General comments

This manuscript presents a new technique for obtaining cloud and drizzle liquid water path by combining multi-channel microwave radiometer, Doppler cloud radar and ceilometer measurements. The new technique is applied to observations of precipitating stratocumulus clouds and evaluated qualitatively by comparison with Doppler cloud radar spectra.

The technique shows great promise and will aid the community investigating the properties of stratocumulus by providing a new piece of information, although the full potential is not explored deeply in this initial study. This manuscript is almost ready for publication, with a few technical aspects to correct.

Thank you for the review and the kind words. We hope to perform a more extensive study in the near future on the impact of these results on aerosol-precipitation interactions. Our responses to your comments are below in red.

Technical comments

Line 18: Replace 'exists' with 'exist'. Accepted.

Line 22: Suggest opening with 'Marine stratocumulus clouds have a significant impact on the Earth's radiation balance as they reflect a greater amount of solar radiation back to space compared to the ocean surface, and emit a similar amount of longwave radiation as the surface.' Accepted.

Line 26: Replace 'Feingold and A. McComiskey 2016' with 'Feingold and McComiskey 2016'. Thanks for catching that. It has been replaced.

Line 31: Move comma from after 'properties' to after 'instrumentation'. Accepted.

Line 32: Do you mean moments here, or would it be more realistic to state 'the shape of the drop size distribution'? Otherwise you should explain what you mean by moments in this context.

We have replaced the sentence to read. "From the point of view of ground-based instrumentation, the study of microphysical and macro-physical cloud properties involves combining data from multiple instruments to retrieve parameters of the hydrometeor drop size distribution (DSD). For example, the radar reflectivity is proportional to the sixth moment of the DSD and was used to retrieve liquid water content that is the third moment of DSD by Frisch et al. (2002)."
Thanks.

Lines 35-36: This statement needs some qualification. Review papers discussing LWP estimation from multi-channel microwave radiometers usually state that care must be taken in the presence of precipitation, and that LWP estimates are not reliable in strong precipitation.

We agree with the reviewer and clarified this statement in lines 53-57. Added 2 references on the topic (Wall et al., 2017 and Bosisio et al., 2013).

Line 58: Replace 'since summer of 2015' with 'since the summer of 2015'. Done-Thank you

Line 61: Suggest stating 'reflectivity-weighted Doppler spectrum'. Done

Line 61: Replace 'Collocated to' with 'Collocated with'. Done

Line 63, 75, 92 and elsewhere: *Replace 'backscatter' with 'attenuated backscatter'*. Done for all instances. Thanks for pointing this important difference.

Line 71: The correct reference for 'auto-calibration of cloud lidar' is O'Connor et al. (2004) not (2005). Done

Line 103: Lidar ratio for cloud droplets at 905 nm is about 19 sr, and is even lower for larger drizzle droplets. Changed

Line 104: The ceilometer attenuated backscatter peaks at cloud base due to the large return from the small but much more numerous cloud droplets, relative to drizzle droplets. Changed

Line 106: Do you mean here, 'the average modal diameter of the full drop size distribution including drizzle drops and cloud droplets'? How reasonable is this assumption considering that these are two distinct hydrometeor populations, normally giving rise to a skewed distribution if they overlap?

Yes, and we agree with the reviewer that this is not the optimal solution. This assumption was very much debated among the authors and we resorted to this option because there is really no sensible way of separating the two distributions. This assumption was only used in the passive retrieval as a way forward to constrain the drizzle size in the cloud. It may require a separate study to understand how optimal this assumption is. In a recent study Glienke et al. (2017) pointed out that the cloud and drizzle distributions are almost in a continuum in marine stratocumuli. However, as they are measured by separate in situ probes, and modelled through different processes, the cloud and drizzle DSD are often assumed to be separate.

Glienke, S., A. Kostinski, J. Fugal, R. A. Shaw, S. Borrmann, and J. Stith (2017), Cloud droplets to drizzle: Contribution of transition drops to microphysical and optical properties of marine stratocumulus clouds, *Geophys. Res. Lett.*, 44, 8002–8010, doi:10.1002/ 2017GL074430.

Line 161: Small drizzle drops may not display a negative Doppler velocity if they are falling into a strong updraft. It is true to state that drizzle drops have a significant terminal fall velocity, but the observed Doppler velocity is the sum of the fall velocity and the air motion.

Thank you for raising this point and we agree with the reviewer that drizzle drops falling in updraft will not fall and rather go upwards, and the radar reported mean Doppler velocity is the sum of the droplet fall velocity and the air motion.

However, we resorted to converting the Doppler velocity to diameter as i) the focus of this study is on (relatively) larger drizzle drops with diameters greater than 100 micrometers that scatter radiation from the cloud and have fall velocity of 0.3 m/s spanning six Nyquist velocity bins ii) the Doppler spectra are averaged on minute timescales in an attempt to minimize the contribution from turbulence, and iii) for the cases analyzed here we didn't encounter a Doppler spectra entirely on the positive velocity.

The sentence has been rephrased as follows: "The methodology is based on the fact that the Doppler spectra of a non-precipitating cloud is centered on zero mean velocity due to their movement with turbulence, while that containing falling drizzle drops is negatively skewed due to their fall velocity. Hence, the presence of drizzle drops in a cloud introduces a negative skewness in the cloud Doppler spectra."

Line 167: Suggest using the term 'drizzle shafts' here and elsewhere in the manuscript. Done.

Line 176: Suggest rephrasing to '.. are as negatively skewed as the Doppler spectra at cloud base'. Accepted.

Lines 177-178: The terminal fall velocity of cloud droplets is very small, and their observed Doppler velocity distribution is a result of turbulence. Added.

Line 185: Not quite true. For Rayleigh scattering, reflectivity is proportional to mass- squared, but the larger drizzle drops are in the Mie scattering regime.

The reviewer is correct that for large drizzle drops that are under Mie scattering regime, the radar reflectivity is not proportional to mass-squared. Our forward model calculations show the Mie-to-Rayleigh backscatter ratio to be 1 for diameters below 400 micrometers, increasing to 1.2 for diameters of 1000 micrometers at Ka-band wavelength (Ghate and Cadeddu, 2019 JGR).

For the drizzle drops analyzed here, we estimate a maximum error of 20% due to this assumption. Further, even under the Mie scattering regime the area under the curve of the Doppler spectra will be still proportional to the mass of the condensate, albeit with a different proportionality than square. We have rephrased the sentence as follows:

"The areas under the final cloud and drizzle spectra (indicated by the red and yellow stripes respectively) are proportional to the total mass of cloud and drizzle liquid water responsible for the radar signal under the Rayleigh scattering regime with some modifications during Mie scattering regime."

Line 264: *Do you mean in-cloud DWP here?* Yes, it was intended above cloud base, we changed it with "in-cloud".

Figure 1: 'together with cloud boundaries from KAZR (cloud top) and ceilometer (cloud base)' 'ceilometer attenuated backscatter coefficient'. Changed

Figure 4: In (a), does cloud LWP include in-cloud drizzle (DWP) or cloud droplet LWP only?
It only includes cloud droplets.

Figure 5: 'Downward motion'. It is not clear how the x-axis is derived.

We used the relationship between size and velocity in Gossard et al., 1990: r=av+b with a=1.4E-4 and b=1E-5. This is now stated in the caption.

Figure 10: The solid line represents the mean of the total LWP measured in each flux divergence bin? How about the bars? The figure caption should be clear.

Thank you, that was forgotten. The caption was rephrased as follows: The black circles connected by a solid line represent the total LWP binned by flux divergence and the vertical bars represent the standard deviation of the data in each bin.