Response to Reviewer#2

The authors kindly thank the reviewer for the careful review of the manuscript, and the helpful comments and suggestions, which improve the manuscript a lot. After reading the comments from the reviewer, we have carefully revised our manuscript. In the current version, we added more discussions into the text with one new text (Text S4), one new table (Table S2) and five new figures (Figure 5, Figure S1 and Figure S4-6). We highlighted all the revisions and changes in the manuscript and the supporting information with blue color. Our responses to the comments are itemized as below.

Comment:

Gas-to-particle partitioning of organics is a key process in secondary organic aerosol (SOA) formation. This manuscript presents field measurements of water-soluble organic carbon (WSOC) in both gas and particle phases, and investigates the characteristics of the particle-phase fraction (F_P), its potential formation processes, optical properties, and size distributions through case analyses. The authors suggest that physicochemical properties such as aerosol pH, aerosol liquid water content (ALWC), and particle composition play dominant roles in governing WSOC formation and Fp dynamics. The manuscript fits well within the scope of Atmospheric Chemistry and Physics (ACP), and the writing is generally clear. However, to support the conclusions more convincingly, the manuscript would benefit from a more thorough and quantitative discussion of the Fp dynamics, detailed analysis of WSOC measurements and chemical composition, more comprehensive characterization of particle size distributions, and improved evaluation of aerosol pH. Therefore, I recommend that the manuscript be reconsidered for publication after substantial revision and inclusion of the necessary details and discussions.

Reply: We sincerely appreciate the reviewer's valuable comments. We have carefully addressed all the concerns and thoroughly revised the manuscript accordingly. The key modifications include:

(1) We have added an in-depth discussion on how organic mass loading and particle

phase state influence WSOC partitioning.

(2) We further analyzed the partitioning behavior of organic acids on a molecular level in both HE and DS to provide a more comprehensive understanding on the key factors controlling WSOC partitioning on dust surface during a long-range transport and its impact on dust particle light absorption.

Detailed responses to each comment are provided below. All the revisions and changes in the manuscript and the supporting information are highlighted in blue color.

Major comments:

Comment:

1. The WSOC data are central to the conclusions of this manuscript. However, the authors only briefly cited previous literature to describe the measurement methods. Detailed descriptions of both the offline and online WSOC measurement techniques, including sampling protocols, instrument calibration, detection limits, and potential uncertainties, should be clearly provided. In addition, during dust events, the particle mass is primarily dominated by coarse-mode particles. It is unclear how the use of a 2.5 μm cutoff inlet ($PM_{2.5}$) can adequately represent the WSOC associated with dust particles. The authors should justify the representativeness of the $PM_{2.5}$ sampling approach for characterizing WSOC during dust episodes or provide supporting data to address this limitation.

Reply: We appreciate the reviewer's constructive feedback. In response, we have made the following revisions to address the comments:

(1) Methodological clarifications:

As suggested, we have expanded the description in Sections 2.1 and 2.2 to provide further details on the sampling methods, instrument calibration, detection limits, and potential uncertainties. These additions ensure greater transparency and reproducibility of our methodology. Please see pages 5-7, lines 98-107, 125-140 and 144-154.

(2) Analysis of WSOC partitioning during DS periods:

In Section 3.2, we observed enhanced WSOC partitioning in $PM_{2.5}$ during DS episodes. However, recognizing that atmospheric particles during DS events are predominantly coarse-mode, we acknowledged the limitation of focusing solely on fine particles. To comprehensively evaluate partitioning behavior and validate the Section 3.2 findings, we conducted additional size-segregated sampling and analysis (Section 3.3). The results confirm that WSOC partitioning is indeed amplified during DS periods, particularly in the coarse mode (see Figure S8).

Comment:

2.(1) The pH calculation is based on the ISORROPIA-II, but the basic evaluation of the predicted and observed parameters (such as NO_3^-, NH_3, etc) is not given, which is important for the model performance. (2) In addition, RH is less than 30% in dust haze, which would introduce much uncertainty for pH calculation. It caused the high pH, up to 7.5, and this value is stable. However, during high Ca^{2+}, indicator of dust episode, pH is comparable to haze and clean days. The more detailed discussion should be added to clarify this.

Reply: (1) We appreciate the reviewer's suggestion and have added the related points to the revised manuscript. Please see the page 7 lines 161-167.

"Figure S1 compares the concentrations of NH_3 and NO_3^- measured by the IGAC instrument with those predicted by ISORROPIA-II model. As shown in Figure S1, the predicted are very close to the measured, suggesting that the metastable mode we used can remarkably reproduce the measured and the model results including ALWC and acidity (pH) are reliable. It should be noted that the samples collected under RH > 95% conditions were excluded in this study, because RH > 95% conditions could increase ALWC and pH estimation uncertainties."

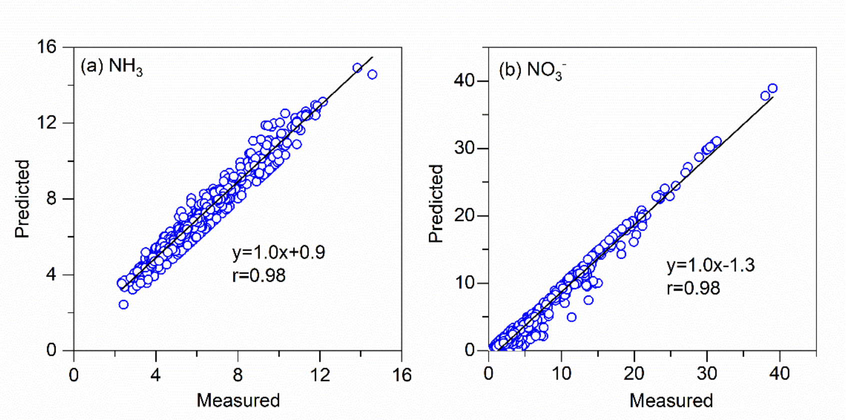

Figure S1. Comparison of measured ammonia and nitrate and predicted by ISORROPIA-II model.

(2) According Fountoukis and Nenes (2007), when the RH ranged between 0.2 and 0.8 at room temperature, the mass fraction of solute as predicted by ISORROPIA-II model agree well with the experimental measurements for a variety of equimolar mixtures of salts. (see section 4 and Fig.3 in Fountoukis and Nenes, 2007). In addition, the high pH value in DS is mainly related to the composition of the particles. As shown in Figure 1c, pH was gradually increased in the begin of DS and up to 7.5 during the stagnant period, then the value of pH at the end of DS gradually decreased and was comparable to those in HE and CP periods. This phenomenon indicates that the chemical species may be changed during dust particle transport. Figure R1 plots the equivalent ratios of total measured ions in $PM_{2.5}$ in DS period. The ratio of total measured anions to cations was close to unity in the dust storm begin period (the first day in DS) (Figure R1a). But the slope of regression line was only 0.49 (Figure R1b) in the dust stagnant period (the second day in DS), then the slope increased to 0.74 (Figure R1c) during the end of dust storm period (the third day in DS), indicating that particles in stagnant period were more basic. When crustal species are in excess compared to all the anions (such as dust storm samples in this study), ISORROPIA-II model assumes that a presence of excess carbonate in the aerosol phase and the solution is close to neutral (Fountoukis and Nenes, 2007). Thus, it caused the pH of particles was high and stable. The ratio of anions to cations was higher in the end period than in the stagnant period, indicating that more acids replaced CO_3^{2-} at the

dust particle surface during the dust storm long-range transport, which could reduce the basicity of dust particles.

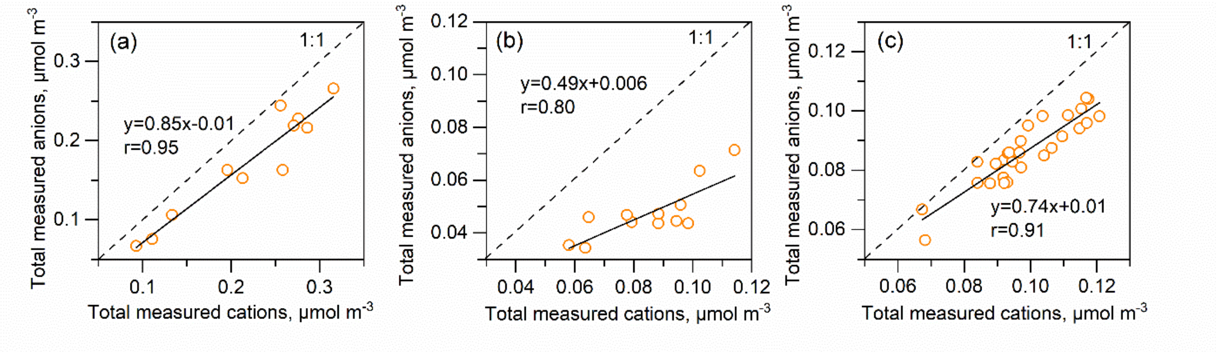

Figure R1. Correlations for cations and anions in $PM_{2.5}$ samples during (a) the begin, (b) the stagnant, and (c) the end period of dust storm. X axis represents the sum of measured Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}. Y axis represents the sum of total measured Cl^-, NO_3^- and SO_4^{2-}.

Comment:

3. During the chemical analysis, the organic acids, NACs and IMs are detected. However, the detailed discussion is not given, which is important for WSOC Fp and dynamic characteristics. The Fp and gas-to-particle partitioning (kp) depend on the chemical properties of organics, aerosol components, particle phase, etc. In this manuscript, the authors just discussed the influences of inorganic components. The driving impacts of organics and particle phase was not considered. It should be added.

Reply: Thanks for the comment. We added in-deep discussion on the formic and acetic acids partitioning in our revised manuscript, which are the most abundant organic acids in atmosphere. The F_p of IMs and NACs calculation requires its gaseous concentration. However, we cannot obtain the gas phase IMs and NACs concentrations due to the instrument limits. In section 3.3, we found that NACs can be formed through gas-to-particle partitioning at the coarse mode in DS and IMs can formed through heterogenous reactions at the coarse mode in DS. More discussion about the driving factors of WSOC F_p (such as organic mass loading and particle phase state) as shown in the latter and revised manuscript. We also analyzed the factors controlling the organic acids partitioning in DS. Please see pages 10-12, lines 244-281:

"To further analyze the factors controlling the WSOC partitioning, we investigated the partitioning process of formic and acetic acids, which are abundant species of WSOCs in the atmosphere (Table S2). As shown in Figure S4, F_p of formic and acetic acids in HE presented strong correlations with ALWC, pH and T. In DS, however, compared with ALWC and T, F_p of formic and acetic acids exhibited a stronger correlation with pH, further indicating that the partitioning of WSOC was more significantly affected by the particle acidity in the presence of dust storm.

Apart from the above factors that influence the F_p variations, aerosol mass loading may also affect the partitioning of WSOC (Lutz et al., 2019). According to the Raoult's law, the field gas-particle partitioning coefficient can be described as follows (Pankow, 1994):

$$K_i = \frac{i_{particle}}{i_{gas} M_{org}} \qquad (R1)$$

where K_i is the partitioning constant of i compound, $i_{particle/gas}$ are the particle and gas phase concentrations of compound i, and M_{org} is the concentration of aerosol organic mass ($WSOC_p$ are used here). In this section, our main focus is the F_p of WSOC in $PM_{2.5}$. Thus, i and M_{org} are the concentrations of formic and acetic acids and WSOC in $PM_{2.5}$. By definition, the K_i is governed by the organic aerosol mass loading. However, as shown in Figure S5, the partitioning constants (K_i) of formic and acetic acids did not correlate with $WSOC_p$ in both HE and DS periods, indicating that the effect of aerosol organic mass loading on the uptake of WSOC during the campaign was not significant. As shown in Table 1, the $PM_{2.5}$ and WSOC loadings in DS were comparable to those in HE, although PM_{10} loading was much higher in the dust storm period. Moreover, the pH (4.8 ± 1.5, Table 1) of $PM_{2.5}$ in DS was 1.4 units higher than that (3.4 ± 0.3) in HE, which means that H^+ concentration in DS was one order of magnitude lower than that in HE. According to the equations R2 and R3, the low H^+ concentration in DS was favorable for the organic acid equilibria shifting toward the aerosol aqueous phase. Thus, the impact of pH variation on F_p was much more significant than organic aerosol mass loading in DS, taking a key role in WSOC partitioning process during the dust storm event. Previous studies found that diffusivity of organics in particles strongly depends on the phase state of particles (Gkatzelis et al., 2021; Ma et al., 2022). Here we further investigated the impact of particle state on WSOC partitioning during the campaign by calculating the phase state of fine particles (see the detailed method in SI). As shown in Figure S6, fine aerosols were mainly in liquid state during the HE period and mainly in solid or semi-solid phase during the DS period. Thus, F_p linearly and negatively correlated with Tg/T along with an increasing ALWC in HE. However, such a trend was not observed in DS, again suggesting that the key factors controlling the gas-to-particle phase partitioning process of WSOC were different during the two particle pollution events, which was ALWC in HE and pH in DS, respectively.

$$\mathrm{RCOOH(g)} \longleftrightarrow \mathrm{RCOOH(aq)} \qquad \text{（R2）}$$

$$\mathrm{RCOOH(aq)} \longleftrightarrow \mathrm{RCOO^{-}(aq)} + \mathrm{H^{+}(aq)} \qquad \text{（R3）}$$

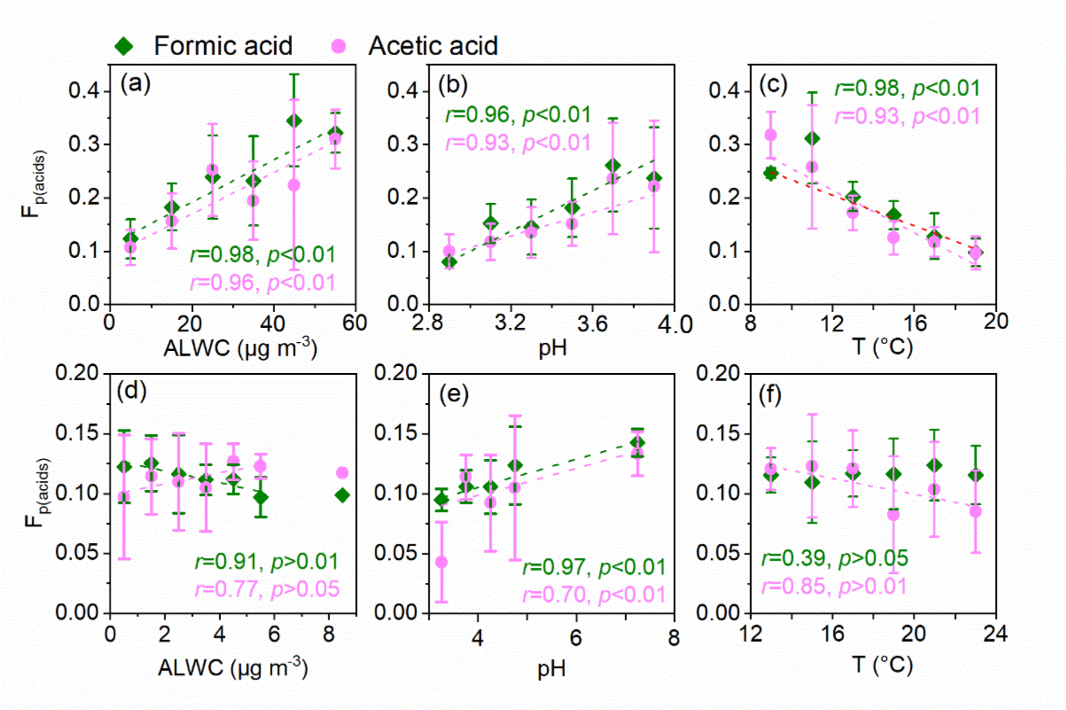

Figure S4. Factors affecting the gas-to-particle partitioning coefficients of formic and acetic acids in (a-c) HE and (d-f) DS periods in spring 2023 in Shanghai.

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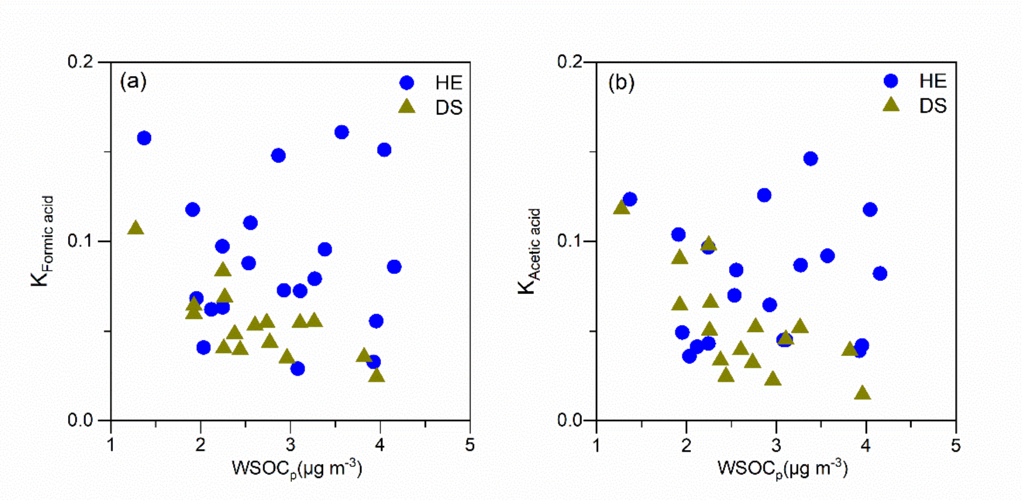

Figure S5. Partitioning coefficients of low molecular organic acids (formic and acetic acids) versus particle phase WSOC during HE and DS periods.

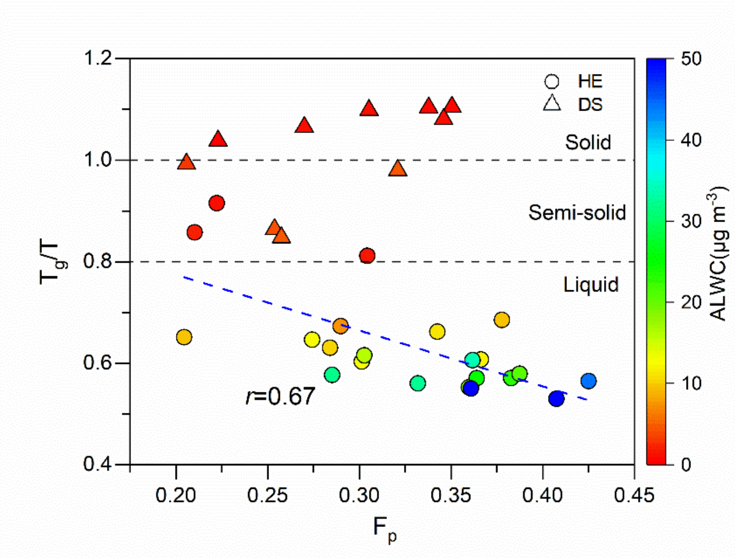

Figure S6. Particle-phase-state transition from solid to liquid particles compared to the partitioning coefficient of WSOC during HE and DS periods.

Comment:

4. The size distribution of WSOC, NACs, etc. have been discussed, but the measurement of size distribution was not given. It should be added.

Reply: Suggestion taken. In this study, the size-segregated samples were collected using a 9-stage Anderson sampling collector. In section 3.3 and 3.4, the discussion of chemical species was based on the size-segregated samples. We added the sampling methods, sampling instrument and chemical species analysis methods in section 2.1 in the revised manuscript, please see pages 5-7, lines 98-119 and lines 125-154.

Specific comments:

1. In the abstract, it mentioned the time resolution of WSOC is 1h, but it is 3h in the method. Please clarify it.

Reply: Thanks for the comment. In this study, online $PM_{2.5}$ WSOC samples were collected hourly. However, due to the instrument detection limits, three adjacent WSOC samples were merged to provide a large sample volume. Thus, the time resolution of gas and particle phase WSOC measurements were 3h. We revised this sentence in the abstract. Please see lines 25-29.

2. Line 62, the "NOx" should be replaced with "NO_x". Please checked all the upper and lower superscripts of the article.

Reply: Suggestion taken. We have revised the sentences according to the reviewer's comment and checked all the upper and lower superscripts of the article.

3. Line 153, the author stated a "significant formation of SNA". Once the term of significance was used, the statistical and significance analyses are necessary. Please add it. In addition, the Ca^{2+}, as the indicator of dust, peaked at a short time, indicating minor influence of dust, not lasting three days. Please clarify it.

Reply: Thanks for the comment. First, we conducted a significance analysis of the data (t test, $p<0.01$) and added the result into the revised manuscript. Please see page 8 line 188.

Second, on the third day (13 April) at DS, the ratio of $PM_{2.5}$ to PM_{10} was 0.15 ± 0.03, which was 0.18 times that of the HE (0.74 ± 0.17) and 0.29 times that of the CP (0.51 ± 0.14), indicating abundant coarse particles in the Shanghai atmosphere. Moreover, the relative contribution of Ca^{2+} to total water-soluble inorganic ions was 0.09 ± 0.03 on the third day, which was slight lower than the whole DS period value (0.14 ± 0.07), but was 18 times of that in HE (0.005 ± 0.003). Thus, based on the above discussion, we think that the impact of the DS on the 13 April in the Shanghai atmosphere still proceeded.

4. In lines157-168, the measured average WSOCp is about 2 μgC m^{-3}, but in Table 1 and 2, the total carbon of oxalic acid, Pyr, NACs and IMs are large than the average WSOCp. Please checked it.

Reply: Thanks for the comment. In the tables, the units of NACs and IMs are ng m^{-3}. Other organic acids concentration units are μg m^{-3}. In this study, the ratio of the sum of organic acids and IMs to WSOC was 6.2%.

5. In section 3.2, the author discussed driving factor of WSOC partitioning. In previous study (Ma et al 2022), it has reported that the particle phase would influence the OVOCs partitioning. For example, when ALWC was over 15 μg m^{-3}, as indicator of liquid phase for particles, it would weaken the gas-to-particle partitioning of OVOCs with kp>10^{-5}. In this manuscript, the author just discussed the general WSOC partitioning, which was determined by the chemical components. The more detailed information is needed.

Reply: Thank you for the advice. We added the discussion about organic acids partitioning, effect of particle phase on the WSOC F_p in the revised manuscript. Please see pages 11-13, lines 244-250, and lines 270-279.

"To further analyze the factors controlling the WSOC partitioning, we investigated the partitioning process of formic and acetic acids, which are abundant species of WSOCs in the atmosphere (Table S2). As shown in Figure S4, F_p of formic and acetic acids in HE presented strong correlations with ALWC, pH and T. In DS, however, compared with ALWC and T, F_p of formic and acetic acids exhibited a stronger correlation with pH, further indicating that the partitioning of WSOC was more significantly affected by the particle acidity in the presence of dust storm.

Previous study found that the diffusivity of organics in particles strongly depends on the phase state of particles (Gkatzelis et al., 2021; Ma et al., 2022). Here we further investigated the impact of particle state on WSOC partitioning during the campaign by calculating the phase state of fine particles (see the detailed method in SI). As shown in Figure S6, fine aerosols were mainly in liquid state during the HE period and mainly in solid or semi-solid phase during the DS period. Thus, F_p linearly and negatively correlated with T_g/T along with an increasing ALWC in HE. However, such a trend was not observed in DS, again suggesting that the key factors controlling the gas-to-particle phase partitioning process of WSOC were different during the two particle pollution events, which was ALWC in HE and pH in DS, respectively.”

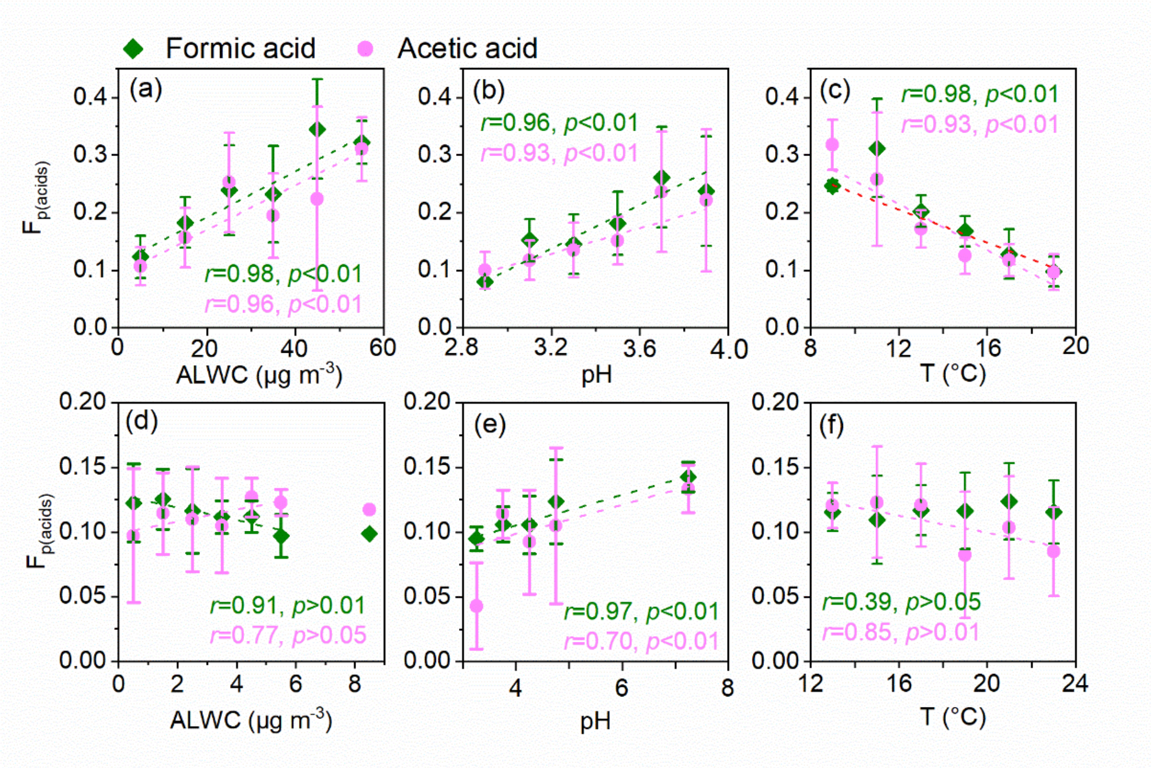

Figure S4. Factors affecting the gas-to-particle partitioning coefficients of formic and acetic acids in (a-c) HE and (d-f) DS periods in spring 2023 in Shanghai.

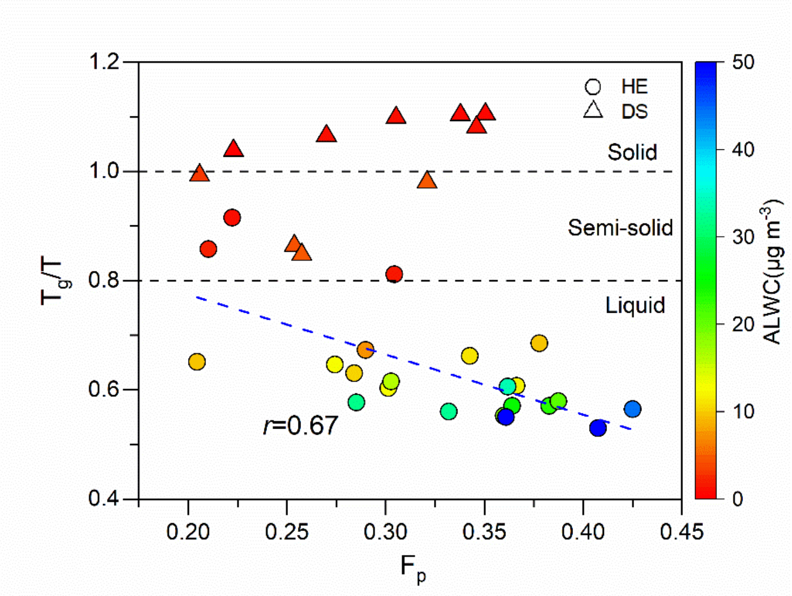

Figure S6. Particle-phase-state transition from solid to liquid particles compared to the partitioning coefficient of WSOC during HE and DS periods.

6. In lines 196–205, the authors suggest that aerosol pH is a key factor influencing WSOC partitioning during the DS period, based on correlation analysis. However, further clarification is needed. During DS, Ca^{2+} and Mg^{2+} are the dominant cations, whereas during HE, NH_4^+ predominates. This shift in ionic composition likely alters aerosol hygroscopicity, thereby affecting aerosol liquid water content (ALWC). The manuscript posited out that in the HE period, higher ALWC dilutes H^+ concentrations, leading to higher aerosol pH, whereas during DS, lower ALWC results in more concentrated H+ and hence lower pH. In fact, the pH in these two cases are the opposite trend. Specifically, the authors should provide detailed data or modeling results to validate the inferred relationship between ALWC, ionic composition, and pH, and to strengthen the mechanistic interpretation of WSOC partitioning behavior across all the measured data.

Reply: Thanks for the comment. Indeed, higher ALWC could dilute H^+ concentrations, leading to higher pH. However, a pH is determined not only by ALWC, but also by the cations and anions. For example, the particles in DS were enriched in Ca^{2+}, Na^+ and Mg^{2+} cations, which significantly reduced the H^+ concentration and resulted in a higher pH. In fact, in DS the H^+ concentration was 9.2×10^{-8} M, which was one order of magnitude lower than that (4.7×10^{-7} M) in HE. This is the reason why pH in DS was higher than that in HE, although ALWC was lower during DS. Moreover, for verifying the WSOC partitioning behavior, we also discussed the partitioning process of low molecular organic acids, i.e. formic and acetic acids, in our revised manuscript. We found that those low molecular weight organic acids partitioning behaviors were consistent with that of WSOC. Please see page 11, lines 244-250.

"To further analyze the factors controlling the WSOC partitioning, we investigated the partitioning process of formic and acetic acids, which are abundant species of WSOCs in the atmosphere (Table S2). As shown in Figure S4, F_p of formic and acetic acids in HE presented strong correlations with ALWC, pH and T. In DS, however, compared with ALWC and T, F_p of formic and acetic acids exhibited a stronger correlation with pH, further indicating that the partitioning of WSOC was more significantly affected by the particle acidity in the presence of dust storm."

7. In Lines 249-253: How can the author determine that the coarse particles are enriched with $Ca(NO_3)_2$ or $CaCO_3$?

Reply: Thanks for the comment. As we replied previously, coarse particles in the planet boundary layer are often derived from soil and dust. Those dust-related particles are enriched in carbonates, which are mostly $CaCO_3$ (Laskin et al., 2005; Tobo et al., 2010; Li et al., 2014). In such alkaline conditions, $Ca(NO_3)_2$ are formed from the reactions of $CaCO_3$-containing particles with HNO_3. In previous studies, Ca-rich particles contain rich nitrate have been detected previously, such as Beijing and Shanghai (Li and Shao, 2009; Wu et al., 2020).

We added the references into the revised manuscript. Please see page 14, lines 327-330.

8. In 238-246, the role and influence of IMs for F_p of WSOC was not clear? IMs were mainly formed through the aqueous reaction of NH_3 and carbonyls. The low ALWC would not favor the formation of IMs. It should give more discussion, such as the phase state.

Reply: Thanks for the comment.

Our study confirmed that IMs can be formed through aqueous-phase reactions during DS. Such aqueous-phase reactions can enhance the F_p of WSOC. Moreover, our previous study confirmed that IMs were mainly formed through the aqueous reactions of free ammonia ($NH_3(aq)$) with carbonyls (Figure R2a). As shown in Figure R2b, the equilibrium between NH_4^+ and $NH_3(aq)$ depends on the aerosol aqueous phase pH. In DS, the higher pH was favorable for the formation of $NH_3(aq)$, which promoted the reaction of carbonyl with $NH_3(aq)$ to produce IMs. In DS, the concentration of $NH_3(aq)$ was 0.76 ± 0.5 M, which was more one orders of magnitude higher than that in HE (0.017 ± 0.014 M). The higher concentration of $NH_3(aq)$ in DS was favorable for the formation of IMs. Moreover, we also added in-deep discussion on the influence of the phase state on WSOC partitioning. Please see page 12, lines 270-279.

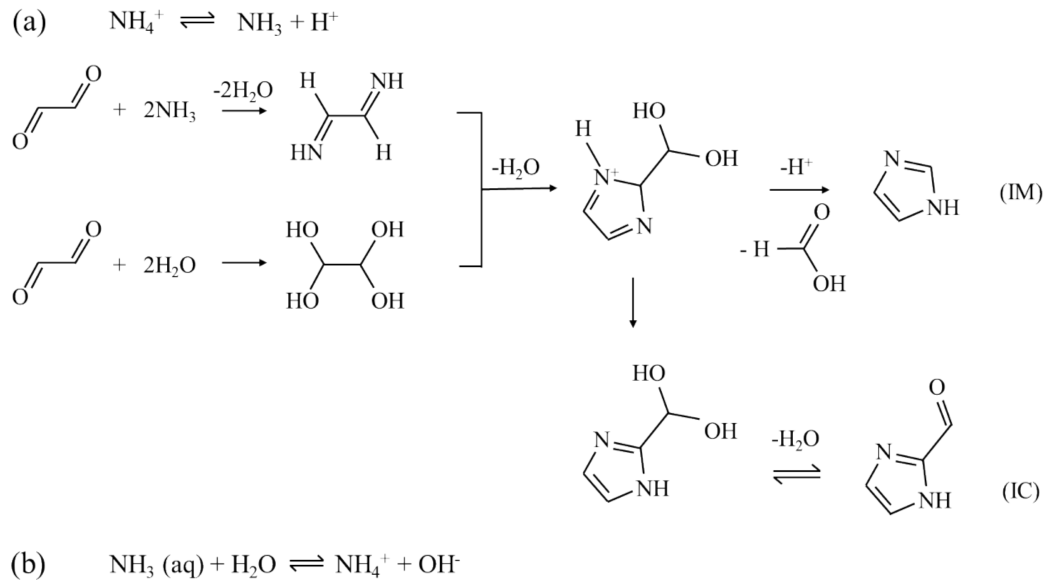

Figure R2. Reactions of free ammonia with carbonyls (cited from Liu et al.,(2023)).

9. In Lines 255-258, the author pointed out that N_2O_5 hydrolysis would promote NO_3^- formation due to those mineral dust particles and hygroscopic, but in DS, no obvious NO_3^- formation occurred compared other observed time. Thus, it did not support a linear correlation between NO_3^- and NH_4^+ in the coarse mode. Please clarify it. In addition, this discussion should apply to the whole campaign, including WSOC, F_p, pH, size distribution and driving factors.

<u>Reply:</u> Thanks for the comment. Indeed, there were no obvious NO_3^- formation in $PM_{2.5}$ during DS (Figure 1). But, as shown in Figure S9, the concentration of NO_3^- in the coarse mode in DS was almost twice times higher than in NDS, indicating abundant NO_3^- formed in DS, especially in the coarse mode.

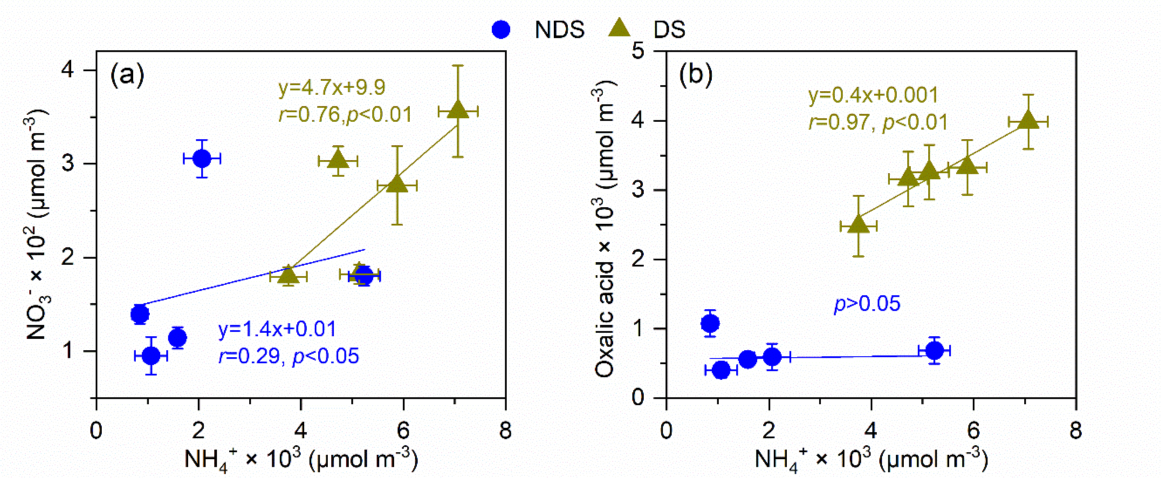

Figure S9. Liner fit regression for the NH_4^+ with (a) NO_3^- and (b) oxalic acid in coarse mode (>2.1 μm) of particles in the non-dust storm (NDS) and dust storm (DS) periods in Shanghai during spring of 2023.

10. In Section 3.4, the author should give the detailed information of the measurement of absorption, such as the solvent, the filter mass, etc., to reduce the uncertainty. In addition, the relationship of the concentration of chromophores or the ratio to WSOC with MAC or Abs should be added to differentiate the dust and haze. The filter of dust is yellow, but the haze filter may be black or grey, how to differentiate the influence of inorganic components.

Reply: Suggestion taken. The detail information about experiment, including instrument, solvent, filter areas, were added to the Section 2.2. Please see page 5, lines 125-137.

In this study, the filter samples were extracted by ultrapure water. The extract was filtered through a 0.45 μm PTFE syringe filter to remove water insoluble particles (black carbon etc.). The light absorption of water-soluble BrC measured using LWCC (World Precision Instrument, Inc., USA). Inorganic components are light absorbing, but the light absorption of those species is in the wavelength smaller than 250 nm. In this study, we investigated the Abs and MAC in the wavelength range of λ = 250–500 nm in Shanghai. Thus, the effects of inorganic components on the light absorption were negligible.

“To further analyze the factors controlling the WSOC partitioning, we investigated the partitioning process of formic and acetic acids, which are abundant species of WSOCs in the atmosphere (Table S2). As shown in Figure S4, F_p of formic and acetic acids in HE presented strong correlations with ALWC, pH and T. In DS, however, compared with ALWC and T, F_p of formic and acetic acids exhibited a stronger correlation with pH, further indicating that the partitioning of WSOC was more significantly affected by the particle acidity in the presence of dust storm."

11. Check the references (pages, volume, issue, journal (abbreviation or full), etc.) to meet the requirement of ACP.

Reply: Done. We have checked the references and revised the incorrected references.

12. The current title of the manuscript is overly long and could be more concise. A shorter, more focused title would improve readability and better reflect the core content of the study.

Reply: Suggestion taken. New title was revised as follow:

Measurement report: Simultaneous measurements on gas- and particle-phase water-soluble organics in Shanghai: Enhanced light absorption of transported Asian dust

References:

Fountoukis, C. and Nenes, A.: ISORROPIA II: a computationally efficient thermodynamic equilibrium model for K+-Ca2+-Mg2+-NH4+-Na+-SO42--NO3--Cl--H2O aerosols, Atmos. Chem. Phys., 7, 4639-4659, https://doi.org/10.5194/acp-7-4639-2007, 2007.

Gkatzelis, G. I., Papanastasiou, D. K., Karydis, V. A., Hohaus, T., Liu, Y., Schmitt, S. H., Schlag, P., Fuchs, H., Novelli, A., Chen, Q., Cheng, X., Broch, S., Dong, H., Holland, F., Li, X., Liu, Y., Ma, X., Reimer, D., Rohrer, F., Shao, M., Tan, Z., Taraborrelli, D., Tillmann, R., Wang, H., Wang, Y., Wu, Y., Wu, Z., Zeng, L., Zheng, J., Hu, M., Lu, K., Hofzumahaus, A., Zhang, Y., Wahner, A., and Kiendler-Scharr, A.: Uptake of Water-soluble Gas-phase Oxidation Products Drives Organic Particulate Pollution in Beijing, Geophys. Res. Lett., 48, e2020GL091351, https://doi.org/10.1029/2020GL091351, 2021.

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Li, W., Shao, L., Shi, Z., Chen, J., Yang, L., Yuan, Q., Yan, C., Zhang, X., Wang, Y., Sun, J., Zhang, Y., Shen, X., Wang, Z., and Wang, W.: Mixing state and hygroscopicity of dust and haze particles before leaving Asian continent, J. Geophys. Res-Atmos., 119, 1044-1059, https://doi.org/10.1002/2013JD021003, 2014.

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Liu, X., Wang, H., Wang, F., Lv, S., Wu, C., Zhao, Y., Zhang, S., Liu, S., Xu, X., Lei, Y., and Wang, G.: Secondary Formation of Atmospheric Brown Carbon in China Haze: Implication for an Enhancing Role of Ammonia, Environ. Sci. Technol., 57, 11163-11172, https://doi.org/10.1021/acs.est.3c03948, 2023.

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