Evaluation of aerosol vertical distribution from the EMEP model using EARLINET measurements

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Providing information on aerosol backscatter and extinction profiles, lidar instruments offer a unique possibility of evaluating vertical distribution of aerosols calculated with chemical transport models.

The EMEP/MSC-W model (Simpson et al., 2012) calculates aerosol extinction from the 3D fields of aerosol mass concentrations applying aerosol type specific extinction efficiencies, and accounting for the effect of relative humidity following Chin et al. (2002). The calculations were made on global (1x1°) and European (50x50 km) domains for the year of 2012.

Within the ACTRIS/ACTRIS-2 project, EARLINET data have been incorporated in the AeroCom database (Schulz et al., 2009), which allows visual comparison of the model results with lidar extinction profiles at 532 and 355 nm wavelengths for the actual year and also with climatological (over 13 years) data (Fig. 1). The latter provides more robust comparison as much more measurements are included.

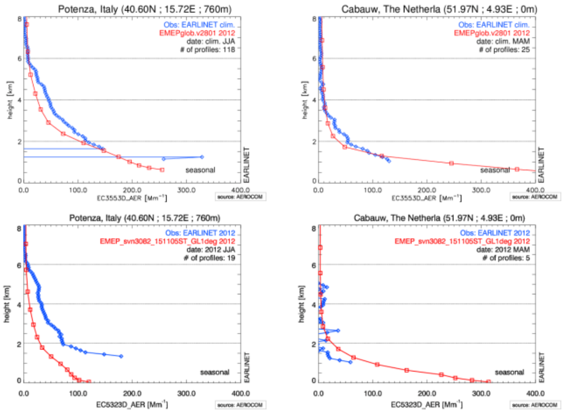

Figure 1. Aerosol extinction profiles at 532 and 355 nm at Potenza (IT) and Cabauw (NL) from the EMEP model for 2012 (red) compared to lidar (blue) climatology (upper) and 2012 (lower).

In this work, model calculated aerosol extinction (α) and backscatter (β) at 532 and 355 nm are compared with lidar data on hourly basis. Different degrees of "smoothing" of lidar vertical profiles are tested (i.e. averaging the data over 100m and 1 km layers, and corresponding to the model layers). Beside qualitative evaluation, quantitative analysis of the correspondence between model and measurements is performed for 2012 with the focus on the period of EMEP/ACTRIS campaign (June-July 2012), including 72-h continuous lidar measurements (Sicard et al., 2015).

We found that in general the model agrees with lidar better: for backscatter than for extinction coefficient; for 355nm than for 532nm and at 3-6 km altitudes compared to lower and higher levels (Fig. 2). The model tends to overestimate measurements below 2 km and underestimate above 7-8 km, especially so for β. Accounting for the vertical variability of lidar ratio in calculations of β should improve this (β= α/50sr is used here). Also compared to 72-h continuous lidar measurements modelled α is closer to the data at 3-5 km altitude compared to 1-2 km (Fig. 3). Further, better agreement is obtained when lidar data is 'smoothed", i.e. aggregated in thicker layers. Also temporal smoothing of model results shows positive effect. Finally, recommendations for model comparison with lidar profiles are made.

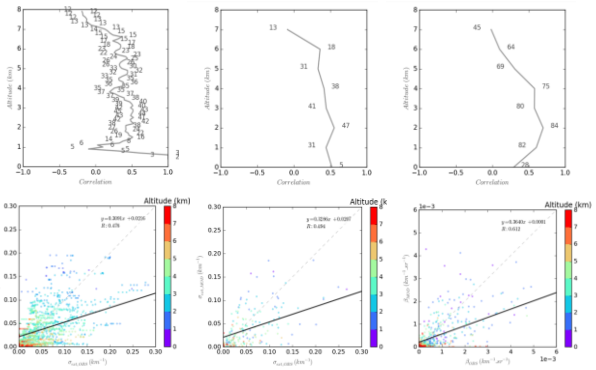

Figure 2. Correlation vertical profiles (upper) and regression (lower) between the model and lidar with 100m (left) and 1km (middle and right) data averaging: for extinction 355nm (left, middle) and backscatter 35nm (right).

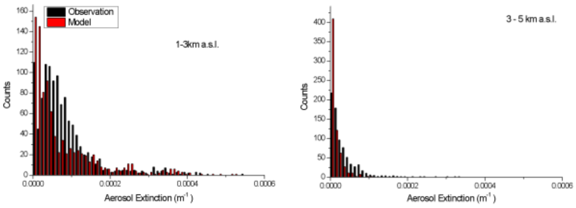

Figure 3. Frequency distribution of calculated and lidar extinction coefficients at the lowest 1-3 km (left) and at 3-5 km (right)

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