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Trend estimates of AERONET-observed and model-simulated AOT percentiles between 1993 and 2013

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Recent Aerosol Optical thickness (AOT) trend studies used monthly or annual arithmetic means that discard details of the generally right-skewed AOT distributions. Potentially, such results can be biased by extreme values (including outliers). This study additionally uses percentiles (i.e. the lowest 5%, 25%, 50%, 75% and 95% of the monthly cumulative distributions fitted to Aerosol Robotic Network (AERONET)-observed and ECHAM/MESSy Atmospheric Chemistry (EMAC)-model simulated AOTs) that are less affected by outliers caused by measurement error, cloud contamination and occasional extreme aerosol events. Since the limited statistical representativeness of monthly percentiles and means can lead to bias, this study adopts the number of observations as a weighting factor, which improves the statistical robustness of trend estimates. By analyzing the aerosol composition of AERONET-observed and EMAC-simulated AOTs in selected regions of interest, we distinguish the dominant aerosol types and investigate the causes of regional AOT trends. The simulated and observed trends are generally consistent with a high correlation coefficient (R = 0.89) and small bias (slope$\pm 2\sigma$ = 0.75 $\pm$ 0.19). A significant decrease in EMAC-decomposed AOTs by water-soluble compounds and black carbon is found over the USA and the EU due to environmental regulation. In particular, a clear reversal in the AERONET AOT trend percentiles is found over the USA, probably related to the AOT diurnal cycle and the frequency of wildfires.