

## Reviewer 2

This manuscript presents theory and simulations for deriving Ice Water Content (IWC) and Snowfall Rate  $S$  directly from stand-alone G-band radar reflectivity and Doppler velocity measurements. The derived retrieval is applied to two case studies with measurements from the GRaCE 200GHz Doppler radar at Chilbolton. Retrieved IWC and  $S$  are compared to airborne in-situ IWC and surface gauge measurements, respectively.

The presented retrieval is convincingly introduced by concise simulation and theory. Limitations are well discussed when applied to measurements. The manuscript is timely as it, for the first time, makes use of G-band radar data to derive cold microphysics parameters. I recommend publication with *minor revisions* after the following comments have been addressed by the authors.

***Thanks a lot for your helpful feedback on the manuscript!***

### General comments

- The manuscript contains 9 Sections. In order to make the manuscript structure more compact and highlight connections between the Sections, I recommend moving Sections 5-7 as subsections to Section 4, or combining them in a new Section 5, e.g. labeled: *Sensitivity to retrieval parameters*. For similar reasons, I propose to move the description and discussion of the attenuation correction in Sec 8 (ll 338-366) to a stand-alone subsection.

***We have now added a stand-alone subsection (8.1) to discuss the attenuation corrections considered when looking at the data collected during the two case studies. We appreciate your suggestion of combining Sections 5-7 to make the structure more compact and have given it careful consideration. However, we were unable to come up with a meaningful way to do this as the content in these sections does not all fall under the category of sensitivity analysis. For example, sections 5 and 6 connect the simulation data to the theory. As a practical part of that we see what happens for different scattering models, but the purpose is not purely to vary the scattering model and see the differences.***

- The authors compare retrieved IWC and  $S$  to rain-gauge and in-situ data, respectively. Here, it would be nice if the G-band performance could be further highlighted compared to state-of-the-art empirical relations obtained from “standard” radars operating at Ka- or W-band, to give the reader an idea on advantages compared to other cloud radars.

***Thank you for this idea to further emphasise the value of our new technique. We did begin to explore this idea; however we have ultimately chosen not to include a comparison with empirical relationships at low frequencies. Our reasoning is as follows:***

*The best way to understand the advantage of G-band is expressed in figures 1 and 2, which show that unless  $D_m$  is known a-priori, there are large uncertainties in estimating IWC and S from radar data at lower frequencies. Empirical relationships between these variables and radar parameters at “standard” frequencies like Ka or W band therefore have to rely (either explicitly or implicitly) on statistical correlations between  $D_m$  and Z in order to make a retrieval. These relationships can vary between different geographical regions, different cloud types, even between different regions of a single heterogeneous cloud system. At G-band things are much less uncertain, because the quantity that you measure and the microphysical property you want to know are essentially proportional to the same moment of the size distribution.*

*We did begin to compare some empirical IWC-Z and S-Z relationships to our retrievals in the case studies. We found some similar structures in the data and some qualitative and quantitative differences (some of them large). The challenge then is to interpret what those differences mean. It could reflect the weakness in what these empirical relationships assume about the size distribution parameters, as discussed above, highlighting the benefit of G-band which is insensitive to those issues. But it could also reflect differences in what is assumed about the characteristics of the particles: e.g. a different mass-size relationship inconsistent with our choices.*

*The other issue is that our verification data is imperfectly co-located with our radar samples, and this means that there will always be deviations from any retrieval, even if it were perfect. It is good enough to make an assessment that our retrievals are realistic, but it makes a meaningful comparison of two competing retrievals against the gauge / aircraft data difficult.*

*So, although we agree that this is an interesting practical question, the interpretation of the comparison is more subtle than it first appears, and opens up a number of non-trivial questions which are beyond the scope of this paper, and which we feel would distract from our key findings.*

Minor comments:

- Fig 1: plotted variable name should be added to y-axis label, also L105, 108  
*Fixed this.*
- Figs 9c, d; 10; 13: missing label on colorbars  
*Fixed this.*
- Fig 12 caption: description of colors missing  
*Fixed this.*

Technical Comments:

- L1-4: sentence is very long. I suggest to split into two: [...] proportional to their mass ( $m$ ). Hence, measurements [...]

*Fixed this.*

- L124: snowfall rate  $S$  (italics)

*Fixed this.*