Interactive comment on “Nitrate transboundary heavy pollution over East Asia in winter” by Syuichi Itahashi.

This study analyzed two episodes (characterized as type N and type S according to the dominant compositions) with the high PM2.5 concentrations reaching around 100 μg/m3 during an intensive observation campaign in January 2015 at Fukuoka in western Japan. Several ground-based measurements and the CMAQ model as well as the path analysis of HYSPLIT model have been utilized to investigate the transboundary air pollution for both types. Authors addressed their results with the comprehensive methods and proved the importance of the transboundary air pollution dominated by NO3-, which will help refine our understanding of the transboundary heavy PM2.5 pollution in winter over East Asia. However, there are several rooms the paper can be much improved scientifically, such as the non-linearity effects of the sensitivity simulation to the secondary pollutions and the explanation of high speed of transboundary air pollution. If we take the 1000 km distance between coastline of China and western Japan, which is assumed by the authors, the transport of air mass speed will be almost 15 m/s while the traveling time is 18h. Is this reasonable for the wind speed reaching so high during the observation period? Overall, this is a nice piece of paper with clear objectives and methods and will provide valuable results. I recommended it for publication in Atmospheric Environment after minor revisions. Some comments and suggestions are listed as follows:

1. On Page 3, Line15. Observation and model simulation section. Authors should introduce their dealing methods for the different data. For example, the chemical compositions of aerosols measured by ACSA-12 and Denuder-filter pack method are 1 hour and 6-8 h, respectively. For CMAQ model, it is the hourly results. So, how could authors get the statistical parameters like R, MFE?

2. On Page 6, Line12. Authors introduced the emission settings in the model simulation. They assumed the emissions in 2008 are similar with that in 2015. Although they issued the NO2 column in China from satellite observation is similar to those for 2009, the SO2 is complicated. How is the picture for SO2 emission? And How about the VOCs? At least, the emission amount for the primary air pollutants between China, Korea and Japan should be listed out.

3. On Page 7, Line3. "Because the amount of emissions from China is larger than that from Japan, to avoid large nonlinearities in the atmospheric concentration response to emissions variation (e.g., Itahashi et al., 2015), the sensitivity simulation was designed to switch off the anthropogenic emissions in Japan." Why the anthropogenic emissions in Japan be switched off could avoid the nonlinearities? What is the amount of the anthropogenic emissions taken up in Japan, and how about the other sources, like biogenic and agriculture? Because, based on the previous study, the emission cut by 20-30% may decrease the nonlinearities in maximum in the sensitivity simulation.

4. On Page 7, Line9. It seems that Fig 2. should be Fig 4. and same as that Fig. 2a to Fig 4a.

5. On Page 7, Line20. Temporal variation of particulate matter. Authors presented very good simulation of particulate matters as well as their compositions in Japan and China during the period. It is curious to me, during the type N and type S episodes, the simulated wind speed is much higher than the observations, how the air pollution simulated well?

6. On Page 8, Line10. "therefore, the transboundary air pollution was dominant during January 2015". First, similar as the above mentioned how the authors delimited the non-linearities just from switch off the anthropogenic emission in Japan? Second, how about the anthropogenic emission take up in the whole emission in Japan, what about the biogenic, such as ocean sources?

7. On Page 10, Line14. "Based on the model results, because the domestic contribution for HNO3 was observed on January 14". It is confused to me that HNO3 was observed since this the model results.

8. On Page 10, Line23. BC section. BC is over estimated during both type N and type S episodes, while SO42- and NH4+ is underestimated. Can the authors explain this? Since in the following sections, "the rates of decrease of total sulfate, total nitrate, and total ammonia were generally consistent with the rates of decrease of normalized BC and CO." (On page 14, Line 26), and "For SO42-, the concentration was higher when the air mass arrived at Fukuoka compared with that in China, suggesting

the fast production of SO42- during the transport process." (On page 12, Line 3), if the BC is over estimated, the SO42- should be more overestimated. One exceptions, the BC or the transboundary has been overestimated in China.

9. On Page 11, Line25. "The traveling time from the coast of China to Fukuoka was about 18 h." As it is mentioned above, the traveling speed will be reached at 15 m/s, which means the wind speed should be 15 m/s. Is this reasonable? From the observations of meteorological conditions in Fukuoka, during the two episodes, the wind speed is 5-8 m/s, which is significant slow than 15 m/s.