Anonymous Referee #2:

1. Page 1, line 19. Which population was used to do the population weighting?

Response: The population data used in this study are taken from the LandScan Global Population database (ORNL, 2010, Bright et al., 2011). We have added this information and the following reference to the revised manuscript.

Page 6, line 15 is revised as: 'The population-weighted mean mass concentrations of $PM_{2.5}$ over China were estimated using population data taken from the LandScan Global Population database (ORNL, 2010, Bright et al., 2011). The annual population-weighted mean concentrations were in the range of 63.9–75.2 μg/m^3 during 2005–2012 and were nearly twice the Chinese national standard.'

Reference: Bright, E. A., Coleman, P. R., Rose, A. N., and Urban, M. L.: LandScan 2010, in, 2010 ed., Oak Ridge National Laboratory, Oak Ridge, TN, 2011.

2. Page 3, "2.2 Satellite-derived PM2.5 and chemical composition concentrations": what's spatial resolution for data integration and model fitting? what's the detailed meanings of AODCTM in equation (1) and (2)? Although the method has been published in Geng. et al. 2015, it would be easier for readers' understanding if more information given in this manuscript.

Response: The satellite AOD data is at the spatial resolution of 0.1° × 0.1°, and the conversion factors are taken from the nested-grid GEOS-Chem model, which has a spatial resolution of 0.5° × 0.666°. The output datasets ($PM_{2.5}$ composition data) are at 0.1° × 0.1°. AOD_{CTM} means AOD data comes from a CTM model.

We have revised the manuscript to better describe our method: 'The satellite-derived $PM_{2.5}$ concentration datasets used in this work were adopted from Geng et al. (2015). These data were calculated using satellite AOD and conversion factors between AOD and $PM_{2.5}$ simulated by a CTM, and the spatial resolution of the dataset is 0.1° × 0.1°. Following Philips et al. (2014), the satellite-derived chemical compositions of $PM_{2.5}$ at 0.1° × 0.1° were estimated by applying composition-specific conversion factors to satellite AOD. The equations used for the $PM_{2.5}$ and composition calculations are:

$$PM_{2.5,satellite} = AOD_{satellite} \cdot \frac{PM_{2.5,CTM}}{AOD_{CTM}} \quad (1)$$

$$Composition^{k}_{satellite} = AOD_{satellite} \cdot \frac{Composition^{k}_{CTM}}{AOD_{CTM}} \quad (2)$$

where subscript ‘satellite’ and ‘CTM’ represent data from satellite and model respectively; *k* represents different chemical compositions, including SO_4^{2-}, NO_3^-, NH_4^+, BC, OM, dust and sea salt, in this study.’

3. Why is population-weighted concentrations used to evaluate the inter-annual variation? What’s the advantages of population-weighted concentrations comparing with unweighted concentrations in analysis the effects of controlling policies and emissions on PM2.5?

Response: We believe that the population-weighted mean concentrations can better reflect the changes of anthropogenic emissions, because anthropogenic emissions are usually emitted in populous regions. Putting more weights in populated area could partially avoid the influence of natural sources, such as dust from the desert. The northwestern part of China has very high $PM_{2.5}$ concentrations due to dust, but there is little population and emissions in that region. Using population-weighted mean concentrations can reduce the contribution of dusty region in the mean $PM_{2.5}$.