Answer to Reviewer 1

Reviewer 1 suggested that we could include more case studies. Whilst we agree that this would be very interesting, there are two reasons for not doing this:

- The 11 of April case study is very typical of the observations made by the aircraft during the campaign and includes the two types of aerosol transport observed during the campaign.
- One of the main goals of the paper is to discuss in some detail the joint use of airborne data (lidar + in-situ), CALIPSO data and transport modelling using FLEXPART. Doing this in detail for several cases would make a very lengthy paper.

Reviewer 1 suggested a comparison of our results with the existing literature on long range transport in relation with optical properties. There are very few studies focusing on Arctic studies and most of this kind of work was done for dust outflow over the Atlantic or across the Pacific between Asia and North America. Since we are dealing with different aerosol sources, and much smaller aerosol optical depths, our results are not really comparable with the work of Freundentaler (2009) on Saharan dust, Mattis et al (2004) on mid-latitudes aerosols. We added these references to previous campaigns in the Appendix where we discuss the value of using pseudo ratio and the difficulty to compare our results on the optical properties of aerosol with previous studies.
We also included additional discussions on the color ratio in the lidar measurement section (2.3) and refer more directly to the work published by Catrall et al. (2005). Color ratio values have also been included in the various tables and discussed in CALIO section (4). It is also important to mention that this paper is not meant to establish a detailed climatology of the aerosol optical properties to be compared with previous studies as it would need a more extensive data set using many airborne and ground-based platforms. 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 with CALIOP aerosol layer products. It is also important to assess how far CALIOP data could be further used for the air mass time evolution. These goals are better explained in the Introduction and section 2.

Specific comments:

A brief general description of the campaign was added even though as stated before our objective is to focus on a specific case study to test a methodology to study the evolution of the aerosol properties of aerosol layers in the Arctic.

Use of the pseudo color ratio

The use of the pseudo color ratio was chosen to be comparable with the CALIPSO data set, again because this is the main purpose of this paper and not a comparison with previous aerosol studies made at other latitudes. The difference is extensively discussed in Appendix A. The pseudo color ratio is relevant to our work because we are dealing with small optical depths reducing the strong influence of the aerosol amount on the interpretation of the particle size influence. This is better explained in the Introduction and section 2.3.1.

The more standard aerosol color ratio is now also presented for airborne lidar measurements in a specific figure for the layer where it is significant. It was already in Table 2 in the first version, but it is now in Tables 2, 3a, 3b, 4, and discussed more in detail in corresponding sections. It however appears to be of limited use for our purpose, i.e. the relative comparison of the layers considering the low optical depth and associated error bars. Some comparison with previous studies is included but not developed because of these limitations.

We do not fully agree with Reviewer 1 saying our pseudo color ratio is different from the CALIOP version 2 data set, because we have precisely chosen this definition to match the CALIOP aerosol products. The only small difference between CALIOP color ratio and our so called pseudo ratio would be the fact that CALIOP color ratio also includes the optical depth due to aerosol layers in the 7- 40 km range above the altitude range of the aerosol layers compared to our airborne lidar. However, along the CALIPSO track we have studied, the upper layers either contain aerosol with small optical depths, for which difference may be estimated (this is discussed in section 4) or correspond to semi-transparent cloud layers, for which the optical depth ratio between 532 and 1064 nm is close to one.

Use of the pseudo depolarization ratio

Reviewer 1 points out the difficulty of deriving a good absolute measurement of the depolarization ratio. We fully agree with this and reference to the extensive work of Freudentaler and Cairo are given in the Appendix A and section 2.3.1. We could not add much about this topic in our paper. Again, we stress that the main interpretation of our depolarization measurements is to make a relative comparison between the observed layers rather than discussing how far our depolarization measurements can be used as a reference one for the Arctic layers. An error bar is given on this ratio in Table 2 assuming a 10% error on the attenuated backscatter.
We agree that the description of the airborne lidar measurements was missing and it is now added in the new version with a better description in section 2.3of our depolarization measurement using the airborne lidar. We do not use a narrow band interference filter justifying the 1.5% assumption for the Rayleigh depolarization. This is discussed in section 2.3.Our pseudo ratio was recalculated using a normalisation factor for the parallel and perpendicular 355 signal such that the ratio is 1.5%. This was done independently in the first version inducing indeed a small bias at near range where the aerosol free region is generally located. The depolarization ratio is now always larger than 1.5%. We explain in the Introduction and section 2 that the analysis of aerosol layer properties using a pseudo ratio is chosen because we need a method similar to the CALIPSO calculation of the depolarization ratio. Of course because of the wavelength change, we can only compare relative variation in the different CALIOP layers with relative variation in the airborne lidar observations. As this method allows the identification of the aerosol sources, results are discussed in comparison with transport model.

It was a large oversight on our part not to mention the large amount of work made by the CALIPSO team in the acknowledgements. This is obviously corrected in the new version.

We made the technological corrections and apologize for remaining imprecise formulation in the first version especially in the figure captions and Appendix A.