The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-326

Anonymous Referee #2

Referee comment on "Tricentennial trends in spring ice break-ups on three rivers in northern Europe" by Stefan Norrgård and Samuli Helama, The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-326-RC2, 2021

Overall this paper presents a new long-term river ice record and examines changes in the breakup timing between three northern rivers. It first places the records in historical context and then compares them to temperature changes, and examines temporal changes including extreme timing of ice off events. Overall, while interesting, the manuscript reads as a bit verbose, and qualitative in places where perhaps some quantitative analysis could be used. There is some interesting information presented, and the long-term datasets analyzed together are a new contribution to the literature, but I think some of the qualitative description could be reduced to shorten the read.

The main thing I found to be lacking is the treatment of precipitation. The authors indicate quite correctly snow is important for breakup timing, not just with respect to delaying melt through high albedo as mentioned but also for the effect on the ice thickness. Also, when discussing ice break up – do the extreme events link to precipitation (rain or snow?) as well as temperature? Only temperature is compared. Can you include snow changes as well? derive a simple metric, perhaps total winter snowfall from typical freeze-up to break-up months? Or total winter/spring precipitation to include spring rainfall? I imagine the records may not go back as far as the entire river ice record, perhaps that is why they are not included. But some inclusion of precipitation in the analysis is important and I feel that is should be addressed with more detail when revised.

The authors should add a map to show where the rivers are to provide spatial context.

Some details are missing from the methods that I think will add more clarity.

Adjusting the dates to the vernal equinox is interesting and could use a bit more explanation of how that is done. When looking at the tables, its clearer that is the difference between identified date and the equinox is used, but 3.2 as written is not very

clear. How was the actual equinox determined? Is this a dataset available somewhere with the timing listed for the relevant years before the calendar change? As someone who has never worked with datasets going back that far historically, I found this very interesting.

The temporally extreme events – I found this section confusing and after several reqds still do not understand why 2 of the list of years were used. Can this be re-written more clearly? or explained why only 2 were used?

"In this analysis, we used the calendric dates to rank the breakups". – does that not skew some of the early records?

Section 3.5 – what is the model used for 1960-2020? More information is needed here to describe the data fully.

Specific comments:

78-80: Are the other two study rivers regulated? I think not based on the sentence about the power plant boom but confirming would be good in the text. Comments later on about how the power plant may have changed the timing of break up but they focus on the thermal effects – did regulation have any effect with respect to water level?

112-113: "In Aura River, the records suggest that thermal breakups have delayed the ice-off date and this is because spring is the driest season in Finland (Irannezhad et al., 2014)." This could use a small clarifying sentence added that thermal break up would be later than mechanical break up since its thermodynamic rather than dynamic and the dry spring would reduce the runoff/melt. Its more or less stated in the sentences earlier, but an explicit sentence stating that would be useful. Also why more thermal now? is spring becoming drier?

155-118: This whole bit is unclear to me. Lack of clear breakup dates because thermal melt made it challenging to determine the timing in Pori. Thermal break ups are delaying ice off because its dry. Then 'this' is because you are comparing ice off to ice breakup? I think you need to add some more info here on the timing difference between ice off and break up – you are comparing 2 different things. how much time generally passes between the two events on the Aura river? Is it consistent? (see comment later on this as well).

255: How did you count thermal break ups and distinguish from dynamic? are they distinguished in the records?

316: April 16 and 15 respectively?

343-346: Can you really compare the moving stake to breakup? is there a consistent offset?

402-404, 433: How do you define strong? Common pattern of variability, can you analyze statistically to quantify this?

449-450 and onwards: why is the change in the Kokemaki River actually an overestimation of climate change? Explain?

476-479: Talking about projected temperatures. How about projected precipitation and possible effects on breakup?

516: "Arguably, the warmer climate that is dominating in the south is changing more rapidly, and with less predictability, than the colder climate dominating in the north. A similar latitudinal shift has been noticed in Swedish lakes (HallerbaÌ□ck et al., 2021; Weyhenmeyer et al., 2005). " Is this not because the temperature is closer to 0 in the lower latitude river reaches so a small temperature shift will have a more pronounced effect on the ice? This is seen in lake ice in near-zero regions compared to northern regions.

Table 2 has lines every 10 records but table 2 does not, I would suggest removing them from Table 1.