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Interactive comment on "Lead detection in Arctic sea ice from CryoSat-2: quality assessment, lead area fraction and width distribution" *by* A. Wernecke and L. Kaleschke

Anonymous Referee #3

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This study shows a novel method of sea ice lead detection from CryoSat-2 waveforms. Manually determined leads from MODIS are used as a control data set, and the new method and previously published lead detection algorithms are compared. Lead widths are derived for the Arctic and also compared to AMSR-E data, showing the spatial distribution of leads across the basin.

The subject of lead identification from CryoSat-2 is a much needed area of study, and the present study identifies some parameters which can improve detection mechanisms. I believe this part of the study is quite worthwhile to publish. However, I think the authors are too ambitious in labeling the false detection of leads with the MODIS data. The 250 m spatial resolution of MODIS is far too coarse to capture small leads

(which are still seen by CryoSat-2) and have been found to be the most common type of leads in high resolution submarine sonar data. Based on the available data set, it would seem possible that only the true lead detection for large leads can be reliably stated, there is too much uncertainty in stating that false detections are present in other methods given the inability of MODIS to resolve small leads. This scaling back still provides worthwhile results, but better bounds the data within the lead detection ability of the control data set.

Another point that needs clarification is specification of the angles which are considered off-nadir (and therefore not used) in the classification scheme and control data sets. Off-nadir data are always going to be present in the data so long as the pulse shape is broader than the transmit pulse, so this needs to be considered.

Both of these main points tie in to a suggestion made by another reviewer, namely that the retrieval of surface elevation from identified lead points could be used to determine the impact on SSH determination. In my opinion, this would greatly enhance the results of the study.

Other comments

2171, 14-16: What wavelengths are the MODIS bands? It would be helpful to have this in the text for those unfamiliar with MODIS.

Section 2.1: It should be noted that the spatial resolution is quite different between CryoSat-2 and MODIS for the comparison. The CryoSat-2 footprint is not constant, and is largely a function of surface roughness. A rough surface will have a rectangular footprint size of $\sim$380 m x 1650 m, while a coherent scattering return from a smooth surface can still dominate the return even when the area is small, see Drinkwater 1991.

Also one distinction to make is that the leads detected can be off-nadir, these need not be labeled as false detections, but they should be accounted for if used in the retrieval of surface elevation.

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2171, 15-18: It is a bit ambiguous how leads are identified in the MODIS imagery, in particular, are only nadir leads considered, if not, how far off-nadir can a lead be?

2172, 5-7: I am not sure what is meant by "favoring surface scattering instead of reflection"? This is just a confusion over word choice, perhaps it is meant that more energy is scattered away from the receiver?

2172, 13-18: The reflection and transmission of energy between the air and ice/ snow layers is probably not important compared to the geometric factors which affect the angular dependence of the backscattered energy.

2174, 3-5: What specific angle is defined as being off-nadir? This is an important distinction to make.

2176, 5: A description of the Nelder-Mead simplex algorithm would be beneficial here, along with some rationale for the chosen parameters.

Section 3.1: A point brought up by another reviewer is that the MODIS data may not be showing some of the smallest leads due to 250 m resolution of the imagery. Lead width statistics are available from submarine sonar data (e.g. McLaren, 1989; Wadhams, 1981; Wadhams and Horne, 1980) and show that most leads are < 20 m. Thus, it is difficult to say with confidence that leads detected by CryoSat-2 and not by MODIS are false detections. Only the TLR for the largest leads can be determined with such a data set.

2180, 8: The CS-2 track is very much two dimensional, the pulse-limited across-track footprint size is not negligible and could impact the results.

2187, 20: Some caution is needed in the lower threshold value as this number will depend on factors such as the altitude and that the transmit power is stable over time.

Interactive comment on The Cryosphere Discuss., 9, 2167, 2015.