

Interactive comment on “The mathematical principles and design of the NAIS – a spectrometer for the measurement of cluster ion and nanometer aerosol size distributions” by S. Mirme and A. Mirme

Anonymous Referee #3

Received and published: 28 September 2012

I'm very certain, that this will be an excellent instrument to measure atmospheric aerosol size distributions in the nanometer size range. So the instrument should be improved and developed further. This review will discuss only two major points of the manuscript. Page 7412, equation (4): The Cunningham slip correction indicated that the range of the continuum is to be extended to smaller particles. This correction can be regarded as correction to the macroscopic viscosity. For particles of about 1 nm the slip correction is about 100. That exceeds by far any tolerable size of a correc-

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tion factor. With correction factors greater than one also errors are multiplied. Instead the authors should consider of using equations of a thermal carrier gas, as it is done for thermal diffusion and coagulation. Page 7418: In measuring concentrations of atmospheric aerosol particles (or calculating concentration densities) in aerosol physics we are in the excellent situation of getting suspicious, if negative values are resulting. Negative values are not a sign that concentrations are close to zero. Negative values in this case are always a sign that the channels are not measuring independently, as required for calculating the results. Or phrase it differently; the channels are too narrowly spaced. Or again phrase it differently; the claimed resolution of the instrument (21 electrometers or 21 independent informations) is better than the instrument in reality can deliver (there are not 21 independent informations). So with a calibration aerosol, which would fit from its size range into one channel only, also neighboring channels are showing concentrations. A paper dealing with this problem (but with a totally different instrument, a screen diffusion battery) is: Bashurova, V.S., V. Dreiling, T.V. Hodger, R. Jaenicke, K.P. Koutsenogii, P.K. Koutsenogii, M. Kraemer, V.I. Makarov, V.A. Obolkin, V.L. Potjomkin, A.Y. Pusep (1992): Measurements of Atmospheric Condensation Nuclei Size Distribution in Siberia. *J. Aerosol Sci.* 23, 191-199. In that case the calibration matrix (or penetration matrix or instrument matrix H) is rather badly conditioned, meaning the maximum values are far out of the main diagonal. In the case of this paper, the maximum values are not far from the main diagonal. This should be corrected, by widening the channels as indicated below. There are two solutions to this dilemma. - Advertise the instrument only for very specific size distributions which damp the ill behavior of the instrument matrix. These are calibration aerosols with one concentration peak at one well defined particle size or two concentration peaks spaced apart. Atmospheric aerosols are far more complex. - Reduce the number of channels. The new channels must not necessarily be equally spaced. The most important point is that the main diagonal of the instrument matrix H contains the maximum values. An instrument designed this way consequently is showing a good error tolerance. The reduction of the resolution also can be obtained by combining (several) adjacent chan-

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nels of the present instrument into one channel. This could be done in the evaluation. Any other efforts to avoid negative values in the results might change the shape of the resulting aerosol size distribution out of control. This way we could produce a model of an atmospheric aerosol which never existed.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 7405, 2011.

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