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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of atmospheric circulations on the interannual variation in $PM_{2.5}$ concentrations over the Beijing-Tianjin-Hebei region in 2013–2018" *by* Xiaoyan Wang and Renhe Zhang

Anonymous Referee #2

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This study makes a full investigation about the effects of atmospheric circulations on the interannual variation of PM2.5 over the Jing-Jin-Ji region, which is interesting and valuable to both science community and the society. It defines six types of atmospheric circulations and reveals their roles (favor or unfavor) to the PM2.5 concentration. In principle, the paper is a good contribution to the science community and worthy for publication after a minor revision as suggested below.

General Comments (1)It is always a puzzle regarding the relative contribution from emissions, meteorology, climate and topography to the aerosols observed. The authors

found the results in Line 365-375, regarding which I have two questions here. The first one, also the most important one, the relative contribution from meteorological contribution found here is ∼37% for most stations, which is much higher than the values found by other studies (∼10%), then why? May you please give an explanation? The second one, with the same emission map, the decrease of PM2.5 from simulations between 2017 and 2016 is larger than that from observation, which seems to me that it implies more emissions in 2017 than in 2016. Is this true or possible? (2)Another thing is that the aerosol pollution is often coupled with the meteorology, causing non-linear relationships between aerosol pollution and meteorology or aerosol emissions. In other words, the relative contribution from both factors could vary with the air pollution cases. How could you account for this coupled effect?

Detailed Comments Line 17 and 43, full spell should be provided for PM2.5 when first used. Line 44-47, regarding the aerosol effect on climate by changing the surface radiation balance, four more references are recommended, Garrett and Zhao (2006, DOI: 10.1038/nature04636) and Zhao and Garrett (2015, doi:10.1002/2014GL062015) showed the aerosol's strong warming effect in the winter Arctic through increasing cloud thermal emissivity; Zhao et al. (2020, https://doi.org/10.1093/nsr/nwz184) showed the impacts of aerosols on the weather and climate by changing the radiation over the Tibetan Plateau; and Yang et al. (2018, DOI: 10.1016/j.atmosres.2018.04.029) showed the cooling effect of aerosols to Hongkong region climate during past 30 years. Line 47, "pollutions" -> "Pollution" Line 42, "air quality" -> "the air quality" Line 51-52, you may change the second "strengthening" to "improving" Line 64-67, One more reference could be also cited, which show significant improvement of air quality in five typical cities in China during recent several years, along with detailed discussions about the potential reasons for pollutions in these cities, Zhang et al. (2019, https://doi.org/10.1007/s13143-019-00125-w). Line 69-72, these are true, which also include the dilution due to increasing the planetary boundary layer (Yang et al., 2016, doi:10.1002/2015JD024645), exchange of polluted and clean air, and hygroscopic growth of aerosols (Sun et al., 2019, DOI: 10.1029/2019EA000717;

Zhao et al. 2018, https://doi.org/10.1007/s00376-017-7069-3). Moreover, Garrett et al. (2010, https://doi.org/10.1111/j.1600-0889.2010.00453.x) demonstrates the importance of long-range transport and wet scavenging to the aerosol amount in the Arctic; Sun et al. (2019) showed the relative roles of wet scavenging and hygroscopic growth the aerosols in Beijing, and Zhao et al. (2018) showed the fast growth of fine aerosols particles in Beijing. Line 72-76, regarding the climate signals, this is important. One thing I am not sure is how to differ this with short-term meteorological influence. The other is that Chen et al. (2019, https://doi.org/10.1007/s00382-019-04706-3) suggested that the Arctic warming have a strong tele-connection with mid-latitude air pollution (aerosol amount). For example, an increase in Arctic surface temperature in summer is associated with enhanced air pollution in Asia in winter. Line 80, "contribution to" -> "contribution from" Line 106-108, since you are focusing on the winter time PM2.5 mass concentration over the BTH region, I would suggest to add a short paragraph to describe the wintertime PM2.5 pollution over the BTH region in the introduction part. Line 115, the region is also defined in Figure 2, why not using Figure 2? Line 116-117, Does this imply that the daily data is set as missing when the missing data is more than 40% in a day? Line 119-120, what do you mean "nonlinear methods" here? Line 125, "Zhang et al. (Zhang et al., 2012)" -> "Zhang et al. (2012)" Line 126-127, what do COST and PM mean here? Line 139, NCEP FNL should be fully spelled when first used. Line 151-153, This is true. However, it just represents one case with different meteorology (2016 vs 2017). You may add one sentence to assume that this result is used to represent the typical value of meteorological contribution to PM2.5 concentration. Line 157-158, Why do you use so long time to spin-up (15 days)? May you please briefly explain? Line 163, "Dominate" -> "Dominant" Line 177-178, "the accumulate" -> "accumulate". In other word, remove "the". Line 273, "in the last section": do you mean "this section"? Line 299-301, delete either "although" or "but" Line 311-313, "when the favorable circulation duration shorter . . ." -> "when the favorable circulation duration is shorter . . ." Line 365-375, I have two questions here. The first one, also the most important one, the relative contribution from meteorological

contribution found here is $\sim$37% for most stations, which is much higher than the values found by other studies ($\sim$10%), then why? May you please give an explanation? The second one, with the same emission map, the decrease of PM2.5 from simulations between 2017 and 2016 is larger than that from observation, which seems to me that it implies more emissions in 2017 than in 2016. Is this true or possible? Line 403-404, I would suggest "The 2020 is the key and target year for the three-year action to win the battle for a blue sky goal set in 2018".

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