Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2018-317-AC6, 2019

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

Received and published: 1 February 2019

"As there are already five reviews available (and more referees have accepted the review of the paper) I can be short with my statements. I agree with what has been mentioned by the other reviewers with respect to the pre-conditions (cloud optical thickness, homogeneity), so I can restrict myself to comments mainly related to the ceilometersas this has not yet been covered in detail."

Thank you for your constructive feedback. We have implemented your comments as explained below.

"Section 2.1: The expression "z pixel" might be revised/improved"

We replaced "z pixel" by "z retrieval".

"Section 2.2: Please add 1-2 sentences to describe the type of ceilometers used, and the basic characteristics of the instrument and the cloud height retrieval."

We added that the ceilometers are lidar ceilometers which are operating at a wavelength of $0.9\,\mu$m to Section 2.2. Additionally, we mention that the cloud base height retrievals are derived by evaluating the vertical gradient of the backscatter profile.

"Is the very coarse vertical resolution of the METAR-messages an issue?"

Due to the rounding, the given vertical resolution of the METAR $\hat{z}_{\text{base}}$ reports is 100 ft (≈ 30 m) for heights up to 5000 ft (≈ 1500 m) and 500 ft (≈ 150 m) between 5000 ft and 10000 ft (≈ 3000 m). We expect the uncertainty of the MIBase retrievals to be larger than this (RMSE ≈ 400 m), so that the resolution of the METAR messages is a small contribution to the total uncertainty.

"What about using backscatter profiles from ceilometer networks, e.g. in Europe: derived cloud base heights are quite reliable and the vertical resolution is in the order of 10 meters. Please comment on this; maybe in the conclusions."

Due to the large homogeneous data set, we focus on the continental U.S. We are aware of harmonisation efforts within Europe. Therefore, we added the following sentence to the conclusion: "Within Europe, the European Cooperation in Science and Technology (COST) activity is expected to harmonize the networks of the different weather services (e.g. Haeffelin et al., 2016 and Illingworth et al., 2018, for further reading) enabling more inter comparisons in the future."

"Is the variability of the 30 s messages used to exclude certain data sets (temporal variability translated to spatial inhomogeneity [taking into account the bins of the messages])?"

As far as we know from the ASOS handbook, no filtering for inhomogeneity is performed.

“The discussion of the implications of the time period of 30 minutes for averaging could be extended.”

We added the following sentences to the new Section 3.4: “The METAR reports comprise retrievals over a 30 minute period. During this time, cloud formation and cloud dissipation can alter the cloud scene and cause mismatches between MISR and METAR retrievals.”

“Section 3: Better use another word for "field of view" (R_f) here: according to page 7, line 11 it has nothing to do with the optics of the radiometers onboard of MISR as one might expect.”

We agree that “field of view” is inappropriate here. We changed it to “MIBase cell” throughout the manuscript. For consistency, we also modified the notation for the radius which defines the size of the MIBase cell from R_{fv} to R_{c}.

“Section 3.2: Taking into account the very poor vertical resolution of the ceilometers and the large "footprint" of the inter-comparison I feel that it is not justified to end up with a $\hat{z}_{\mathrm{base}} \approx 853$ m (pretending a one-meter-accuracy). Can you give an uncertainty instead of using "≈".”

As stated above, the binning during the data processing of the ceilometer measurements, leads to a vertical resolution of the METAR retrievals between 100 ft (≈ 30 m) and 500 ft (≈ 150 m). This resolution should suffice for the analysis carried out in this study. The native METAR ceiling report was 2800 ft which is an integer multiple of the measurement resolution. Here we convert to SI units, which leads to values which look not round at all. To avoid the illusion of one meter accuracy, we changed that particular instance to $\hat{z}_{\mathrm{base}} = (853 \pm 15)$ m and added: “Since METAR values are rounded to the nearest 100 ft and no information on uncertainty is available, we

estimate an uncertainty of approximately 15 m.”

“Page 10, line 17 states that a cloud base height of 7010 m was retrieved. In section 2.2 it is stated that the ceilometers have a vertical range of up to 3700 m. Please explain.”

This height was included in that particular METAR message. This can happen, because a subset of the ceilometers has a higher measurement range. In case of multiple layers, and if at least the lowest retrieval occurs within the reporting range, cloud heights outside this range can be included in the report.

“The caption of Fig. 12 could be misleading. Mention that deviations are shown right at the beginning of the text.”

We edited the caption and the axis labels.

“The conclusions of the papers cited in Hannay et al. (2009) are mainly based on thermodynamics. They do not cover pbl-retrievals based on backscatter. This is however relevant for ceilometers (that are used as reference in this paper). Therefore the agreement/disagreement of ceilometer-retrievals with model results should be discussed as well: a lot of papers have recently been published focussing on the potential of ceilometers in general and the determination (and its accuracy) of the mixing layer height (or pbl).”

The reason why we are citing Hannay et al. (2009) is that they provide studies from the area we are interested in, i.e. the southeast Pacific. Their comparison to observations based on radiosonde data and microwave radiometer retrievals shows that the models underestimate the boundary layer height in this region where stratocumulus clouds prevail. Their conclusion should not be generalized outside this area. To clarify that the study by Hannay et al. is carried out over the southeast Pacific, we updated the manuscript accordingly. We agree, that where available Lidar and ceilometer measurements would be beneficial to validate the mixing layer heights and cloud heights from models. However, we are not aware of such comparisons for this particular region.

"I agree that the MIBase can be a promising tool for remote areas, and for climatological studies with the corresponding (extended) spatiotemporal averages. Nevertheless a few comments on the benefit of the retrieval based on individual observations would be desirable, considering the large uncertainty and the missing coverage of the diurnal cycle. So combination with ground based ceilometer networks (where available) should be envisaged, especially as ceilometers are a very direct and accurate approach (no calibration required, continuous operation) for z_{base}*-retrievals."*

We added "Depending on the application, the MIBase uncertainty and the missing coverage of the diurnal cycle can be a limitation. However, in combination with ceilometer networks, both temporal and spatial patterns can be investigated." to the conclusion.

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2018-317/amt-2018-317-AC6-supplement.pdf

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-317, 2018.