The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2020-125-RC2, 2020

The Cryosphere Discussions
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Interactive comment on "Observation-derived ice growth curves show patterns and trends in maximum ice thickness and safe travel duration of Alaskan lakes and rivers" *by* Christopher D. Arp et al.

Anonymous Referee #2

Received and published: 4 July 2020

This work presents an excellent synthesis of a broad data set to create a comprehensive view of lake and river ice changes in Alaska. I found this to be one of the more enjoyable papers to review in quite some time and commend the authors for their well written manuscript. The length of the acquired time series are rare in ice records and highlight some important changes taking place in the regions, particularly highlighted by the comparison of trends in the long term vs recent term records. Combining the lakes and rivers into a collective freshwater ice analysis is well tied together in the discussion, especially on how the driving forces that affect ice growth/decay can both be

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similar or differ.

Overall, the results this work presents tie in nicely with overall changes taking places in the cryosphere, particularly how the strongest trends were identified in the Barrow region where the sea ice and snow are also changing rapidly. It was good to see this presented in field data records. The field data presented here is one of the major strengths of this paper. Much work in the north is done with modelling and remote sensing with limited validation as field data is so challenging to come by in the remote areas. I think this manuscript presents a valuable contribution to not only Arctic ice but freshwater ice studies in general and provides further insight on an important aspect of the cryosphere. The manuscript is concise, well-illustrated, and meets the objectives. I offer a few thoughts below for the authors consideration.

Using the modified Stefan's equation, if I understand correctly, alpha and alpha prime for melt are derived by using the actual field data to fit the curves. So, in effect, even though it's a temperature driven model, you actually are capturing the effect of snow on the various ice thicknesses through that adjustment. This might be something to add a few comments on and potentially further explore. There might not be enough field data for this, but some comments on how the a and a1 values differ/compare for similar region lakes/rivers with different snow cover might lead to some interesting points. While I would normally object to temperature-only based ice models, since these curves are adjusted for actual recorded thickness measurements and the specific thickness on a certain day is not the goal (as specific snow-related thickening/melt will be missed), this modified Stefan's approach is still very valuable for an overall sense of the standardized thickness curves. The inclusion of the snow and snow-related ice processes and how the model, in some essence, captures some of these effects through the adjustment will strengthen the argument for using this approach. I do note that this approach does not work very well in southern regions where white ice is prominent (we've done it, but the results suggest some differences from observations), from what I understand of the Alaskan ice cover, the ice is predominantly thermodynamic similar to that across NWT.

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A few comments on the potential limitations of excluding the non-thermodynamic ice in the more southern regions of Alaska (where I am not familiar with the ice - perhaps this region still has limited white ice and hence this is not relevant) might also strengthen the rational for the methodology.

The margin of error for ice thickness measurements is a great addition. I like this very much and can see this being quite useful for researchers in regions that do not have large/long datasets such as that in Alaska to get a sense of the utility of their samples.

I also quite like the ITD metric derived for analysis as well. Having the 'safe to travel' data for comparison is a tremendous asset that lends confidence to this, albeit conservative, method for examining the safe travel duration. I think your ITD metric will also be quite useful for ice researchers to learn from and modify to their respective regions.

In your results section where you examine if the temperature or snow explained the variations in the ice thickness (pg. 18-22), have you explored the combined effects somehow? Results we come across more frequently now in our work (in more southern regions) is that it appears snowfall changes are buffering the temperature changes with respect to their effects on the ice thickness. I do not disagree at all with the discussion of these results pointing out that other drivers are likely in play here, but perhaps a few comments on the combined effects of temperature/snow changes might offer some explanation for the lakes that show no agreement.

Very small suggestion here, define (or refresh the reader) what is meant by upland for the snow measurements in the results. I intuitively think 'upland' somewhere in the basin, though I understand this be on shore at the nearest weather station.

On page 19, the comments about the observers potentially taking measurements in the compact snow vs. undisturbed snow is an excellent point to highlight. I think this warrants an additional sentence on how the compaction may have led to further thickening. That might be a beneficial clarification for researchers who do not focus on lake ice.

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I was pleased to read a good discussion of the variability in snow depths between upland regions and on the ice. Some good points were raised here, while the average on-ice snow depth is 60% (in Alaska) of that on-land the annual variability can be very large. Are there any on-ice snow measurement you can use to further explore this on any of your study lakes that don't have good correlation to snow upland? Particular geographic settings leading to much larger/smaller percentages on ice? This may be beyond the purview of the existing dataset, but just a thought to explore if the data exists.

Technical comments:

Pg 2, Line 9 – Serreze and Francis 2006 – that's quite out of date for Arctic research, I suggest using a more up to date reference.

Pg 3, line 7 – I believe rivers should be plural

Pg 8, line 18 – TWITS. I absolutely love this.

Pg 28, line 4 – I believe temperature should be plural

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