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A weekly heavy haze episode in Hangzhou city in December of 2013: Characteristics, origins and implications

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Air pollution and heavy haze have recently become China's biggest environmental problem due to the rapid economic and industrial developments and urbanization. However, the sources for the formation of the heavy haze for many cities remain unknown. Here, we analyzed the characteristics of air pollution in metropolitan Hangzhou city (China) from November 25 to December 11, 2013, on the basis of surface observations at 8 urban monitoring stations for $PM_{2.5}$, PM_{10}, O_3, NO_2, CO and SO_2 and satellite observations for aerosol optical thickness. The sources for the formation of heavy haze were identified by the analysis of trajectory clustering, the receptor models such as potential source contribution function and concentration weighted trajectory. The results show that for the weekly heavy haze episode (December 3 to 9), the mean concentrations of $PM_{2.5}$, PM_{10}, SO_2, NO_2, and CO are 293.4$\pm$103.2, 376.8$\pm$119.4, 58.0$\pm$37.2, 118.5$\pm$39.3 and 2429$\pm$740 μg m^{-3}, respectively. The back trajectory cluster analysis indicates that the predominant clusters are south (37.1%) and southeast (28.6%) during the weekly heavy haze episode at Hangzhou. The results of the receptor models show that the sources affecting formation of the extremely high $PM_{2.5}$ in Hangzhou are mainly located in the southeastern coast of Zhejiang and Fujian provinces, north part of Jiangxi and central part of Jiangsu province. Rather than local emissions, it is also found that air mass pathways and cross-border transports are crucial factors for determining high $PM_{2.5}$ concentrations and formation in Hangzhou. The two-way coupled WRF-CMAQ model was also used to study the formation of haze in Hangzhou. It is necessary to implement the air pollution control measures for all industrial areas on local, regional, and even national scales in China.