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Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "Determination of optical and microphysical properties of thin warm clouds using ground based hyper-spectral analysis" *by* E. Hirsch et al.

**Anonymous Referee #1**

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Review of Hirsch et al. "Determination of optical and microphysical properties of thin warm clouds using ground based hyper-spectral analysis"

The authors describe an interesting new technique to retrieve droplet effective radius of very thin liquid water clouds from ground-based spectral measurements in the IR window region. The method is based on techniques developed for the detection of aerosol and trace gas plumes. It is described very systematically from theory over method development and sensitivity analysis to experimental validation using a droplet generator. Especially the latter is a most interesting aspect I've hardly ever seen in



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cloud remote sensing before.

Weaknesses, in my opinion, exist mainly in the weak discussion of the relevance of the object of study and of the limitations of the method. While the former might have been neglected due to the fact that little attention was payed to the subject of very thin clouds by the scientific community before, the latter is clearly presented in the manuscript, but nonetheless hardly stated in the final discussion section.

I recommend the acceptance of the manuscript to AMT after some changes.

Major issue 1 - limitations of the method

page 9, line 16 and following: You already state here that even for monodisperse droplets the capability of the retrieval might be limited to size derivation for very small droplets only.

page 11, line 3: Again you state that you only expect to be able to seperate the size for droplets smaller than 3 micron with your retrieval method.

page 22, line 16-22, figure 22: Once more, the accuracy of your method seems to be limited. Retrievals larger than 3 micron are mostly off by up to 50%, often they are even not within your range of 10 most likely solutions, and for the largest particles the range of possible solutions covers the whole possible size range. I find your statement somewhat over-positive.

section 5 And again, I find your summary/ discussion overly optimistic given that you encountered some decisive weaknesses of your retrieval (and admitted to it throughout the largest part of your manuscript). Your method is limited to quantitative results for the size range up to 3 or 4 microns. Above that you can only see that droplets are of large typical cloud droplet size. Talking about the "twilight zone" near clouds, this is would be still very interesting information. Please clarify.

Major issue 2 - aerosol sensitivity test



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page 17, line 28: Now you are applying the 50 m layer method, I was already confused about for water vapor (see later issues), to the aerosol. This, in my opinion, is not a hard test for your retrieval, although you state it repeatedly. In contrast to the water vapor, you do not have a chance to get a good estimate of the aerosol situation in retrieval situtations (or do you expect that?). Thus the 50 m thick "dust storm" like aerosol perturbation you test is less critical, and maybe optically less thick, than a ususal but unknown summer aerosol situation in the whole boundary layer of say 1500 m. Thus I don't find this "obvious" (page 18/line 2). Please change this test or convince me and other readers that you don't have to.

Major issue 3 - relevance of very thin liquid water clouds

page 4, line 24: I noticed here and somewhere later that you do not give a maximum optical thickness value? See also later issue (page 10). What is the upper optical thickness limit of your method? Could you please add it or comment on it.

page 10, line 5: Miles et al. (2000) show mean effective radius smaller about 2.5 mu only for two out of hundred cases! This leads to the decisive question whether you develop a technique for something worth measuring. I think yes, but you might want to discuss the issue in more detail.

page 10, line 6: I would very much prefer to see a 2D probability density function of Miles et al (2000) data and of your selection of forward setups. This could replace Figure 6 completely and add important information to tables 1 and 2.

Other issues:

Page 4, line 17, "The purpose ...": What are the properties you want to talk about? Please state here. Reading on, I have the impression that you should retrieve optical thickness in addition to the effective radius. Isn't optical thickness the most important information? Can you comment on the problems doing so?

page 5, line 1: I can not remember that I find this structure - "1. indentify physi-



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cal phenomenon", "2. best solution" - in your later retrieval description. Please correct/comment.

page 5, section 2.1: Please state clearly in the beginning of this section, that you first look at monodisperse droplet sizes and only later on realistic size distributions.

page 6, line 24: I have no idea what "standoff detection" is. Might be my personal problem and totally clear to everybody else. But if not, could you add a comment?

page 8, line 18: Can you please clarify what "inactive" "stable" weather is. Stable inactive weather could mean weeks without sun and thick fog and stratus clouds. Which is probably not what a Israeli summer is like.

page 9, line 14, Fig 5 and all following "cross SAM" plots: Can you introduce this tool with a few more sentences here. What is a good cross-SAM value? Later on page 13, line 23 you state "10°" and promise more details in section 4 (which are not given there, as far as I remember). Please state it here. You might even add a line to the cross-SAM plots.

page 9, line 21: Please avoid the abbreviation of the unit "micro-meter" to just "mu" (mu being the greek single letter). Better write "mu m" as in line 19 on this page.

page 11, section 2.4, Figure 8: Do you need figure 8, if you repeat the same things in the text "A" ... "C" here?

page 15, section 3.2.1: I first wondered why you chose the very exotic variation of water vapor in a 50 m layer just beneath your cloud and not situations with vapor content changing over the whole sub-cloud column. Later I understood that your general requirement is that you need to know the background vapor profile anyway. Thus you only check the impact of fluctuations in water vapor between your local situation and nearby soundings/ pre-calculated soundings. Right? (1) This all does not become very clear here. Please clarify. (2) The systematic check how your retrieval might be impacted by vapor profiles which are not part of your forward data set is only discussed



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in 3.2. Think about moving section 3.3 in front of 3.1.

page 16, line 22 ... and figure 13: Might be better to give the liquid water path values instead of a arbitrary LWC in your 50 m layer.

section 4, page 21, 2nd paragraph: From this discussion the question arises whether there should not be a section 3.4 "Sensitiviy to droplet size distribution shape". Please think about it. At least show something on the size of errors caused when you apply a mod-gamma distribution derived retrieval on the admittedly unusual spray distributions.

Technical corrections:

page 12, line 14, wording: "method's range" should maybe be something like "method's range of application". page 17, line 2: "Apart the" -> "Apart from the" page 18, line 9: "that" -> "than" page 21, line 6: "above" -> "over"

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Interactive comment on Atmos. Meas. Tech. Discuss., 4, 7277, 2011.