

# Review of: Estimation of degree of sea ice ridging in the Bay of Bothnia based on geolocated photon heights from ICESat-2

## 1 General Comments

### 1.1 Paper Synopsis

I found this to be an interesting paper on a topic of significant human relevance. In it, the authors use the ICESat-2 laser altimeter to retrieve the ridginess of ice in a way comparable to that traditionally charted by ice analysts for marine navigators. I believe their analysis to be generally rigorous, and the figures in particular were well presented. I have relatively few concerns about subsequent publication of this manuscript, although I would like my questions concerning ridge-alignment anisotropy and cloud-cover to be directly addressed before publication.

### 1.2 Reproducibility

It is unfortunate that the FIS charts are not publicly available, and so this analysis is not replicable without contacting the authors. I do however appreciate that this is not within the authors' control if FIS insist on holding the copyright. It was pleasing to see the analysis code uploaded to an open repository, with nice use of markdown for context. Although this is beyond the remit of my role as reviewer, I would encourage the authors to ensure that all defined functions have docstrings so as to boost code readability. I would also encourage the authors to consider storing their code in a persistent location such as that provided by Zenodo, for which it will receive a digital object identifier (DOI).

## 2 Specific Comments

L126: “We also discarded all measurements that deviated from the geoid elevation by more than 3 m”. I feel like the reader would benefit from knowing what fraction of photons this is? Is there a risk that you're throwing out more photons during high tides than low tides? What's the typical sea surface anomaly on the geoid here? Wouldn't you be better off discarding measurements based on their deviation from the tide-corrected sea surface?

Fig 2: what are the units of the y axis? I appreciate that because it's a histogram, 'Density' corresponds to the number of relevant photons per bin, but what's the bin-width? Without knowing that, the specific values on the y axis are meaningless. Just an idea, but consider displaying this data as a probability density function (i.e. plot the probability of the max-height photon having a given elevation anomaly). By doing that you could perhaps squeeze in some meaningful information on the y axis rather than it just being 'density'.

L211: You talk about the drift pattern in the Bay of Bothnia being West to East. I imagine a consistent drift-pattern like this would produce an anisotropy in ridge orientation (probably aligning them along the North-South axis?). Because IS2 tracks also run broadly North-South, it seems to me you might have a sampling issue here, particularly with regard to ridge density. To restate this, you're only measuring ridge-density along one direction, and that's (generally) the direction that the ridges themselves might preferentially run. I feel this needs to be addressed in your discussion. Are ridges aligned anisotropically in your study area? Can you use the fact that IS2 has non-parallel ascending and descending tracks to get a handle on this?

This paper argues that IS2 DIR retrieval would be of significant operational benefit to ice analysts, but does not substantially address the impact of cloud cover on measurement availability (although it does discuss the role of low lying clouds on surface ranging biases). The authors state that only 25 granules of data were available in the three-month period that they searched within. Firstly, I feel that a reader that is non-expert in IS2 would benefit from the term ‘granule’ being defined here. Second, while this number is of some use, I think the reader would benefit more from knowing on what number of days can the study-area be analysed for DIR in this way? Were those 25 granules confined to a small cluster of days, or do the granules represent the three month time period well? Are there some months where DIR is more retrievable than others due to cloud masking? These questions significantly affect the utility of the proposed retrieval method.

### 3 Technical Points

L83: it seems unnecessary to define an acronym (RF) for random forest when that acronym is not subsequently used.

L83: I think you mean dual-polarization and not dual-frequency (my understanding is that RADARSAT is just C-band).

L181: should be “low-lying” I think

L196: would perhaps be clearer if phrased “The distribution of the *number* of elevation anomalies”. Or perhaps *frequency* is the right word? I feel that ‘amount’ is a bit vague for a quantity that is presumably well defined. Again in 197: the small *number* of counts.

L199: “the most interesting regions...” this seems like a subjective statement (what is the *most* interesting) worded as fact. I guess they’re interesting to you because of the variability or magnitude of ridge density/amplitude. Perhaps rephrase slightly to “Regions of particular interest are...”

L204: Grammar: “the ridge densities for DIR5... *are* higher compared to...”. Technical Point: You’re also saying two things in this sentence: (a) you make a valid and useful comparison between HEM and IS2 ridge density (b) you make an unsupported statement (“however not unlikely”) about the feasibility of your retrieved IS2 ridge density. I would separate these two claims into distinct sentences, and I think you should offer a citation to support the reasonable-ness of your higher densities. If this isn’t available to you then I would avoid the statement that it’s ‘not unlikely’.

L207: Not sure a “high spatial distribution” is meaningful. Do you mean a high spatial density?

L209: coincides

L210: “Once more, this can be described by the sea ice measured ... is close to the coast and/or fast-ice” Needs rewording for clarity.

L214: experiences

L224: Even if it **were**

L228: **comparatively**

L232: Do you mean you’ve emphasised it before in this manuscript? Or in previous works? Clarify.

L237: **sunlight** (one word), the second half of this sentence needs a look at too.

L279: ‘tremendous’ is quite a loaded and subjective term, consider rewording.