

Comments by referees are in blue.

Our replies are in black.

Changes to the manuscript are highlighted in red both in here and in the revised manuscript.

Reply to Ref #2

The hygroscopicity of pollen species is not well-recognized. The authors investigated six different type of pollen particles using two methods. This work provides valuable dataset for hygroscopicity study community. I have two major comments, which should be addressed and implemented in the revised manuscript. Afterwards, I would like to review another round.

Reply: We would like to thank Ref #2 for his/her insightful and detailed comments, which have largely helped us improve our manuscript. We have addressed all the comments adequately in the revised manuscript, as detailed below.

(1) In 3.2.1 Theories, the authors assumed the pollen grains are spherical, then, build the link between kappa and mass hygroscopic growth. While, the pollen gains may not the case and are porous in real world. Assuming a spherical particle could lead to a big bias, for example, higher increase in mass, but, smaller hygroscopic growth in diameter. Actually, the mass growth is significant, but the kappa is very small value compared the atmospheric secondary organic aerosols. The authors only mentioned in line 362-364 that porosity and internal structure, might play an important role in determining the hygroscopicity of pollen grains. But no any discussion in theory part. A detail discussion on the non-spherical situation and its effects on the relationship between kappa and mass growth should be given.

Reply: We agree with the referee, and as suggested, in the revised manuscript (page 17-18, line 323-330) when we discuss κ values of pollen species we have added a few sentences to further discuss the particle sphericity assumption and its implications for the derived κ value: “It should be noted that in order to convert the measured mass growth to diameter growth and κ values, one key assumption is particle sphericity; nevertheless, pollen grains are known to be non-spherical and porous, and therefore our derived κ values might be smaller than the actual values. For example, although the mass increase was substantial (around 30-50 % at 90% RH) for the six pollen species examined, their κ values at 25 °C were derived to be in the range of 0.034-0.061, significantly smaller than those (0.1-0.2) for typical secondary organic aerosols produced in smog chamber studies (Petters and Kreidenweis, 2007; Kreidenweis and Asa-Awuku, 2014).”

(2) For the kappa theory proposed by Petters, 2007, the particles being studied should be assume as solution. Differently, Freundlich adsorption isotherm is water adsorption by materials. The principles between two theories are quite different. The authors may clarify the purpose by using two different theories to fit the observed curve. Which method is more suitable to explain the water uptake of pollen?

Reply: First of all, as discussed in Section 3.2.2 in the original manuscript, it was concluded in our work that the modified κ -Köhler equation is more suitable to explain water uptake by pollen because when compared to the Freundlich adsorption isotherm, it fits the experimental data much better.

Furthermore, in Section 3.1.1 of the revised manuscript, we have explained further why we attempted to use these two different equations/theories to fit the experimental data, as detailed below.

We tried to use the modified κ -Köhler equation because it relates our measured mass growth to the single hygroscopicity parameter. In the revised manuscript (page 14, line 258-262) we have added a few sentences to provide further explanation: “Eq. (5) relates mass growth experimentally measured in our work to the single hygroscopicity parameter (κ), which has been widely used in atmospheric science to describe hygroscopic properties of aerosol particles under subsaturation as well as their CCN activities under supersaturation; nevertheless, a few assumptions are needed to derive Eq. (5), as discussed.”

We also tried to use the Freundlich adsorption isotherm to fit our data because it provides a direct relationship between RH and our measured mass growth, without any additional assumptions. In the revised manuscript (page 14, line 258-262) we have added one sentence to provide further explanation: “One advantage of the Freundlich adsorption isotherm is that it provides a direct relationship between RH and mass growth which was experimentally measured in our work, without any additional assumptions.”