We thank the Editor and the Anonymous Referee #1 for their constructive comments and suggestions.

We provide below a point-by-point response to these comments, along with the corresponding changes in the manuscript.

Moreover, some more (minor) changes have been applied in the manuscript, mainly correcting typos and syntax errors, which are not reported here, but they are provided in the manuscript with track changes.

Reply to the Editor

Editor Comment (EC):

Thank you for your response to the reviewers' comments. As you see, reviewer 1 has provided a second round of responses. The main criticism is that while the lidar is designed to detect dust particle orientation, the paper does not provide observations to show that the instrument can detect particle orientation.

I appreciate that there may be difficulties in obtaining such measurements, and as such I consider the instrument description and measurement data in current form valuable for publication. However, there should be a much clearer communication of the fact that the current work and instrument has not yet detected oriented dust (or other orientated particles), and therefore the instrument has not been tested fully in this objective. This should be included and more explicitly defined in the abstract, main article, and Overview/future perspective section. An explanation of the difficulties in using rain as an example should also be covered in the article (as in the previous responses to reviewers).

Reply:

In order to emphasize the fact that our instrument has not yet detected particle orientation, we included the following in the abstract, main article, and Overview/future perspective sections:

Line 12: “The work presented does not include the detection of oriented dust (or other oriented particles), and therefore the instrument has not been tested fully in this objective.”

Line 69: “In Section 7 we present the first measurements of the system, acquired during a dust-free case in Athens, Greece (we should note that the instrument has not acquired measurements of oriented particles yet).”

Line 377: “Further work is required towards improving the system performance and fulfill its objective. Firstly, the system has not yet measured dust orientation, or the orientation of other particles (e.g. rain as in Hayman et al. (2012)), thus it is not fully tested in this respect. The detection of the orientation of rain has been tried, but it hasn’t been completed, since it entails high technical challenges, mainly due to the analog detection of the signals which are saturated from overlaying clouds and/or the385rain. Although this is not impossible to cope, it requires extensive experimentation, which will be part of our future work.”

EC:

In addition, please respond to the most recent response from the reviewer, and make appropriate changes to the article.

Reply:

We provide a point-by-point response to the reviewer's comments below.

EC:

Finally, it seems unclear whether the example presented relates to a dust-free case, or a dust case with no orientation. It seems that the description of the aerosol case has been changed from dusty (first submission) to dust-free (second submission). Please explain the justification for changing this description in your response.

Reply:

The presented case is dust-free, as indicated by the dust transport simulations from the WRF-Chem model (no transport of dust particles in Athens and in the Mediterranean Sea region). These results are also supported from close-to-zero VLDR measurements at 532 nm (indicating spherical -no dust- particles), acquired with the PollyXT lidar of NOA at the PANhellenic GEophysical observatory of Antikythera (PANGEA).

In order to clarify this in the text, we have included the following in the manuscript, in line 345: "The absence of dust is supported from the WRF-Chem model simulations, indicating that desert dust has not been advected over the region, as well as from the low values of VLDR at 532 nm, measured with the PollyXT lidar of Antikythera (Baars et al., 2016), indicating spherical particles (not shown here)."

The justification for changing the dusty case (presented in the first submission) to the dust-free case (in the second submission) is provided in the discussion of the second submission: Due to the absence of measurements of dust orientation, in order to avoid confusion, we include a dust-free case to the "First measurements" section, which shows no orientation (as expected). We use these measurements to show that the instrument works as expected and provides "no orientation" flags, for dust-free atmospheres.

Reply to Reviewer #1

Reviewer Comment (RC):

The authors have made some positive revisions to the manuscript. They have provided additional details about the instrument specifications and added 2D plots of the observations (which look very nice). However, there is not an explanation about how the standard deviation of the derived data products is obtained. Most significantly, I would note that the shared comment from both previous reviewers has not been substantively addressed: There is no demonstrated observation of any oriented particles in this manuscript.

Reply:

Regarding the standard deviation of the data products, it is derived as the standard deviation of the values of the orientation flags at a specific range of heights.

We added the clarification in line 354: "…(the standard deviation is calculated as the variation of the values of orientation flags from the full-overlap height up to 1.5 km)."

RC:

The standard for what warrants publication of an instrument paper ultimately rests with the editors. I feel this work does not meet my standard largely because I feel an instrument needs to prove out the parameter space of it's measurements. My experience is that an instrument that has not demonstrated its purpose (in this case detecting oriented particles) is probably not done. It is very possible that aspects of the instrument design and operation will change in the process of attempting to measure particle orientation through polarization. If this work is published as it is, that would potentially result in a published design which is not consistent with the system eventually in operation. It does not appear to me that this research effort has yet achieved a milestone that is appropriate for publication.

To be clear, this work shows that the instrument does not detect orientation when there is clear air and in at least one instance of dust where we also assume the particles are not oriented. That helps assure us that it doesn't suffer from excessive false positives and captures true negatives. But how well does the instrument perform when there are oriented particles? That is undemonstrated, but it is the entire novelty of the instrument.

This is not the first lidar designed to measure oriented particles in the atmosphere. It is, as stated in the manuscript, the first lidar (that I am aware of) designed to detect oriented dust. A review of previous publications on oriented particle detection lidar includes example cases (e.g. Kaul et al 2004, Hayman et al 2012). So while I support the eventual publication of this manuscript, I think the authors need to do more work.

Reply:

As responded to the EC above, in order to emphasize this limitation of our work, we included the following in the manuscript:

Line 12: "The work presented does not include the detection of oriented dust (or other oriented particles), and therefore the instrument has not been tested fully in this objective."

Line 69: "In Section 7 we present the first measurements of the system, acquired during a dust-free case in Athens, Greece (we should note that the instrument has not acquired measurements of oriented particles yet)."

Line 377: "Further work is required towards improving the system performance and fulfill its objective. Firstly, the system has not yet measured dust orientation, or the orientation of other particles (e.g. rain as in Hayman et al. (2012)), thus it is not fully tested in this respect. The detection of the orientation of rain has been tried, but it hasn't been completed, since it entails high technical challenges, mainly due to the analog detection of the signals which are saturated from overlaying clouds and/or the385rain. Although this is not impossible to cope, it requires extensive experimentation, which will be part of our future work."

RC:

I do not think that the request that this instrument is able to detect some oriented particles (not necessarily dust) is unreasonable. As has already been discussed, there are some predictable cases where these observations can be made. If the detectors are not linear in cases of rain, why can't the laser or detection path be attenuated? This should not be a particularly difficult task. In any case, the problems the authors have encountered may be inconvenient but they are not insurmountable.

Reply:

We agree with the reviewer that the problems encountered for measuring the orientation of rain are not insurmountable, but they do require a lot of experimentation and time, which we choose to include as future work.

RC:

Finally I would make a comment about instrument design that should not be viewed as an argument against publishing this manuscript:

While this system is designed to meet the technical requirements to measure the polarization signatures of oriented dust, I am skeptical that the design meets the practical requirements. If oriented dust is relatively rare, then building an instrument that requires attended operation with high power (non-eye-safe) lasers is going to make detecting such instances quite difficult. Continuous operation is a likely requirement to perform any meaningful study of this phenomenon.

Reply:

We thank the reviewer for his/her insight. A continuous-operation instrument would be much more preferable for many reasons, but it is also much costlier and its construction is more challenging. In any case, the design incorporates parts that can be upgraded for continuous and automatic operation in the future. This aspect is not discussed in the manuscript since it is in a very preliminary stage. The system will be applied in a forthcoming experimental campaign in Cape Verde to measure possible particle orientation within the SAL. Intensive measurements will be taken, and the high-power laser operations will be interrupted automatically in case of an aircraft overflight will be detected over the site (through a radar that will operate along with the lidar to apply all eye-safety measures for our operations).