Atmos. Meas. Tech. Discuss., 8, C290–C292, 2015
www.atmos-meas-tech-discuss.net/8/C290/2015/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Joint retrievals of cloud and drizzle in marine boundary layer clouds using ground-based radar, lidar and zenith radiances" *by* M. D. Fielding et al.

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Received and published: 12 March 2015

General Comments: The authors present an original method to retrieve cloud and drizzle vertical profiles. Although they focus on marine boundary-layer clouds, their technique is in general very valuable to characterize drizzle in low-level clouds. Thus, I find the paper suitable for publication in AMT. However, I have some concerns with the methodology as described in the text and summarized in Figure 1. The details of the method are sometimes confusing and not clear. Please see the list of specific comments.

Specific comments: 1. In order to decide if a profile includes drizzle or not, a threshold of -17 dBZ is used (p6 l29-p7 l1) If a cloud has been identified as drizzling, it is further

checked in which height exactly drizzle has to be retrieved: first cloud and drizzle boundary heights are identified. However, drizzle is not retrieved, "where the observed radar reflectivity is less than or equal to Zc." I have some problems here: Zc has not been introduced yet (first explained in l20 ff). Do you mean the threshold of -17 dBZ here? Or Z related to cloud droplets only? But then how do you know, if also drizzle is present and the measured Z is a sum of both, Zc and Zd?

2. p 9, l 8 ff: Can you explain in more detail how the gradient is calculated?

3. Figure 1: a) What is Z_cb? Z at cloud base? I supposed that you check each cloudy bin for drizzle using the threshold of -17 dBZ. b) Why is y=Z_d in constrained mode above cloud base? And how do you know Z_c? (see comment 1) Anyhow, I have problems with this notation: cloud radar only provides Z and it does not distinguish between Z_c and Z_d. So y = Z, always. I am not sure if I got it right but I try to summarize: Depending on the presence of drizzle the forward model for Z changes: relaxed mode (cloud droplets only): Z=Z(Z_c)=Z(N_c,W_c) constrained mode (below cloud base, drizzle drops only): Z=Z(Z_d)=Z(N_W,r_0,ν) constrained mode (above drizzle top, cloud droplets only): Z=Z(Z_c)=Z(N_c,W_c) constrained mode (between cloud base and drizzle top, cloud droplets and drizzle drops): Z=Z(Z_c,Z_d)=Z(N_c,W_c,Z_obs) So in this case Z does not depend on N_W, and r_0,ν at all because Z_d is described as max(0,Z_obs-Z_c)? It would be helpful to include such kind of overview of the forward models in this flowchart. c) I have assumed that the shortwave zenith radiances are part of the observation vector. However, they are not part of y in Figure 1. It is not clear to me how exactly they are used in the retrieval framework. d) Since you are using "relaxed mode" and "constrained mode" in the text, I would also include these terms in the figure.

4) p 12, l15 ff: Can you explain in more detail how the initial ensemble is generated (which values)? Shouldn't you here also refer to Table 1?

5) Can you also include one or two sentences on how the convergence criterion is

defined? Do all ensemble members always converge? If not, what is the percentage of converged members?

6) Figure 6 and Figure 10: Do the error bars represent the variability of cloud properties within the column (since column-averaged values are shown). Or are they the retrieved uncertainty based on the spread of the converged ensemble members? If the latter is the case, then I don't understand p18, l 5: "As the retrieval uncertainty for drizzle within cloud is comparable to the uncertainty for drizzle below cloud base,...": The error bars for drizzle above cloud base are much larger and thus the retrieval uncertainty.

Technical corrections 1) p.5, l7: underlying 2) Figure 1: please set vectors in bold, e.g. Wc (that should be a profile, right?)

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 1833, 2015.