

Interactive comment on “Characterization of aerosol hygroscopicity, mixing state, and CCN activity at a suburban site in the central North China Plain” by Yuying Wang et al.

Anonymous Referee #1

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Based on a field campaign conducted in Xingtai in the central North China Plain, the authors discussed about the chemical composition, hygroscopicity and CCN activity of aerosol particles. There have been a number of studies talked about the north part of NCP but very few about the central part. And it was found that aerosol mixing state and hygroscopicity in Xingtai largely differs from that in the north part of NCP. My major concerns are:

1) Xingtai locates at the western boundary of NCP and is heavily affected by the mountain-valley wind (L126). Can the measurement well represent the background aerosol in the central NCP?

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2) I did not find a strong connection between the sections of CCN (section 4.3.3 and 4.4) and HTDMA (section 4.1 to 4.3.2). They look like two independent works but each of them a too weak to be an individual study.

Specific comments:

L51: defined as the mixture of solid and liquid particles suspended in air,

L79: I did not see any causal relationship between L72-78 and L79-81

L113: the author need to give more detailed information of the station. Does it locate in urban, sub-urban or rural environment? What about the surroundings, any roads, industrial or residential activities nearby?

L114: how do the authors define the NCP? From the map in Fig. 1 it seems the station locates at the southern boundary of the plain. In L126 the authors also state the station is “heavily affected by the mountain-valley wind”.

L138: are then passed – pass

L144: Normally the RH of the HTDMA should be calibrated with ammonium sulfate, especially for high RH measurement. Did the authors calibrate the system during the campaign?

L147: I suggest to use single letter for variables, for example, f_g for growth factor.

L154: An Aerosol Chemical. . .

L156: Is the cyclone for all the aerosol instruments or only for the ACSM?

L164: Is there a separate inlet line with PM1 size cut for the aethalometer? I think the authors need to give a clear description of the inlets and sampling line for all the instruments. Now I am a bit confused.

L181: I do not know why the SS needs to be corrected. Normally after applying the calibration parameters to the system, the set SS is the true effective SS in the chamber.

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No more correction is needed. Is the SS corrected with the first or second calibration result? Is there any large difference between the two calibrations?

L183: AR defined in the manuscript is determined both on chemical composition and PNSD. I suggest using critical diameter.

L235: I guess here the authors mean the kappa-Sc relationship.

L246: How do the authors define the mean diameter.

L261: Is there undefined species? Maybe the authors can do a simple mass closure between ACSM and SMPS data by assuming a typical aerosol density in that region, to check if there is anything missing in the aerosol mass defined by ACSM. This is important since the authors use this data later to estimate kappa.

L267: How did the authors assume the kappa for HOA, SOA and OOA?

L277: the hydrophobic mode locates at kappa of 0.05 for Dd of 40 nm, and shift towards 0 for large particles. Do the authors have any explanation on this?

L305: the difference decreases with increasing size because most of the larger particles are well aged.

L316: of precursors

L316: is there trace gas (SO₂, NO_x etc.) measurement during the campaign to support the hypothesis here?

L346: 100 nm is too much for nucleation mode.

L359: From Fig. 6 it seems kappa already starts decrease at 12:00. The secondary aerosol production is also active in the afternoon (Fig. 7b). Why does kappa for larger particles decrease?

L360: in Fig. 6c, kappa of larger particles also reaches ~0.4 around noon, which is also very close to that of pure AS. But from Fig. 6d we can see there is still a large

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fraction of hydrophobic and less-hygroscopic species.

L370: the growth of the newly formed particles is also driven by condensation of sulfate and organics.

L374: why does the PM1 composition differs largely from 40-200 nm particles? 200 nm is in the accumulation mode which is the main contributor of PM1 mass. So I would not expect a large difference between κ_{chem} and $\kappa_{\text{gf},200\text{nm}}$.

L387: Use critical diameter in stead of AR in this section.

L394: the number concentration of fine particles. . .

L400: I do not think one can get this conclusion based on the discussion in this section. The result is in consistent with it but can not directly prove it. Also I think the paper of Dusek et al., (2006) should be cited here. Dusek U, Frank G P, Hildebrandt L, et al. Size matters more than chemistry for cloud-nucleating ability of aerosol particles[J]. Science, 2006, 312(5778):1375.

L407: the critical diameters of aerosol for SS from 0.07% to 0.80% range from about 30 nm to 200 nm. As shown in Fig.6, there is a large difference between κ_{chem} and κ_{gf} and the authors claimed that PM1 composition “differ greatly from 40-200 nm particles” (L374). It means one can not use the PM1 composition in the CCN closure. I think a better way might be to compare the κ obtained from HTDMA and CCN measurements. Although some species may exhibit different κ in sub- and super-saturation, at least the two measurements are in the same size range.

L434: From this paragraph what I understand is, 0.31 is the average κ_{chem} and calculated Nccn is not sensitive on the variation of κ_{chem} . But how can you make sure that 0.31 is a good proxy for the calculation of Nccn in XT? You found some discrepancies between the calculated and measured Nccn and claimed that there are some biases in measured Nccn. So, there is no reference to check which κ value is appropriate. Normally, water depletion effect can be neglected if $N_{\text{ccn}} < 1e4$. Maybe

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you can try to do the fit for data points $<1e4$ and $>1e4$ separately.

L437: the sensitivity of Nccn on aerosol mixing state is not examined in this section.

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