

The Cryosphere Discuss., referee comment RC1
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Comment on tc-2021-2

Anonymous Referee #1

Referee comment on "Ice roughness estimation via remotely piloted aircraft and photogrammetry" by James Ehrman et al., The Cryosphere Discuss.,
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This manuscript shows the application of remotely piloted aircraft (RPA)-based photogrammetry in estimating ice surface roughness. It also explores the relationship between the surface roughness and subsurface one, based on the RPA results and empirical equations. This study shows the ability of RPA to monitor the ice roughness, which is an important factor affecting the river flow, ice condition, and infrastructure.

However, the presentation of this manuscript, especially the methodology and discussion, is not clear. It is hard to follow the logic, e.g., the validation of the hypothesis that the surface roughness of the newly frozen ice is indicative of the subsurface roughness. Moreover, the writing of this manuscript can be improved significantly. I recommend the authors conduct a thorough language editing to improve the readability and clarity.

The specific comments are as follows.

The section 2 seems a mixture of site description, metrics of surface roughness, methods used for estimating surface roughness, and the RPA. I suggest separating the part of site description to be a new section and moving the rest to the methodology, to make the manuscript's structure clearer.

In section 4.1, the "two points" scenario has the worst performance, compared with the other scenarios using more control points. Does it indicate that at least three control points should be used to geo-rectify the DEM results? If it does, why the results of using no control points are comparable to the geo-rectified ones, as presented in Table 2? Why their difference can indicate the systematic errors introduced by the lack of geo-rectification?

In section 3.2.4, you compare the Nezhikhovskiy ice Manning's n and the observed ice Manning's n . What is the observed ice Manning's n ? Is it another observable you estimate from the RPA images? Have you ever checked the Manning's n estimated by Beltaos equation?

In Line 275, you demonstrate that the comparison between the Nezhikhovskiy ice Manning's n and the observed ice Manning's n can indicate the relationship between surface and subsurface roughness. Accordingly, in section 5.3.1, you present the comparison results. Could you elaborate on that why this comparison can indicate the linkage between surface and subsurface roughness?

In Figure 10, the label of the horizontal axis is PRA roughness. Is this consistent with the observed ice Manning's n ?

Could you elaborate on this sentence "Since the original observations that supporting Equation 3 related thicker ice to ice with a rougher sub-surface, the link between surface ice roughness and ice thickness supports a link between surface and sub-surface ice roughness." in the section of 5.3.2?

The Beltaos equation requires the roughness height of the flow boundary (denoted by D) and hydraulic radius (R). The roughness height of the flow boundary refers to the roughness of the upper ice surface or the lower one?

In section 3.1.2, how to use the observed water level and channel bathymetry data to estimate hydraulic radius? Similarly, what kind of observation and method used to estimate ice thickness? The references are at least included.

Line 255, what is the peak picking algorithm?

What does "i" mean in Equation 2?

Line 275, what does "p" stand for?

Table 6, What is $F_{1,4}$?