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Comment on amt-2021-7

Anonymous Referee #1

Referee comment on "Evaluation of satellite retrievals of liquid clouds from the GOES-13 imager and MODIS over the midlatitude North Atlantic during the NAAMES campaign" by David Painemal et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-7-RC1, 2021

Review of "Evaluation of satellite retrievals of liquid clouds from the GOES-13 Imager and MODIS over the midlatitude North Atlantic during NAAMES campaign", by Painemal et al.

The authors compare effective radius (r_e) and optical depth (τ) retrievals in low liquid water clouds from in situ and remote aircraft observations with retrievals from satellite observations. The aircraft retrievals are r_e from a Cloud Droplet Probe (CDP) and both r_e and τ from the NASA GISS Research Scanning Polarimeter using observations at 2.26 μm (r_e) and 0.865 μm (τ). RSP r_e is retrieved using a polarimetric technique while τ is retrieved using a standard reflectance-based method. The satellite cloud retrievals are from GOES-13 and MODIS (Aqua and Terra) using CERES Edition 4 algorithms which use a visible channel and a near IR channel (3.79 μm for MODIS, 3.90 μm for GOES-13). The differences between the various datasets are presented and discussed. Both satellites r_e are larger than aircraft r_e. GOES-13 r_e is notably larger than MODIS r_e, and the authors show that the difference increases towards the backscattering direction. The hypothesis is that for this geometry of observation, retrieved r_e depends on the prescribed effective variance of the size distribution used in the satellite algorithms, which might not be well adapted.

The results presented in this manuscript are of interest for the scientific community. However, I think that the main comments below should be addressed before the manuscript can be published, and I also suggest considering the specific comments.

Main comments

1) The authors state that the RSP r_e retrievals are at 2.26 μm (line 105, page 4). I could not find information about retrievals at 2.26 μm using the polarimetric technique in the various references. The authors should give more details about the retrieval technique,

and perhaps explain why this channel was chosen to retrieve r_e.

2) How do the authors justify that the RSP r_e retrievals at 2.26 μm are mostly sensitive to the cloud top (optical depth ≈ 1) (lines 176-177, page 6)? Based on the work by Platnick (2000), they state that 3.79-3.9 μm satellite r_e is representative of about 2 optical depths down from the cloud top (line 161, page 5). Stating that the RSP retrievals at 2.26 μm are weighted higher in the cloud than the satellite retrievals at 3.79-3.9 μm seems inconsistent with Platnick (2000). Please explain.

3) I believe that a discussion regarding the expected differences between retrievals at 2.26 μm (RSP) and 3.70-3.90 μm (satellites) is missing.

4) The authors state that post-deployment evaluation of the CDP probe showed that there was an overcounting of droplets for all bins (lines 94-96, page 3) and that as a result, CDP could provide only r_e, but not water content, extinction coefficient, and cloud droplet number concentration. Therefore, I don't understand how the authors could determine the $\tau = 2$ altitude level from the top to determine CDP cloud-top r_e (lines 166-167, page 5). Please explain.

5) The authors mention the presence of supercooled liquid water clouds during the cold months when they present the airborne observations (line 85, page 3), and in the conclusion, they state that both supercooled and warm boundary layer clouds are a climatological feature (lines 331-332, page 10). However, I do not see any discussion on this topic in the presentation of the results. Why is this important? Are the comparisons different for supercooled and water clouds? Please develop.

Specific comments

Abstract, line 18: I suggest specifying in the abstract which GOES-13 and MODIS (Aqua and Terra) products are used for the study.

Introduction or where relevant: please define "effective radius".

Lines 70 and 84, page 3: I found that Fig. 1 was not very informative because too small. I would suggest 1 panel per campaign with the associated mean Aqua "cloud cover". It looks like the caption should actually say "low cloud fraction".

Line 85, page 3: please explain how RSP data could confirm the presence of supercooled

cloud tops during the cold months. During which campaign(s)?

Line 150, page 5: Please describe the CERES SSF product and provide a reference.

Line 193, page 6: The authors give an overview of the cloud vertical structure during the campaign. Is it for only one of the 3 campaigns? If yes, which one? Please clarify. Should results for warm clouds and supercooled clouds be shown separately?

Line 195, page6; Fig. 3: the authors state earlier in the text (lines 86-87) that cloud sampling was limited to boundary layer liquid clouds with a mean cloud top height of 1376 m±602 m (± standard deviation). What about cloud base?

Lines 287 to 290, page 9: this discussion is difficult to follow without an illustration or at least a reference.

Lines 321-322, page 10: please explain how the effective variances shown in Fig. 12 (not Fig.11) were retrieved. Is it from RSP or CDP?

Technical comments:

Line 140, page 5: “east-west” => could be rephrased.

Line 321-322, page 10: Fig.11 should be Fig. 12

References: the format does not seem compliant with AMT specifications.