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Interactive comment on "Sea ice detection with space-based LIDAR" *by* S. Rodier et al.

Anonymous Referee #1

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General Comments The paper presents a creative and novel technique for discerning sea ice presence which is independent of other remote sensing techniques currently in operation. This is a valuable contribution to the remote sensing field, particularly considering the potential for higher resolution discrimination of ice presence which may allow detailed examination of ice edges, marginal ice zones, or landfast ice. The development of the technique is based on sound principles and a cross validation with an existing standard-bearer of sea ice remote sensing products (AMSR-E) is highly valuable, and indicates promise for the product's utility. The key gap in this otherwise sound introduction of a novel technique is the lack of a physics based or absolute technique calibration. The AMSR-E cross-validation does not provide this necessary 'absolute' validation benchmark, thanks to numerous known problems with AMSR retrievals (weather, ice wetness etc) and the discrepancy of pixel/footprint size in the comparison. Making this product useful for higher resolution sea ice remote sensing

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will require a more discrete validation against a data product of higher resolution and certainty than the AMSR-E product. Suggestions would include validation against high resolution optical satellite imagery such as global fiducials products, ICEBRIDGE imagery, shore based landfast ice observations, or surface based observations collected from icebreakers under the ASPECT protocol. I hope the authors will consider more detailed validation against an absolute benchmark, if not in this publication, for future work. If an 'absolute' validation is beyond the author's current scope, there should at least be discussion of what happens when the CALIOP footprint is composed of partial ice and partial ocean, or what happens when a heavily melt pond covered piece of ice is within the footprint – scenes are often mixed ice and water, even at this scale. I'm particularly curious if the derived ratio is altered as if by linear mixing of components or some more complex change that weights partial footprints toward ice or snow.

Other general questions which the manuscript should address briefly- What percentage of the time is retrieval not possible due to clouds? What is the repeat time and surface coverage of the CALIOP product? Can pan arctic products be created from this method or is this effectively a line scanner?

Specific Comments 4684 – line 5 90m diameter, spaced 335m apart – This sentence contradicts several others below where the diameter is referred to as 335m, please correct whichever needed to make all consistent.

4685 Your examples show very easy scenarios for differentiation (all snow covered winter ice and all ocean). Please also include an example of a complex situation, such as mixed sea ice in mid-summer – this is where your method might be most useful, so it would be helpful to present a transect across complex ice-ocean environment along with the AMSR-E concentration along that transect and any other observations available to show how well it does.

4686 Top... You should include how big an altitude bin is. Not knowing, I wonder if there is a prospect for low wet clouds (often present in summer) to interfere because

TCD
7, C1862–C1865, 2013

they could be included in the span of the 7 altitude bins used.

4687 The comparisons here could probably benefit from some statistics. I would expect that in an AMSR-E pixel with 60% ice concentration (labeled “ice” in that scheme), nearly 40% of the CALIOP retrievals would be deemed “wrong” (open water). Can such a simplistic concept be expanded to show why the agreement drops in mid-summer when more AMSR cells have low concentrations?

4687 Top – I’m confused by lines 2-3 and lines 8-9. Are you discarding footprints that are anywhere outside of the AMSR-E pixel (8-9) or that are more than 12 km outside the pixel (2-3). Please clarify. Also, what is the time offset between datasets, if any? I infer that the AMSR product is a daily average and the CALIOP product is a point in time during that day, but explicitly stating this would be helpful. Ice motion may be a concern if the points are not same-day.

Pg 4687 line 15 – “classified by AMSR-E as water, open water, or ice. . .” Are “water” and “open water” unique categories or is this a typo?

Pg 4689 Lines 13 – 17 It is extremely unlikely that Calipso is pinpointing newly formed melt ponds – perhaps leads. Melt ponds are simply too small to be detected at a 335m (or is it 90m) resolution. Also, “Artic” is spelled wrong.

Pg 4689 line 20-25 This section is sketchy. Caliop detected water inside a 90-100% ice pixel. . . How much? Did CALIOP detect 100% water or just a few footprints within this area? Again this may be because I don’t understand what figure 5a is trying to show.

Also - CALIOP (misspelled in paper)

Also - CALIOP detection ability would be an asset to the community for uncertainty analysis and detailed scene classification – this is fluff. State more rigorously what this product could actually be used for or discard.

References - A Perovich paper is listed twice. Polashenski et al 2008 referred to in text doesn’t seem to exist. Other errors may exist, I did not check these thoroughly.

TCD

7, C1862–C1865, 2013

Figures 3 and 4 use same shapes for Jan/Feb and Jul/Aug with red-green reversed – this is super hard for red-green color blind folks.

Figure 5a – I don't understand Figure 5a. Seems that all of the Arctic is classified as less than 0.2 – yet it was not the case that all of this area was open water. A better explanation of what exactly this figure is showing would be helpful to readers like me.

Table 1 – any particular reason why you included Jan-Oct but not Nov and Dec? Please include all months or explain why you didn't.

Interactive comment on The Cryosphere Discuss., 7, 4681, 2013.