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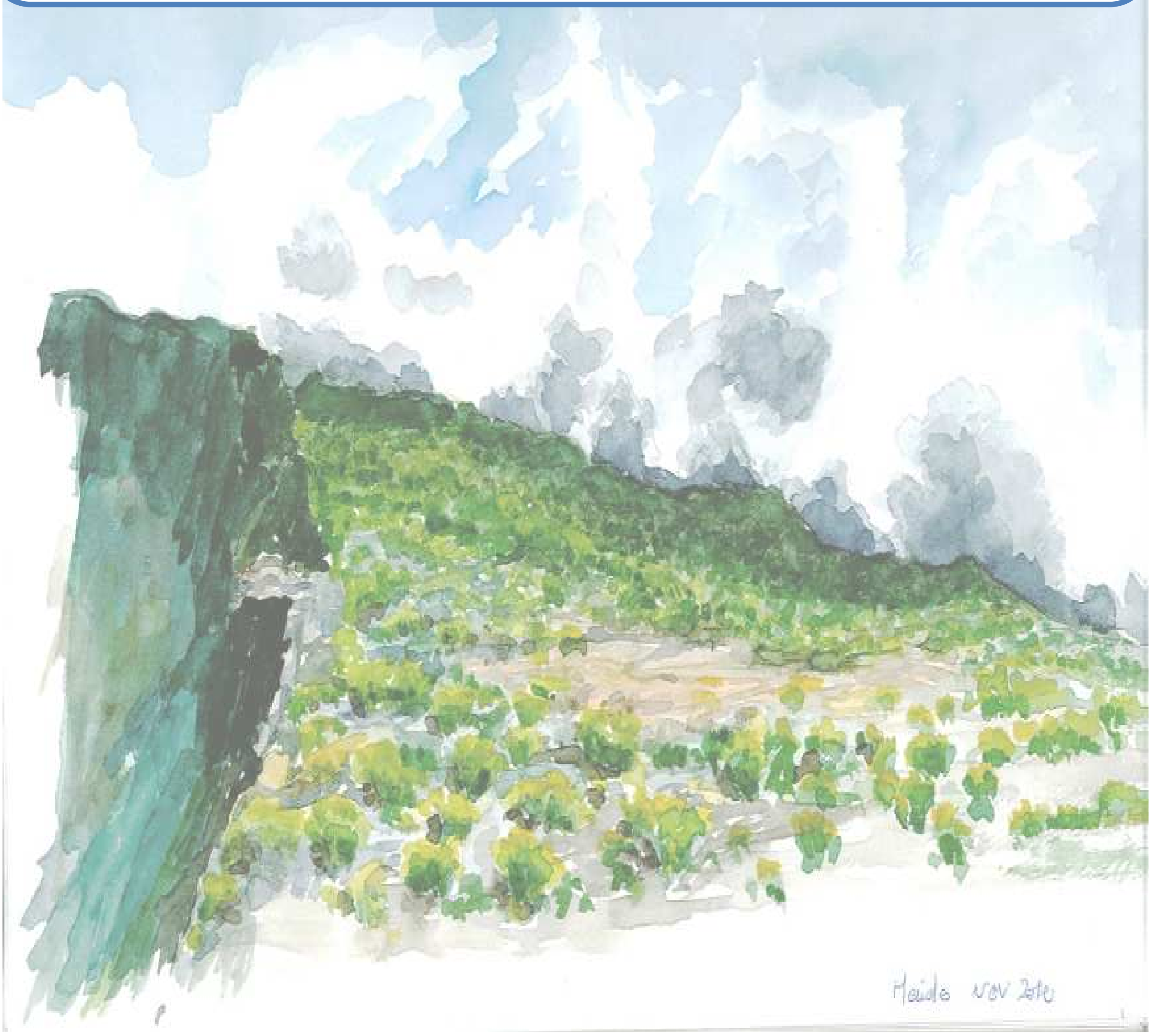
S'ouvrir aux mondes

2011 NDACC Symposium
Network for the Detection of Atmospheric Composition Change

SESSION 4

WATER VAPOR



Poster Session

4P-5 On the Way to Combined DIAL and Raman Lidar Sounding of Water Vapour at Zugspitze

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The primary greenhouse gas water vapour has moved into the focus of lidar sounding within the Network for the Detection of Atmospheric Composition Change (NDACC). Lidar systems with an operating range reaching at least the tropopause region are asked for, with some hope of future extension into the stratosphere. As a first step, we installed in 2003 a powerful differential-absorption lidar (DIAL) at the Schneefernerhaus high-altitude research station 300 m below the Zugspitze summit (Garmisch-Partenkirchen, Germany) [1]. This lidar system, located at 2675 m a.s.l., provides water-vapour profiles in the entire free troposphere above 3 km with high vertical resolution and an accuracy of about 5 % up to 8 km without observable bias [2,3]. Most importantly, due to the high sensitivity of the DIAL technique this wide operating range is also achieved during daytime and under dry conditions. We present examples from the routine measurements of this lidar system during the past four years, in part carried out simultaneous to ozone lidar measurements. A range extension of the DIAL measurements into the stratosphere would require a research platform located at an unrealistic altitude of about 7.5 km [1]. Here, the stronger absorption band of H_2O around 935 nm could be used. Due to the very low stratospheric water-vapour mixing ratio of about 5 ppm lidar sounding of H_2O in the stratosphere is a highly demanding task for all lidar methods. On the other hand the lack of sufficiently accurate routine measurements with other instrumentation (such as radiosondes or microwave radiometers) between roughly 10 and 20 km is a strong motivation for the lidar community. Our solution is a particularly big Raman lidar system, which is currently under development at the Schneefernerhaus. By using a 350-W xenon-chloride laser system (308 nm) and a 1.5-m-diameter receiver we hope to extend for the first time accurate humidity measurements to almost 30 km. At the same time the sensitivity for water vapour around the tropopause will be enhanced. The big XeCl laser (308 nm) is normally used for industrial production and not fully suitable for the application in a scientific system. By using an intra-cavity Fabry-Perot etalon and a thin-film polarizer stable single-line operation with about 99.5 % spectral purity and a linear polarization of 99.4 % have been achieved. A fraction of the radiation will be wavelength shifted by stimulated rotational Raman scattering in hydrogen. This emission will serve as a reference for retrieving the ozone density profile, which is necessary for correcting the absorption losses during the upward propagation of the 308-nm beam. It will also be used for the stratospheric and mesospheric temperature measurements that are based on the atmospheric density determined by Rayleigh scattering. In the lower atmosphere temperature measurement will be based on rotational Raman

shifting. The calibration of the Raman lidar will be ensured by simultaneous measurements with the DIAL system.

[1] H. Vogelmann, T. Trickl, Wide-range sounding of free-tropospheric water vapor with a differential-absorption lidar (DIAL) at a high-altitude station, Appl. Opt. 47 (2008), 2116-2132 [2] Wirth M., et al., Intercomparison of Airborne Water Vapour DIAL Measurements with Ground Based Remote Sensing and Radiosondes within the Framework of LUAMI 2008 Contribution S07-P01-1, 3 pp. in: Proc. 8th International Symposium on Tropospheric Profiling, A. Apituley, H. W. J. Russchenberg, W. A. A. Monna, Eds., http://cerberus.rivm.nl/ISTP/pages/index.htm, ISBN 978-90-6960-233-2. [3] H. Vogelmann, R. Sussmann, T. Trickl, T. Borsdorff, Intercomparison of atmospheric water vapor soundings from the differential absorption lidar (DIAL) and the solar FTIR system on Mt. Zugspitze, Atmos. Meas. Technol. 3 (2011), 835–841