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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Widespread air pollutants of the North China Plain during the Asian summer monsoon season: A case study" *by* Jiarui Wu et al.

Anonymous Referee #2

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This study evaluates the influences of air pollution from North China Plain (NCP) on its surrounding regions, including Northeast and Northwest China (NEC and NWC), when Asian summer monsoon (ASM) is present. The case study with WRF-Chem modeling in this study suggests that the air pollution emitted or formed over NCP could significantly deteriorate the air quality at certain areas in NEC and NWC, particularly in terms of PM2.5 and ozone concentrations. Since the transboundary transport is a key issue in regional air pollution control in China and there is lack of such studies, I recommend publishing this work, after the authors have sufficiently addressed following issues. Major points: 1. The horizontal grid spacing for the simulations in this study is 10 km, which is the lower bound for the WRF model to turn on the cumulus scheme to consider the sub-grid-scale effect of convective and/or shallow clouds. Was any certain cumulus scheme used in this study? Which one was used? If the simulations conducted without the cumulus parameterization, what are the potential influences on the results? 2. Typically, the accuracy in chemical transport model simulations depends on emission inventory, meteorology, and chemistry. The key features in the aerosol chemistry in China are related to very efficient secondary formation (Guo et al., Proc. Natl. Acad. Sci. USA 111, 17373, 2014; Zhang et al., Chem. Rev. 115, 3803, 2015). Specifically, the efficient secondary aerosol processes include aerosol nucleation and rapid growth under favorable conditions (Zhang et al., Chem. Rev. 112, 1957, 2012; Qiu et al., Phys. Chem. Chem. Phys. 15, 5738, 2013). It would be necessary that you clearly state how those processes were accounted for in your chemistry module. 3. Also, aerosol impacts on meteorological fields could be significant, which might further affect the aerosol pollution condition in the lower troposphere. Also, aerosol-cloud interactions might modify temperature and moisture profiles and precipitation (Wang et al., Atmos. Chem. Phys. 11, 12421, 2011), leading to potential feedback on the atmospheric chemistry. Aerosol radiative effects induced by black carbon (BC) or other aerosol components could stabilize boundary layer and thus reduce the height of boundary layer, tending to exacerbate aerosol pollution near ground (Wang et al., Atmos. Environ. 81, 713, 2013). A particular important aspect is the aging of BC, which considerably enhances light absorption (Khalizov et al., J. Phys. Chem. 113, 1066, 2009; Peng et al., Proc. Natl. Acad. Sci. USA 113, 4266, 2016). 4. It would also be necessary to mention the potential impacts of climate changes on pollution conditions in China (Wu et al., Sci. China: Earth Sci. 59, 1–16, 2016). Minor points: As indicated in lines 81-84, the impacts of ASM on the air pollution over Northern China varies with the intensity of ASM. A case study on one-year monsoon season (May 2015) as reported in this work may not represent the various response under different ASM conditions. In addition to carry on more ASM episodes in future, how strong is the ASM season in this work relative to other years and/or the normal situation? A more detailed description of the strength of the simulated ASM will help us to evaluate the uncertainty range of the results in this study. It is good that the authors discuss the relative contribution of North China Plain to its surrounding regions in Figures 10 and 12, could the authors also provide the mean values of the contributions percentages in Tables 2 and 3? Also, please state the contribution percentages in the abstract. If available, could the authors add the uncertainty in the two tables and discuss it in the body text? In lines 221-222, the work by Wang et al. (PNAS, 20016) is relevant, which has documented the possible efficient SO2 conversion pathway with assistant of NO2 in aqueous phase. Regarding the uncertainties from meteorological fields as mentioned in line 335, how do the simulations perform in predicting the regular meteorological parameters, such as temperature, wind speed, and so on, comparing to observations? In section 3.3 lines 259-260, the authors mentioned that the simulations can be used for evaluating the interactions of the two emissions (i.e., with NCP emissions only and with non-NCP emissions only), but there are no discussions about the interactions in the remaining part of the manuscript. It is interesting to know how possible the non-NCP emissions affect NCP. Could the authors show some results about the interactions of the emissions from the two regions?

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