We would like to thank Dr Landulfo for his constructive comments and suggestions that have really helped us prepare a new and improved version of our work. Following, our response to the referee's comments:

Eduardo Landulfo comments (11 Feb 2011)

Comment #1

In the paper there is no discussion about the different instrument accuracies and precisions that could be better explored by some statistical analysis in the data. Maybe some comments on that could be added to the discussion.

E. Landulfo is right. This information will be included in the revised manuscript, as follows:

"The resulting average uncertainty on the retrieval of tropospheric aerosol backscatter coefficient when using the NTUA and Raymetrics lidars (including both statistical and systematic errors and corresponding to at least 30–60 min. temporal resolution) is based on the methodology described by Bösenberg et al. (1997) and is of the order of 20–30% (see Table X)".

"The main goal of the Vaisala CL31 ceilometer is to report on the aerosol backscatter coefficient profiles, as well as cloud base height and mixing height in the lower troposphere. The Quality Assurance procedure and the uncertainties (based on statistics) of the parameters provided by the CL31 ceilometer are discussed in Münkel et al. (2007) and are given in Table X".

Comment #6

Page 76, line28 - Explain the Quality Assurance in the aerosol profiles.

This information can be included in the revised manuscript, as follows:

"The Quality Assurance of the retrieved aerosol profiles by the NTUA lidar system has been evaluated in the frame of the EARLINET project by performing direct inter-comparisons, both at hardware and software levels, with a reference lidar system (Böckmann et al., 2004; Matthais et al., 2004; Pappalardo et al., 2004)".

"The main goal of the Vaisala CL31 ceilometer is to report on the aerosol backscatter coefficient profiles, as well as cloud base height and mixing height in the lower troposphere. The Quality Assurance procedure and the uncertainties (based on statistics) of the parameters provided by the CL31 ceilometer are discussed in Münkel et al. (2007) and are given in Table X".

Comment #8

Page 76, ln. 10. What does MOCVD stand for?

MOCVD stands for <u>M</u>etal-<u>O</u>rganic <u>C</u>hemical <u>V</u>apor <u>D</u>eposition. This is a technique for depositing thin layers of atoms onto a semiconductor wafer. Using MOCVD you can build up many layers, each of a precisely controlled thickness, to create a material which has specific optical and electrical properties. Using this technique it's possible to build a range of semiconductor photo detectors and lasers.

In the revised manuscript the explanation of the MOCVD acronym will be provided, as follows:

“The ceilometer used in this study is a Vaisala CL31 model, described in detail in Münkel and Räsänen (2004), Münkel et al. (2007), Emeis et al. (2008). It is equipped with an InGaAs/MOCVD (Indium Gallium Arsenide/Metal-Organic Chemical Vapor Deposition) pulsed diode laser emitting at 905 ± 10 nm and having an energy per pulse of 1.2 μJ ± 20 % (factory adjusted)”.

Comment #9

Page 78. What is Raymetrics f number?

The f number of the Raymetrics lidar system is 4 (focal length f=800 mm/diameter of the telescope d=200 mm).

This info will be provided in the revised manuscript.

Comment #11

Page 81. Some discussion has to added here concerning what are the lasers instruments versus radiosondes probing - the former are probing aerosols (even indirectly) and the latter temperature so it might be a source of the discrepancies observed.

E. Landulfo is right. This information will be included in the revised manuscript, as follows:

“In lidar research, it is customary to consider the PBL height as the height, below which most of the aerosol is confined, even if this layer is not always a well-mixed layer [e.g. Matthias and Bösenberg, 2002]. The determination of the PBL height from the lidar data is done by identifying the first significant negative gradient in the range-corrected lidar signal, starting from ground. The steep gradient in the range-corrected lidar signal results from the strong decrease in aerosol backscatter caused by lower particle concentration and humidity above this height. The method is simple and it has been used since the ‘90s [e.g. Flamant et al., 1997; Menut et al., 1999]. Of course there are discrepancies between the lidar and radiosonde derived PBL height due to the fact that the thermodynamically defined PBL is not usually confined with the height of the well-mixed layer, as discussed by Joffre et al. (2001) and Hennemuth and Lammert (2006) and the references therein”.

Comment #12

Also a table to record all different limits of detection and performances might be handy for the discussion and understanding of the whole text.

E. Landulfo is right. This information will be included in the revised manuscript, as follows:

Table X: Technical properties of the CL31 ceilometer and the Raymetrics and NTUA lidars. Typical uncertainties on the retrieved values of the aerosol backscatter coefficient, the mixing and cloud height are also given.

	CL31 ceilometer	Raymetrics lidar	NTUA lidar
Measurement range (m) daytime/nighttime	70-7500	200-10000	1000-15000
Range resolution (m)	5/10 (selectable)	7.5	7.5
Laser system	InGaAs MOCVD laser diode	Quantel Big Sky CFR 200	Quantel Brilliant
Wavelength (nm)	905	355	355/532/1064
Laser pulse energy (mJ)	$1.2x10^{-3}$	30	400/150/75
Laser pulse duration (ns)	110	10	5
Mean pulse repetition rate (Hz)	8192	20	10
Typical uncertainty on aerosol backscatter coefficient (30 min average time)	±20%	±20-30%	±20-30%
Typical uncertainty on mixing height determination (30 min average time) (m)	±200	±100	±100
Typical uncertainty on cloud height determination for 30 min average (m)	±10 up to 200	±15 up to 200	±15 up to 200

Comment #14

Geo coordinates might be useful for the different site locations

Geographical coordinates for the different site locations will be provided in the revised version of the manuscript.

The rest of the comments are technical and their answers will be provided in the revised version of our manuscript

REFERENCES

Böckmann, C., et al., Aerosol lidar intercomparisons in the frame of EARLINET: Part II - Aerosol backscatter algorithms, *Applied Optics,* 43, 977-989, 2004.

Bösenberg, J., Timm, R., and Wulfmeyer, V.: Study of retrieval algorithms for a backscatter lidar, Final Report, MPI Report No. 226, pp. 1–66, Hamburg, 1997.

Emeis, S., Schafer, K., Münkel, C.: Long-term observations of the urban mixing-layer height with ceilometers. – *IOP Conf. Series: Earth and Environ. Sci.*, 1, 012027. doi: 10.1088/1755-1315/1/1/012027, 2008.

Flamant, C., Pelon, J., Flamant, P., and Durand, P.: Lidar determination of the entrainment zone thickness at the top of the unstable marine atmospheric boundary layer, *Boundary Layer Meteorol*., 83, 247–284, 1997.

Joffre, S., Kangas, M., Heikinheimo, M., and Kitaigorodskii, S. A.: Variability of the stable and unstable atmospheric boundary-layer height and its scales over a boreal forest, *Boundary-Layer Meteorol*., 99, 429-450, 2001.

Hennemuth, B., and Lammert, A.: Determination of the Atmospheric Boundary Layer height from radiosonde and lidar backscatter, *Boundary-Layer Meteorol*., 120, 181-200, 2006.

Matthais, V., et al., Aerosol Lidar Intercomparison in the Framework of the EARLINET Project. 1. Instruments, *Applied Optics*, 43, 961-976, 2004.

Matthias, V., and Bösenberg, J.: Aerosol climatology for the planetary boundary layer derived from regular lidar measurements, *Atmos. Res*., 63, 221–245, 2002.

Menut, L., Flamant, C., Pelon, J., and Flamant, P.: Urban boundary layer height determination from lidar measurements over the Paris area, *Appl. Opt*., 38, 945–954, 1999.

Münkel, C., Eresmaa, N., Räsänen, J., and Karppinen, A.: Retrieval of mixing height and dust concentration with lidar ceilometer, *Boundary-Layer Meteorology*, 124, 117-128, 2007.

Münkel, C., and Räsänen, J.: New optical concept for commercial lidar ceilometers scanning the boundary layer, *Proc. SPIE* 5571, 364 (2004); doi:10.1117/12.565540, 2004.

Pappalardo, G., et al., Aerosol lidar intercomparison in the frame of EARLINET: Part III: Aerosol extinction Raman lidar algorithm intercomparison, *Applied Optics,* 43, 5370-5385, 2004.