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Atmospheric
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Interactive comment on "Effect of humidity on nitric acid uptake to mineral dust aerosol particles" *by* A. Vlasenko et al.

Anonymous Referee #2

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This is a very nice study of the uptake kinetics of gas-phase nitric acid onto mineral dust particles, including pure silica, pure calcium carbonate and a mixture of minerals in Arizona Test Dust. This is the first such study conducted in an aerosol flow tube which is significant because it relaxes to some degree uncertainties in calculating the collision rate with the surface that arise when studying the uptake of gases into bulk, porous solids. Also, the aerosol flow tube technique allows uptake kinetics to be measured under conditions of elevated relative humidity, which can not be done for fast kinetics with other techniques (such as a Knudsen cell). And so, this is the first study of the RH-dependent kinetics of this reaction and it is seen that the kinetics increase with increasing RH in accord with more water on the surface. I recommend publication

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based on the fact that these elevated RH measurements are novel, important, and appear to have been well conducted.

A few questions/points:

1. Is it correct to say that the aerosol surface area is “controlled” by the SMPS system (page 11826)?

2. I have a general question of how the overall reaction time (of 1.9 seconds) is determined. Is this just from the bulk velocity/flow tube length? Was the mixing length considered, where the nitric acid and dust first diffuse together (page 11826 and other locations)?

3. What other chemicals arise from the nitric acid production scheme, such as ozone, HO2 or H2O2 (page 11827)?

4. “was measured” to “were measured” and “is illustrated” to “are illustrated” on page 11829.

5. Why were some experiments not conducted without the addition of extra, non-labeled NO2 (HNO3)? With much lower partial pressures of nitric acid, these experiments would have given more information about the nature of the initial uptake coefficient of nitric acid onto a surface that is not in the process of getting saturated (page 11830).

6. Was there any indication that the wall loss rate constant increased after a kinetics experiment had been conducted involving dust? I.e. how did exposure to dust affect the wall loss rate constant (page 11834)?

7. There appears to be an error in the aerosol surface area quoted on page 11837, perhaps in the units?

8. Perhaps change the word “row” to “suite” on page 11839.

9. I am not convinced that the uptake coefficients would necessarily scale to 10ˆ-3 for

dry conditions, and so compare well to the data of Goodman et al. (p11840). Instead, could some of the difference arise from the fact that the Goodman et al. uptake coefficient is corrected for the BET surface area whereas it is not in this paper? Also, it might be worth pointing out in the paper why drier conditions were not studied (presumably, the water was needed to make OH).

10. On page 11841 it is stated that there may be no more than a 20% correction to the dust surface area based on the agglomeration effect. Where does this estimate come from? Could an estimate come from analysis of specific surface areas that have been measured by BET methods of dust samples of this type?

11. Concerning the relationship of the measured uptake coefficient to the atmosphere it might be worth pointing out that all atmospheric measurements either use a total dust mass or surface area assuming spherical geometry, i.e. the measurements made in this paper (also assuming spherical geometry) are well suited to comparison to those that may prevail in the atmosphere.

12. Could comparison to the uptake kinetics of nitric acid on other mineral dust surfaces, such as those studies by Frinak et al. also be presented?

13. Table 2. I am surprised by the very low uncertainties in the aerosol surface area. Are these precision uncertainties only?

14. Following on with point 13, what is the estimated uncertainty from the unmeasured surface area at particle diameters larger than 1 micron for the ATD and SiO2 (see Figure 2)? What transmission losses in the SMPS prevail for particles between about 0.5 and 1 micron, where a lot of the aerosol surface area is present? How do these factor into uncertainties in the reported uptake coefficient?

15. I note that the data in Figure 5 are very nice, for a difficult experiment.

16. Figure 6. What is the (g) term referring to in the y-axis caption?

17. There is a missing left bracket in the caption for Figure 8.

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