Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-966-RC1, 2020

Atmospheric Chemistry and Physics
Discussions

Interactive comment on "The haze pollution under strong atmospheric oxidization capacity in summer in Beijing: Insights into the formation mechanism of atmospheric physicochemical process" *by* Dandan Zhao et al.

Anonymous Referee #3

Received and published: 21 January 2020

This study of haze pollution during summer in Beijing, as shown in this paper, provides the synergistic effect of physico-chemical processes in the atmospheric boundary layer (ABL). The seriously polluted surrounding areas of Beijing in the South/Southwest are generally 60 up to 300 km away from Beijing. Beijing can be in contrast clean. Southerly winds of more than 20 up to 30 km h-1 during early morning transport these pollutants to Beijing and initiate primarily the haze formation. During daytime the PM2.5 level increases to 75 μg m-3 during several hours in Beijing, supported by a simultaneously stable ABL structure. Additionally, the O3 concentration is quite high at daytime

(250 μg m-3), showing a strong atmospheric oxidation capacity. Significant sulfate and nitrate concentrations are formed through atmospheric chemical processes with a sulfur oxidation ratio (SOR) up to 0.76 and a nitrogen oxidation ratio (NOR) which increases from 0.09 to 0.26 so that the particulate matter (PM) concentration level is rising further. Even so, the increase in sulfate is mainly linked to southerly transport. During night the PM2.5 concentration is sharply increasing from 75 μg m-3 up to 150 μg m-3 during 4 hours and persists at that high level until the next morning. With simultaneous extremely stable ABL structure the formation of secondary aerosols which is dominated by nitrate is quite intense, so that this configuration is driving the outbreak of a haze pollution. In that case the PM concentration levels in the South/Southeast of Beijing are significantly lower than in Beijing, even below air quality standards, because the contribution of pollution transport is almost neglectable. Corresponding to the formation of a nocturnal stable boundary layer height at lower than 0.3 km, the extremely low turbulence kinetic energy (TKE) of up to 0.05 m2 s-2 inhibits the spread of particles and moisture and causes elevated levels of PM2.5 and relative humidity (about 90 %) near to the surface. Under quite high humidity and strong ambient oxidization capacity, the NOR rapidly increases from 0.26 to 0.60 and heterogeneous hydrolysis reactions at the wet particle surface are very significant. The nitrate concentration explosively increases from 11.6 μg m-3 up to 57.8 μg m-3, while the concentrations of sulfate and organics slightly increase by 6.1 μg m-3 and 3.1 μg m-3, respectively. With clean and strong winds passing over Beijing, the stable ABL is broken with potential temperature gradients turning to negative values and ABL heights increasing to about 2.5 km. The strong turbulence activity caused by TKE values of 3 up to 5 m2 s-2 notably supports the pollution diffusion. So, the self-cleaning capacity of the atmosphere is always responsible for the dispersion of air pollution. Even so, the reduction of atmospheric oxidization capacity by strengthening the collaborative decrease of nitrogen oxide (NOx) and volatile organic compounds (VOCs) emissions is urgent as well as the continuous regional joint decrease of air pollutant emissions. General comments This study shows the complexity of haze formation processes due to coupling of transport, turbulence,

stability of the lower atmosphere as well as chemical reaction. The central rule of atmospheric oxidization capacity is found and their influence upon the haze generation is described. The new results of this study are well described and discussed in relation to the state-of-the-art research of haze formation. It would be helpful for the whole understanding of haze in Beijing if the influence of haze upon the radiation transfer in the atmosphere and thus the transport, turbulence and stability, which is mentioned in the introduction, or one can say the self-cleaning capacity of the atmosphere (that means feedback mechanisms) is described also. It is shown in Fig. 9 only. The conclusions are a summary only and in this summary no relations to the existing knowledge / papers are given. Thus, a discussion of the results in relation of the state-of-the-art knowledge about summer haze in Beijing is required so that one can follow what is new and what is supported by this study. The conclusions in the last sentence of the abstract must be given and discussed in the chapter conclusions. The paper addresses relevant scientific questions within the scope of ACP. The paper presents novel concepts, ideas, tools and data. The scientific methods and assumptions are valid and clearly outlined so that substantial conclusions are reached. The description of experiments and calculations allow their reproduction by fellow scientists. The results are sufficient to support the interpretations and conclusions. The quality of the figures is good. The figure captions should be improved so that these are understandable without the overall manuscript: terms must be explained, description of parameters. The related work is well cited so that the authors give proper credit to related work and own new contribution. The title reflects the whole content of the paper. The abstract provides a concise and complete summary. The overall presentation is well structured and clear. The language is fluent and precise but must be improved in very much details. It is necessary that a native speaker is improving the manuscript. The mathematical formulae, symbols, abbreviations, and units are generally correctly defined and used. No parts of the paper (text, formulae, figures, tables) should be reduced, combined, or eliminated. The number and quality of references is appropriate. Specific Comments Figure caption 1: Set the letters a) – f) to the single instruments. Line 581: Why diffusion stage if wind increased

(line 589)? Use Dispersion stage? Technical corrections Line 727, 873: doi number is missing. Lines 770, 772: the reference is incomplete. Lines 856, 858, 859: improve the format.

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