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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Analyzing the turbulence in the Planetary Boundary Layer by the synergic use of remote sensing systems: Doppler wind lidar and aerosol elastic lidar" *by* Gregori de Arruda Moreira et al.

Anonymous Referee #1

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This manuscript presents results from the SLOPE campaign in Granada, Spain, in which the objective was to obtain closure between remote sensing and in-situ measurements. For this manuscript, the focus is on characterising the planetary boundary layer using a Doppler lidar, multi-wavelength lidar (MULHACEN), and a profiling microwave radiometer, all operating at high temporal resolution (2 seconds). The authors investigate the use of fluctuations in aerosol number density from the elastic system (EL), vertical velocity fluctuations obtained from the Doppler lidar (DL), and potential temperature profiles retrieved from the microwave radiometer (MWR), to identify the

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boundary layer height (PBLH).

Some of the methodology is relevant, and the influence of random error introducing extra noise in higher-order moments is explored using suitable techniques, but the manuscript is not yet suitable for publication unless some major issues are addressed.

Major comments

The manuscript title and abstract suggests that different methods to determine PBLH will be combined synergistically, but this is not discussed at all in the main text. The main text seems to focus on whether various parameters derived from each instrument agree and does not suggest how they can be combined. In addition, the reader is not informed how PBLH should be derived from many of the DL and EL parameters, or how they could be combined if the purpose was to describe a synergistic retrieval method. Please decide whether you are describing a synergistic approach, or an intercomparison, and structure the manuscript accordingly.

The EL and DL parameters are calculated over 1-hour periods. Is this 1-hour timescale suitable during rapidly varying conditions such as during the morning growth of the boundary layer? Did you try using a running average? What is the impact if you change the averaging period, and why was 1-hour chosen when the MWR data are averaged over 30 minutes?

The manuscript requires a much more rigorous description of the processes driving turbulent mixing in the boundary layer. This does not need to be very long, but any processes referred to should be described accurately, e.g. it is the positive surface heat flux that is responsible for buoyancy (convection), not just intensifying convection. The energy flux balance at the surface partitions net radiation into sensible heat flux, latent heat flux and ground heat flux, hence, there can still be a positive sensible heat flux even when the net radiation is negative, such as during the early evening in urban regions, which is almost certainly what is happening in the two case studies shown here. It is not surprising that RH is somewhat inversely correlated with temperature

if the specific humidity mixing ratio remains constant; however it is not safe (and not necessary) to state anything about latent heat fluxes if you are not measuring them.

Minor comments

MWR data analysis: The MWR retrievals have, by some margin, the lowest vertical resolution of the methods detailed here, especially at the altitudes for typical daytime PBLH. The PBLH retrievals also seem very smooth in time. How does this compare with PBLH retrievals from DL and EL? Is it likely that the MWR provides the most accurate measure of PBLH? Do you use MWR PBLH as a reference for DL and EL retrievals or not? The manuscript requires some discussion on these issues.

Doppler lidar analysis: There are no time-height plots of the DL signal and velocity measurements so it is difficult to judge whether some of the features seen in the DL parameters are due to low SNR conditions. The interpretation of skewness is not appropriate and should be rewritten.

Elastic lidar analysis: Is it safe to assume the two-way transmittance is negligible? Especially since you use the 532 nm wavelength (molecular extinction may be important). What are the typical molecular, aerosol and total extinction values for the cases shown here? There are no time-height plots of the statistical parameters calculated from EL data so it is difficult to judge whether these provide a reliable guide to the boundary layer development - please include these.

Doppler lidar and Elastic lidar analysis: Since you make some effort to quantify the influence of noise on the statistical parameters derived from these two systems, it would be beneficial to discuss how this impacts your interpretation, e.g include time-height plots of the correction factor or relative correction, relative importance in determining PBLH, how much temporal averaging is required to obtain good results. What is the minimum integral time scale that the DL and EL can measure? Is it the acquisition time that allows you to observe turbulence throught the PBL, or is it more likely to be a function of the instrument sensitivities?

Case study 2: Did you try cloud-screening EL data before calculating EL parameters? The PBLH from EL would agree much better with PBLH from MWR in Figure 13, and maybe Figure 14 (it is hard to tell with the scales used). Clouds should also be visible in DL data.

Technical comments Line 36: What do you mean by cyclic processes?

Line 37: Large variability of what?

Line 39: Surface heating is unlikely to impact the upper troposphere.

Line 84: Distinct?

Line 89: Replace 'responsible of' with 'responsible for'.

Line 98: Explain '(s and p)'.

Line 104: Please include a few more Doppler lidar operating parameters: pulse repetition frequency, telescope focus.

Line 106: Use 'laser beam pointing at vertical', since the ground surface may not be horizontal!

Line 108: Replace 'which is part of the MWRNet' with 'which is a member of MWRNet'.

Line 112: State how many frequencies measured in each band.

Line 128: Replace 'MWR data analyzes' with 'MWR data analysis'

Line 130: PBLH not defined yet.

Line 188: Do you mean '(Pal et al., 2010)'?

Line 220: Replace 'Under' with 'Below'.

Lines 220-221: This sentence does not make sense. Do you mean 'Below the PBLH_MWR, correcting for noise does not have a significant impact on the profile, but is more evident above'?

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Line 261: Define Rn (presumably net surface radiation).

Line 320: Do you mean '(Ansmann, 2010)'?

Figure 4: Autocovariance from DL? What are the units for variance and skewness?

Figures 5,7: Profiles from which instrument, and from which location? At what time, and on what day? What height is the surface?

Figure 6: Autocovariance from EL? What are the units for variance, skewness and kurtosis?

Figures 8,11: Which instrument are panels A-C from? Are the black lines (temperature) from the MWR retrieval? Is it more appropriate to plot variance in log scale?

Figure 9,12: Which instrument is this figure from? This is a time-height plot of RCS, not a profile.

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