The Cryosphere Discuss., 7, C1929–C1933, 2013
www.the-cryosphere-discuss.net/7/C1929/2013/

The Cryosphere
Discussions
Open Access

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

Anonymous Referee #3

Received and published: 9 December 2013

The authors present a new technique to assess CALIPSO lidar measurements to infer ice and open water prevalence in the polar regions. The method depends on analyses of CALIOP 532 nm depolarized surface returns, and results are compared to ice concentrations derived from AMSR-E passive microwave data.

The classification of ice and water using specific values of CALIPSO depolarized surface returns appears to be consistent with surface classification by AMSR-E. The CALIPSO surface classification scheme is however based on empirically-derived depolarization ratios for each surface type, which are derived via direct comparisons with AMSR-E classifications. The authors then go on to complete an analysis of 6 years of CALIPSO data, verifying their results with AMSR-E. Since the CALIPSO classification ratios were empirically derived using AMSR-E data, we would, of course, expect good comparisons!

Due to the significantly different resolutions, I am not convinced by the verification of the CALIPSO ice/water classifications using AMSR-E data. In my opinion a more robust assessment would be to compare the CALIPSO classifications to data at a similar resolution (footprint size). Numerous independent data sources exist at a similar resolution to CALIPSO, including satellite sea ice imagery from e.g. ASAR, Radarsat, MODIS, or even high-resolution airborne digital imagery or laser altimetry measurements over sea ice. Indeed validation of CALIPSO measurements over sea ice with any of these data sources could further refine the ratio scales and improve the fidelity of the ice classification scheme, potentially extending it beyond a simple "ice" / "water" classification, to open water, newly refrozen ice, first-year ice, deformed ice, etc.

The study provides a promising methodology using CALIPSO measurements for high-resolution ice/water classification in the polar regions. However, the article is essentially an engineering study of CALIPSO depolarization data and may therefore be better suited to publication in an IEEE journal, rather than The Cryosphere. The authors missed the opportunity to develop the dataset into a study of a scientifically interesting parameter. For example, an obvious next step would be to assess the seasonal and interannual variability in the prevalence of open water in the Arctic over the 6-year study period.

The usefulness of ice and water classification in high-latitude CALIPSO data is not fully established. In my opinion these data have great potential, but the authors' statements (P4689 L24-25, P 4691 L17-18, L21-22) are vague and general. E.g. could the authors elucidate how these new data would be used to improve numerical sea ice models? Were the authors to develop the manuscript so that it included a more robust assessment of the CALIPSO surface classification with respect to independent data at a similar resolution, and extend their assessment to include scientifically interesting parameters, the manuscript may warrant publication.

Specific Comments:

How are the “northern hemisphere” and “southern hemisphere” regions defined? Is there a latitudinal limit applied, does the analysis include the open ocean or is it restricted to the polar oceans, i.e. the Arctic and Southern Oceans?

What is the latitudinal coverage afforded by CALIPSO? How does this limit the scientific value of the data, particularly over the Arctic Ocean (e.g. Fig. 5)?

Fig. 1. and P4684 - P4685: Figure 1 needs revision to link it more clearly to the statements within the text (Section 2). For example annotating the figure to identify features referred to within the text would help. Figs. 1 (a) and (e) are not described. Y-axes need labels, and (b) (f) (c) (g) need color bars/scales, otherwise values referenced in Section 2 cannot be identified in Fig.1. What are the units of the data displayed? Some are absolute depolarizations, while others are ratios? What does the steepening gradient in red/orange in Fig. 1 (f) signify over the open ocean? Is there evidence for polar clouds? Suggest re-scaling the figure to zoom in on the surface e.g. +/- 2 km to help the reader in identifying features mentioned in the text.

P4687 L2-3: Why not simply calculate the offset in meters? The spatial extent of 1 degree longitude varies with latitude, and is particularly troublesome if used as a scaling factor in the polar regions where it approaches 0 m at the pole.

P4687, L5-6: How was AMSR-E snow depth used for “comparative analysis and validation”?

Fig. 2. and P4687: Further details are required to explain how the authors accounted for differences between the CALIOP and AMSR-E footprints. Assuming the depolarization ratios assigned for defining each surface type work, there will be a much higher variability in the surface type (ice/water) defined along-track the CALIOP orbit, than would be resolved by the AMSR-E footprint. It is therefore surprising that the agreement between the two datasets is so high. At 90 m, the CALIOP footprint would presumably be sensitive to leads between ice floes, polynyas, etc. Can the authors explain how the two datasets were compared? Were the CALIOP results averaged, or gridded

in some fashion, to achieve such high agreement with AMSR-E?

Fig. 2: What does “mix” signify? Fig. 2: Are these results for the entire year (2010) and what latitudinal limits do they span?

Figs. 3, 4, 6, 7: How do the results for the northern hemisphere and southern hemisphere compare? There are many differences in sea ice conditions between the two polar regions (e.g. higher incidence of icebergs, smaller floes, more frequent leads, polynyas in the Southern Ocean). Do the authors find evidence of these differences in their results? Fig. 7: There appears to be an annual trend in the Southern hemi. water classification. Can the authors comments on this? Is it e.g. evidence of instrument drift?

P4689 L16-17: What evidence do the authors have to prove that they can “pinpoint the locations of pockets of water (newly formed melt ponds)?” Melt ponds are transient features on the sea ice and typically only occur for a short period during the summer melt season. Again, direct comparisons with independent imagery would strengthen the argument here. How would this signal differ from wide leads or polynyas? What do the authors mean by “chunks of ice”, do you refer to sea ice floes, icebergs, or something else?

Fig. 5: Units on color bars are needed. CALIPSO pixels (Fig 5a) look larger than 90 m – can you explain?

Table 1: Why was the analysis completed over only 10 months (what about November and December) and why was 2009 selected over other years? Do the data from other years provide similar results? What gives rise to the decreasing trend in the “total samples” and “fraction matching” throughout the year, and why is it particularly low in August and September?

P4687 L9: odd formatting of large number P4689 L18: Misspelling of Arctic. The acronym “AMSR-E” is also misspelled in places.

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