A wind, temperature, H2O and CO2 scanning lidar mobile observatory for a 3D thermodynamic view of the atmosphere.

Fabien Gibert[(1)], Dimitri Edouart[(1)], Paul Monnier, Claire Cénac[(1)], Vincent Gauthier[(1)] , Henri Salvador[(1)]

[(1)] Laboratoire de Météorologie Dynamique (LMD/IPSL), École Polytechnique, Institut Polytechnique de Paris, Sorbonne Université, École normale supérieure, PSL Research University, CNRS, École des Ponts, Palaiseau, France , *E-mail:gibert@lmd.polytechnique.fr*

The motivation of this work is to provide advanced observations of the main variables that characterise the land-atmosphere exchanges of momentum, temperature, water vapor and carbon dioxide. Multiple goals include: (i) to address the representativeness of in situ measurements in heterogeneous landscape, especially for surface fluxes (ii) to assess the relevance of Monin-Obukhov similarity theory (MOST) which links gradient and flux close to the surface (iii) to address the issue of dissimilarity of scalar transport such as heat and water vapor or CO_2 in inhomogeneous landscape (iv) to help to find advanced model parameterizations of land-surface or boundary layer - free atmosphere exchanges and transport processes, for both convective and stable planetary boundary layers. To do so, new observations are needed that can provide, first, a 3-D view of the atmosphere and second, that have turbulence-scale temporal and spatial resolutions in order to investigate flux-gradient relationships and estimate higher-order moments.

In this paper we present the characteristics and the performances of two scanning lidars that were developed at Laboratoire de Météorologie Dynamique, Ecole Polytechnique during the last years. First one is a temperature and water vapor Raman lidar at 355 nm (TERA). This lidar uses a diode-pumped and seeded tripled Nd :YAG laser that provides 200 mJ pulses at 100 Hz and a 50 cm diameter telescope and scanning device. The detection uses a cascade of interference filters for Raman temperature rotational and H2O vibrational channels. Second is a prototype DIAL and Doppler lidar at 2051 nm (COWI). This lidar makes use of a fiber-pumped dual wavelength seeded Ho :YLF MOPA emitter that provides 10 mJ pulses at 2 kHz. The lidar has a coherent detection for wind speed measurement and a direct detection using a new HgCdTe APD and a 20 cm diameter telescope for differential absorption measurement of CO_2. The mobile lidar observatory is completed by two in situ flux stations with sonic anemometers and gas analyzers to assess the precision of lidar data of wind speed, temperature, H_2O and CO_2 mixing ratios and to serve as a reference for flux estimates.