## <u>Review:</u> Radar-radiometer retrievals of cloud number concentration and dispersion parameter in marine stratocumulus

### by

### Remillard et al.

The authors present an update to traditional radar-radiometer methods (e.g. Frisch et al. 1995, 1998, 2002) for the retrieval of microphysical properties in non-drizzling marine strato-cumulus cases using additional constraints provided by a 1D microphysical model. Principally, the idea to include a microphysical model to constrain the retrieval presents an innovative way to at least partially overcome the rather large uncertainties given the uncertainties that occur when relating radar reflectivity to the microphysical properties of clouds (i.e. LWC, N, effective radius…).

Generally, I think the authors must mention (especially in the title and the abstract) more the rather limited range of applicability of their method to non-drizzling strato-cumulus clouds. What percentage of clouds observed at the Azores site are actually non-drizzling? And which published retrievals so far deal with drizzle? (i.e. Frisch et al. 1995 (JAS), O'Connor et al 2005 (JAM), Löhnert et al. 2008 (JTECH)…)

Specific points:

1.) Page 7511, lines 6-10: Please explain the underlying assumptions for the effective radius formula and indicate the uncertainties to be expected from the NFOV measurements / retrieval.

2.) Page 7515, lines 2-6: Please quote the exact equation used from Korolev and Mazin 2003. Is $S_{qs}$ at all dependent on the solute of the droplet?

3.) Page 7515, lines 13-14: The causality of the sentence is not clear to me.

4.) Page 7515, line 19: Mention explicitly the remaining two unknowns.

5.) Page 7516, top: How is the minimization carried out? Explain how the $N_{cld}(z)$ profile is actually derived.

6.) Page 7518, last paragraph: a consistency check the authors could carry out would be to integrate the retrieved LWC over the depth of the cloud and compare this to the LWP measured by the microwave radiometer.

7.) The discussion on page 7519 contains uncertainty estimates due to retrieval and measurements uncertainties. The authors should discriminate better between these two, especially when comparing the Frisch method and the method presented in their study. E.g. temperature, pressure and LWP uncertainties may be regarded as measurement uncertainties, which propagate through the retrieval equations. On the one hand, it is important to compare both retrieval results on the basis of measurement uncertainties. On the other hand, the variation of the lognormal width gives a sensitivity of the results to an assumption within the retrieval. The method presented here also uses many assumptions (e.g. eq. (8) or (12)) related to the pure evaporation growth regarding a rising parcel, respectively the steady state super-saturation approximation. Parameters and approximations used, respectively made in these equations should also be tested towards the sensitivity of the retrieval results if the comparison with the varying logarithmic width are to be fair.

8.) Table A1 should contain all symbols and parameters contained in the paper (e.g. $r_0$, $N_{cld}$, $N_{norm}$…)

9.) Fig. 2 / Fig. 5: The authors should explain the occasional occurrence of $N_{cld}$ values larger than 600 cm$^{-3}$. Why do these cases look "binned" to certain, exact values?

10.) Fig. 3 / Fig. 6: A plot including the effective radius uncertainty would also be conclusive. I would find the errors in sub-plot (c) easier to interpret if they were given in %. Why does the method presented here give a minimum (optical depth), respectively maximum (effective radius) w.r.t. the Frisch method that is varied within the sensible logarithmic width range?

11.) It would be nice if some of these questions could be covered in the Summary / Outlook: What are the next steps in remote sensing of strato-cumulus clouds? Do the authors plan on including drizzle, use a more sophisticated model, and apply the retrieval to continental clouds? Have they thought about further evaluation of their method, e.g. the ARM program?

Further "minor point"

1.) The paper is written and structured in a clear way. However, the figures are too small in this pdf version and thus difficult to read.