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Atmospheric Measurement Techniques Discussions

Interactive comment on "Microwave Radar/radiometer for Arctic Clouds MiRAC: First insights from the ACLOUD campaign" *by* Mario Mech et al.

Anonymous Referee #1

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This paper summarizes the performance of a new radar, a W-band airborne profiling FMCW radar. While I know how FMCW works, I have no actual practical experience with this kind of radar. My experience is with pulse-pair W-band profiling radars. Also, I am not going to comment on the high-frequency microwave radiometers to retrieve water vapor profiles in cold, dry environments, since that is not my expertise.

The main benefit of FMCW is that it can provide higher sensitivity and range resolution with a low power transmitter by utilizing it with close to 100% duty cycle. However FMCW systems can have issues that are difficult to avoid (see, for example, Delanoe et al, 2016 about their W-band FMCW radar BASTA), and clearly the authors are aware

of these issues.

Slanting the beam at about 25 deg from nadir, I expect, would indeed help with some reduction of the range lobes, but then you need to assume homogeneity in the horizontal in order to provide the vertical plane reflectivity. The paper explains why this slant angle approach is used, but it comes with a trade-off, essentially reducing both horizontal and vertical resolution. Given that the Polar 5 aircraft does not fly more than about 3 km AGL, this is perhaps not that big of a deal. On the other hand, based on the reported sensitivity (Fig. 1), the MIRAC should be able to probe clouds much farther than 3.5 km range, even though such data are not presented.

Personally I have more questions about radar performance issues (e.g., attenuation in liquid and in strong echoes, both of which are rare in the Arctic), but instead of showing more on the radar performance, the paper discusses the airborne radar data processing and multiple coordinate transformation at length. These things are rather standard and have been done before. Yes, I understand that given the slanted beam and wind installation, one need to know the 3D beam pointing angle quite correctly in order to end up with a vertical plane, but it is not as critical since this paper is not doing anything with the Doppler (at least in this paper). I am not sure why the authors discuss it at such great length instead of just mentioning the principle and some references, including the lengthy appendix for things that have been done and published before. Still, it is good to see the steps discussed systematically because it give confidence that it is done correctly, and then other papers can refer to this one.

This radar is an airborne version of a ground radar, and as far as I know, this is the first time a FMCW radar is deployed on an aircraft. For a ground based FMCW radar, a dual-antenna system may not be that much of an issue. For an airborne deployment, I think, bi-static can create problems not counting that you also need more space. With the increasing output power of the latest solid state amplifiers (SSA), I honestly do not see a reason to go with FMCW for airborne cloud radars. The paper cites 1.5 W for the MIRAC W-band SSA, today you can buy a 50 W W-band SSA. For FMCW

radars, the range lobes are a more serious issue than they are for a pulse radar using compression, but I am impressed that the ground contamination is limited to 150 m AGL, at least over the ocean.

This paper, while including some discussion on the radar and its sensitivity, is more descriptive about Arctic cloud properties from data collected during an Arctic campaign (and showing how much better this is than what CloudSat can see). That is fine for journal focusing on the science. But in a journal like Atmospheric Measurement Techniques, I expect to see more elaborating on the FMCW issues, especially for an airborne use, which is novel. For example, the paper describes the filtering they do, but presents just one figure/case to show that the filters generally do the job and get rid of the range lobes interference. Generalization is difficult to really evaluate: what about the areas where those lobes mix with strong weather echoes, and what about complex terrain? Thus there is not much to judge on the technical side of the radar even if I was experienced with FMCW technology and its issues. I do not have enough experience to judge the radiometer especially when it is combined with a radar, and I am wondering about possible interference between the 95 GHz radar and the 89 GHZ radiometer when used simultaneously.

In short, this paper nicely describes the MIRAC system, and it seems quite suitable to the thin, low reflectivity Arctic clouds and the low absolute humidity there. But the paper does not describe the radar performance in a broader context and for more diverse weather situations, and it mixes science (e.g. the layering of Arctic clouds) with instrument description. The latter should be the sole focus of papers in AMT.

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