General Comments:

This is a good paper presenting results of aerosol optical properties and size distributions in one of the most polluted areas of the world. These measurements are important both for climate modeling and describing air quality in North China. Nowadays there are already fairly many papers published about similar measurements at relatively near-by sites, as also the authors refer to in section 4.1.1. In the present paper I didn't find much really new compared to those articles. I wish you could highlight the most important differences between your results and those presented in the above-mentioned papers, in addition to the different average absorption and scattering coefficients that you already mention. In any case, I do recommend the publication of this work in ACP, after some small revisions.

Response: Thanks for the comments. Two highlights are addressed in the text. One is that the measurements show that the pollutants transported from the southwest in the NCP is more significant than that from the two mega cities, Beijing and Tianjin for both spring and summer. The other one is that a detailed analysis for the uncertainties of the measurements was performed. We added a sentence in the abstract: "The pollutants transported from the southwest in the NCP are more significant than that from the two mega cities, Beijing and Tianjin in both spring and summer".

Detailed Comments:

Reviewer: *P.9571, L 6-7. Your "winter" campaign was from 6 March to 5 April. Don't you consider this spring? Doesn't the vegetation start producing secondary organic aerosol already in March at these latitudes? It starts in March even more norther. Ok, but this is not an important point, just consider it.*

Response: Thanks for this suggestion. As the reviewer pointed out, March is considered as early spring in China. All the "winter" in the paper has been replaced with "spring" or "early spring".

Reviewer: *P 9573, L7. You write "A Tandem Differential Mobility Particle Sizer (TDMPS, IfT, Leipzig, Germany) (Birmili et al., 1999) was used to..." Well, Birmili et al. talk about "Twin Differential Mobility Particle Sizer", not Tandem. The word "Tandem" is in a way reserved for using for instance with VTDMA and HTDMA.*

Response: This is a typo. "A Tandem Differential Mobility Particle Sizer" has been replaced with "A Twin Differential Mobility Particle Sizer".

Reviewer: *P9573, L10-12, You write about combining the DMPS and the APS data. How did you deal with the overlapping range? How about converting aerodynamic diameters to mobility diameters: what density did you use and based on what?*

Response: Based on previous measurements of chemical particle composition at Beijing, Wehner et al. (2008) used a density of 1.7 gcm^{-3} to convert the aerodynamic diameters to mobility diameters for APS data. Since we have no directly measurement of the aerosol density, the same value was assumed in this paper. To make clear of this, the sentence "Electrical mobility diameters measured by TDMPS and aerodynamic diameters measured by APS were converted to volume equivalent diameter (DeCarlo et al., 2004)" has been replaced with "Electrical mobility diameters measured by TDMPS and aerodynamic diameters measured by APS were converted to volume equivalent diameter (DeCarlo et al., 2004), using a particle density of 1.7 gcm^{-3} for the particles

larger than 800 nm as a mean density for the coarse mode (Wehner et al., 2008)".
We chose TDMPS data for the overlapping range of TDMPS and APS data, since TDMPS was more reliable in this size range (400 nm – 800 nm).

Reference:

Wehner, B., Birmili, W., Ditas, F., Wu, Z., Hu, M., Liu, X., Mao, J., Sugimoto, N. and Wiedensohler, A.: Relationships between submicrometer particulate air pollution and air mass history in Beijing, China, 2004–2006, Atmos. Chem. Phys., 8, 6155–6168, 2008

Reviewer: *P9754,L6-7 "To obtain the size-resolved volume fraction of BC, the BC mass size distribution observed in CAREBeijing (Cheng et al., 2009) was used in this study." This is fine. But did you use just one size distribution, in Cheng's paper the BC size distributions varied. And to help the reader of the present paper, I hope you would give also some actual numbers describing the BC size distribution, for example mode diameter and mode width, size range, or some other concrete measures of the size distribution.*

Response: Yes, we used the average BC size distribution reported by Cheng et al. (2009). In fact, we have tried several types of BC size distribution. It was found that the calculated aerosol optical properties were not sensitive to the types of BC size distribution. Therefore the average BC size distribution was applied. As recommended by the reviewer, the sentences "To obtain the size-resolved volume fraction of BC, the BC mass size distribution…. Thus, the BC mass size distribution normalized by the total mass concentration in Wuqing is assumed to be the same as the average one in Yufa." has been replaced with "To obtain the size-resolved volume fraction of BC, the average BC mass size distribution…. Thus, the BC mass size distribution normalized by the total mass concentration in Wuqing is assumed to be the same as the average one in Yufa, which distributes as a quasi-log-normal distribution with the geometric mean diameter of 114 nm and the standard deviation of 2.12.".

Reference:

Cheng, Y. F., Berghof, M., Garland, R. M., Wiedensohler, A., Wehner, B., Müller, T., Su, H., Zhang, Y. H., Achtert, P., Nowak, A., Pöschl, U., Zhu, T., Hu, M., Zeng, L. M.: Influence of soot mixing state on aerosol light absorption and single scattering albedo during air mass aging at a polluted regional site in northeastern China, J. Geophys. Res., 114, D00G10, doi: 10.1029/2008JD010883, 2009.

Reviewer: *P9577, L13. What is SDZ? You don't define it anywhere.*

Response: SDZ is the abbreviation of Shangdianzi regional background station. The full name has been added in the paper when SDZ is mentioned at the first time.

Reviewer: *P9578, L5-6. " ... a wavelength correction for aerosol absorption is applied to the measured absorption coefficient using an empirical approach, ... with the absorption exponent = 1 ... (Bodhaine, 1995)." This is the only somewhat serious point about this paper, and the correction requires some extra work. Qualitatively your results will remain the same, just the numbers change. The point is that the Ångström exponent of absorption varies quite a lot, depending on the source of soot. The paper of Bodhaine deals with aerosol measurements at real background sites, very different from yours. At your site I am sure there are many different sources: open biomass burning, coal combustion, diesel engines etc. that all produce soot with different*

wavelength dependency of absorption. Now you are "extrapolating" from one wavelength, 637 nm to 550 nm, which is a long wavelength interval. This creates quite a lot of uncertainty to your results. So, I suggest you interpolate your scattering coefficients to 637 and present all SSA results at that wavelength. The uncertainty would definitely be smaller.

Response: Thanks for this valuable comments and suggestions. As advised by the reviewer, all the SSA was presented at wavelength of 637 nm instead of 550 nm in this paper. The sentence "To calculate ω, a wavelength correction for aerosol absorption is applied to the measured σ_{ap} using an empirical approach, $\sigma_{ap} \propto \lambda^{\beta}$, with the absorption exponent β=1 (wavelength λ in the interval 0.45–0.70 μm) (Bodhaine, 1995)" has been replaced with "To calculate ω at the wavelength of 637 nm, a wavelength correction is applied to the measured σ_{sp} using an empirical approach, $\sigma_{sp} \propto \lambda^{\alpha}$. The Ångström exponent (α) is yielding from the measured σ_{sp} at the wavelength of 550 nm and 700 nm." All the corresponding tables and figures have been also updated with the new values.

Reviewer: *P9579 L9. Here you mention the "calm winds" for the first time. How do you define that? Is that for example v < 1 m/s or what?*

Response: "calm winds" in this paper is defined as wind with speed smaller than 2 ms^{-1}. The sentence "In spring, the maximum σ_{sp} and σ_{ap} occur with calm winds, independent on wind directions." has been replaced with "In spring, the maximum σ_{sp} and σ_{ap} occur with calm winds (wind speed<2 ms^{-1}), independent on wind directions.".

Reviewer: *P9583. L14-19. "It should be noticed that only a small part of the measured data is in the range of the corresponding calculated values for internal and external mixture, as shown in Table 3. The ratios of measured data that enclosed by the calculated values are low, varying from 1.6% to 84.4% for different wavelengths and parameters." I don't understand these sentences at all. And I don't understand Table 3 at all either. You are talking about ratios. Ratio is something devided by something else, for example the ratio of A to B is A/B. What are you dividing by what to get Table 3? And what do you mean by "enclosing"? I don't want to be picky, I just don't understand. Please clarify the text and the caption.*

Response: Thanks for the comments. We have rephrased this paragraph as "It should be noticed that only a small part of the nephelometer-measured σ_{sp} and σ_{bsp} fall within the range of the corresponding calculated values based on the assumptions of internal and external mixture. Table 3 shows the ratios of the amount of measured σ_{sp} and σ_{bsp} that fall within the two calculated values to the total amount of the measured σ_{sp} and σ_{bsp}. Most of the ratios are low, varying from 1.6% to 84.4% for different wavelengths and parameters". We also have rephrased the title of Table 3 as "The ratios of the amount of nephelometer-measured σ_{sp} that fall within the range of the corresponding calculated values based on the assumptions of internal and external mixture to the total amount of the measured σ_{sp}".

Reviewer: *P9599, Table 6. Here is the same problem as in my previous question. The table title is "Ratios of …" What is divided by what? A ratio equals division. Please clarify the caption and also the associated text on P9585 L15-18.*

Response: Thanks for the comments. The two correlating paragraph has been rephrased as "Comparisons similar to those described in section 4.2.1 are carried out for the measured and calculated values, taking into account the uncertainties of the parameters. For the σ_{sp} and σ_{bsp}, the calculated value with assumption of external mixture plus triple standard deviation and the calculated value with assumption of internal mixture minus triple standard deviation are defined as the boundary of the possible range within which the measured values should be fall.

Table 6 displays the ratio of the amount of measured σ_{sp} and σ_{bsp} which fall within the possible range to the total amount of measured σ_{sp} and σ_{bsp}. For all the three wavelengths, more than 97% of the measured σ_{sp} falls within the possible range of Mie calculations for both spring and summer. For σ_{bsp}, the ratios of points that fall within the possible range are lower than those for σ_{sp}. More than 90% points are satisfied.".

We also have rephrased the title of Table 6 as "The ratios of the amount of nephelometer-measured σ_{sp} and σ_{bsp} fall within the range of the corresponding calculated values based on the assumptions of internal and external mixture to the total amount of the measured values, considering the uncertainties of the calculations".

Reviewer: *P9602, Fig 3. The subplots have quite a lot of information, in my opinion too much. I think it would make sense to separate the wind frequency distribution as two separate subplots. Then the other thing about this plot is the dash-dot lines, which stand for average values in each direction: I don't see any scales for them. What is the "ten to the power m/s" in each subplot?*

Response: Thanks for the suggestion. The wind frequency distribution has been separated as subplots. The "ten to the power m/s" has been corrected as "10 m/s". In each subplot, the radial direction relate to the wind speed at which the average of variables (shaded contour) is. Wind speeds are shown from 0 (inner circle) to 10ms^{-1} (outer circle). And the dash-dot lines stand for the relative mean values at each wind direction. The caption of Fig. 3 has been revised as "Wind speed and direction dependence map of σ_{sp} (B, F), σ_{ap} (C, G) and ω (D, H), as well as wind rose (A, E). The upper fours pictures are for spring and the lower ones are for summer. In each picture, the shaded contour indicates the average of variables for varying wind speeds (radial direction) and wind directions (transverse direction). The dash-dot lines stand for the relative mean values at each wind direction". Also, corresponding corrections has been made in section 4.1.2.

Reviewer: *Finally: why don't you present also mass scattering and absorption efficiencies?*

Response: Thanks for this suggestion. We have considered about this. Since the aerosol chemical composition data from BernerImpactor is still in data processing, we do not have the directly measuring of aerosol mass concentration. The calculation of the aerosol mass concentration from measured PNSD needs a reliable estimation of the aerosol density, thus the scattering mass efficiency and absorption mass efficiency depend on the density of aerosol which we use. There will be large uncertainties for the calculated scattering and absorption efficiencies using assumed density of aerosol, so we decided not to present them in this paper.