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A better understanding of the atmospheric boundary layer structure using ALCs, MWRs and Doppler lidars in the framework of TOPROF

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The COST Action TOPROF was specifically designed to coordinate the operation of Automatic Lidar and Ceilometers (ALC), Doppler lidars and microwave radiometers (MWR) across Europe, in order to be networked, to provide quality controlled observations of atmospheric variables in near real time and to better exploit synergies among the existing instrumental networks. Within this framework, significant developments were conducted on instrument characterization and standardization to offer robust techniques with growing spatial coverage for a set of targets (e.g. aerosol particles, clouds and fog). In particular, one of TOPROF tasks deals with the atmospheric boundary layer (ABL). The ABL height is a fundamental quantity for the description of vertical mixing processes in the lower troposphere and, therefore, controls the build-up, evolution, persistence and dispersal of atmospheric constituents released at or close to the surface.

During the last years, many methods based on remote-sounding have been developed to characterize the ABL. Due to the variety of the observed quantities, such as temperature, brightness temperature, particles, backscattering, motion, and wind, a further characterization of the various layers in the lowermost part of the atmosphere is possible. This includes identification of the stable layer using temperature profiles or cloud-driven mixing layer based on Doppler lidar measurements.

There are different methods depending on the observed quantity. For instance, gradient, variance, extended Kalman filter, and wavelet methods are used to derive ABL heights (and different sublayers) from ALC measurements. However, these approaches can often not capture the complex structure of the ABL. To overcome this drawback, a new generation of ABL retrieval methods for ALCs has been developed in the framework of TOPROF, which are able to solve the layer attribution by involving additional information from surface measurements and/or specific principles and rules. Where other profilers (e.g., wind lidar, MWR) are operated alongside an ALC, instrument synergy offers huge potential. Such combinations are being explored and new synergy methods being developed, since many sites offer long-term multi-instrument datasets.

The ongoing research into the structure and dynamics of the ABL has revealed a multitude of phenomena with an increasing level of complexity and numerous terms. Thus a single point of reference is being compiled (a review paper) to condense, analyze, and digest published results and to propose guidelines for future research.