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Atmospheric Measurement Techniques Discussions

Interactive comment on "Cloud base height retrieval from multi-angle satellite data" *by* Christoph Böhm et al.

Christoph Böhm et al.

c.boehm@uni-koeln.de

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"This paper describes an interesting technique to infer cloud base height from MISR measurements within selected areas. The paper is well written. The technique is described well. I recommend the paper to be accepted for publication after some minor suggested additions and corrections listed below."

Thank you for your constructive feedback. We have addressed your comments in the following way:

"The authors should describe better to which kind of cloud fields this method can be applied. The abstract states "it can be applied if some cloud gaps occur within the

chosen distance of typically 10 km." However, cirrus are excluded in the evaluation, because it probably would not work on cirrus. I also do not expect the technique to work particularly well on areas dominated by deep convection and congestus, for example. Please discuss the expected limitations of the technique related to cloud types."

We agree that MIBase has limitations in respect to cloud types. Therefore, we introduced two new sections "3.4 Scene limitation" and "4.1 Scene structure influence" into the manuscript and modified abstract and conclusions accordingly. In short: A bias towards a certain cloud type can be introduced by two sources: the MISR cloud top product, yielding more valid retrievals for specific cloud types, or the MIBase algorithm. Therefore, these two aspects would have to be investigated separately. Many approaches to distinguish different cloud types from satellite data have been proposed, e.g. the cloud optical depth / top height approach by the International Satellite Cloud Climatology Project (ISCCP). However, this kind of classification is not unique, depends on the horizontal resolution and likely needs additional data products. Therefore, it goes beyond the presented study.

To investigate the performance of the MIBase algorithm in dependence on parameters which are also relevant for cloud type classification, we determine RMSE, bias, and the correlation coefficient in dependence on z_{top} and the cloud vertical extent Δz. A figure showing the results can be found in the added supplement material (Fig. 2). For most cloud fields which are observed within this study, z_{top} ranges between 1000 m and 2000 m (supplement Fig. 2a). For a lower z_{top}, the RMSE shows a minimum of approximately 300 m and increases for clouds with higher z_{top}. As we already discussed at the end of section 4, this behavior could be due to the termination of the z_{base} range by the threshold height h_{min}. However, in case of even lower z_{top} values, the RMSE increases. As these low z_{top} values approach the threshold height, two different cloud scenes are possible: the cloud extents below the threshold height indicating near surface clouds or fog, or the cloud is extremely thin. In this study we excluded scenes for which the ceilometer reported a cloud below the threshold height. Therefore, low clouds or fog

should not be included in the statistics, unless the ceilometer did not detect it. In particular for very thin clouds, the RMSE is lowest (supplement Fig. 2f). In conclusion the higher RMSE for very low z_{top} values could indicate that the MIBase algorithm does not perform as well in proximity to the threshold height. This is also indicated by an increasing correlation coefficient with increasing z_{top} (supplement Fig. 2d). High correlation coefficients (supplement Fig. 2h) and low RMSE (supplement Fig. 2f) for cloud thicknesses up to 1000 m indicate that the algorithm works particularly well for thinner clouds.

For cirrus clouds or high clouds in general, we cannot make a robust statement as we tax the accuracy of the METAR reports insufficient for this particular height range.

For overcast situations, z_{base} cannot be retrieved. We added statistics on how many apparent overcast cases are observed to the manuscript (Tab. 5, Fig. 10 of the revised manuscript).

"Page 7, line 7: I agree that MISR cloud top heights are probably superior to those of other passive satellite instruments, but not to those from active instruments, in particular lidar."

Agreed. We added "passive" to the sentence.

"Figure 12: In the caption note that these are anomalies. Also add a Delta in front of the y-axis labels."

Thank you for pointing out that this was not clear enough. We added a Delta to the y-axis label and edited the caption to make it clearer to the reader that we show anomalies here.

"I thought the discussion of multi-layer situations on page 8 was interesting and I suggest to add some words about that in the conclusions."

If we include multi-layer cases we would add 689 cases (10%) to the statistics for the year 2007 (432 cases or 8% in 2008). With these additional cases, the correlation with the ceilometer retrievals decreases slightly from 0.66 to 0.64 (2007 and 2008) and the RMSE increases slightly from 385 m to 395 m (2007) and from 404 m to 418 m (2008). The MISR cloud top height product includes a correction for cloud advection. This is carried out via a cloud motion vector which is determined at a certain cloud feature height at a 17.6 km horizontal resolution. The wind correction is applied to any cloud top height retrieval which is within 840 m distance from the feature height of the cloud motion vector. Collocated cloud motion vectors and their neighbors are considered for the correction of a cloud top height retrieval. We suspect that the wind correction in multi-layer cases, i.e. cases with a wide range of cloud heights, might not be as accurate. At the same time multi-layer cases might also lead to a false comparison with the ceilometer, since it is unclear which layer passed over the ceilometer and which may have not. Therefore, we decided to exclude multi-layer cases from the evaluation and do not mention them in the conclusion.

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2018-317/amt-2018-317-AC2-supplement.pdf

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