

Dear Editor(s)

A new version of the article ‘Tricentennial trends in spring ice breakups on three rivers in Northern Europe’ has now been uploaded.

We have made great changes in language and tried to ‘tighten’ up the manuscript, as requested. Several sections have been removed or re-written. This is evident when viewing the authors-track changes file. It is mostly red.

Moving sections (as suggested by the reviewer) improved the quality and readability, but it forced us to also rewrite and move information.

A professional proofreader have edited the language. All errors are still ours.

This manuscript is now about 800 characters shorter than the previous version (this excludes references and figure/table captions).

This is, thanks to the reviewers an improved manuscript.

Overall comments:

The authors have greatly revised the manuscript and provided a much-improved version with better scientific rigour. The authors appear to have addressed all of the initial reviewers’ concerns. With respect to further reducing the wordiness commented on by all of the initial reviewers, some sections could still use tightening up. The study area in particular is where the manuscript seemed to be still excessively wordy, although it is interesting information, and does provide supplementary information.

First, we want to thank the reviewer for having the energy to thoroughly read the manuscript and make detailed suggestions for improvement! This has helped us to improve the manuscript immensely.

Second, we tightened up the manuscript even further. It is now approximately 800 characters shorter than the previous version.

Third, the manuscript has now been professionally proofread to improve the language.

For example, Line 81-84: Again 102-104 and 125-130.

86 words: “Founded in 1612 on an island in the middle of the river, Tornio was known as a trading hub. In 1800, Tornio had a population of 710, and in 2019, 22,000. The Swedish twin-city of Haparanda was founded on the western side of Tornio in 1842 and today the Tornio-Haparanda region has a combined population of about 32,000 inhabitants. The number of bridges crossing the Torne River has increased during the 20th century. However, the only bridges in Tornio are situated below the breakup observation site.”

43 words: The population of the twin cities Torino and Haparanda (Sweden) has grown to X in 2019 from X in 1800, with additional bridges constructed in the 20th century all located downstream from the breakup observation point with no influence on the ice observations.

Or something to that effect that conveys the information more succinctly.

The suggested changes altered the meaning and the information that we originally tried to convey, which was to include metadata about the sites. Some of these descriptions were residues from older versions. However, the article has now changed so much that we shortened this up and made some changes.

There are also instances where the authors tell an interesting explanation about the data, but it is not quantified and reads as conjecture. e.g.

Line 558 “The record warm winter in 2020 caused the second latest breakup the last 100 years in Torne River and the question is what caused this strangely late event” but the warm winter did not cause the late break up, the cool spring did, with the information presented.

Line 568: In 2020, January to March were warmer than the *average but April slightly *colder and the nights were still cold at the end of month (Lehtonen, 2020). This *slight difference in temperature development *probably extended the breakup to 20 May. Thus, a warmer winter caused thinner than average ice, but a colder spring caused a later breakup”

Average: quantify – how much warmer than average.

Colder: quantify – how much colder

Slight: Quantify – what is the difference

Probably: likely resulted in the

This is the discussion section, and I do not disagree at all with the content being discussed, but it would be much stronger if quantified succinctly.

If we included all monthly and daily data in the discussion, would not the reader wonder why we did not do the analysis?

If April 2020 was colder than the long-term average, and April temperatures are relevant for the timing of the breakup, then we feel that saying that it was colder than the long-term average conveys enough information to speculate about possible effects (=unusually late ice breakup). Noting that April was 0.3 degrees colder than the long-term average only leads to another question: how does 0.3 degrees impact breakup dates?

Overall, I think the data presented is valuable to the scientific community, and the authors have created a useful dataset that should be published, but the style of the manuscript needs polish before publication.

Specific Comments:

I raise a few points in the revised version for the Authors to review:

2.3.1 – That is about the data, would fit better into section 3 rather than section 2 study area
You are correct. We moved the section and made changes to make them fit together.

Methods section, 252-253 – interpolating the missing data – how?

4.2.2 is a bit unclear and leaves questions unanswered. So increased discharge prior to break up is possibly resulting in earlier break up. But the average discharge AT the breakup date has decreased. While the mean winter discharge has increased. But none of these are actually why the break up changed, it's the lake levels in the watershed? Were the lake levels increased in 1957? And reduced again in 1980? Was there any impact from 2004? It's interesting, but needs more rigour in the description if possible. One of the earlier reviewer responses did comment there was not a lot of data regarding the power plant impacts, if I

understand that correctly, and this manuscript version has quantified the impacts some which is great. But if you are able to either add more info on what the changes were, or simply say there are no records of what the changes are if that is the case, it would tie it up better and not leave the reader hanging.

Related, 397-399 – “This is probably an effect of increased mean winter discharge at Harjavalta (Korhonen and Kuusisto, 2010); however, it should probably be attributed to lake-level regulations in the watershed area.” this is unclear. What is it attributed to, the discharge or the lake level? Does the discharge data confirm that? were the lake levels raised and hence increasing the discharge? Need clarification here. Also, I suggest avoiding ‘should probably’ or probably altogether and pick ‘likely’ or ‘possibly’.

429 – Quantify ‘strong’, looks like < 0.3 .

4.3.3 – the use of the word usually is too qualitative. Quantify the results and avoid using ‘usually’ repetitively.

We rewrote this and removed the lake level discussion. The lake level regulations most likely answers why the discharge has increased, but this was not the purpose of the article. We got carried away with all the data. This section was rewritten.

Figure 1: I suggest making the red dots bigger.
Turned the dots into squares and made them larger.

Table 3 is listed twice, rather than Table 4
Changed.

Figure 4- why are some of the months capitalized and others not? Explain the darker shaded bars in the caption as being significant (making the assumption that’s what they are) . Also, why is temperature $p < 0.001$ while precipitation is $p < 0.01$?

The months were capitalized to distinguish between years. Added explanation to caption.
Changed significance levels so they match.

Typological Comments:

Most of the minor changes are lost in the larger changes throughout the manuscript.

I have flagged some typos and missing words to fix up that caught my eye while reading, but I was not scanning specifically for things like this so could be more to catch with a final proof read.

Thank you. Small typos occurred continuously. We hope for a final proof read if the article is accepted for publication.

Line 28-29 34-35, throughout: freeze-up vs. breakup why one hyphenated and not the other? This might be grammatically correct? but it seems odd. Something to check into maybe. Previous papers in The Cryosphere have used ‘freeze-up’ and ‘breakup’ and all styles are standard in this type of research. We chose to change it to break-up as suggested by our proofreader.

Line 35 – in some places references are listed early to recent, and in other they are most recent to earliest. Should be consistent and in the style the journal wants.

Changed to ‘recent -> early’. (Our preference, the journal seem to accept all variations).

Line 30: coma missing after floods
Added.

Line 39: missing. at the end of the sentence
Added.

Line 43: they were discontinued
Changed

Line 69: “The last 180 km, before entering the Baltic Sea, the river marks the border between Finland and Sweden. “ For the last? or remove ‘the river’ – awkward to read
Changed.

154: perhaps reword “The Professor of Meteorology” to, Oscar Johansson, Professor of Meteorology This is probably just a regional difference in how titles are used. We saw it more as a rhetoric style. Title before name was our way of highlighting the researcher’s title: “The meteorologist Johansson” instead of “Johansson the meteorologist”.

156: but the most recently updated was: updated version?
Clarified.

185: the describing the Aura River breakup process: extra the?
Changed.

189: Thermal breakups have are not a new phenomenon in the Kokemäk – have something? or just are?
Mistake slipped through. Corrected.

191: has: should be have.
Changed

204: A comparison of the in the newspapers published: of the? In the?
Improved.

264: The hydroelectric power plant in Kokemäki River in Harjavalta was taken into use in 1939 “Taken into use” is not correct in this context, perhaps began operating? but, did the construction begin sooner? And if so, when was the impact on the river (e.g. in Canada, the Peace River was dammed before the power plant actually started operating). We added an explanation, even though it feels as if these explanations are the type of we have been asked to remove. In the long-term, with regard to impact on the ice breakups, it does not matter if we choose 1938 or 1939. It has no impact what so ever on the analysis because of the length of the series.

270: ‘was used’: were used
Changed.

460: Stressed (s is missing)
Added.

495: What years does this warming covered? You included the years for the cooling periods earlier

Added years.

498: This is drastic: this is a drastic?

Changed.

501: development? Not too sure what this is referring to?

Changed.

515-516: “The increase of early breakups has thereafter been explosive” creative! But better to be more scientific in writing

Correct. Rewritten.

534: and once earlier I believe – the use of the word exponential to describe a large change – I advise the authors to pick a different word – exponential implies an exponential function.

Removed and rewritten.

547: cannot: should be can no, or cannot be taken for granted.

587: “Reducing the discharge enabled the river to freeze-up and reduced the risk for frazil ice jams.” What is a frazil jam? Vs a jam in general? Maybe a small parenthesis explanation here of what a frazil jam is, first mention of frazil throughout the paper.

Removed this section as it relates to freeze-up process and ice jams, not necessarily to the breakup (at this stage).

528: includes.

Changed.

558: The record warm winter in 2020 caused the second latest breakup [in] the last 100 ...

Changed.