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Interactive comment on “A comprehensive characterisation of Asian dust storm particles: chemical composition, reactivity to SO₂, and hygroscopic property” by Q. Ma et al.

Anonymous Referee #2

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This paper used SEM-EDX, TPD and FTIR to study morphology, elements and chemical compositions of Asian dust particles collected in Beijing, used Knudsen cell measured the initial uptake coefficient of SO₂ on the particles, and used infrared absorption peak of water to discuss the hygroscopic property of dust particles and the particles reacted with SO₂, it concludes that SO₂ has low reactivity on the Asian dust particles, both under wet and dry conditions. This study provides new information for the Asian dust, however, I have a number of concerns about the methodology and the discussion.

1. In the introduction section, it seems that the authors are not familiar with the reported researches in this field, it says “Little data is available, however, on the heterogeneous

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reactivity and hygroscopic behavior of the Asian dust particles”(Pg 8901 line 26-27). In fact, many field and laboratory studies have been conducted on the heterogeneous reactivity and hygroscopic properties of Asian dust and its main components. (Hanisch and Crowley, 2000; Underwood et al., 2001;Laskin et al., 2005;Ullerstam et al., 2003; Zhang et al., 2006; Sullivan et al., 2009), which the authors did not mention. Similarly, for the laboratory studies on SO₂ reaction on mineral dust (Ullerstam et al., 2002; Ullerstam et al., 2003; Li et al., 2006; Zhang et al., 2006; Prince et al., 2007), the author only mentioned one model study (P8902 Line3-5“Numerous field, laboratory and modelling studies have provided convincing evidence that mineral dust plays an important role in the chemistry of sulfur dioxide (Dentener et al., 1996; Song and Carmichael, 1999).”

2. The authors need to address if the Asian dust is unique compared to other dusts in the sense of chemical compositions, otherwise, it is no need to separate Asian dust from other mineral dusts. Dust particles from different regions have similar major components, such as aluminosilicate, carbonate, and oxides; while their fractions may be vary. It makes more sense to know the compositions of the dust particles, before carrying out laboratory study on the physicochemical properties of the dust particles.

3. Pg8902 line 8-9, from just one observation (Xie et al 2005), the author came to the conclusion that the conversion rate of SO₂ to sulfate is low, many observation studies on the composition, concentration, and properties of dust particles were not mentioned in the paper. For example, the internal mixing of sulfate and alumonosilicate observed during ACE-Asia (Sullivan et al., 2007), and the study on the interaction between sulfate and mineral dust (Arimoto et al., 2006;Tang et al., 2004;Jordan et al., 2003) .

4. The dust particle sampling method of the study is not representing the particles in the atmosphere. The authors used a “clean jar” to collect one dust event in April 2006 (Pg 8902 line 21-23) for the study. No information about the sampling method, number of samples, and size distribution of the dust particles was provided. Sample from one event at a specific event could not represent the Asian dust, not to mention that the sample collected was those deposited on the ground, which are generally

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coarse particles, this is why they got large size ($d_{0.5}=20 \text{ }\mu\text{m}$). Comparing to coarse particles, fine particles could have very different compositions, surface area/volume ratio, and reactivity; this might be the reason why they observed low sulfur content. The composition, concentration, and properties of dust particles are influenced by sources, transport paths, and interaction with gaseous pollutants, studies on the SO_2 reaction with Asian dust from samples of just one dust event should not be extrapolated to the whole Asian dust.

5. Usually SEM-EDX analysis is based on analyzing a large number of particles collected with single particle sampler. The authors only used Figure 1 (SEM-EDX measurement) to illustrate the compositions of dust particles, and provided no information about the number of particles measured and the size distribution; one may doubt its representativeness. The SEM-EDX analysis was conducted by depositing particles on copper after dispersed in water (Pg 8902 line 5-8), with this process, water soluble components, such as $\text{Ca}(\text{NO}_3)_2$, $(\text{NH})_4\text{SO}_4$, CaSO_4 could be lost, hence the results could not reflect the original dust particles.

6. The authors used Mg/Al ratios of soil from different regions and concluded that “The results do imply, however, that other aerosol sources are continually deposited on the dust particles during transportation.”(P8905 line 28-P8906 line 1). It did not give the source of air mass; thus it is hard to know what “Other aerosol source” means.

7. P8906 line15-24, P8907 line 26-28, the bulk sample used by the authors could not separate external and internal mixing states; the observation of NO production should not be used as a direct evidence of NO_3 - coating.

8. Figure 5b, with AFM Krueger et al (Krueger et al., 2005) have showed that water is not evenly distributed on the surface, it is more proper to use the integrated absorption area of water to discuss the role of RH.

9. Pg 8912 line 5, in Al-Hosney et al., 2005, no oxidization of SO_2 by HNO_3 was mentioned, delete this.

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10. Pg 8912 line 19-20, the statement “These results suggest that the removal effect of SO₂ by mineral dust during dust storms should not be overestimated.” is not correct. Besides uptake by mineral dust, SO₂ could also be oxidized by O₃ on the surface of mineral dust particles (Li et al, 2006).

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