We would like to thank both reviewers for their 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:

Anonymous Referee #1

Comment 1:

Page 77, ln.13. "The inner part of the lens is used for the alignment of the instrument and for the laser beam emission, while the outer part is used for the collection and focusing of the backscattered radiation onto the receiver".
The description of instrument is not very clear. The authors should provide either more information on ceilometers design or give a proper reference.

The reviewer is right. A more precise description of CL31 is given in the new version of our manuscript. Proper references are added. Specifically, the references given concern the full technical description of CL31 through the User's Guide of the instrument (Vaisala User's Guide, 2009) and several methodology issues provided by Münkel and Räsänen (2004), Münkel et al. (2007), Eresmaa et al. (2009). Specifically, the following text has been added in the instrumentation section of our paper:

"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). In brief, CL31 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). The emission frequency is 8.19 kHz, while the pulse duration is 110 ns. Briefly, CL31 uses a novel single (common) lens design, whose main innovation is in the way the common lens is used for transmitting and receiving light. The centre of the lens is used for collimating the outgoing laser beam, whereas the outer part of the lens is used for focusing the backscattered light onto the receiver. The division between transmitting and receiving areas is provided by an inclined mirror with a hole in the centre. This arrangement significantly reduces the optical cross-talk between transmitter and receiver. According to the Vaisala User's Guide (2009) the full overlap height of the instrument is achieved for altitudes higher than 10 m, although in practice it is of the order of 70 m (Martucci et al., 2010). The separation between the two areas is achieved by an oblique mirror. The backscattered data are acquired and stored by a 60 MHz digital processor and stored in a hard disk unit. Thus, the aerosol backscatter coefficient is obtained from 70 m up to 7.5 km height, with a selectable spatial resolution of 5 or 10 m and temporal resolution of 2 s to 120 s (Vaisala User's Guide, 2009). In our case we used 10 m range resolution and 2 s temporal resolution".

Further technical details for the CL31 ceilometer are given in Vaisala's CL31 User's Guide (Vaisala User's Guide, 2009)".

Comment 2:

Page 82, ln.5. To compare UV lidar and IR ceilometer backscattering coefficients the authors use extinction Angstrom exponent. However extinction and backscattering Angstrom exponents may differ. Actually backscattering exponent can be taken from AERONET retrievals, if these are available.

In fact we use the backscattered-related Angstrom exponent and not the extinction Angstrom exponent. However, this was not clear in the text. After the reviewer's comment the following text is added in our paper:

"Since our goal is to compare the retrievals of both instruments, in terms of the aerosol backscatter coefficient and the mixing height, a spectral conversion (for the retrieval of the first parameter) is needed when different wavelengths are used. The conversion factor used is the backscatter-related Angstrom exponent, which is retrieved from the extinction-related Angstrom exponent taken from multi-filter radiometer (MFR) measurements. Specifically, the backscatter-related Angstrom exponent equals the extinction-related Angstrom exponent, when the lidar ratio is assumed spectrally independent, according to the following equations:

$$C(z) = -\frac{\ln\left(\frac{\alpha_{\lambda_1}}{\alpha_{\lambda_2}}\right)}{\ln\left(\frac{\lambda_1}{\lambda_2}\right)} = -\frac{\ln\left(\frac{S_{\lambda_1} * b_{\lambda_1}}{S_{\lambda_2} * b_{\lambda_2}}\right)}{\ln\left(\frac{\lambda_1}{\lambda_2}\right)} = -\frac{\ln\left(\frac{S_{\lambda_1}}{S_{\lambda_2}}\right)}{\ln\left(\frac{\lambda_1}{\lambda_2}\right)} - \frac{\ln\left(\frac{b_{\lambda_1}}{b_{\lambda_2}}\right)}{\ln\left(\frac{\lambda_1}{\lambda_2}\right)} \Leftrightarrow C(z) = -\frac{\ln\left(\frac{b_{\lambda_1}}{b_{\lambda_2}}\right)}{\ln\left(\frac{\lambda_1}{\lambda_2}\right)}$$

where: C(z) is the Angstrom exponent (backscatter or extinction-related); α_λ, b_λ are the extinction and backscatter coefficients, respectively; S_λ is the lidar ratio; λ_1, λ_2 are the wavelengths (e.g. λ_1=355 or 1064 nm, λ_2=910 nm)."

Besides, since the lidar ratio for CL31's aerosol backscatter retrievals is assumed by default to be equal to 30 sr (Vaisala User's Guide, 2009), in our revised paper we also adopted for the aerosol backscatter retrievals by our lidars the use of a lidar ratio equal to 30 sr, in order to have more comparable aerosol vertical profiles.

Comment 3:

The authors use Klett method for calculation of aerosol backscattering. Probably due to low ceilometer signal the choice of the reference point (region with pure molecule scattering) should be a problem. It would be good if authors could make comments about corresponding uncertainties.

The choice of the reference point for our Klett calculations in the case of the lidar signals was set at 7 km, since the signal to noise ratio (SNR) is still quite high even during daytime (higher than 1, according to SNR calculations based on Heese et al. (2010), for averaging over more than 30 minutes). For the lidar signals in Athens, the lidar returns are first corrected for background light and range. The range-corrected signal return for the molecular atmosphere is then estimated using radiosonde data. The lidar range-corrected signal is then normalized on the molecular return to check for calibration of the system and find the total attenuated backscatter signal. Through this procedure, the aerosol-free tropospheric region is defined as the region where the total attenuated backscatter signal is equal to the molecular attenuated backscatter signal. This region for Athens is usual above 6-7 km. In this work, the pure molecular atmosphere was around 7 km, and this was the reference height assumed for our retrievals.

The ceilometer's retrieval of the aerosol backscatter coefficient is achieved by an automatic algorithm provided by Vaisala. As far as the retrieval of the reference height is concerned, the reference height is given internally in the CL31 software. No further information is provided except the information given in Münkel et al. (2007) and the Vaisala User's Guide (2009).

After the reviewer's comments the following text is added in Section 2.2 of our paper:

"The resulting average uncertainty on the retrieval of 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) in the troposphere is based on the methodology described by Bösenberg et al. (1997) and is of the order of 20–30%. The choice of the reference height for our Klett-backscatter retrievals in the case of the lidar signals was set at 7 km, since the signal to noise ratio (SNR) is still quite high even during daytime (higher than 1, according to SNR calculations based on Heese et al. (2010), for averaging time over more than 30 minutes). For the lidar signals in Athens, the lidar returns are first corrected for background light and range. The range-corrected signal return for the molecular atmosphere is then estimated using radiosonde data. The lidar range-corrected signal is then normalized on the molecular return to check for calibration and find the total attenuated backscatter signal. Through this procedure, the aerosol-free tropospheric region is defined as the region where the total attenuated backscatter signal is equal to the molecular attenuated backscatter signal. This region for Athens is usual above 6-7 km.

The corresponding average uncertainty on the retrieval of aerosol backscatter coefficient when using the CL31 ceilometer data averaged over 30 min is briefly discussed in Münkel et al. (2007) and is of the order of 20%. As far as the reference height is concerned, it is given internally in the CL31 software. No further information is provided except that given in Münkel et al. (2007) and the Vaisala User's Guide (2009)."

Comment 4:

Page *83, ln.25. The comparison with Raymetrics lidar was performed at 355 nm, while in the case of NTUA Raman lidar data are given for 1064 nm. Why different wavelengths were used? Why not to use Raymetrics at 1064 nm?*

The Raymetrics lidar system is able to record only the elastically backscattered signal at 355 nm, while the NTUA lidar system records signals at 1064, 532, 355, (elastic channels) and 607, 407, 387 nm (Raman channels).

We have to note that the portable Raymetrics lidar was available only for the first part of our inter-comparison campaign and was collocated with the CL31 ceilometer. During the second part of our inter-comparison campaign the Raymetrics lidar was not available. Thus, the inter-comparison was made only with the NTUA lidar system. During the second part of our work we have chosen to use 1064 nm because this wavelength is closer to 910 nm in which the ceilometer emits. This information is available in the Section 2. The necessary spectral conversions were made according to the aforementioned method (see response to Comment #2).

Comment 5:

Backscattering profile from Raman lidar in Fig.7 looks "more smoothed" than the ceilometer profile. Did both instruments have the same range resolution?

The range resolution is the same. No range averaging has been applied. The observed difference is related to the lower SNR values of the ceilometer's signal compared to the lidar signals (see also reply to Comment #3).

Comment 6:

Page 85, ln.24. "An additional uncertainty is introduced by the use of a lidar ratio of 30 sr used by default by the ceilometers..". Why not use the same lidar ratio for lidar and ceilometer?

The referee is right. The same value for the lidar ratio should be used. In our revised manuscript all calculations are made under the assumption of a common lidar ratio of 30 sr for all instruments and for a common time period. (See also answer to Comment 2).

Therefore, our plots are revised as follows:

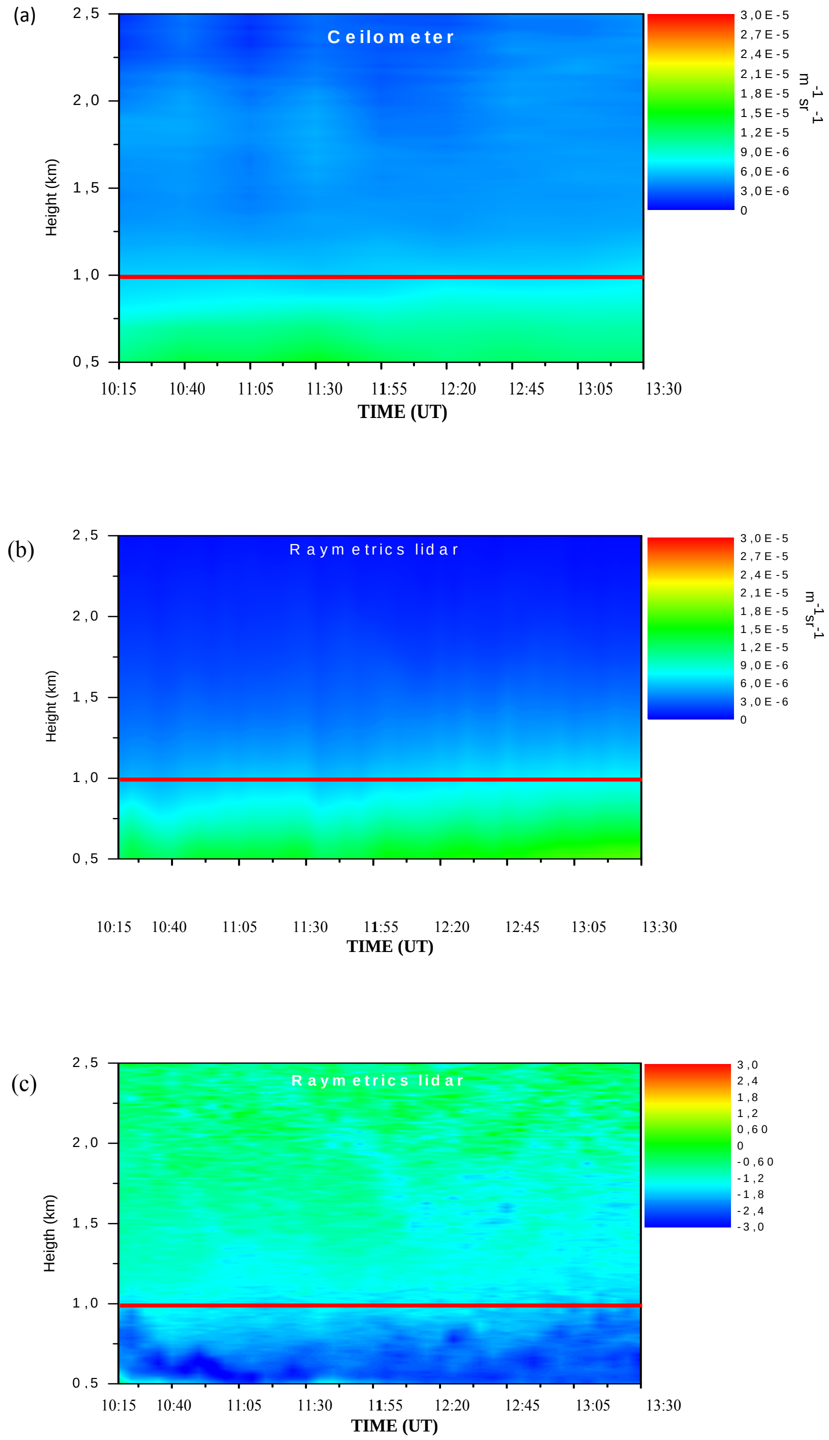

Fig. 1. Aerosol backscatter coefficient (in $m^{-1}sr^{-1}$) obtained **(a)** by the ceilometer and **(b)** the Raymetrics lidar. **(c)** The first derivative of the logarithm of the range-corrected lidar signal (in A.U.) obtained by the Raymetrics system. All curves are valid from 10:15 to 13:45 UTC on 26 November 2008. Red lines represent mean PBL height around 12:00 UTC.

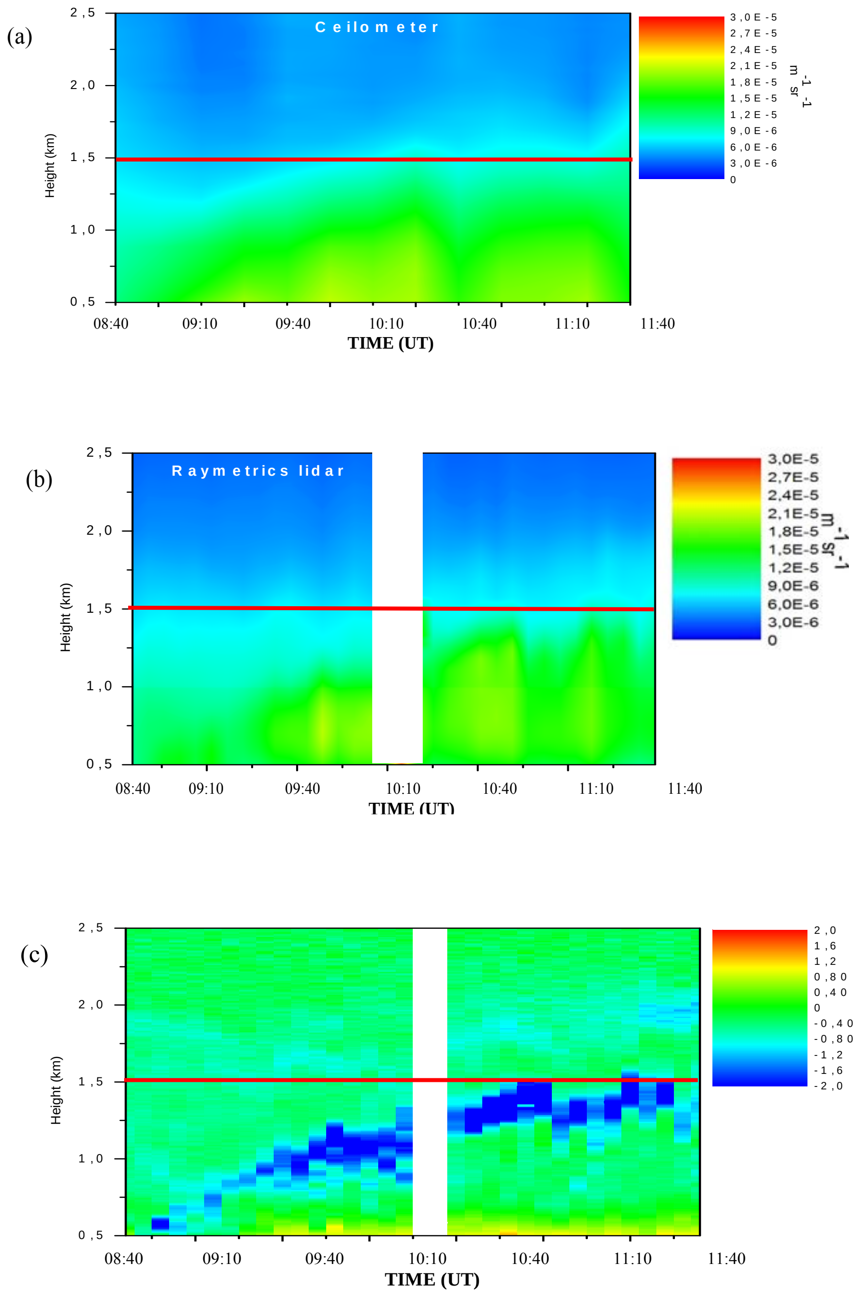

Fig. 2. Aerosol backscatter coefficient (in $m^{-1}sr^{-1}$) obtained **(a)** by the ceilometer and **(b)** the Raymetrics lidar. **(c)** The first derivative of the logarithm of the range-corrected lidar signal (in A.U.) obtained by the Raymetrics system. All curves are valid from 08:40 to 11:35 UTC on 27 November 2008. Red lines represent mean PBL height around 12:00 UTC.

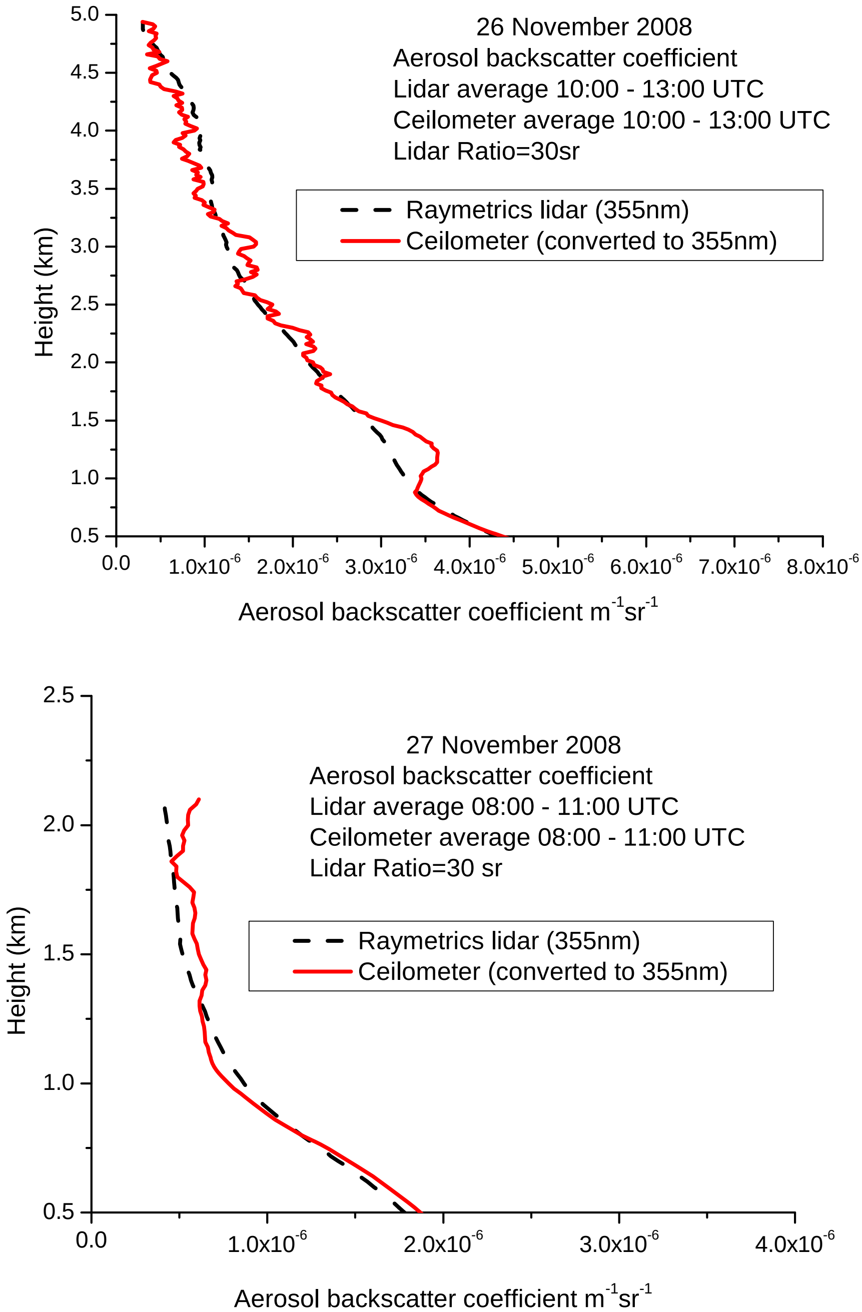

Fig. 4. Comparison of the aerosol backscatter coefficient profiles obtained by the Vaisala ceilometer and the Raymetrics lidar **(a)** on 26 November 2008 and **(b)** on 27 November 2008.

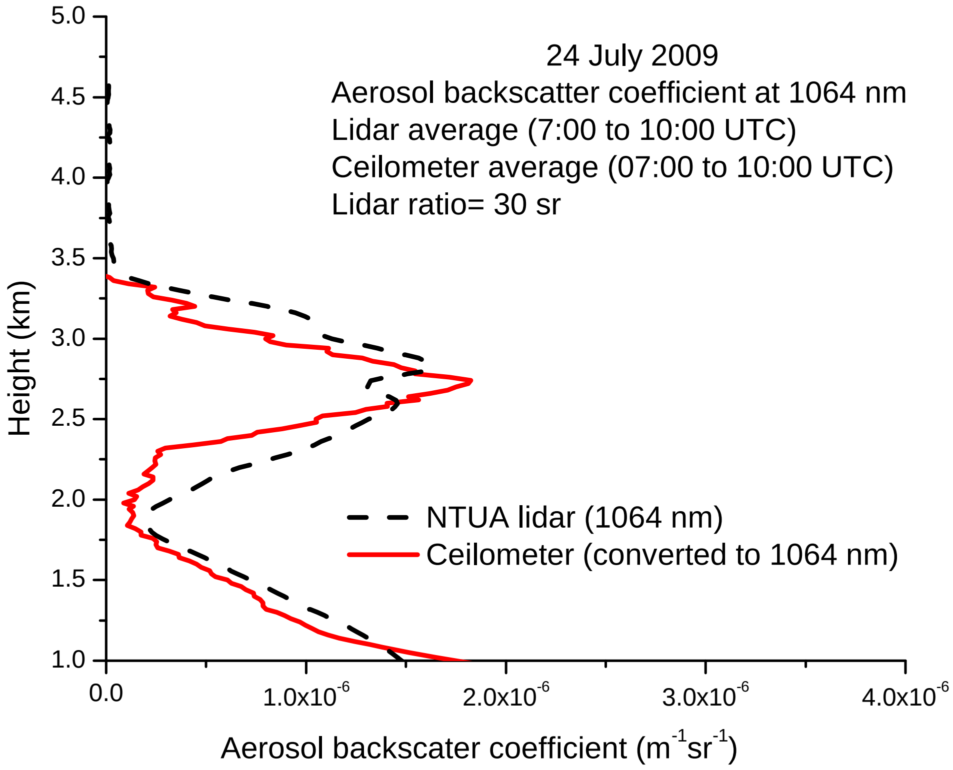

Fig. 10. Aerosol backscatter coefficient profiles obtained by the Vaisala ceilometer (11:00– 13:00 UTC) and the NTUA Raman lidar system (11:00–13:00 UTC) on 24 July 2009.

The corresponding part of the manuscript has been changed accordingly.

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