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The vertical distribution of aerosol over Europe: comparison of observations and model results.

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Vertical profiles of aerosol extinction were measured systematically at a number of stations in the frame of the European project EARLINET. These were obtained using Raman lidar in the UV around 355 nm emission wavelength. A sufficiently large number of measurements under different conditions were performed such that statistically significant averages can be derived in addition to the individual profiles.

The combination of a general circulation model with an aerosol module yields the 4-dimensional distribution of aerosols and their properties. We have used specifically the LMDzT-INCA model, coupling the general circulation model LMDzT of the Laboratoire de Météorologie Dynamique to the INCA (Interaction with chemistry and aerosols) module of CEA-CNRS, to simulate the aerosol distribution over Europe starting with the year 2000. Other model results as provided through the AEROCOM initiative are shown, too.

Because the quality of the simulations depends on the representation of the aerosol life-cycle and some critical atmospheric parameters in the model as well as on accurate information about aerosol sources, comparisons with observations help identify the critical parameters and processes. On the basis of individual observations, which nominally cover 30 minutes only, the correlation between model results and observations is rather low, between 0.2 in the lower layers and 0.5 in the upper layers. This is not unexpected because aerosol is known to have a very inhomogeneous distribution, so even small errors in the calculated transport patterns can cause large differences in the aerosol distribution. General circulation models are not specifically suitable for such detailed description of highly variable fields. However, when the results are averaged over larger spatial and temporal scales the results are much more promising.

To be specific, when temporal averaging over the year of 2000 and spatial averaging over 4 stations in Northern Europe is performed, the mean difference between the lidar observations and LMDzT-INCA model results is only 20%. For the 3 southern stations this difference is somewhat larger, 29%, and the observed altitude distribution in comparison to the modelling of specific aerosol components leads to the conclusion that mainly Saharan dust outbreaks contribute to the observed differences for the southern stations. In addition vertical mixing appears to be stronger than predicted in this region.

The results from a variety of models differ considerably, in particular in the modeled vertical distribution. The EARLINET observations provide a valuable tool to identify the relevant causes for these differences and attribute them to specific processes in the lifecycle of aerosols.