Changes in ground-level PM mass concentration and column aerosol optical depth over East Asia during 2004-2014

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Multi-year records of MODIS, ground-level particulate matter (PM) mass concentration, CALIOP, and ground-level lidar were analyzed to investigate seasonal and annual changes of aerosol optical depth (AOD) and PM mass concentration over East Asia. Least mean square fit method is applied to detect the trends and their magnitudes for each selected regions and stations. Eleven-year MODIS measurements show generally increasing trends in both AOD (1.18 % yr^{-1}) and Ångström exponent (0.98 % yr^{-1}), especially over the east coastal industrialized region in China. Increasing trends of AOD were found for eight cites in China (0.80 % yr^{-1}) and Seoul site, Korea (0.40 % yr^{-1}), whereas no significant change were shown in Gosan background site (0.04 % yr^{-1}) and decreasing trend at five background sites in Japan (-0.42 % yr^{-1}). Contrasting to AOD trend, all fifteen sites in China (-1.28 % yr^{-1}), Korea (-2.77 % yr^{-1}), and Japan (-2.03 % yr^{-1}) showed decreasing trend of PM_{10} mass concentration. Also, $PM_{2.5}$ mass concentration at Beijing, Seoul, Rishiri, and Oki show significant decreasing trend of -1.16 % yr^{-1}. To further discuss the opposite trend of surface PM mass concentration and column AOD, we investigate vertical aerosol profile from lidar measurements. AOD estimated for planetary boundary layer (surface~1.5 km altitude; AOD_{PBL}) from CALIOP measurements over East China show decreasing trend of -1.71 % yr^{-1} over the period of 2007-2014, wherever AOD estimated for free troposphere (1.5 km~5 km altitude; AOD_{FT}) show increasing trend of 2.92 % yr^{-1}. In addition, ground-level lidar measurements in Seoul show decreasing AOD_{PBL} trend of -2.57 % yr^{-1}, whereas, AOD_{FT} show no significant change (-0.44 % yr^{-1}) between 2007 and 2014. This significant decreasing AOD_{PBL} and increasing AOD_{FT} trend is attributable to the relative contribution of complex processes that may include decrease of coarse particles near surface following the implementation of numerous air pollution control and changes in meteorological factors (convection, precipitation, etc.).

Key words: particulate matter, aerosol optical depth (AOD), MODIS, lidar, trend