Dust-related ice nuclei profiles from polarization lidar: methodology and case studies.

This paper describes a methodology for estimating ice nuclei concentrations from polarisation lidar data. While on first reading this sounds like a revolutionary achievement it is not quite what it seems. The lidar data are used to estimate the number concentration of dust particles greater then 280 nm, and then a parameterisation from the literature is used to convert this to the concentration of ice nuclei. Of course, this method can only measure mineral dust ice nuclei, and the results are very uncertain indeed – around 60% on the dust particle concentration and a further order of magnitude in the conversion to ice nuclei. The title needs to reflect this uncertainty or people unfamiliar with lidar will believe that the global distribution of ice nucleus concentration can now be measured with reasonable accuracy (indeed, a cloud physics colleague of mine, on seeing the ACPD paper, rushed into my room to tell me exactly this). So a title like 'Estimated dust-related ….' would be a better reflection of the content of the paper. The first paragraph of the conclusions also needs toning down in view of the uncertainties in the INC parameterisation.

The introduction makes no reference to previous studies deriving INC from lidar data, yet in 3.4 we are told that the concept originated in Ansmann et al (2008) and was further discussed by Seifert et al (2011). A proper discussion of previous work should be provided in the introduction, and the advances presented in this paper identified and put in context. What's new here?

Although the writing and diagrams are clear, and the argument is straightforward, I found the paper surprisingly difficult to follow. The first paragraph of 3.1 assumes that the reader has read the previous paper by Mamouri and Ansmann, but in fact there is enough information scattered about this paper to work out what is going on. The paper would be easier to read if this information were presented coherently at the beginning of 3.1. Crucial information (like the fact that assumed lidar ratios are used to convert backscatter to extinction) are contained in a figure caption; this should be part of the text. Results (fig 1) are presented before the method used to calculate them (the one-step and two-step methods). I don't really understand the significance of the two-step method – the results seems to agree well with the (conceptually-straightforward) one-step method so are they needed? A sentence or two should be included at the end of 3.1 explaining why the two-step method is needed for this paper (if indeed it is).

Section 3.2 is perhaps the heart of this paper, in that it converts the lidar extinction profiles to APC_{280}, which is a product of the sunphotometer retrieval that can be related to INC. The paper does not explain how the column-integrated APC_{280} is derived, nor does it properly discuss the uncertainty in this derivation, leaving the reader struggling to grasp the significance of this calculation. (At the end of 3.2 a value of 20% is quoted for the conversion of AOT to APC_{280} but this is not supported by an argument or by a reference to previous work). A linear relationship between the integrated lidar extinction and the column APC_{280} is not surprising – very crudely they are both measurements of the amount of desert dust – but the closeness of the relationship is remarkable. Fig 3 also illustrates nicely the value of polarisation lidar and the separation it allows of spherical and non-spherical backscatter. However, the slope depends on the assumptions behind the retrieval leading to fig.2, which should be better explained.

Maybe it's just me, but I couldn't understand why plotting AOT and APC_{280} normalised with dust layer heights (fig 4) gave a different result to fig 3, nor why fig 4 doesn't show any of the Limassol data. Perhaps this could be better explained.

On line 15 of p.25756 is a very important paragraph stating what this paper is really about. This paragraph needs to be at the beginning of the paper so the reader understands where it is going.

Fig 10 – why have you applied a different lidar ratio to the two datasets?

Finally, a couple of small typos:

p.25754 l. 7 – radii (not radiis)

p.25763 l.20 – extent (not extend)