General comment

The manuscript addresses the important problem of deriving the degree of sea ice ridging from the ICESat-2 laser altimeter measurements. Data and methodology are well presented, however the accuracy of the results and applicability the method to other ICESat-2 measurements is questionable. As suggested below a major revision is needed to assure feasibility of the presented method.

My first concern is that the same data is used both to train the method (by analyzing the elevation anomalies histograms and setting the intervals in Section 2.3) and to validate the method (by comparison of along-track IS2 DIR with maps of FIS DIR in Section 3.1). Generally speaking, usage of the same data both for training and validation precludes conclusion of extrapolating the algorithm applicability. What if it worked well only on these data points?

My second concern is related to the validation approach and results. Only a qualitative comparison of along-track observations with maps is performed and no quantitative estimation (for example, in a form of a confusion matrix) is provided. Understandingly, the DIR product from FIS is quite coarse and cannot capture all spatial variations of ice ridging. That makes quantitative comparison with IS DIR less useful. But what if it makes useless also the algorithm training (i.e., finding the elevation anomalies intervals)?

These two questions are open and I, therefore, suggest changing the emphasis of the paper: instead of presenting an algorithm for sea ice ridging estimation from ICESat-2 (with a questionable training/validation approach) the paper should rather present a comparison of ICESat-2 elevation anomalies with ground truth data. Such a change in the accent implies several major modifications:
- Change of the title, goals and, correspondingly Abstract, Introduction and Conclusions.
- Plotting of elevation anomalies on Fig. 3 instead of classification into IS2-DIR(1,2,3).
- More detailed analysis of profiles of photon height (and plots of the profiles) in critical cases when FIS DIR doesn't correspond to elevation anomalies.
- Comparison of elevation anomalies, or photon height profiles with other independent data, e.g. Sentinel-1, Sentinel-2 in the aforementioned critical cases.

Specific comments

Title: Consider "Comparison of degree of sea ice ridging in the Bay of Bothnia with elevation anomalies in geolocated photons from ICESat-2"

Line 15: "information ON ice conditions"

Line 26. "Divergent motion forms cracks ..., and convergent motion results in …"

Line 91: "from 1 TO 3."

Line 91: "is AN imaginary"

Figure 2. The black line (DIR2) is almost indistinguishable from the dark blue one (DIR3). Consider green, or any other brighter color.

Equation 1. The equation says that you sum up 150 values of h_max and then subtract h_mean. That does not correspond to the text. Equation needs to be corrected.

Lines 150 – 155. In the first sentence I would recommend to replace "we classify IS2 geolocated photon heights into different DIR categories" with "we compare IS2 geolocated photon height with different DIR categories" and correspondingly rewrite the rest of the paragraph.

Figure 3 and 4: Color of fast ice and FIS DIR0 is very close and hard to distinguish. The same applies to FIS DIR 1 and FIS DIR4. Figure caption describes DIR3 as blue and DIR4 as red, but to me it appears as violet and pink.
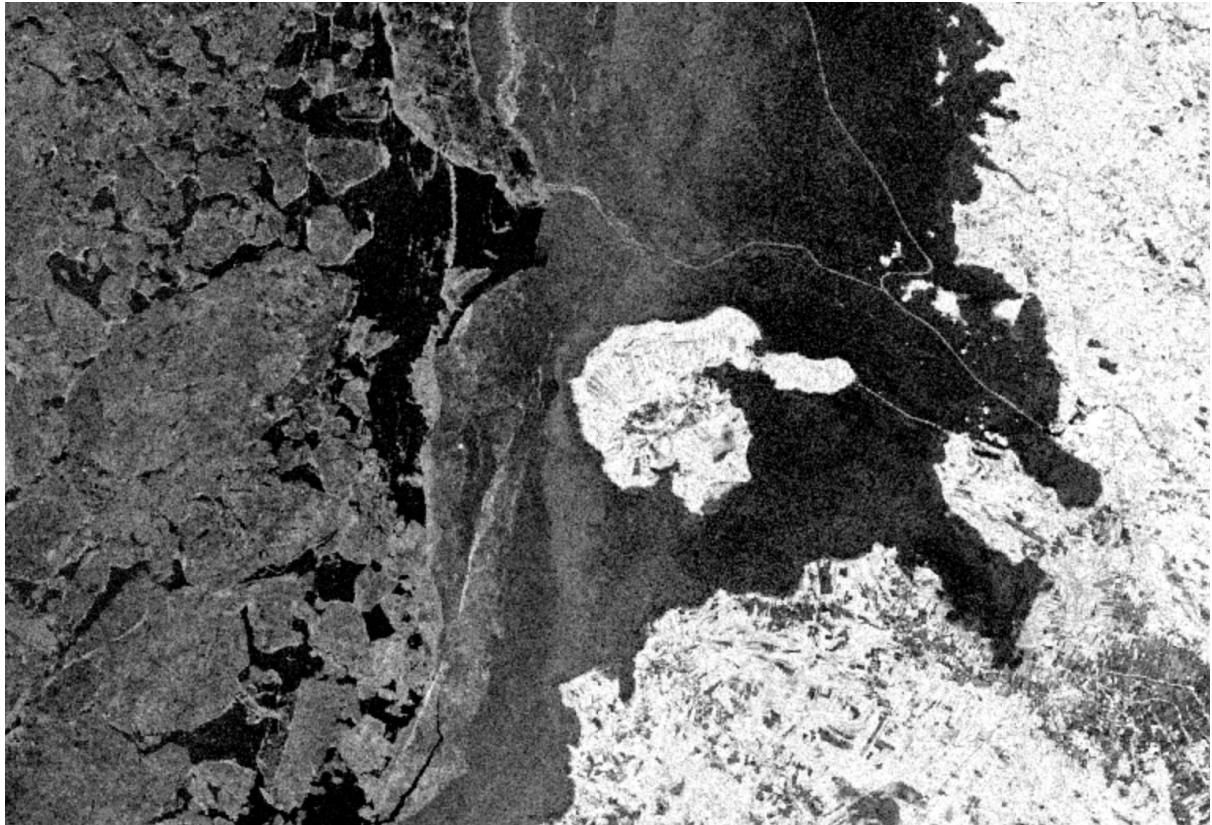
Figure 3 and 4: 27 March appears before 23 March. Is it incorrect title or incorrect map? The same with 01 and 17 February.

Figure 3 caption: "where several photon heights could be extracted from AND compared to …"

Figure 4: Color of DIR and counts of sails is almost indistinguishable or has very bad contrast (e.g. light blue points on light purple DIR3 polygons).

Line 156. I disagree that behavior of IS2 DIR follows the FIS DIR zones even generally. I would say that they correspond only in 50% of cases. That's why it is better to compare not DIR to DIR but h_a to DIR. This sentence and the paragraph below need to be rewritten accordingly.

Line 167. If "more deformation is expected to occur due to the ice drift pushing ice floes towards the coast" why is that not reflected in FIS DIR? Area west of Oulu is heavily trafficked and presumably the ice charts are the most accurate here as a lot of reports from icebreakers should come. But IS2 reports a lot of DIR4 measurements unlike DIR3 reported by FIS ice chart. Inspection of a SAR image on 23 March 2019 (see below) shows a lot of ice flows separated by leads. Maybe covered with thin ice. Could the IS2 DIR4 be modulated by edges of the floes, rather than the ridges? In my opinion that is a very good example to illustrate better by collocation of IS2 and SAR and showing profiles of geolocated photons and the detected ridge sails.

Line 199: On fig 4.a most of green dots (very low number of ridges) occur over DIR3 (ridged ice) which is not discussed in the text. That's a major disagreement which seems to be ignored. For the sake of completes of the study, not only the positive cases but also the negative cases should be highlighted and explained.

Line 224: Cloud cover is another major factor limiting availability of IS2 measurements. It cannot be ignored as it also limits the applicability of IS2 for operational ice charting (see also the comment below).

Line 228: I don't agree that "this study shows the potential". The study only compares IS2 and manual ice charts on a couple of cases with ~50% accuracy. How can actually IS2 measurements be used in ice charting? Which weight should an ice analyst give them compared to icebreaker observations? How accessible IS2 data would be due to cloud cover and latency? These and other questions need to be answered to show the potential.

Line 233: "to estimate the ice conditions in certain areas for planning purpose"

Line 255: Can you specify how IS2 could be used?

Line 262: Given low correlation between IS2 and DIR I would recommend to rephrase: "… we have showed that there is some level of correspondence between FIS DIR and height anomalies using geolocated …"

Lines 270 – 273: Please rephrase "…we find that in some cases along-track densities of relative …" and split into simpler sentences.