**Anonymous Referee #2 R**eceived and published: 20 March 2012

The referee would like us to make sense of the various measurements that have been published and makes some general suggestions to help us do this. We address these suggestions and propose a new figure that might 'reduce the confusion'.

***A number of experimental papers on sulfuric acid nucleation has been published in the literature. It has recently become clear that in the past, the experiments have suffered from 1) impurities and 2) imperfect particle measurements. For these reasons, the results from the various studies appear conflicting whereas in reality they probably are not. (I) In terms of Fig. 6 of the present ms, if H2SO4 is kept constant, impurities can cause the experimental curves to shift upward and have a gentler slope than is the case with pure sulfuric acid - water nucleation. On the other hand, imperfect particle detection (i.e. detector sees only particles clearly larger than the critical nuclei) can cause the experimental curves to shift downward and have a steeper slope than would be seen with a perfect particle detector (because a fraction of particles is lost to chamber walls before detection, and this fraction is larger when growth rate is smaller). (II)***

(I) We are not exactly sure what this statement means. We suppose that the referee is suggesting that with proper interpretation of each experimental result, errors can be identified and corrections applied. Whether this is possible is not certain (see below) and also we feel that this is beyond the purview of this paper.

(II) It would be very difficult to extract a binary nucleation rate when unknown contaminant(s) influence a measurement. It might be possible to identify particle detection efficiencies. See (V) below.

***In the present ms, the authors list a number of past experimental results and just note that the "discrepancies are based on experimental conditions or techniques, such as deficient particle counters or contaminant species)(III) . (Note that important results are missing from Fig. 6 that should be added: Sipilä et al., Metzger et al, Kirkby et al. (IV) ) In order to reduce rather than increase confusion, they should discuss the seemingly conflicting results in more detail. What results might have been affected by contamination, what results might have been affected by insufficient particle detection, and to what degree? (V) What is the additional information from the present experiments?(VI) In particular, a detailed comparison to the results of Kirkby et al. should be made.(VII)***

(III) We will **add references to the studies** where these two effects were explored or declared.

(IV) We will **add Metzger and Sipila 2010 to Fig. 6 and Sipila to Table 1.** Kirkby et al. 2011 was already in Fig. 6b. We are not aware of any RH variations in that work.

(V) We are considering **adding a figure** that takes out some of the potential systematic variability displayed in Figures 6a and b. This figure would plot results on a relative acidity scale, which might reduce the complexity of the comparisons. This referee might like us to put in a deciding line that would suggest contamination issues for purported binary results that lie far to the NW of it and perhaps particle detection efficiencies for results that lie far to the SE of it. Note that we have discussed the effect of contamination on our experiment in the Supplement. We cannot reliably say anything quantitative about contamination in other experiments.

(VI)The additional information from the present experiments is summarized: power dependencies on H2SO4 as a function of RH, power dependencies on RH as a function of RH, extraction of critical cluster H2O content, documentation of large effects of low pptv levels of N-base additions, rough estimate that tens of ppqv (fmol/mol) amounts of base present can be a concern. Please see our response to referee #3 for more details.

(VII) We have included the Kirkby et al. results in Table 2 and in Fig. 6 and the present results compare favorably. **We are considering going a step further in the Supplement**, to suggest more strongly that sub-pptv levels of ammonia (or amines) that might be present in the Kirkby et al. experiment (an upper limit of 35 pptv was quoted) might have allowed for particle formation pathways other than the binary H2SO4/H2O mechanism

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