

## Comment on tc-2022-132

Anonymous Referee #2

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Referee comment on "Ice thickness and water level estimation for ice-covered lakes with satellite altimetry waveforms and backscattering coefficients" by Xingdong Li et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-132-RC2>, 2022

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Lake ice is a very important component of the cryosphere, and couples closely with global warming and local climate. This manuscript provided a detailed method on estimating ice thickness and water level for ice-covered lakes. Some field measurements were also included to test the feasibility of the method. I think the main problems currently are the lack of some detailed explanations on method itself and also on the results, as listed below.

- A table summarizing all seven lakes are possible more direct to readers to understand them, except for Figure 1. And what are the red numbers in Figure 1?
- L147-149 can be moved to the introduction section.
- There no citation to Figure 3b. And the text on Figure 3a seems not to match the explanations on L 215-225.
- L285 "the highest peak in the freezing period and the highest peak in the melting period were chosen to characterize the ice-on and ice-off dates ". It is easy to validate these dates. Do you have some validations to the field measurements? In lake ice cycle, the ice-on date and ice-off date are always not at a single day, instead the process would last for several days sometimes. But there is an obvious peak according to Figure 4, how to correspond to the real conditions in lake ice?
- What is Sig on L293? Do we have a mathematical expression on function CumSum?
- L303, "we can derive LITs based on backscattering coefficients without in situ ice thickness measurements. "I don't understand this sentence. There is not necessary to validate results of remote sensing?
- L303-305. Both equation (10) and section 4.1 are cited here, then can we put these sentences in later sections?
- The reflection on air-snow interface is not shown on Figure 5, and also not in the equation 5. A schematic diagram like Figure 5 should be placed in the front of the method section.
- Equation 6,  $H_i$  should be the ice thickness, not the thickness of snow and ice if according to Figure 5.
- In equations 5-11, there are some key points not mentioned. First, snow thickness cannot be ignored because it was even larger than the ice thickness on some boreal lakes. Secondly, main reflections occur on the air-snow interface rather than the snow-

ice interface, the attenuation in the snow layer also cannot be ignored. Overall, snow is a key impact factors on the lake ice remotes sensing, do we have some discussions on this issue, especially for equations 5-11?

- There are some obvious unusual points on Figure 7a, do we have some explanations here?
- Figures 8-9. These lakes belongs to totally different climate regions. The snow and ice thickness of Baker Lake and GSL are larger than that of Hulun Lake and Har Lake. Thicker snow will introduce more uncertainty into remote sensing as the author said on L446-448, but the results in Figure 8 seems to be better than that in Figure 9. And why CC was employed in Figure 8 while R2 was in Figure 9?
- The radar backscattering coefficient depends on the ice crystal type such as granular ice and columnar ice, and also on the gas bubble size, ice salinity et al. The information on the ice physics are not mentioned here, and will the difference in ice physics of these lakes pose some impacts on the thresholding process?