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Calibration of a transportable vibrational and rotational Raman lidar using a meteorological probe aboard an ultra-light aircraft

Julien Totems, Patrick Chazette, and Alexandre Baron
CNRS-LSCE, Gif sur Yvette, France (julien.totems@lsce.ipsl.fr)

The proper calibration and qualification of temperature measurements by a rotational Raman (RR) lidar is a difficulty inherent to this technique. It requires sampling multiple vertical temperature profiles with a range including those that could be observed during actual measurements. Special care must be taken in the planetary boundary layer that contains most of the atmospheric water vapor and presents variable gradients. Biases due to different overlap factors on the RR channels at low altitudes and strong elastic return leakage from clouds have to be quantified.
To perform this calibration, concomitant radiosondes are generally used. We tested a parallel approach using a meteorological probe mounted aboard an ultra-light aircraft (ULA) performing spiral flight plans around the lidar laser beam between the surface and 3 km above the ground level. This more flexible approach had already been used successfully to calibrate on-site measurements of the water vapor mixing ratio by a vibrational Raman lidar. An important difference is the calibration function which requires the optimization of 3 to 4 parameters, compared to just one for the water vapor.
The lidar calibration and qualification campaign was conducted in the south of France in June 2018. The results show the full potential of the envisaged approach. The night-time accuracy reached on temperature measurements is better than 0.5 K for an altitude lower than 3 km (100 m & 30 min integration). Following the calibration along time allowed to highlight its excellent repetitiveness, with a standard deviation below 0.2 K. The experimental approach will be presented as well as the temperature / water vapor lidar system. We will discuss the main results with regard to the different key components of the lidar and the encountered weather conditions. The comparison to a more conventional approach, using radiosondes, will also be presented.