Increases in wintertime aerosol concentrations and severe haze days in eastern China over the past decades: Roles of variations in meteorological parameters and anthropogenic emissions

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The increases in wintertime aerosol concentrations and severe haze days in eastern China over the past decades were quantified by using observed atmospheric visibility, observed $PM_{2.5}$ concentrations, simulated $PM_{2.5}$ concentrations from the Goddard Earth-Observing System (GEOS) chemical transport model (GEOS-Chem), as well as simulated climate change from 15 CMIP5 climate models. Observed winter haze days (defined as days with atmospheric visibility less than 10 km and relative humidity less than 80%) averaged over eastern China (105–122.5˚E, 20–45˚N) increased from 21 days in 1980 to 42 days in 2014. Averaged over eastern China, simulated wintertime surface-layer $PM_{2.5}$ concentrations from the GEOS-Chem model exhibited an increasing trend of 10.5 (±6.2) $\mu g\ m^{-3}$ $decade^{-1}$ over eastern China in the past decades, in which the changes in anthropogenic emissions and in climate contributed 87% and 17%, respectively. Observed severe haze days (defined as days with observed $PM_{2.5}$ >150 $\mu g\ m^{-3}$) occurred mainly over Northern China. Conducive weather conditions, such as reduced surface winter northerlies, weakened northwesterlies in the midtroposphere, and enhanced thermal stability of the lower atmosphere, were an important ingredient of severe haze episodes. Results from the 15 CMIP5 models showed that the frequency of weather conditions conducive to severe haze events in northern China increased substantially under greenhouse warming.

Keywords: air quality, aerosol, climate change, severe haze, eastern China

