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Application of the variability-size relationship to atmospheric aerosol studies: estimating aerosol lifetimes and ages

J. Williams[1], M. de Reus[1], R. Krejci[2], H. Fischer[1], and J. Ström[2]
[1]Max Planck Institute for Chemistry, Mainz, Germany
[2]Institute of Applied Environmental Research (ITM), Stockholm University, Sweden

Abstract. Aerosol variability is examined as function of particle size for data collected over the Northern Indian Ocean in February 1999 as part of the INDOEX experiment. It was found that for particles believed to be of terrestrial or oceanic origin, the variability correlated with the average number concentration. For particles that are thought to be formed and grow in the atmosphere through coagulation and condensation an anticorrelation was observed, the minimum in variability coinciding with the maximum in the number concentration. Three altitude ranges were examined (0--1, 4--8 and 8--13 km) and the minimum in variability was found to occur at lower particle sizes in the free troposphere (0.065 μm) than in the boundary layer (0.165 μm). The observed variability has been compared to that generated by a numerical model in order to determine the relative importance of the physical processes. Modelled variability of 0.02 μm particles caused by nucleation was not observed in the measurements. A previously derived empirical relationship for aerosol residence time was compared with the measured variability as a function of bin size. The aerosol variability / residence time relationship was characterised by a coefficient (*b*) at all altitudes and for both correlating and anticorrelating regimes. By combining the derived coefficient with the model predicted lifetime for 0.020 μm particles we estimated residence times and ages as a function of particle size and altitude. General agreement was found with previous estimates of aerosol residence time. In the upper atmosphere aerosols of 0.065 μm in size have residence times of approximately 1 month and can be transported on a hemispheric scale. The same size aerosol has a lifetime one order of magnitude less in the boundary layer and therefore will not be transported far from the source regions.

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