

# ***Interactive comment on “Ship and satellite observations over the ocean for verification of the shortwave cloud radiative effect in climate models” by T. Hanschmann et al.***

*Reply to the review of Anonymous Referee #3*

*First of all, we thank anonymous referee #3 for his/her comments on our paper.*

*We will provide our response to each comment in the following. The comments of the reviewer will be shown in regular letters and our reply will be shown in italic red letters.*

1) p.17747, ch.2.1. ship measurements (I)

- with regard to ship movement and salt coating on the radiometer dome a constant measurement error of 4% for hourly means is assumed. Might it be favorable to consider wave height and/or meteorological conditions to reduce uncertainty at least in fair weather conditions?

*Indeed, for our cruises wave height information are only available at an interval of 3 hours from meteorological observations and ship movements are stored every second. Thus, considering meteorological conditions is an interesting idea. However, we think that the main uncertainties arise from coating through sea spray and sea salt and even stronger from the reflection and shadowing effect of ship superstructure, which in turn depends on the location of clouds and the sun with respect to the orientation of the ship. Note that fair weather conditions mostly occur in sub-tropical regions with broken trade wind cumulus clouds. Therefore, measurement errors might be even larger under these conditions. We changed the related sentence in the manuscript to:*

*“Due to ship movement and salt coating on the radiometer dome and also from shadowing and reflection at the ships super structure which in turn depends on the location of clouds and the sun with respect to the orientation of the ship measurements have likely a slightly degraded accuracy compared to land-based operation”*

2) p.17748, ch.2.1. ship measurements (II), cloud fraction from TSI vs observation

- ‘for the majority of the images ...’: even though it is related to another publication - SYNOP is often used as reference observation but several investigations in the past revealed that there are some weaknesses in dedicated atmospheric conditions too. TSI algorithm might suffer some limitations too, how is that handled? Concerning shaded pyranometer data, are they substituted by calculated quantities? (last sentence not clear)

*The TSI algorithm performs with lower accuracy mainly during times of low sun. These cases are excluded from our study as we consider only observations with a cosine of the solar zenith angle larger than 0.15. After visual inspections of the sky images we also remove pyranometer measurements when the sun is behind the ship superstructure. In figure 3 these time frames are marked by the gray bar as “missing input”. We did not substitute these periods by calculated or interpolated quantities.*

3) p.17749, ch.2.2 satellite based estimates

- the discussion on uncertainties of satellite retrievals refers obviously to accuracy estimates of climate variables, i.e. daily or monthly sampling intervals. For this study instantaneous data are utilized. How it is assured that the referred numbers are valid for the high-temporal-resolution data too?

*CM SAF references always refer to daily- and monthly mean values. We only consider daily means here. For the LWP the accuracy of the KNMI LWP-retrieval is used, which is the algorithm used for the CM SAF LWP datasets (Roebeling et al. (2008)). These are instantaneous data.*

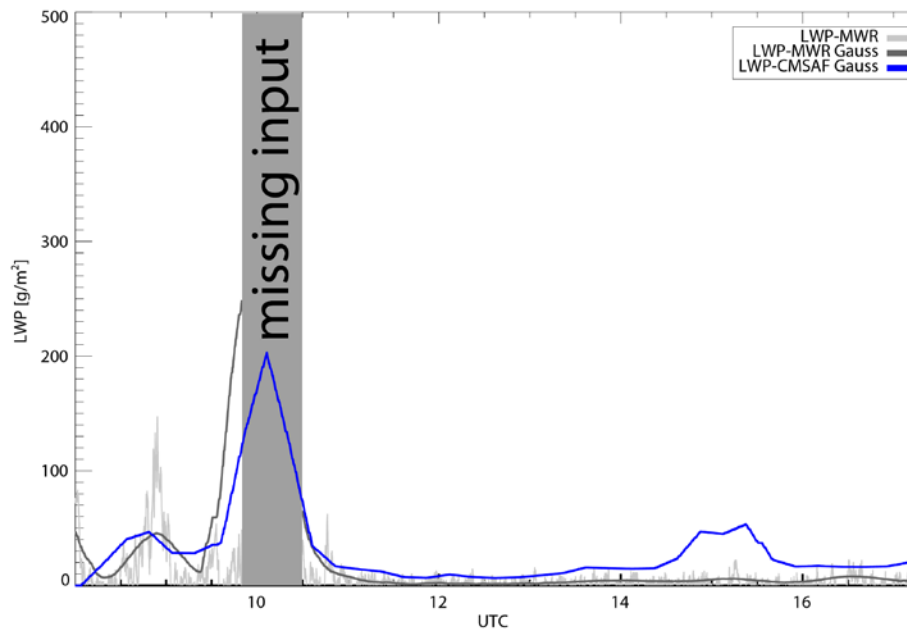
**REFERENCE:**

Roebeling, R. A., Deneke, H. M., and Feijt, A. J.: Validation of cloud liquid water path retrievals from SEVIRI using one year of CloudNET observations, *J. Appl. Meteorol. Clim.*, 47, 206– 222, doi:10.1175/2007JAMC1661.1, 2008. 17748

4) p.17751, ch.4.1 reference to figure 1

- the curves indicate the usability of the weighting techniques applied. But some questions arising: CMSAF data should be there around 10, even if MWP is not. If sun is below the horizon no CMSAF data can be calculated, thus 'no data', not zero should be drawn. Is there an explanation concerning the somehow mismatching behavior around 15?

*First of all, we agree that the CM SAF LWP should not be zero during night time and we will shorten the x-axis to only show daytime data (figure 1).*



**Figure 1: LWP comparison from microwave radiometer and CMSAF. Figure 1 in manuscript with redefined x-axis**

*The increased CM SAF LWP likely results from a broken cloud field passing the scene above the closed cloud cover. This might not be captured by the microwave radiometer but increase the reflectance of solar radiation.*

5) p.17752, ch.5 , item 1

- "atmosphere in the model is completely described by ship-based measurements", maybe intention here is to say described by ship-based measurements only' (?). Pls clarify.

*Thank you for mentioning this. Your phrase does sound better and we will change the manuscript accordingly.*

6) p.17754, ch.5, line 7

- "... well captured by all experiments with PS-RSAT being slightly better than the other experiments". The statement refers to figure 3a. I can't comprehend - did you use more information than is shown in the figure, pls. explain.

*The general curve of the SWCRE in figure 3a of the manuscript is well captured by all experiments for the time period until 12 UTC. All experiments show over-/ or underestimation before and after the missing input period. The experiment PS-RSAT shows a slightly better performance than some of the other experiments, but we also have to agree that this is also true for other experiments such as CM SAF. We will remove the second part of the sentence from the manuscript.*

7) p.17755, 2nd passage

- "... no systematic differences are found using ship-based or satellite-based cloud properties ...". In fact there were found differences (of course - no one would expect a perfect match), how can be excluded systematic deviations at this stage of evaluation, or asked different: how do you define a 'systematic deviation'?

*We found differences in our results as shown in table 3 in our manuscript. But, we could not identify a systematic behavior in the results, such as generally degrading accuracy when using satellite-based cloud property data.*

*To clarify, we have replaced the phrase "no systematic differences" by "no clear quality differences" in the manuscript.*

8) p.17756, next to last sentence commencing with "Furthermore ..."

- What cloud cover source is suspected to be biased in relation to what. "cloud side scattering" (coulisse effect is meant ?) is apparent in human observations too. What about parallax correction in SEVIRI data and does that solve the problem comprisingly ? Pls. clarify.

*To address the comment on cloud side scattering and cloud fraction bias we rewrite the sentence in the manuscript which makes our expression more clear:*

*"Furthermore, the cloud cover used in this study is derived from the sky imager for pixels with a wide range of observation zenith angles. Hence, it may be biased relative to zenith view for broken clouds with large vertical extent due to obscuration by cloud sides and is affected by clouds which have little relevance for radiation e.g. opposite to the sun and far away at the horizon."*

*The parallax correction was considered but since our observations are made close to the sub satellite point (less than 45° and mostly less than 30° viewing zenith angle) and because spatial averaging is performed this correction has not been expected to significantly improve the accuracy, in particular due to the lack of reliable cloud top height information (the inversion of low-level maritime Sc causes difficulties for passive satellite retrievals)*

9) Editorials/typos:

p.17751, 5th line: obtained

p.17752, 5th line: information

p.17754, 7th line: better than

p.17757, next to last line: reduce the limitations

*Thank you for noting these typos. We will change the text accordingly.*