Point by Point Reply for the manuscript titled: "Bedfast and Floating Ice Dynamics of Thermokarst Lakes Using a Temporal Deep Learning Mapping Approach: Case Study of the Old Crow Flats, Yukon, Canada."

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We would like to thank the referees and the Editor for a very fruitful review process which substantially helped improve the clarity and quality of the manuscript. The minor changes to the manuscript are as follows:

1. *A more extended discussion of the use of different polarizations and instruments has been added to the Data and Methods section.*
2. *The figure that demonstrates comparability of HH and VV backscatter for floating and bedfast ice has been included in the manuscript.*
3. *The scientific value of the study has been highlighted in the Abstract, Introduction, and Conclusion sections of the manuscript.*
4. *The process of using ice thickness field data to evaluate lake ice thickness classification results has been explained in further detail in the Data and Methods section of the manuscript.*

Referee #1

Dear authors of the revised manuscript egusphere-2022-388,

The manuscript has been improved significantly from the previous version and the reviewer comments have been responded and mostly taken into account.

Thank you for your comments and a fruitful review process.

It would be useful to include the information related to using different polarizations and instruments You provided in the response to the reviewer(s) in the manuscript. Also the figure included in the response could be included in the manuscript.

After this minor revision and finalizing the layout in co-operation with the TC editor/typesetter the manuscript will be ready for publication.

Thank You.

Thank you for a valuable comment. The discussion related to the use of different polarizations and instruments has been added to the Data and Methods section (subsection 3.1. SAR imagery) and the figure has been added to the subsection 3.6 Comparison to thresholding.

The manuscript has been updated as follows:

Under sub-section 3.1:

"Although using different SAR instruments and polarizations within the same classification algorithm presents its challenges, previous research has shown that such combination is suitable for the mapping of bedfast and floating ice regimes. For instance, Duguay and Wang (2019b) have developed a thresholding algorithm for Sentinel-1 adjusted for incidence angle and have demonstrated comparability of VV and HH polarized C-band SAR imagery for the purpose of classifying lake ice regimes. Engram et al. (2018) also proposed an interactive threshold classification method to analyze floating and bedfast lake ice regimes across Arctic Alaska using 25-year time-series (1992-2016) of C-band SAR images from different platforms (ERS1/2, RADARSAT-2, Envisat, and S1) with both HH and VV polarizations."

Under sub-section 3.6:

"In order to benchmark the proposed method against commonly used techniques of lake ice regime classification, it was compared to one of the most recent variations of the thresholding approach designed by Duguay and Wang (2019b) and applicable to S1 data acquired at HH and VV polarization as is illustrated in Fig.6 below."

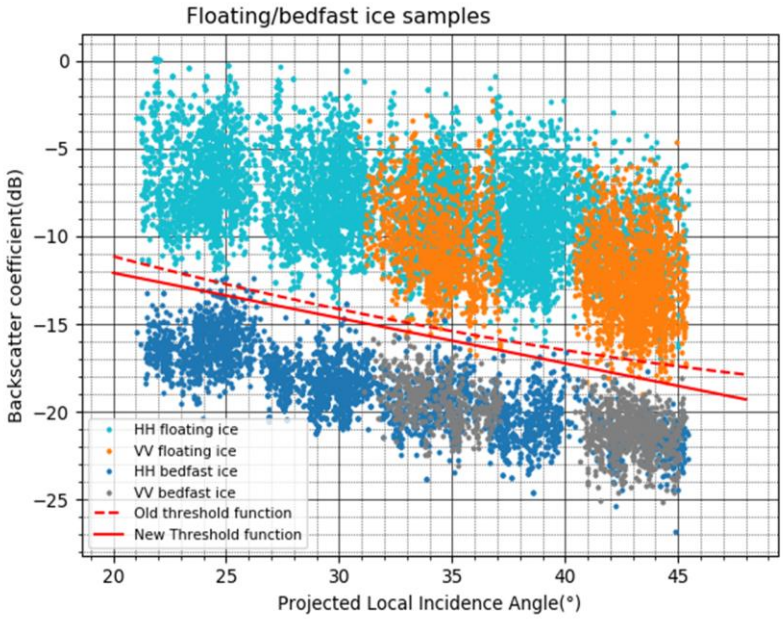

Figure 6. Relationship between HH and VV polarized backscatter and projected local incidence angle of floating and bedfast lake ice. The "New Threshold function" represents the threshold function proposed by Duguay and Wang (2019b) for lake ice classification and used in this work for the purpose of comparison. The Figure is adopted from Duguay and Wang, 2019b.

Referee #2

The manuscript has been improved a lot and I am overall happy with revision. The paper can be accepted for publication with some edits identified below.

Thank you for your comments and a fruitful review process.

1. The scientific value of this study should be emphasized more.

Thank you for a valuable comment. The scientific value of this work has been highlighted in the Abstract, Introduction, and the Conclusion sections of the manuscript as follows:

Under Abstract:

"The proposed lake ice regime mapping approach allowed to assess the combined impacts of warming, drainage, and changing precipitation patterns on transitions between bedfast and floating ice regimes, which is crucial to understanding evolving permafrost dynamics beneath shallow lakes and drained basins in thermokarst lowlands such as OCF."

Under Introduction:

"Documenting transitions between bedfast and floating ice regimes in relation to climatic trends is crucial to understanding permafrost dynamics beneath shallow water in thermokarst plains such as OCF, with potential implications for methane emissions and the regional carbon balance."

Under Conclusion:

"This study provides a landscape-level perspective on the combined impacts of climatic warming, interannual variations in precipitation, and accelerated lake drainages on the extent of bedfast and floating ice in the OCF. The unexpected overall increase in the fraction of bedfast ice and rapid transition of floating to bedfast ice following catastrophic lake drainage will inform ongoing analyses of permafrost distribution, recovery, and sustainability in drained lake basins.

This work provides a strong baseline for future thermokarst lake-ice dynamics analysis, a topic of circumpolar relevance as thermokarst lowlands cover approximately 20% of the northern permafrost regions (Jones et al., 2002) and contain globally significant stores of soil organic carbon (Olefeldt et al., 2015). Documenting transitions between bedfast and floating ice is crucial to understanding permafrost dynamics beneath shallow lakes and drained lake basins, with potential impacts on methane ebullition and the regional carbon balance."

2. How to use the ice thickness data to evaluate lake ice classification results? This processing progress should be explained in more details.

Thank you for a valuable comment. The process of using ice thickness data to evaluate lake ice classification results has been further detailed in the Data and Methods section (subsection 3.5 Accuracy assessment) of the manuscript as follows:

Under sub-section 3.5:

"Bathymetric measurements of July 2000 were matched with the corresponding TempCNN predicted classes for March 2000 based on geolocation and analyzed in the context of CLIMo simulated ice thickness for the same year. Specifically, if the depth of the data point (based on the bathymetric measurement) was shallower than the CLIMo simulated ice thickness for the corresponding vegetation type (taiga, tundra, or mixed – using Turner et al., 2014 OCF land cover classification) and the label created by TempCNN was "bedfast ice", the point was considered to be classified correctly. Analogously, if the depth of the data point was greater than the CLIMo simulated ice thickness and the TempCNN label was "floating ice", the point was considered to be classified correctly. Ice regime observations made in early April of 2009 and 2021 were also matched with the TempCNN classification output. In this case, both ice thickness and lake depth measurements were available. As such, if the lake depth was equal to the ice thickness, the point was considered to be bedfast, while if the lake depth exceeded the ice thickness measurement, the point was considered to be floating. The precision of the utilized field lake depth and ice depth measurements was 1- 2 cm."