Dear Anonymous Reviewer #2,

Thank you for taking the time to provide your review comments. Modifications based on these comments will significantly improve the quality of this research paper.

General Comments:

1. *Regarding the missing discussion of the application to MYI.*

   Agreed, thank you. The title of the paper has been changed to emphasize the application of the method to FY ice. As is consistent with another reviewer's comments, clarification on the nature of the ice cover (undeformed FY ice) has been added where needed. Specifically regarding this issue we have added a discussion of the potential application (and related limitations) of extending this technique to MYI to the discussion paragraph on P826 L8. This paragraph discusses the use of longer wavelength SAR to overcome surface roughness limitations imposed by ponds; for MYI it is likely the roughness of the ice cover, which is expected to be predominantly surface scattering this late in summer, that would limit the use of PR for discriminating ponds. I.e. the large surface roughness of the MYI may limit the PR contrast between ponds and ice, limiting retrievals at C-band except possibly at large pond fractions.

Specific Comments

Abstract

P806/L12: Corrected.

Introduction

P808/L28: Corrected.
P808 bottom: In the past, volume scattering of C-band energy from the ice cover adjacent to ponds was largely assumed negligible (e.g. Drinkwater, 1989). However it was shown to occur in Scharien et al. (2010) during periods of relatively low water volumes including freezing events (0 to 2%), when ε* is low and the effective penetration depth of the energy was large enough that scattering from air inclusions within seasonally desalinated upper ice layers occurred. This has been added.

Drinkwater, M. R. (1989), LIMEX ' 87 Ice Surface Characteristics : Implications for C-Band SAR Backscatter Signatures, *Geoscience and Remote Sensing, IEEE Transactions on , 27*(5), doi: 10.1109/TGRS.1989.35933

2.Physical Model

1 Paragraph: corrected.

P811/L14-16: Agreed as to the importance of figuring out the incidence angle "problem" as well as azimuth. In the introduction (P810/L18-22) the following research question was given: "What are the limiting radar and target parameters on the unambiguous retrieval of melt pond information from dual-polarisation SAR? " followed by some considerations made during the study. In the revised paper we will outline the importance of incidence angle and azimuth as part of these considerations.

P812/L27-28: This is not necessarily the case when the two cover types are considered in terms of their structure and microwave interactions. If ice lids are present this implies a negative surface energy balance and a low permittivity bare ice cover (i.e. no melt water), with volume scattering from bare ice expected to occur from voids within the desalinated and retexturized upper ice layers, and surface + volume interactions between layers (e.g. Eicken at al., 1995; Scharien et al. 2010). Though not well studied, ice lids are newly formed from freshwater in the ponds and would not be characterised by the voids and inclusions present in bare ice. As well it isn't well understood what the contribution to scattering is from the ice lid – pond interface is. In Fig. 6 of Scharien et al. (2012) C-band backscatter signatures of bare ice and melt ponds are shown for both freezing and melting conditions. Backscatter from an ice lens is much smaller than bare ice and decreases more rapidly with incidence angle; also the PR of an ice lens increases with incidence angle whereas for bare ice it remains ~0dB across all incidence angles. These results point to an ice lens being a surface scatterer and from a melt pond backscatter context, the dampening of wind-wave roughness by the ice lens is the dominant effect.

Eicken, H., Lensu, M., Lepparanta, M., Tucker III, W.B., Gow, A.J., and O. Salmela (1995), Thickness, structure, and properties of level summer multiyear ice in the Eurasian sector of the Arctic Ocean, J. Geophys. Res., 100(C11): 22,697 – 22,710.

Scharien, R. K., T. Geldsetzer, D. G. Barber, J. J. Yackel, and A. Langlois (2010), Physical, dielectric, and C band microwave scattering properties of first-year sea ice during advanced melt, *J. Geophys. Res., 115,* C12026, doi:10.1029/2010JC006257.

Scharien, R. K., J. J. Yackel, D. G. Barber, M. Asplin, M. Gupta, and D. Isleifson (2012), Geophysical controls on C band polarimetric backscatter from melt pond covered Arctic first-year sea ice: Assessment using high-resolution scatterometry, *J. Geophys. Res., 117,* C00G18, doi:10.1029/2011JC007353.

<u>3. Methods</u>

P815/L21: corrected.

P815, bottom: The models were used to generate 2D surface roughness parameters using the cross-correlation technique of Landy et al. (2013). Regarding the inclusion of a model in Fig. 2, it has been deemed unnecessary as per a valid comment made by another reviewer and will not appear in the final version of the paper. Of course it is the derived roughness parameters which are important.

P817/L17: corrected.

4. Results

P819/L4: Agreed and corrected. There is no observable difference with the exception of the one case where the rough superimposed ice layer was measured after the removal of the snow cover.

P821/L15: corrected.

P821/L16: They are named according to the paper from which they were derived: *Vachon and Wolfe* and *Zhang et al*.

5. Discussion

P825/L15-20: Please refer to general comment #1 regarding the missing discussion of the application to MYI.

P826/L6: It can be assumed that the deep-water approximation, where water depth is larger than one-half the wavelength of surface wind-waves, would apply to melt ponds on MYI ice so that the wave height and surface roughness would be independent of depth and waves would grow as a function of wind stress, available fetch, and time. Melt ponds are typically smaller on MYI compared to FYI due to enhanced topography so that they have less available fetch. Conversely it is more likely that there is a depth dependence on roughness and backscatter when ponds are shallow and the shallow or intermediate approximations describe the behaviour of wind-waves. Together these factors point to the likelihood that pond surface roughness would be less on MYI than on FYI and the statement made on P826/L6 needs to be revised so that it does not mislead the reader by suggesting that simply deeper ponds lead to increased surface roughness and related effects on backscatter and PR.

6. Conclusions

P826/L21: statement will be re-written to ensure correctness. We intent to conclude that, under the assumption that surface roughness is below the Bragg limit, the retrieval of pond fraction is possible without the need for wind speed information – then follow this statement with the concluding statement regarding limitations to that statement.

Technical Comments:
Fig. 2, right bottom: this part of the figure has been removed.