

Interactive comment on “Detecting charging state of ultra-fine particles: instrumental development and ambient measurements” by L. Laakso et al.

L. Laakso et al.

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Anonymous Referee 1:

This paper is a really interesting piece of work - a creative instrumental setup, the 'Ion-DMPS', to determine the relative importance of ion-induced nucleation compared with neutral nucleation. The paper is mostly very clear and well-written and the results are definitely of high interest. At this point, however, the core results are based on theory that is not well enough explained and justified.

If the theory is better explained and justified (and is correct), the paper becomes excellent- if not, I don't see how it could be of much use.

MAJOR COMMENT: 1. The main conclusions of the paper are based on the use of equation 1 (on page 6410), which is an approximation based on four important approx-

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imations, listed before the equation.

First of all, the text is now written in such a way that it should be straightforward to 'see' how the equation comes about. This is however not the case. Second, all of the listed assumptions can be either wrong or at least somewhat approximate.

Thus, in my view, it is desirable that the derivation of equation 1 is shown in detail (repetition of the 'Kerminen and Kulmala derivation, as the authors state it...), starting from an exact equation and showing in detail where each of the four assumptions comes into play and how. In addition, some estimation of the effect of these assumptions on the results presented is needed. If this is not achievable in a 'simple way', then, based on the authors' previous work, they possess a detailed modeling framework, by which such estimations could be easily done.

The authors would like to thank the referee for comments, which considerably improved the quality of the article.

Motivated by the comments by both reviewers, we made a more detailed theoretical investigation on the behavior of the nuclei charging state. Most importantly, we re-derived equation (1) without making the wrong assumption that ion-aerosol attachment coefficient is constant with particle size. As a result, the new equation (1) is different from the one presented in our previous version of the manuscript.

Describing the derivation of equation (1), including investigating its validity under different atmospheric conditions, takes more than 10 journal pages, so we decided to present it in a separate paper that will be submitted to a journal in a near term.

In addition to re-deriving equation (1), we totally rewrote sections 4.1 and 4.2 and combined them together. Uncertainties were better taken into account when presenting the results, especially with regard to the contribution of ion-induced

nucleation.

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