Response to Reviewer #2

This manuscript describes size distribution, volatility and hygroscopicity measurements taken during a 1-month campaign in Beijing. The analysis focuses on the hygroscopic growth factor at 90% RH, the volatility shrink factor at 300°C, and the number fractions or more hygroscopic/more volatile particles. Auxiliary data include PM2.5 and PM10 from a monitoring station.

Overall this measurement report paper is easy to read. The measurement methodology appears to be sound. Data for each figure are available in a publicly available repository. The conclusions are limited to descriptive statistics of the data. Per journal guidelines, measurement reports should present substantial new measurement results. Manuscripts may be considered for publication even if broader implications for atmospheric chemistry and physics may be less developed. In the opinion of this referee, this manuscript at the cusp of the "substantial new measurement results" threshold. However, there are concerns about the broader utility of the dataset, likely limiting its overall impact on the field.

Reply: Thanks for your comments. Understanding the aerosol hygroscopicity and volatility in different conditions is crucial for determining their environment and climate effects. The understanding of characteristics of hygroscopicity and volatility under different polluted conditions remains inadequately understood. Simultaneous measurements of aerosol hygroscopicity and volatility were performed using Volatility-Hygroscopicity Tandem Differential Mobility Analyzer during April 2024 in Beijing. The study aimed to enhance understanding aerosol mixing state and evolution under different conditions and provide reliable observational constraints for reducing discrepancies between simulation results and observational data. We restructured the manuscript and added more comparison between the results in this study and previous researches, hopefully, it meets the requirements of ACP.

Major comments

The novelty/utility of this dataset is not entirely clear. The data are novel in the sense that they have not been published before and add to the available datasets on the topic. However, size-resolved hygroscopicity and to a lesser extent volatility datasets have been widely available for more than a decade. No clear new conclusions that "substantial advances and general implications for the scientific understanding of atmospheric chemistry" could be drawn from the work (hence the measurement report and focusing on descriptive results). But even as a measurement report, the utility of the dataset seems limited without additional contextualizing data. It is not immediately clear how this data could be used in future studies to advance the field further.

Reply: Thanks for reviewer's comments. We have reorganized the introduction and reviewed the previous researches in the introduction. As reviewer's mentioned, aerosol hygroscopicity or volatility have been widely investigated worldwide. However, the simultaneous study of hygroscopicity and volatility in China is still limited (Cai et al., 2017; Kim et al., 2011; Wang et al., 2017; Yu et al., 2025; Zhang et al., 2016), especially under different pollution environments. Besides, one of the most important natural aerosols in the atmosphere, dust aerosols significantly affect atmospheric chemistry, human health, climate change, and biogeochemical cycles (Chen et al., 2021; Kurai et al., 2014). Schladitz et al. (2011) demonstrated that the influence of dust particles was observed down to 300 nm during the Saharan Mineral Dust Experiment (SAMUM). Previous studies revealed that the changes of submicron aerosol effective density and optical properties during the dust period (Lu et al., 2024; Xia et al., 2019). Lu et al. (2024) found that the effective densities of 150, 250, 350, 450 nm under dusty conditions were higher than those during non-dusty periods, which reflected the dust influence on accumulation mode particles. Although the climatic and environmental effects of dust are considerable, limited studies focus on the dust effect on aerosol hygroscopicity and volatility simultaneously, especially on submicron aerosols. This study aims to enhance understanding aerosol mixing state and evolution under different conditions and offer reliable observational constraints for reducing discrepancies between simulation results and observational data. We have restructured the manuscript and strengthened the comparison with existing researches. Besides, we added the analysis with aerosol optical properties' data to explore the dust effect on aerosol properties. The results of aerosol hygroscopicity and volatility under different pollution environments and a case study of a dust event advance our understanding of aerosol mixing state and evolution under different conditions, providing reliable observational constraints for model evaluation.

The analysis of the dust event should be omitted from the title abstract and conclusion. Yes, $PM_{2.5}$ and PM_{10} increase for a few hours due to dust. But there are three significant weaknesses. First, only a single dust event is presented. Second, the dust event comes with a different airmass, which unsurprisingly has different overall aerosol properties. These may or may not be related to dust. Finally, it is unclear how the mostly supermicron dust is relevant for the sizes for HGF and VSF (50 – 300 nm). Perhaps some fraction of particles in the 300 nm size bin are dust, but that fraction is unclear. At minimum the authors should show that aerosol volume from the size distribution (total and 250-350 nm) correlates with the increase $PM_{2.5}$.

Reply: Thanks for reviewer's suggestions. We have changed the title of this manuscript and reorganized the content. We focus on the characteristics of hygroscopicity and volatility of submicron aerosols under different pollution environment, including this dust event. Although only one dust event is presented, it represents a typical spring dust episode in Beijing—an important atmospheric process that contributes significantly to regional particulate pollution, and limited researches focused on the dust effect on size-resolved aerosol hygroscopicity and volatility. Previous studies showed that Mongolia is an important source of dust for China (Chen et al., 2023; Zhang et al., 2024). The back trajectories analysis during the dust period were displayed in the supplement (Figure. S2), which showed that the air mass containing dust particles mainly originated from the central and western of Mongolia. The figure R1 showed the variation of particle volume size distribution, surface size distribution and number size distribution on April 15, 2024. During the dust period (6:00-12:00), accumulation mode particle number decreased, while the accumulation mode particle surface and volume remained large. Figure R2 showed variation of particle volume fraction size distribution, surface fraction size distribution and number fraction size distribution on April 15, 2024. Volume and surface fraction were large during the dust period, implying the dust effect on accumulation mode particles. Dust particles, suspended in the atmosphere, range from less than 0.1μm to over 100μm (Adebiyi et al., 2023). Previous studies have observed dust particles in submicron aerosols (Hu et al., 2012; Panta et al., 2023). Although we didn't have the aerosol chemical composition data, we used aerosol optical properties, size-resolved aerosol hygroscopicity and volatility to demonstrated that dust particles effect on submicron aerosols. Low SAE for PM_1 and PM_{10} suggested the dominated aerosols were affected by dust. The mean f(80%) for PM_1 and PM_{10} was 1.03 and 1.02 during the dust period. The results of size-resolved hygroscopicity and volatility showed high number fraction of non-volatile components and nearly hydrophobic particles at 200 and 300 nm during the dust period suggested that dust particles can be as small as 200 nm in diameter. We have revised this manuscript thoroughly. This analysis not only enriches the dataset by capturing aerosol properties under dust conditions but also provides critical evidence into how dust events modulate submicron aerosol physicochemical properties.

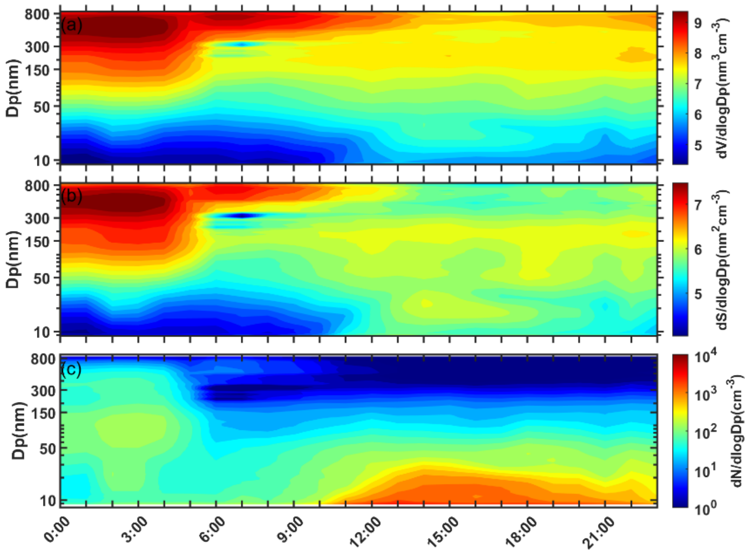

Figure R1. The variation of particle volume size distribution, surface size distribution and number size distribution on April 15, 2024.

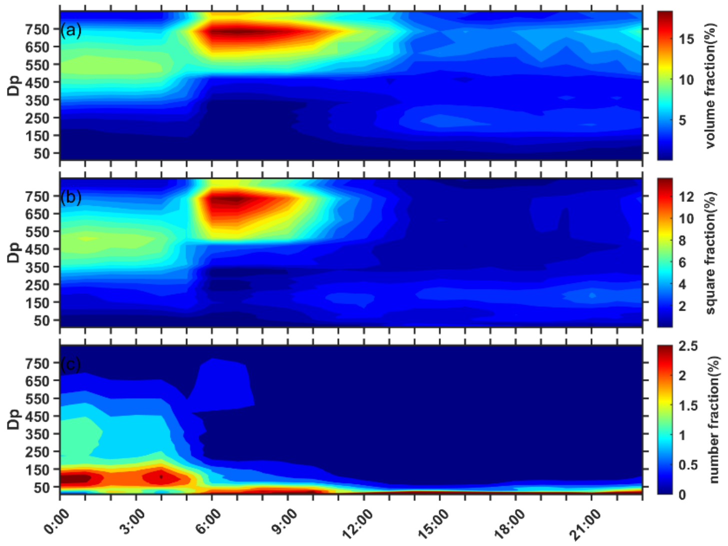

Figure R2. The variation of particle volume fraction size distribution, surface fraction size distribution and number fraction size distribution on April 15, 2024.

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