We thank the Reviewer for his/her new round of comments on the paper. The responses to general and specific comments are given below. We marked the reviewer's and the author's comments by "RC:" and "AC:", respectively.

General comments

RC: In my opinion it would be very useful to discuss the coarse Aeolus resolution (vertical and horizontal) compared to the raw Calipso resolution based on the numerical simulation. This would give a hint how much information is lost due to the resolution matter and would give valuable advise for the future planned space lidar missions. It should be also easily achievable with the tools already developed.

AC: We agree that this is a very important issue, which has been addressed in the previous works (e.g. Chepfer et al., 2013) and is discussed in application to Aeolus (see e.g. the recent presentations on Aeolus L2A processors by Dabas et al., and Donovan et al., 2021 at the 3rd Aeolus L2A working meeting, 16.12.2021). We have performed the requested simulations and put them in a new Sect. 4.2. The advice for the future lidar missions can be formulated similar to Nyquist criterion for signals. In application to cloud observations, this means that the sampling rate converted to meters along the track should be smaller than or comparable to the typical size of the smallest optically thick clouds we want to resolve, that are typically shallow liquid clouds in the boundary layer. So, we speak about the resolution of about 100-300m, but, as we show in new Section 4.2, even going down to 3 km from 87 km fixes a lot of problems. We put a stress on thick clouds because of the following effect: if a scene containing optically thick clouds and clear sky is averaged, strong signal from clouds will trigger the cloud detection and the whole averaged area will be marked as cloudy thus leading to an overestimate of cloud amount. On the other hand, the downside of increasing the resolution is also obvious – in the case of an optically thin cloud the weak signal-to-noise ratio will prevent its detection. Correspondingly, it is highly advised to use a high resolution, which is just enough to tell the thick cloud from clear sky and perform additional averaging, if needed, to detect thinner clouds (Chepfer et al., 2013). We addressed these issues specifically for ALADIN in the new Sect. 4.2, even if it is not fundamentally new information.

RC: It is not clear for me if you adapted the Calipso grid also to the Aeolus vertical resolution. As you know, the vertical resolution of Aeolus is changing with geographical region and also special range-bin settings are chosen for specific time periods. Have you considered this? If yes, please state this explicitly, if not please do so.

AC: We chose not to use variable vertical grid of ALADIN. Instead, we fixed a 1 km vertical grid everywhere and filled it with the corresponding CALIPSO and ALADIN data. We added this information to Section 3.3 and Section 3.4. We'd like to note that the sensitivity of the cloud detection to the vertical resolution has been discussed and quantified in (Chepfer et al. 2010) using CALIPSO raw data.

RC: With respect to the comment above I wonder how useful the section 5.4 (Cloud altitude detection sensitivity) is. Considering 1-2 km thick range bins of Aeolus in the upper atmosphere, I do not understand the usefulness of your chosen approach and how Fig 9. can be created with this high resolution. In my opinion, section 5.4 is only useful, if you use Caliop raw resolution data and discuss your findings with respect to the coarse vertical resolution of Aeolus. Then, there is also no need to allow the large vertical range of +-3 km but limit it to 2 neighbouring range bins of Aeolus in the vicinity of a cloud. And a final conclusion would be good: How superior or not is Calipso with respect to thin cloud detection based on its raw resolution? Or in other words: Is the current resolution sufficient or not for cloud detection and what resolution would you recommend.

AC: As for the resolution of Fig. 9, one has to keep in mind that this is an average distribution and that each bin corresponds to more than one colocation. In this case, if, for example, the ALADIN cloud was found 10 times at -2 km, 27 times at -1 km and 63 times at 0 km with respect to CALIOP peak, the mean downward shift would be equal to 0.47 km. As for the last question, we address it in new Section 4.2 along with the horizontal resolution.

RC: And for what is a mean cloud height useful?

AC: If the mean is composed of high- and low-level clouds mixed together then this information is of poor use. Nevertheless, the mean cloud height might be useful for future use of ALADIN data for climate-oriented studies. Indeed, mean cloud heights are used in several studies coupling CALIPSO data with radiation to characterize co-variabilities and better understand the climate system. In particular, it is used in cloud feedback analysis (eg. Vaillant de Guélis et al. 2017, 2018). Other examples of studies using CALIPSO cloud mean height and radiation are presented in (Guzman et al., 2017; Frey et al., 2018; Morrison et al., 2019; Perpina et al., 2021).

RC: In my opinion Sec. 5.5 can be omitted, it could be covered by one statement: No temporal variation was found during for the analysed period. The plots confirming this could be put in the supplementary material. But in my opinion, it distracts the focus of the current paper by opening a new side topic which is not helpful for the paper structure.

AC: We see the point, but the whole study stems from the Cal/Val activity of ALADIN, for which the temporal stability of the instrument and its products was the key issue. The instrument team had to fix the laser induced contamination, optical losses, and hot pixel issues and it would be unfair to hide this under one sentence. With this section, we wanted to highlight that the aforementioned issues were fixed at least down to uncertainties of our analysis that it a good result.

Specific comments:

RC: Line 25: Improve phrasing

AC: we simplified the second part to “considering the differences between the instruments”.

RC: Bley et al., 2021: Is referring to confluence which is not publicly available. Thus, it cannot be referenced. Please find another source of reference or provide the information on a public repository or in your supplementary material.

AC: We agree that the referenced material is unavailable for the general public, but we cannot copy-paste the confluence pages, so we changed the reference to “ESA, ESA News, ALADIN overview and timeline of the RBS settings, available at https://earth.esa.int/eogateway/instruments/aladin/overview-of-the-main-wind-rbs-changes, 2021.” and we ask an advice of the AMT technical team whether such a reference is acceptable.

RC: Line 176: CALIOP also emits 1064 nm.

AC: Fixed, thanks.

RC: Line 185: The multiple scattering coefficient is used for CALIOP. Did you also consider multiple scattering effects for Aeolus?

AC: The ALADIN’s field of view is much narrower than that of CALIOP and multiple scattering effects are usually not considered for this instrument. Nevertheless, (Donovan et al., 2020) estimate them to be non-negligible, so we took a value of 0.9 for our recalculation procedure. We also tested the value of 0.7 and found that it affected only the low-level clouds retrieved from recalculated SR_532 for ALADIN. We added a short discussion of this value after new Eq. 8.

RC: Line 242: Writing down the final formula would be really helpful here.

AC: We added a final formula.

RC: Eq. 9: Must be wrong. You subtract the same parameter from each other.

AC: Fixed, thanks.

RC: Line 255: Eq. 10: How useful is the term cloud fraction based on 87 km resolution?

AC: Indeed, it is not useful for a single ALADIN bin, but the equation holds true for zonal averages and other types of averages.

RC: Line 287: What is Aladins original laser pulse frequency rate?

AC: It is equal to 50Hz, we added this information to this line.

RC: Caption Fig. 4: Please use once again full words for your parameters: E.g.: CDA (cloud detection agreement) or cloud fraction CF...and so on. So that the reader can understand the figures without digging in the text.

AC: We have updated the figure caption, thanks.

RC: Line 305: would be great to have the cloud fraction of Caliop at native resolution for comparison. This could give an indication evidence how much of clouds are missed due to the coarse horizontal resolution of Aeolus.

AC: We address this problem in new section 4.2 (see also the answer to the first general comment). The coarse resolution of ALADIN might lead both to under- and overestimation of cloud cover for certain type of scenes such as boundary layer shallow liquid in the tropical subsidence boundary layer that represents 2/3 of the surface of the entire Tropical belt (30S/30N).

RC: Line 317: would be nice to write these latitude bands directly in figure 5.

AC: We added the latitude band limits on top of each column

RC: Line 327: Phrasing: "Both rows show….."

AC: we have rephrased it to "zonal averages agree reasonably well up to ~3km altitude;"

RC: Line 335: How can a peak be detected within 1 km when the vertical resolution is 1 km?

AC: Please, see our explanations in "General comments" section.

RC: Line 338: I guess Fig 5 is meant.

AC: Fixed, thanks.

RC: Line 343: "This gives a hint that the instrumental part itself provides the backscatter information sufficient for cloud detection up to 20 km, but the detection algorithm suppresses noisy solutions. "◊ I cannot follow this conclusion. Can you give more detail?

AC: Unfortunately, we cannot provide more details as we do not work with L2A algorithms. According to what we've heard at the Aeolus Workshops and to the common knowledge of the retrieval algorithms, it is quite natural that the unregularized solution will be rejected if some parameter the r.m.s. of the difference between the measured signal and the simulated one is large or if the layer-per-layer retrieval does not converge in the case of a noisy signal. The idea of this paragraph was to tell the reader that the instrument itself can measure the signal at these heights, but the signal quality is not always enough to obtain a good solution.

RC: Line 351: Fig 5 or 6 f?

AC: We meant Fig. 5f here since it shows an averaged plot with a noticeable PSC signature. Please, see the next comment regarding the overestimation of SRs for PSCs in our approach.

RC: Line 351: "…confirms this assumption because the vertical extent and the composition of these clouds yield a stronger SR signal than that for the cirrus clouds (Noël et al., 2008)." again I cannot follow that conclusion. Can you explain more why the PSC detection confirms your theory with respect to the lower SNR of Aeolus?

AC: The observed effect is likely explained by an artificial increase of SR in PSC area due to our conversion procedure of ALADIN data to SR'532. This conversion assumes the particulate extinction and backscatter are the same at 532 and 355 that is not true for PSCs composed of STS droplets (Jumelet et al. 2009). At the same time, the signal itself should be strong enough to be detectable, so the initial logic behind the aforementioned lines is also true. This is now discussed in Sect. 5.1.

RC: Line 355: Fig 6 instead of 5?

AC: Fixed, thanks. We note that the updated version of the manuscript uses new enumeration due to a new figure added after Fig. 3.

RC: Line 376: I cannot see this 40% according to the given color bar. At which plot shall I look at?

AC: 40% is a ratio between the values seen in Fig. 8a (~6%) and those estimated in Fig. 4 (blue dashed curve, theoretical CDA with noise), which is about 10% at heights above ~8 km. One can also divide the number of YES_YES cases by a sum of YES_YES and YES_NO cases to get the same 40% for high clouds.

RC: Line 380: phrasing to be improved:"… false detection rate of both instruments is low that is a good result."

AC: We have rephrased this sentence to "This indicates that the false cloud detection induced by a small SNR in cloud-free area is rare for both instruments. We consider this to be a good sign as it shows the stability of the ALADIN retrieval algorithm for weak signals."

RC: Line 402: "To explain the observed behavior, one needs to have either smaller $\alpha part(\lambda,z)$ values, or larger $\beta part(\lambda,z)$ values, or both. " I cannot follow this conclusion. Can you please explain.

AC: Here, we hypothesize that not all variables are always accurately retrieved. This allows us to discuss what bias of which parameter would explain the observed discrepancy. We are focusing on an unexpected retrieval of a peak beneath a thick cloud and we speculate that for these cases either the extinction coefficient at and above the considered point is unrealistically low, or the retrieved backscatter coefficient is unrealistically high, or both.

RC: Line 405: Please improve phrasing: “The uncertainties of the parameters used for their estimate are small (Bucholz, 1995; Ciddor, 1996), so they cannot give preference to the low-level clouds and suppress the higher ones.”

AC: We removed the part after the references because it is redundant.

RC: complete section 5.3 should be improved concerning language.

AC: We have simplified this section and improved the phrasing.

RC: Line 411: “To reduce the low-level clouds in Eq. 1, “ why reduce low level clouds? I thought no_Yes, means no Caliop cloud but an Aeolus cloud. this does not make sense to me.

AC: This is true, NO_YES means that CALIOP did not detect a cloud and ALADIN saw it. The problem is that in the discussed case ALADIN was not supposed to detect any cloud because there was a thick cloud above whereas the ALADIN’s wavelength and observation geometry should lead to full attenuation of the signal at a higher altitude for ALADIN than for CALIOP. Therefore, we considered the ways of reducing the clouds in such situations. In the updated version of the manuscript, we have added the values of multiple scattering coefficient to the discussion in (4c) and we have rewritten this paragraph.

RC: Line 437: Fig. 9 instead of 8?

AC: Yes, thanks.

RC: Line 464: I think, it is the first time that the period which was analysed is mentioned. Please do so earlier.

AC: In the version under discussion, the analyzed period was mentioned in the Abstract (line 18) and then in the text (lines 121 and 464).

RC: Line 486: phrasing: “cloud changes” what are cloud changes?

AC: We have rephrased the sentence: “Performing climate studies and building a long-term cloud record with the help of these instruments requires understanding…”

RC: Caption Fig 2: <1h should be deleted right?

AC: Fixed, thanks.

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