1.094 The causes and consequences of unanticipated decreases in carbonaceous aerosol over the U.S. between 1990 - 2012.

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Abstract:

Exposure to atmospheric particulate matter (PM) exacerbates respiratory and cardiovascular conditions, resulting in ~3.7 million premature deaths per year globally, and ~200,000 per year in the U.S. alone. There has been a significant decline in PM since 1990 in the U.S., attributed primarily to the reduction in inorganic aerosol following implementation of the Clean Air Act amendments (CAAA). Here, using surface observations between 1990 and 2012, we show that both black carbon and organic carbon have also declined dramatically across the entire U.S. by 25-50%; the latter being unexpected and accounts for over 30% of the U.S.-wide decline in PM. Using a chemical transport model, reanalysis meteorology and a new annually varying anthropogenic emissions database for carbonaceous aerosol, we show that the decrease in carbonaceous aerosol can be explained by changes in anthropogenic emissions. Furthermore, the organic aerosol concentration declined despite opposing trends from natural sources. We assess the population exposure and health impacts related to the associated decline in PM, finding that CAAA controls affecting organic aerosol, primarily from vehicle emissions and fuel burning, are responsible for averting 120,000 (59,000 – 197,000) premature deaths between 1990 and 2012; with approximately 69,000 more lives saved than anticipated by the EPA between 2000 and 2010.