Analyzing the turbulent structure of the Planetary Boundary Layer by Elastic lidar

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Abstract: The part of troposphere in direct contact with Earth's surface is known as planetary boundary layer (PBL). This region, endowed with turbulent behavior, is the main responsible for the exchange of momentum and energy between the atmosphere and surface. These characteristics make the understanding of PBL structure important for a wide set of studies, which vary from weather forecasting to pollutant dispersion. However, this layer has a great variability throughout the day, and the classical instruments used to study it has temporal limitation (radiosoundings) or spatial limitation (anemometric and eddy covariance towers). Under this scenario, lidar systems have been fairly applied in the last decade due to the absence of such kind constraints.
In this study, we used an elastic lidar to analyze the turbulent behavior of PBL and its internal processes. VELETA, a Raman lidar (Raymetrics Inc) operating at 355 and 387 nm with 1-s temporal and 7.5-m spatial resolutions, held the data acquisition. This system, located at IISTA-CEAMA (Andalusian Institute for Earth System Research) in Granada – Spain, is part of EARLINET (European Aerosol Research Lidar Network).We obtained the value of 1-h averaged atmospheric transmittance, T(r),and from it 1-s backscatter profiles, β(r), are derived. These values of β(r) were used to estimate the high order statistics moments (variance, skewness and kurtosis) and energy spectrum.
This study enabled us to carry out a detailed description of PBL and it confirms the feasibility of elastic lidar signals for the characterization of the PBL turbulence as evidenced by other more sophisticated techniques such as high spectral resolution lidars (McNicholas, 2014) and rotational Raman lidars (Behrendt, 2015). In the near future we will apply the same methodology to a Doppler lidar and we will also study aerosol fluxes from the synergy of Doppler and elastic lidars.

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