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Interactive comment on "Testing remote sensing on artificial observations: impact of drizzle and 3-D cloud structure on effective radius retrievals" *by* T. Zinner et al.

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Thank you for your review. We first cite the your point of critic in " " and reply to it after the "–>"

1) " Authors used LES generated cloud fields and a Monte Carlo model to investigate whether or not the presence of drizzle affects the cloud droplet size retrieval by MODIS. Through their detailed simulations, they concluded that drizzle unlikely affects cloud droplet retrieval. While the result is welcome to those who retrieve cloud droplet from passive instrument observations, the presentation of their results is not well organized. As a result, how the authors derived such conclusion is not clear. The optical thickness

of the base case is ranging from 7.8 to 9.4. The authors state in the abstract that "the optical thickness 8 to 9 is large enough to mask the drizzle". But using only 1 case, how do the authors derive this conclusion? "

–> We tried to emphasize that this is not a systematic study of many cases, but a detailed case study (with 3 cases) in a first try to identify underlying physics of drizzle impact on passive droplet size retrievals. This is why the title starts with "Testing remote sensing on artificial observations:" and we state in the Discussion "In this respect, this work has to be seen as a first step". We wanted to emphasize the potential of such an approach and not give the final answer to the scientific question in the second part of the title. Nonetheless we tried to make that more clear in the introduction as well as in the disccussions section. Specifically: We replaced the statement "the optical thickness 8 to 9 ... mask the drizzle" which might have been too general, as we did not check this exact relationship. You are right.

2) " In addition, Table 4 shows a similar retrieved size with and without drizzle for all three channels. However, the retrieved size for all channels are significantly different from the true value (especially 1.6 and 2.1, if I am reading the level correctly. I am not sure, however, what 0.86/1.6, 0.86/2.1 mean). Is it possible that the retrieved particle size difference with and without drizzle for all three wavelengths is masked by a large optical thickness error? The 1D case with and without drizzle does not show a large retrieved size difference either despite the abundance of drizzle particles in this case. The result that the retrieved size in the 1D case does not change by the presence of drizzle makes wonder if this is the right cloud field to asses the 3D effects on the size retrieval with drizzle."

–> Most important misconception: Table 4 is not about the stratocumulus but the broken cumulus case. In this case our argument is not that optical thickness is masking the drizzle, but this is happening mainly through retrieval peculiarities. This is already discussed in detail in the text (original manuscript sec. 4.3.2, paragraph 2+3 and sec. 5). Specifics: we changed the tables and their captions, following the comment on the meaning of "0.86/1.6, 0.86/2.1".

3) " If the question is whether or not 1D retrieval is affected by a presence of drizzle, you need to change a size of drizzle particles and optical thickness using a plane parallel cloud and see the retrieved particle size as a function of drizzle particle size and optical thickens. "

–> We have chosen a different approach, deliberately not the approach of generating simplified 1D cases. The problem with a 1D plane-parallel test is that you have to constrict it to variations in one or two parameters or you could write another paper on the topic. You could and should at least vary the values drizzle and cloud water and its profile, as well as the drizzle and cloud effective sizes and their profile which gives you a large number of cases. And the core question, which stays unanswered then, is whether theses cases appear in nature. We show, that in a typical realistic case the drizzle impact is not visible.

4) " In addition, earlier studies (Marshak et al. 2006 JGR; Kato et al. 2006 JGR) show that the retrieved cloud droplet size using a coarse resolution (500 m in this case) is larger than the true value. The result for without drizzle shown in Table 4 contradicts with results in earlier studies. The part of the reason for a larger particle size is a smaller retrieved optical thickness. Because the reflectance at a near IR wavelength saturates at a smaller optical thickness than the reflectance at a visible wavelength, a larger particle size is needed to match the observed reflectance at a near IR wavelength for a given optical thickness retrieved at a visible wavelength. "

–> This question is related to the one in 2) as you also point out Table 4 results for the broken cumulus scene. The reason for these differences to the cloud studies you cite is that this is a specific cloud+precipitation situation, although not uncommon for drizzling cumulus. Marshak or Kato et al investigate small scale variations of effective radius for cloud sized particles within large pixels (for which you describe the two-channel effects), the impact of resolved effects of illuminated vs. shadow retrievals, or the clear

sky contamination issue. All this is done for exemplary, not operational retrievals (e.g. assumptions on cloud/cloud free detection etc.). In contrast, we investigate the impact of precipitation size particles on a real retrieval. That means the reason for the lower COT and REFF is mainly due to the very peculiar precipitation covered areas not covered by clouds and the reaction of the MODIS retrieval to it. The large drizzle droplets dominate our average true value, but at the same time the majority of the drizzle covered pixels with no cloud sized particles in it is not visible to the MODIS retrieval. Correctly, these areas are too dark to be considered qualified for a cloud droplet retrieval by the MODIS algorithm. We tried to add these additional considerations in sec. 4.3.2 (original manuscript).

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