General reply

I would like to cordially thank the authors for their efforts and their detailed response. They made a great effort to restructure parts of the manuscript and to clarify the open questions. The earlier concerns on the cilmatological AOD analysis can be dropped based on the provided explanations and the additional data in the manuscript and supplement (coefficient of variation, spatial correlation and textual changes). Also, the textual changes regarding the 4 specific cases are appropriate, now being less conclusive and leaving open the possibility to noise-induced mismatches between SCA retrievals. I was particularly glad to see the negative values included in the Figure 3, which complement this discussion.
However, two of the raised points have not been addressed to full satisfaction, but both of which will require mainly changes within the text. Hence, I recommend a minor review.

Point 1: Regarding the colocation criterion

Thanks for agreeing that it would be better to use the BRC center instead of the BRC start for colocation. I want to thank the authors for the effort of giving a detailed overview of the number of BRCs that are not affected: It is good to know that 77% of the BRCs (observations) are correctly colocated, which makes me confident that the reached conclusions are not too sensitive to any changes. However, below a discussion of open points:

"*On the contrary, in Athens, due to the "peculiarity" of the site such decision would exclude most of the matchups between Aeolus and ground-based profiles since ALADIN track resides near the edge of the defined circle.*"
I disagree with the statement that a change from the starting coordinate to the center coordinate will effectively reduce the number of BRCs.
To illustrate this point, a small graph below with some randomly simulated overpasses (Fig 1): Panel A shows the colocation method as is, illustrating the skewness around the circle in flight direction because of using the starting coordinate. Panel B resembles the procedure that the authors have shown in their rebuttal: Using the starting coordinate for colocation in the first place, but then checking subsequently whether also the center falls inside the circle. This method of course reduces the number of BRCs, because both the center and the starting coordinate are required to fall within the circle. In line with what the authors state, about 41/53 = 77% of the observations were correctly colocated in this example and remain. Nevertheless, panel C shows what happens using the center coordinate right away, which results in a non-skewed choice of BRCs around the circles center.
On average, the version A and C will result in the same number of BRCs, because the density of observations is not reduced, just different BRCs are considered. However, in this random realisation, there are of course small fluctuations allowing for small differences (53 vs 52).

"Therefore, we think that it is better to proceed with our initial approach trying not to reduce further the already limited number of cases and BRCs."

Following my point above, this cannot be the motivation for keeping the flawed colocation method, as the number of BRCs is not reduced by changing to the center coordinates (since other BRCs that were previously disregarded are "entering the game" from below).
Nevertheless, since the 77 % of the BRCs are correctly colocated, I do not expect a huge impact on the statistical analysis and the reached conclusions. So, although I

am not agreeing with the authors, redoing the analysis with the correct colocation is probably a disproportional effort compared to the potential gain. I strongly recommend however, that since the authors conclude only satisfactory performance of Aeolus, they should stress clearly the weakness of their applied colocation criterion in the methods section. A reader might argue that any poor performance might be caused by the ~45 km offset, which allows in fact observations at 165 km distance instead of 120 km.

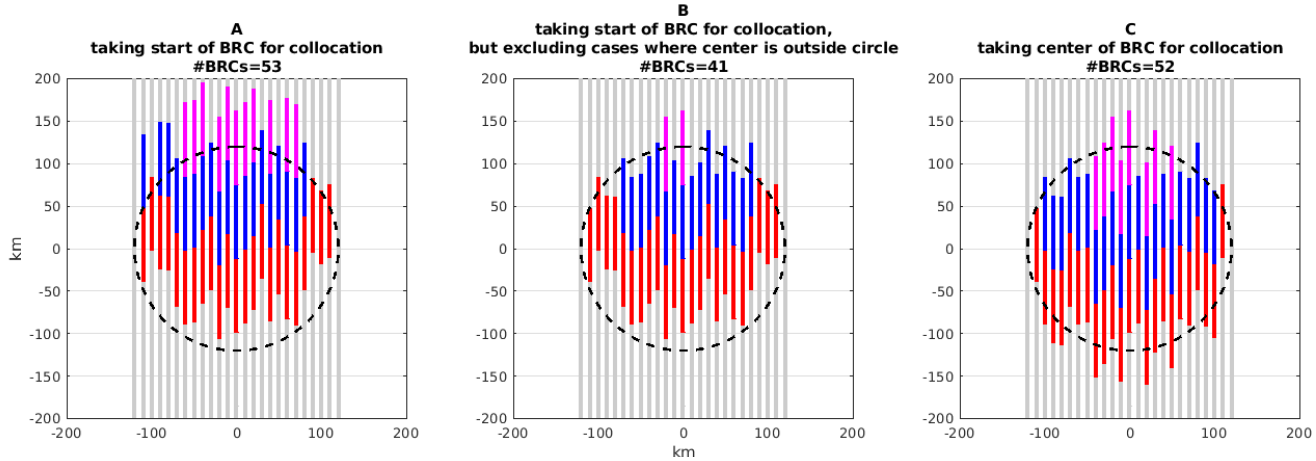

Fig 1: Illustration of the differences between colocation methods on a random realisation of overpasses (the same realisation is used for panels A, B, C). The panels show the results of different colocation strategies. The satellite is passing from south to north in this example. The color-code follows the Figure 2 of the manuscript.

Point 2: Differentiating between “Aeolus”, the “L2a product” and the “SCA product (or retrieval)”

I earlier made the remarks:
“Throughout most of the text, the authors do not differentiate between the performance of the Aeolus satellite itself and the performance of the retrieved SCA co-polar backscatter coefficient within the L2A product. This needs to be clarified, particularly since two significantly improved optical properties products are available as of March this year (see specific comments).“
and
“>*the most important finding is that Aeolus is not capable to reproduce satisfactorily the backscatter profiles*< I find this a bolt statement to make here. It is not Aeolus but specifically the current Aeulos SCA product in absence of cloud flagging. ”

To which the authors answered:

“As it is explained below, we have modified the relevant parts as suggested by the reviewer.”

Overall, this has not been adjusted throughout the manuscript so I explain below in a more detailed manner: What I meant to stress is that sentences like
*“The most important finding is that **Aeolus** is not capable to reproduce satisfactorily the backscatter profiles.”* (L.945 , manuscript with tracked changes)
are not correct. Such statement suggests and concludes incapability of the Aeolus mission itself, while it is particularly the shortcomings of the SCA product that the authors want to underline. Hence, the above statement should be changed to either

*“The most important finding is that **Aeolus’ SCA product** is not capable to reproduce satisfactorily the backscatter profiles.” or*
*“The most important finding is that **the SCA retrieval** is not capable to reproduce satisfactorily the backscatter profiles.”*
I stress this point particularly, since the science teams are and have been working on more refined L2a backscatter coefficient profiles that are already released and included into the L2a product. Hence, there is a need for specification. This is where my impression originated from, that the authors generalize a lot in sections 6.1.x, though I am now sure that this is certainly not intended and hence a misunderstanding due to choice of words. I strongly encourage the authors to differentiate, **so all statements that state “L2a product” and “Aeolus” in place of “SCA product” need to be changed accordingly.**
To provide an extensive list:
L. 39 “L2A backscatter coefficient” → change to “SCA backscatter coefficient”
L. 165, 950 “L2A optical properties” “L2a backacatter” → please specify which of the product(s) they used in the references (SCA, MIE, ICA, AEL-PRO or SCA-MLE)
L. 174 “L2A particle backscatter” → “SCA particle backscatter”
L. 273 “Aeolus L2A product ” → change to “SCA product”
L. 322 “The L2A optical properties product which will be described in the next section, derived by the so-called Standard Correct Algorithm (SCA) (Flament et al., 2021), are provided at the observation scale (on a horizontal resolution of ~90 km) and are available through the Aeolus Online Dissemination System (https://aeolus-ds.eo.esa.int).” → The SCA is part of the L2a, but not the whole L2a is derived by the SCA algorithm. Please change to e.g. “The SCA optical properties are part of the L2A product which will be described in the next section, and are derived by the so-called Standard Correct Algorithm (SCA) (Flament et al., 2021). They are provided at the observation scale (on a horizontal resolution of ~90 km) and are available through the Aeolus Online Dissemination System (https://aeolus-ds.eo.esa.int).”
L. 359 “L2a extinction retrievals” → change to “SCA extinction retrievals”
L. 428 “Aeolus L2A products” → may be changed to “Aeolus SCA optical properties product”
L. 602 “L2a backscatter profiles” → “SCA backscatter profiles”
L. 616 “Aeolus L2A profiles” → “Aeolus SCA profiles”
L. 624, 641, 651, 652, 659, 880, 882, 923, 985, 1081, 1138 “L2A” → “SCA”

L. 39 “Aeolus profiles” → “SCA profiles” or “L2a profiles”
L. 45 “Aeolus performance” → “SCA performance”
L. 48 “Aeolus profiles” → “SCA profiles”
L. 53 “Aeolus performance” → “SCA performance” (though this is likely an issue with all the retrieval algorithms)
L. 170 “Aeolus backscatter profiles” → lease specify which of the product(s) they used in the references (SCA, MIE, ICA, AEL-PRO or SCA-MLE) instead of “Aeolus backscatter profiles”
L. 365, 626, 627, 658, 664, 816, 822, 877, 938, 943 “Aeolus” → “SCA”
L. 716, 730 “Aeolus” → “Aeolus SCA product”
L. 814, 1146 “Aeolus’ performance” → “SCA performance”
L. 816, 826, 867,1053 “Aeolus” → “the SCA retrievals”
L. 842, 845 “Aeolus” → “the SCA ”
L. 883 “Aeolus satellite (SAT) backscatter coefficient” → “Aeolus satellite (SAT) SCA backscatter coefficient”
L. 1002, 1024, 1025, 1027, 1039, 1042, 1050, 1163, 1164 “Aeolus” → “SCA”