

## Review of “CCN concentration and INP-relevant aerosol profiles in the Saharan Air Layer over Barbados from polarization lidar and airborne in situ measurements” by M. Haarig et al.

### General Comments

This paper describes the use of lidar measurements to retrieve profiles of CCN and IN in the Saharan Air Layer over Barbados. It continues the series of paper published by this group that describe the use of these lidar measurements to retrieve particle properties using lidar measurements and to use these measurements to estimate CCN and IN. The paper compares the lidar retrievals with airborne in situ measurements provides to give some indication of how well these lidar retrievals work. Although the lidar retrieval of CCN has large uncertainty, it still provides some utility for estimating the vertical distribution of CCN. I suggest publication after the authors address the minor comments below.

On page 3 and elsewhere, the authors mention the use of appropriate extinction-to-backscatter values for dust, marine aerosol, and continental aerosol. It looks like these specific values are then used to convert backscatter to extinction for use in the retrieval algorithms. However, it's not clear why these specific values are used when the Raman lidar measurements actually provide the means to directly measure aerosol extinction (as well as the extinction-to-backscatter ratio). Why not use the actual Raman lidar measurements rather than these specific values? Is the SNR too low to directly retrieve these parameters during the daytime?

### Specific Comments

1. Abstract, line 5. Suggest “...properties measure in situ with aircraft...”
2. Abstract, lines 7-8, What is meant by “reasonable agreement” between lidar and in situ number concentrations? More quantitative description would be useful.
3. Page 5, line 29. Does the method used by Ansmann et al. (2017) to decide whether the non-dust component was marine or continental use actual measurements of the lidar ratio? It would be helpful to have additional information here.
4. Page 6, lines 11-12. How was the lidar retrieval uncertainty determined to be a factor from 2 to 3? Where did this come from?
5. Page 6, line 13. “Besides the large retrieval uncertainty, other uncertainty sources may have contributed to the systematic bias between the lidar and airborne in situ observations:” The following sentences then describe other uncertainty sources. It's not clear what sources of error contribute to the factor of 2-3 lidar uncertainty which are separate from the other uncertainty sources described in the following sentences. How much additional uncertainty do these other sources add to the factor of 2-3 lidar retrieval uncertainty?
6. Page 7, line 20. What is meant by “large disagreement”
7. Table 1. Near the bottom, the formula for  $n_{CCN}$  contains items  $f_{ss,d}$ ,  $f_{ss,c}$ , and  $f_{ss,m}$ . How are these factors determined?
8. Figure 1. Suggest replacing the flight numbers in the legend with the dates of the three flights.
9. Figure 2. The color images show range-corrected signals of the cross-polarized channel. Why not instead show images of the actual particulate linear depolarization ratio? This would make it easier to compare the results from day to day.
10. Figure 6. Same comment as item 9 above.