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Interactive comment on "Mixing height determination by ceilometer" *by* N. Eresmaa et al.

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According to the comment of Referee #2 the sections dealing existing methods determining the mixing height will be added to the original manuscript.

A section dealing related work using different remote sensing techniques is added in section 1 (Introduction), after the third paragraph.

Other remote sensing techniques include sodar, radio acoustic sounding system (RASS) and wind profiler. Signals emitted by a sodar are scattered by temperature inhomegeneities characterized by the structure parameter of the acoustic refractive index. According to the observations the backscattered signal S has a secondary maximum at the top of the mixing layer (Beyrich 1995, 1997). Emeis and Türk (2004) detected the MH from the sodar data employing two different criteria. According the first criterion a sharp decrease of the acoustic backscatter intensity indicates the top of the turbulent layer; the second criterion diagnoses the (secondary) maxima of the backscatter profile. The search is done separately with both criteria, and the lower height is chosen to denote the MH.

The mixing height can be determined by a wind profiler from the signal-to-noise ratio (SNR). The return signal is received primarily from the inhomogeneities of the radio refractive index (Angevine et al., 1994). These inhomogeneities depend primarily on the fluctuations of the temperature and especially the moisture fields (White et al., 1991). Since there is often a humidity gradient between mixing layer and free atmosphere, a peak can be seen in wind profiler backscatter profile at the top of the mixing layer and SNR (Cohn and Angevine, 2000). However, since the moisture profile is often not as well mixed as temperature profile, there might be some ambiguity in the derived MHs (Seibert et al., 2000)

A RASS detects the speed of a sound wave and thus the profile of the virtual temperature (Görsdorf and Lehman, 2000). Since RASS can also provide the wind profile, the MH can be determined using the bulk Richardson method.

A section dealing existing lidar methods is added in section 2.2 in the manuscript (Method for estimating the mixing height from ceilometer measurements)

Since in general aerosol concentrations are lower in the free atmosphere than in the mixing layer, the MH can be associated with a strong gradient in the vertical backscattering profile. There exists different methods to determine the MH, e.g. the simple threshold method and gradient method. In a simple threshold method the mixing height is reported, when a backscatter signal falls below a fixed threshold value (Münkel and Räsänen, 2004). Melfi et al. (1984) determined the MH as a height at which the backscatter signal exceeds the clear air signal by a small value.

In the gradient method a minimum of the first derivate of the backscattering profile db/dz reveals the mixing height (Endlich et al., 1979; Münkel and Räsänen, 2004; Sicard et al., 2004). Also a minimum of the second derivate (Menut et al.,1999; Sicard

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et al., 2004) or a minimum of the first derivate of logarithm (Sicard et al., 2004), has been used to determine the mixing height.

The method used in this work, originally described by Steyn et al. (1999), is an extension of the gradient method. The mixing height is not determined from the observed backscatter profile, but from an idealized backscatter profile fitted to the observed profile. The robustness of this technique is in utilizing the whole backscatter profile rather than just that portion surrounding the mixing layer. This method also detects only structures in the mixing layer that match an idealized mixing layer.

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