Answer to reviewer 2

The major comment from Reviewer 2 is related to the use of the pseudo color ratio and pseudo depolarisation ratio making difficult a comparison with CALIOP or the work of Cattrall et al. 1995. The reviewer is fully right saying that the pseudo ratios are chosen because we are dealing with weak aerosol layers in the free tropospheric Arctic. The optical properties of the layers discussed in this paper are hardly comparable to previous studies, where larger aerosol loads are considered, e.g. dust outbreaks over the ocean or aerosol layers near strong continental sources.
In fact comparative studies of the optical properties of different aerosol types are already fully addressed in papers like Cattrall 2005 using AERONET data or in Mattis et al., JGR, 2004 using long term aerosol lidar monitoring in Europe, we refer to more explicitely in the text. Although such a comparison is not our objective, as it cannot be done very accurately using the present case study, we have added color ratio information and discuss it to some extent in sections 2.3 and 4. It is also worth saying as explained in the answer to reviewer 1 that in our work the use of the layer optical parameters is mainly to check if their relative variability in the Arctic is consistent with the source attribution of the different layers encountered, the latter being derived by the modelling approach and using CALIPSO product. The overall goals are now better explained in the Introduction of the paper.
Regarding the calculation of the aerosol color ratio and the aerosol depolarisation ratio, a new figure was added for the aerosol color ratio as well as values in Tables 2, 3 and 4, and the depolarisation ratio is now given in Table 2 for the layer where it is significant (it was only in the text in the first version). It appears to be moderatly useful for our purpose, i.e. the relative comparison of the layers considering the error bar. Comparison with previous studies is not developed also because of the large error bar on this product for our aerosol layers.

Regarding the comparison with the CALIOP data, we do not understand why the reviewer says it is not comparable because the choice of the "unusual" quantity is precisely to be comparable with the CALIOP aerosol layer operational products described in the CALIOP catalog (see http://eosweb.larc.nasa.gov/PRODOCS/calipso/Quality_Summaries/CALIOP_L2LayerProducts_2.01.html). The only difference in the color ratio is related to possible attenuation by upper tropospheric layers influencing CALIOP data but not the airborne lidar derived pseudo color ratio. The correction of this difference is expected to slightly improve the comparison as explained in the new version of the paper in the section on CALIOP data. It is also mentioned in the answer to reviewer 1. The CALIOP depolarisation ratios are measured at a different wavelength (532 nm) but using the same method we propose in this paper. Of course because of the wavelength change, we can only compare relative variations in the different CALIOP layers with relative variations in the airborne lidar observations.

Regarding the comparison with the Cattrall et al., 2005 results, the ratio of the total backscatter coefficient at 550 and 1064 nm, given in Figure 8 of their paper, is directly comparable with our color ratio as long as the aerosol layers are weak enough to identify backscatter and attenuated backscatter. It is generally the case for our study. Even though, the work of Cattrall is not based on actual lidar measurements but on backscatter reconstruction from aerosol photometer data of the AERONET network, they use a large amount of observations making possible a discussion of the color ratio variability for different aerosol types. We cannot make a direct comparison of our small specific subset (with low optical depth) with the data of Cattrall but we show that our data are consistent with their work at least on two points: (i) the change between dust of smoke aerosol, (ii) the magnitude of the color ratio being smaller than their estimate because we deal with smaller optical depth, this is also explained in the O'Neill paper. Reference to the work of Cattrall is now better explained in the text (section 2.2 and Appendix A).

<u>Answer to specific comments (all the technical corrections have been made and we thanks the reviewer for this thorough reading and apologizes for remaining errors)</u>

A short description of the overall campaign was added in section 2 as suggested by two reviewers

A more extensive description of the airborne lidar is provided (see section 2)

We use the aerosol layer volume depolarization ratio reported by the CALIOP version 2.2 data (better explained in new version)

As suggested by the reviewer we added the cloud-aerosol discrimination scores and the aerosol classification flags reported by the CALIOP version 2.2 data in the Tables 3 and 4. The main advantage is to specify how far the detected layer is indeed an aerosol layer and to compare our analysis of the aerosol layer source attribution with the algorithm derived by CALIPSO, they generally agree pretty well. This should also be better explained in the text.