Anonymous referee #1

We thank the referee for the useful comments. We have attempted to address each below.

1. We added more recent references about cirrus cloud cover.

Rossow W.B. and Schiffer R.A.: Advances in understanding clouds from ISCCP, Bull. Amer. Soc., 80, 2261-2287, 1999

Stubenrauch C.J., Chédin A., Rädel G., Scott N.A. and Serrar S.: Cloud properties and their seasonal and diurnal variability from TOVS Path-B, J. Climate, 19, 5531-5553, 2006

Wylie D.P. and Menzell W.P.: Eight years of high cloud statistics using HIRS, J. Climate, 12, 170-184, 1999

- 2. Effectively, we mean passive satellite sensors. We replaced the sentence p6381 line8 by "... whereas many passive satellite sensors require visible optical depth..."
- 3. We retrieved cloud boundaries and optical thickness from the scattering ratio (SR) profiles which are retrieved from the Rayleigh-Mie and the Raman vibrational Nitrogen signal (see Ferrare et al., 2001). Because molecular backscattering can be estimated by a dry air density profile, it can further be retrieved from the Nitrogen signal, so SR can be derived from the ratio between the return Rayleigh-Mie signal and the Nitrogen Raman signal. Cloud top and base height are defined as the altitude where the scattering ratio falls below the SR threshold (mean + 3 times the standard deviation in the altitude range 17-19km). Details can be found in Section 3.1 (cirrus clouds properties retrieval for the OHP ground-based lidar). For the optical thickness, details can be found at the end of the section 3.1 (p6385).
- 4. Some details have been added to clarify this section. In fact, to identify the presence of cirrus clouds, we used the optical thickness time series in the altitude range 6-15km (which corresponds to the extreme values of base and top altitude of cirrus clouds over the OHP) using the pre-accumulated lidar signals. Then we identify the periods in these time series that represent quasi-stationary conditions. Such periods are assumed to be representative of unchanged cloud properties. Temporal integration is then applied from these identified periods. So, we derived a SR profile for each identified period (Fig 1). Cirrus clouds properties (top, base, optical thickness) are then determined from the SR profile.
- 5. The discontinuities are the points in the optical thickness time series where a statistical change is observed. These points permit to define the quasi-stationary period which are used to determine the SR profiles. These periods are long enough to provide a better statistical estimator of the cirrus clouds properties.

- 6. Done. Section 3.1. Line 26. We replaced "hypotheses" by "assumptions"
- 7. Done. Section 3.1. p6385. "... are not possible when clouds are too thin (too weak differential signals) or too deep (too large lidar signal attenuation above cloud)...."
- 8. Although the data sampling is different for the ground-based lidar and CALIOP (adaptive sampling used for the OHP ground-based lidar data and three finite integration periods that depend on the detection or not of a cloud for CALIOP), it is interesting to compare these dataset. For a given raw dataset from one single instrument, the way to proceed from the measured variable to the cloud climatology is not unique. For this reason, a given measured dataset of a given instrument can lead to different cloud climatologies. That is why we decided to compare the cirrus cloud climatologies over the OHP from the ground-based lidar (using the adaptive sampling) and CALIOP. Moreover, even if some studies reported differences and similarities between CALIOP and ground-based lidars (Dupont et al., 2010; Thorsen et al., 2011) and attempt to explain them, in our case, the interest is also to compare the cirrus clouds classification from both instruments (if the cirrus cloud classes show similar properties and evolution from the ground-based and spaceborne lidars).
- 9. We agree with the referee that it is difficult to see distinct modes in the cloud properties PDFs. We do not affirm the presence of two modes in the cloud top height PDF; we suppose it could be the case. We indicated because visual analysis can be deceptive, and cannot lead to definite conclusions that the use of cluster analysis is necessary to provide information about the presence of distinct modes (i.e. cirrus clouds classes).
- 10. Cirrus cloud parameters used in the cluster analysis are the cloud top and mean height, optical and geometrical thickness and the mid-cloud temperature. This information has been added in the text. Hierarchical Agglomerative Clustering (HAC) uses these parameters and consists to aggregate them into a small number of clusters. The methodology used consist in two step, (1) determine the dissimilarities between the observations (which are a combination of these different parameters) using Euclidean distance and (2) aggregate them using the Ward criterion (iterative method which consist to find the local minimum of the intra-class inertia between the observations). The final number of clusters is selected choosing the most discriminative partition with respect to the dendrogram which are represented in Figure 5 (left). To ensure this first approach, we performed a Discriminant Factorial Analysis (DFA) which can be only applied on already-classified data. Results from this analysis have indicated that cloud top height (CTH) and cloud thickness (CT) are the most important parameters to discriminate the different classes. As we find important correlation between F1 axis and CTH, and F2 axis and CT, F1 and F2 axes of the figure 5 (right) are representative of CTH and CT respectively and give a visual representation of the discrimination from these parameters.

- 11. We agree with the referee. The section 4.1 describes how we use the cluster analysis. The physical description of the different classes is not appropriate in this section. The corresponding sentence has been removed.
- 12. Effectively it makes sense to normalize by the total number of profiles measured. However in Goldfarb study, it was considered the number of nightly measurements with cirrus normalize by the total number of nightly measurements. This method does not take into account the period during which the cirrus cloud is observed. For example, if a cirrus cloud is detected during 3 hours for a time acquisition of 6 hours, the night of measurements is considered with cirrus. In our case, we considered the time during which the cirrus cloud is detected, either 50% of the total time. That explains the large difference between these two studies. For the total measurements time, it concerns only when the lidar is turned on. The Rayleigh-Mie-Raman lidar at the Observatory of Haute-Provence makes measurements during nighttime throughout the year except in presence of low cloud. A typical measurement period is of around 6 hours but depends on factors such as cloud cover evolution and availability of the operator. Usually lidar acquisitions are made 3-4 times per week.
- 13. Done. The font of axis labels and legends in Fig 8 are larger.
- 14. Done. We added a table (Table 2) about macrophysical cirrus cloud properties presented in Section 4.3.
- 15. In the Fig 12 legend, we mean "time integration". As explain in the Section 3.1. (Cirrus cloud properties retrieval for the OHP ground-based lidar), we temporally integrate the pre-accumulated lidar signals over the periods that represent quasi-stationary conditions which are defined from optical thickness time series. See answer n°4.
- 16. Done. The slope of the regression line have been added in Fig 14
- 17. Done. Section 6. Line 23-24. "...Clouds are thickest (geometrically and optically) at temperatures of ~-42.5°C (mid-cloud temperature),..."