**Atmospheric
Measurement
Techniques
Discussions**

Interactive
Comment

Interactive comment on "Detection and characterization of drizzle cells within marine stratocumulus using AMSR-E 89 GHz passive microwave measurements" *by* M. A. Miller and S. E. Yuter

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Received and published: 16 November 2012

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Reviewer's Comment

. . . I would have liked the paper to be more quantitative in the comparison with radar, AMSU-LWP and MODIS data. In particular this concerns the size distribution. The reader should get a better understanding of the limitation and advantages of the different products.

Though I realize that the comparison with radar data is not trivial I would urge for a quantitative analysis of Fig. 3 or even better including more available radar data. The simplest would be to average the radar data onto the AMSR grid, apply a dBZ threshold and derive HIT and FALSE Alarm rate (or any other skill core). Best would be to plot these as a function of threshold. Using a standard Z-LWC relation an indication of the detection limit of drizzle amount can be gained - you can even show LWC on the upper axis. Of course to be really correct one should also account for the loss in sensitivity with distance (about 9 dB over 30 km) and the increasing height (volume) of the radar beam with distance. What was the elevation angle? However, I am fine to leave these radar characteristics out as they unnecessarily complicate things.

Authors' Reply

Per the reviewer's suggestion, hit, miss, and false alarm statistics have been added for the case where the ship-based radar data was interpolated to the AMSR-E data.

Reviewer's Comment

Fig. 8 is rather important as it summarizes the advantages of the new drizzle product. I do not understand why not all cases are combined to get better statistics. In the end you want to give a clear information on the quality of your algorithm, e.g. "80

Authors' Reply

Figure 8 is intended as a proof-of-concept figure that shows that the drizzle detection algorithm can be used to quantify information on the size of drizzle blobs and to compare the data to other potential methods stemming from different input data to give a general picture of the strengths and weaknesses of the methods. We feel that expanding such an analysis would be inappropriate for this paper. We haven't included enough data to draw robust conclusions. We have research in progress which is using the drizzle detection algorithm to compile a more complete climatology of drizzle cell size, number, and frequency of occurrence for different regions of subtropical stratocu-

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mulus.

Reviewer's Comment - Minor points:

Reviewer's Comment

Title: It needs to be mentioned that it only works for heavy drizzle

Authors' Reply

This change has been made.

Reviewer's Comment

Abstract: I would move "Clouds containing ice are screened out." one sentence up. Or you even don't need it if you somewhere say that you focus at warm clouds at moderate SSTs. I would like that as I find the sentence that background temperature is constrained by IWV and SST misleading. The only way you take SST into account is by focusing on a limited SST range.

Authors' Reply

The wording in the sentence mentioning IWV and SST has been altered.

Reviewer's Comment

Page 4574 line 9. It is not clear if also a MODIS nighttime LWP product is used. Without solar reflectance information the quality is strongly degraded and therefore should not be used! As ViS is shown for the three sample cases (Fig.4) this should not be a problem.

Authors' Reply

The LWP product is not produced at night as we state in Section 1. This is why the

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cases in Figure 5, 6, and 7 are daytime cases. This also illustrates a niche filled by our drizzle detection product since it works at night.

Reviewer's Comment

Page 4575 line 20. Saying that the horizontal TB is used because it is less noisy is misleading as it points at an instrument problem. In fact the ocean emissivity is lower for horizontal than for vertical polarisation and therefore the dynamic range is higher.

Authors' Reply

It is not our intention to imply an instrument problem. When visually comparing the two TB channels, it was clear that there was noise in the vertically polarized channel that did not obviously correspond to any underlying meteorological feature. We do not know what the source of the noise is or if it is or is not expected in the vertically polarized channel. We also added a sentence with citation noting the higher dynamic range of the horizontally polarized channel.

Reviewer's Comment

Page 4576, line 6 Please check the AMSR specification. With an antenna size of 1.6 m the resolution is 14 x 8 km at 36.5 GHz and 6 x 4 at 89.0 GHz. I am pretty sure that the LWP product also includes the 23.8 GHz channel which must have worse resolution than the 36.5 GHz channel. This implies that the real resolution of the standard LWP product is worse and emphasizes the advantage of your algorithm. Anyway note that an LWP algorithm making uses of different frequency channels with different footprints interpolated to a fixed grid probably is not well suited to identify cell structures.

Authors' Reply

The documentation (http://nsidc.org/data/docs/daac/ae_ocean_products.gd.html) states that the LWP product is provided at the resolution of the 36.5 GHz footprint.

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The LWP product is calculated using data from the 19 and 23 GHz channels. The data from lower frequency channels tend to have smoother gradients because they are less sensitive to cloud water than the 36.5 GHz channel. While we don't know for certain what the impact of reducing the foot prints of these lower frequency channels is, we feel that it is best to rely on the documentation provided by the algorithm's creators unless given a compelling reason to do otherwise.

Reviewer's Comment

Page 4576, line 15. The sentence about dBZ and LWP is not strictly correct. Wood et al say "..with peak values of liquid water path at the center of the mesoscale cells exceeding 400 g m−2 and a mean LWP of 150–200 g m−2. Our observations from RF06 are indicating that this surrounding cloud contains significant cloud base precipitation. Since elevated LWP is known to be associated with enhanced precipitation in marine stratocumulus." The connection between LWP (integral) and cloud base precip is missing - so it depends where the radar beam hits the "drizzle" (see also Woods Fig. 13). Maybe it is worth mentioning that 0 dBZ relates to 1 mm diameter drop in a cubic meter or 1 million of 0,1 mm drizzle droplets - so it is all about the occurrence of a few larger drops...

Authors' Reply

Figure 13 of Wood et al. (2011) places the point of 0 dBZ and LWP of 200 g/m^2 in the overcast regime. The transition regime would have a higher reflectivity for the same LWP as it is more prone to precipitation as shown in Figure 12 of Wood et al.. Our aim in justifying a 200 g/m^2 LWP threshold is to create additional context for our definition of heavy drizzle and to justify using that threshold in our comparisons to MODIS CWP and AMSR-E LWP data. The Wood et al. data and data from other studies we cite in Section 2.2 suggest that 200 g/m^2 LWP is a reasonable threshold for heavy drizzle. In a conservative precipitation regime like the overcast area that Wood et al. describes, drizzle is likely at 200 g/m^2 LWP. For other regimes, drizzle is even more likely. It's

worth noting that Figure 12 from Wood et al. uses maximum Z value from a vertically
pointing cloud radar. An average Z value would correspond to a higher LWP value
than that figure would indicate for a maximum Z value and would better correspond to
the values you would expect for a C-band radar with a larger sample volume than the
vertically pointing cloud radar used in Figure 12 from Wood et al..

Reviewer's Comment

Page 4576, line 19 I think the Comstock reference has the wrong year Page 4577, line
2 reference for O'Connor is missing

Authors' Reply

Fixed/bigskip

Reviewer's Comment

Page 4578, line 19 IWV should be kg and probably in Eq (1) as well – note global
average is about 25 mm or 25 kgm-2.

Authors' Reply

Fixed in the places mentioned and in Figure 2.

Reviewer's Comment

Page 4579, line 10 onwards You need to give the resolution of the MODIS cloud top
and the AMSR SST product. The latter must be based mainly on the 6.9 GHz channel
which has coarse resolution. I don't see any problem to downscale the SST but you
should mention it and also that SST is a smoothly varying parameter. Why did you
choose to take the mean cloud top and not the minimum or some percentile?

Authors' Reply

We noted the resolutions of the various input products in Section 2.2.2. In examining

the text, we find no mention of mean cloud top and we are not sure what you are referring to. Please restate your comment.

Reviewer's Comment

Page 4579, line 25 A lot of drizzle features are mentioned here so I was disappointed to only see a simple area distribution in this paper. Maybe say here that you later will show exemplary the size distribution.

Authors' Reply

This list is included as an example of a few of the things we could compute with connected component information for the drizzle detection product. Since this is a proof-of-concept paper, our goal is to communicate potential utility. Comprehensive analysis is beyond the scope of this paper, but is underway for publication in follow-up articles.

Reviewer's Comment

Page 4582, line 17 Say why you know that there is cirrus.

Authors' Reply

We state in the manuscript that the cloud top temperature product indicated cloud tops colder than 273 K. Examining the visible image in Figure 4b suggests cirrus.

Reviewer's Comment

Table 1 Why not exchange columns and lines and then add total number of detected cells and average (median) size.

Authors' Reply

This table has been reformatted and the suggested additions added.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 4571, 2012.

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