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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Analysis of a winter regional haze event and its formation mechanism in the North China Plain" *by* X. J. Zhao et al.

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Reviewer: In this paper, the characters and formation mechanisms of the haze episode occurring in Beijing and surrounding areas from 16 to 19 January 2010 were investigated by analyzing the meteorological conditions, chemical and optical properties of aerosols. Some interesting results were obtained and the descriptions were detailed in the paper. Still, some improvements are needed before this paper can be fully accepted for publication. Response: Thanks for the positive comments. Reviewer: 1. Much aerosol and trace gas data was used in the analysis. However, it would be better if more detailed descriptions about the data quality control were given in Section2. Response: Thanks for the reviewer's suggestion. The data quality control is introduced as following: All instruments at each site are housed in an air-conditioned room with a rel-

atively constant temperature. The TEOM instrument is operated with an hydrophobic filter material to reduce the humidity of the incoming sampled air. The sample stream is preheated to 50oC before entering the mass transducer, and hence semi-volatiles such as ammonium nitrate and water are not measured. The filter loading percentage and flow rates of TEOM are checked once a week, and the filter is replaced when the filter loading percentage is greater than 30%. The averaging time was set to 5 min, and subsequently processed to hourly means in this study. For gas measurement instruments, daily zero/span checks are automatically done using a dynamic gas calibrator (TE 146C) in combination with a zero air supply (TE111) and a set of standard reference gas mixtures (Chemical Metrology & Analytical Science Division, National Institute of Metrology, Beijing, China). Multipoint calibrations are made every 3–6months. For ozone, the standards are traceable to the Standard Reference Photometer (SRP) maintained by WMO World Calibration Centre in Switzerland (EMPA). The national standard gases of SO2, NO, and CO are compared against NIST-traceable standards from Scott Specialty Gases, USA. After the correction of data on the basis of multipoint calibration, hourly average data are calculated and are used for further analysis in this study. Reviewer: 2. In section2.4, meteorological data description should be more detailed. Response: More information about the meteorological data was added as following: The hourly meteorological data, wind direction, wind speed, relative humidity (RH), temperature and pressure were measured with an Automatic Weather Station installed at the SDZ meteorological Station. Wind parameters are observed at 10 m height, while temperature, pressure and moisture information are collected at 1.5m height. In Beijing urban area, the wind profile with time resolution 5min was observed with a boundary layer wind profile lidar located at the Haidian meteorology station, approximately 4 km to the north of BJ site. The profile's range is 3500m with 50m vertical resolution. The radiosonde data of Beijing meteorological station (54511) was used to analyze the vertical structure of temperature in this work. Reviewer: 3. The comparisons of aerosol optical parameters between the urban observation site and Shangdianzi should be added in section 3.2 in order to reflect the regional characters of

aerosol extinction effect during the haze process. Response: Thanks for the reviewer's good suggestion. But unfortunately the measurement of aerosol optical properties was absent in urban area during the study period. With reference to our previous results (Zhao et al., 2011), the aerosol scattering coefficient should be higher in urban area than SDZ due to its higher PM2.5 loading. Reviewer: 4. In section 3.3, the chemical characteristics of Chengde (CD) was deferent from the other three other stations. The author should explain the reason. Whether it was caused by different sources in deferent areas of Hebei province? Response: It's true that emission sources are different in CD from those in the cities in the North China Plain. The results in our another study indicated that the PM2.5 pollution was dominated by coal combustion in Shijiazhuang and Chengde. Motor vehicle exhausts and coal combustion emissions both played important role in Tianjin PM2.5 pollution. However, motor vehicle exhausts had played more important role in Beijing owing to the reduction of coal consumption and sharply increase of cars in recent years. The typical characteristics of species in PM2.5 is the higher loading of POM at CD than that at other three sites, which should be attributed to the coal combustion in this city (Zhao, et al., Atmos. Chem. Phys. Discuss., 13,863–901, 2013,www.atmos-chem-phys-discuss.net/13/863/2013/, doi:10.5194/acpd-13-863- 2013). Furthermore, the different emission sources in these cities caused the different chemical characteristics of PM2.5 during haze period, which will be discussed in the following in the response for the question 6. Reviewer: 5. In line 12 of section 2.1.3, "in previously" should be written as "previously" or "in previous study ". Response: In the revised version, we use "previously" in this sentence as reviewer's suggestion.

Reviewer: 6. The regional haze phenomena and observation data were described in detail from several aspects such as meteorological factors, chemical and optical properties of aerosols, but the analysis about the mechanism of the haze formation need be deep. Response: As the reviewer's suggestion, we analyzed the chemical formation mechanism of this haze episode further. The ratio of $SO4^{2-}$/NO3- has been used as an indicator of the relative importance of mobile versus stationary

sources of sulfur and nitrogen in the atmosphere. The ratio of $SO4^{2-}$/NO3- during the haze period was 1.65, 0.80, 0.61 and 1.10 at TJ, BJ, SDZ and CD, respectively. With comparison to the values 1.52, 1.10, 1.33 and 3.90 in normal days at these four sites, the ratio was slightly increased in TJ, decreased in BJ and SDZ, and significantly reduced in CD in haze days. The change of the ratio indicated that vehicle emissions became more important to form the haze episode in most area except of TJ. The lower $SO4^{2-}$/NO3- at BJ and SDZ in haze days further illustrated that the haze in Beijing area was mainly controlled by the vehicle emissions. Reviewer: 7. Recently, the regional haze event is not rare in China, especially in winter in north China. What is the difference of the main factors influencing the formation compared to the others such as haze occurring in other seasons? Response: We think the main difference is the change of emission and meteorological conditions. In general, the emission sources of particulate matters have evident seasonal variation especially in north China. In spring, the increasing dust events usually lead to haze pollution in regional scale (Huang et al., 2012). The emission from agricultural biomass burning in northern China is one contributor to the regional hazes in June (Li, et al., 2010). In winter, the increased emissions from heating sources enhance the loading of particulate matter in the atmosphere that contributes to the haze formation in some degree. In addition, stable weather condition occurs more frequently in autumn and winter in north China, which is unfavorable for the diffusion of pollution and is the main external cause of regional haze formation. The increased emissions in the winter accompanying unfavorable meteorological conditions caused the regional haze episode in this study. Reviewer: 8. What is the most important conditions influencing the formation of the regional haze in winter in North China? Some suggestions should be added in the discussion section. Response: The unfavorable meteorological condition was the external cause of this regional haze. However, the significant increases of pollutants at four sites including PM2.5 and gases during haze episode indicated that the growing anthropogenic emission in regional scale was the basic reason of the formation of regional haze. The control measures for ensuring air quality in megacity cluster should

be taken in region scale, and the government should pay more attention to the control of vehicle emission that increased sharply in recent years.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/13/C36/2013/acpd-13-C36-2013-supplement.pdf

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Interactive comment on Atmos. Chem. Phys. Discuss., 13, 903, 2013.