10: Same as Fig. 6 but for 15 July 2007

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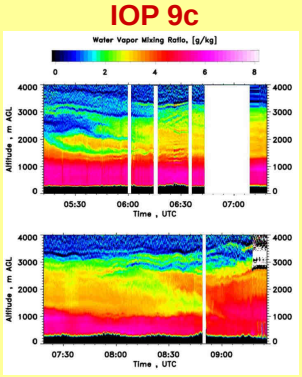
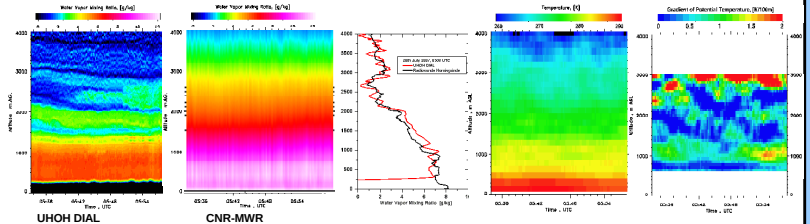


Fig 11: Same as Fig. 6 but for 20 July 2007

Synergetic measurements of ABL key parameters, COPS IOP 9c



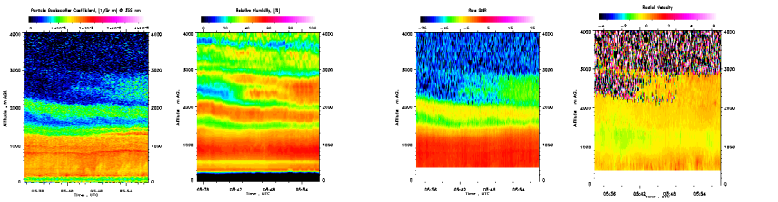
UHOH DIAL Water Vapor Mix. Rat.

CNR-MWR Water Vapor Mix. Rat. Courtesy by: F. Madonna and G. Pappalardo

UHOH DIAL nad radiosonde Water Vapor Mix. Rat.intercomp.

UHOH RRL: Temp.

UHOH RRL: dΘ/dz



UHOH RRL: $\beta_{par,\ 355\ nm}$

UHOH DIAL and RRL: Rel. Hum.

IMK Doppler lidar: Raw SNR and vertical velocity
Courtesy by: Katja Traeumner. Andreas Wiesser, FZK, Karlsruhe