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Results from continuous atmospheric boundary layer humidity profiling with a compact DIAL instrument

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Continuous or quasi-continuous boundary layer water vapour profiling is widely held to be a major unmet requirement for improving weather analysis and prediction. In this paper, we present recent field campaign results demonstrating the performance of a prototype compact Water Vapour DIAL (DIfferential Absorption Lidar) system incorporating a ceilometer-type telescope design. The instrument uses semiconductor laser sources in the submicron wavelength region and is designed to continuously report water vapour mixing ratio profiles in unattended all-weather operation. Extensive comparison campaigns have been carried out in co-operation with the University of Hohenheim, Germany, the Finnish Meteorological Institute FMI, and the German National Meteorological Service, the Deutscher Wetterdienst (DWD). These campaigns included regular radiosonde soundings and established research lidar systems reporting water vapour mixing ratio profiles for comparison purposes. One aim of the campaign carried out at the FMI site in Kuopio, Finland, was an investigation of the performance of the prototype in clean air situations with a low particle density within the boundary layer; for this purpose, during two intensive measuring periods, the radiosonde launch rate had been increased to one per hour. Every two minutes, both the DWD Raman lidar "Ramses" at the Lindenberg Meteorological Observatory, and the DIAL prototype, reported water vapour mixing ratio profiles and uncertainty values based on measurements of the past 20 minutes; the mean absolute deviation of both instruments was less than 0.3 g/kg within the boundary layer. The DIAL prototype was operated continuously, including periods of precipitation, and gives promise for a rugged and low-cost instrument suitable for unattended 24/7 operational use. The new technology is expected to bring significant improvements to short-term weather forecasts in the future. Starting in May 2017, the DIAL prototype will take part in a field campaign at the Southern Great Plains (SGP) atmospheric observatory in Oklahoma, USA. Results from this campaign, involving comparison statistics to a Raman lidar, radiosonde soundings, and a microwave radiometer, are scheduled to be included in this presentation.