

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-227

Anonymous Referee #3

Referee comment on "Significant formation of sulfate aerosols contributed by the heterogeneous drivers of dust surface" by Tao Wang et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-227-RC2>, 2022

I have reviewed the manuscript "Significant formation of sulfate aerosols contributed by the heterogeneous drivers of dust surface" by Wang et al. Authors investigated the different metals and ions of the dust surface are associated with the heterogeneous formation of sulfate and used models to predict the heterogeneous reactivity. This study found that a significant amount of secondary sulfate aerosol was formed during nighttime and the heterogeneous drivers on the dust surface are more efficient to convert SO₂ to secondary sulfate. Given the importance of atmospheric secondary sulfate formation and heterogeneous chemistry of aerosols, this work is both significant and appropriate for this journal. However, there are some issues in this work that needs to be addressed before it can be published, as detailed below.

Introduction: authors should add some broad impacts of secondary sulfate aerosol as the motivation, such as the climate and health.

Line 45: authors need to add relevant references "... mentioned in the previous works" and be more specific.

Method Line 118: Can authors briefly describe the "documented methodologies" and add references.

Line 339-340: Can author provide more explanation about why the different clay minerals can affect the significant change of particle acidity?

Line 343-343: It is very interesting to see the difference in particle acidity between dark reaction and photoreaction, are they statistically different? Can author discuss why the

CCa has the lowest pH among all the different types of clay minerals?

Line 373-374: Earlier authors assert that the sulfate formation is more during nighttime and less during the daytime, but this statement is opposite and confusing. Can the author clarify this?

Line 380-390: In addition to the temperature dependence, did the authors consider the change of relative humidity during the day and night can also contribute to the heterogeneous chemistry reaction with sulfate?

Line 391-393: This sentence "Relative to ... heterogeneous chemistries by ..." does not make sense, please rephrase/refine the sentence.

Figure 5: Can author provide some discussion about the trend shown in Figure 5? Why would it show a dip in sulfate formation rate at pH 5 and more sulfate at higher pH?

Figure 10 Line 558-559: Can author explain why the O_2 affects SO_2 oxidation over pH <4 and why is it starting to decrease after pH 4?