Dear Editor,

We are very grateful for another careful reading and for providing us with a list of points that will further improve the paper. Thank You very much! Our step-by- step answers in bold.

Estimated desert-dust ice nuclei profiles from polarization lidar: methodology and case studies.

R. E. Mamouri and A. Ansmann

This is a much improved version of the paper which, with further minor changes, should be acceptable for ACP.

l. 36 … understanding of heterogeneous ice formation under given…..

Done

l.86 … assumption about the ratio… ***Done***

l.103 …assumptions about the ratio…. ***Done***

l.119 ……..advantage for the following reasons: as …….. ***Done***

l.125 …always show a …. ***Done***

l.201 Details of these… ***Done***

l.213 polarization-sensitive ***Done***

l.254 …, based on the AERONET observations mentioned above.. ***Done***

l.266 … the particle… (omit 'shown') ***Done***

l.276 I understand that you are trying to keep the paper short but the retrieval of the dust backscatter and extinction from the lidar measurements is key to this paper, and merits one or two sentences outlining the principles before directing the reader to Mamouri and Ansmann (2014) for the details.

This is now the extended text:
As explained in \citet{Mamouriansmann2014}, two methods are available for the identification and quantification of the dust contribution to total particle backscattering and extinction. The so-called one-step method is used to separate non-dust particle backscattering from total (fine and coarse) dust backscattering. We assume a particle linear depolarization ratio of 0.05 for non-dust particles and 0.31 for dust particles so that depolarization ratios $<$0.05 and $>$0.31 indicate pure non-dust and pure dust aerosol backscattering, respectively. Mixtures are indicated by depolarization ratios from $>$0.05 to $<$0.31 and are separated by means of Eq.~(3) in \citet{Mamouriansmann2014}. The two-step method distinguishes backscattering from non-dust aerosol, fine-mode dust, and coarse-mode dust particles. Non-dust particles cause a~particle linear depolarization ratio of 0.05 or less, fine-mode dust a~depolarization ratio of 0.16, and coarse-mode desert dust a~particle depolarization ratio of 0.39. In the first step, we separate the coarse-mode dust backscatter coefficient and the residual particle backscatter coefficient (non-dust plus fine dust particle backscattering) using Eq.~(6) in \citet{Mamouriansmann2014}, and in the second round we separate the non-dust backscatter coefficient from the fine-dust backscatter coefficient using Eq.~(11) in \citet{Mamouriansmann2014}. In the case of desert dust observation on 29~September 2011, however, …

l.281 ..two-step method distinguishes backscattering…. ***Done***

l. 294 …. Under these conditions…. ***Done***

l.297 situations (plural) ***Done***

l.310 ..characteristic of… ***Done***

l.334 .. is illustrated in Fig. 3. ***Done***

l.340 ..index i from …. ***Done***

l.358 …. avoid analyzing … ***Done***

l.367 …correlation was lower because…… ***Done***

l.371 …is largely determined… ***Done***

l.407 From the studies… ***Done***

l.418 …seems to be small, given the high overall … Fig. 4 which

includes…. ***Done***

l.425 In situ observations of aerosols from aircraft do not always involve 'significant manipulations' (whatever that means). A well-characterised (or indeed no) inlet and careful attention to the air flow through the instrument will give correct in situ aerosol measurements. Of course, you are correct that such measurements are few and expensive – but not that the method is flawed.

We agree and shortened the text accordingly:
Alternative measurements could be airborne in situ observations of aerosol microphysical and optical properties. But airborne observations are expensive and thus rare from the statistical point of view. Only AERONET…

l.430 statistically ***Done***

l.451 …$APC_{280}(p_z,T_z)$ from ambient pressure … ***Done***

l.479 …parameterizations for higher…. ***Done***

l.488 This paragraph needs some attention. What do you mean by 'remaining variability'? – this half-sentence doesn't make sense. How can the equation 'allow a prediction with a standard deviation of a factor of 5' yet 62% of the time it agrees with field measurements to a factor of 2? Do these numbers (5 and 2) refer to different kinds of aerosol? We are then told that Eq 3 has an uncertainty of a factor of 2. Yet, as far as I can see from Fig 5 the predictions of the two parameterisations differ by a factor of 100 at -35°C. Some discussion of the very large differences between the two parameterisations is needed.

We clarified the text and now give our own conclusion on uncertainties based on Fig.5 and results in Sect. 4.:
Regarding uncertainties in the INC computation, we estimate that Eq.~(\ref{eqincdm10}) allows a~prediction of dust-related INC within an uncertainty range of a factor of 5--10 for temperatures from $-$5 to $-$25\,\unit{{\degree}C}. The parameterization after Eq.~(\ref{eqincdm10}) is based on observational data collected during nine field studies. These field studies were performed at a~variety of locations around the globe over a~14-year period. \citet{Demott2010} further pointed out that an INC uncertainty of an order of magnitude is still acceptable for cloud process modeling. The uncertainties are lower and within a factor of 2 when using Eq.~(\ref{eqincdm15}) \citep{Demott2015}.

From the comparison with the results obtained with Eq.~(\ref{eqincdm15}) in Figure~\ref{figAPCINC} and in the next section, we can conclude that Eq.~(\ref{eqincdm10}) underestimates the dust-related INC by up to a factor of 100 for temperatures below $-$30\,\unit{{\degree}C}.

l.570 … 40 sr. Our own measurements… ***Done***

l.605 ...profile using Eq. (2)… ***Done***

l.630 …were given… … ***we did not find … were given… but changed to: …was taken…***

l.637 …overview of the CALIOP attenuated…. ***Done***

l.674 ...almost impossible because …. ***Done***

l.676 layers: only ………penetrate deeply ………… troposphere could ice formation be observed. ***Done***

l.688 As can be seen… ***Done***

l.710 …paves the way for INC vertical profiling to support ground-based… ***Done***

l.721 ..with a focus… ***Done***

l.723 … next step towards characterising the aerosol … ***Done***

l.732 …account for the large… ***Done***

l.735 …is high, in comparison with the uncertainties… ***Done***

l.739 …for INC profiling …. situations dominated by fine-mode…. ***Done***

l.743 Under such conditions… ***Done***

l. 745 …no longer apply so that…. ***Done***

l.746 We may also test ***Done***

Fig.5 Please use different colours to distinguish the lines at different temperatures (-15 and -35 look identical to me, and -25 isn't that different)

Is now improved (APC in grey, as in the figures later on), and red, green, blue for the different temperatures.

Fig.6 and Fig 11 The inset diagram is too small to read the axis labels and annotations. Please make them readable.
Is now improved. More is not possible.

Fig.8 Noisy curves are blue, not black
Is changed accordingly

Fig.10 Colours in right-hand plot are light and dark blue, not green and blue
Is changed accordingly