

The Cryosphere Discuss., referee comment RC3  
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## **Comment on tc-2021-326**

Anonymous Referee #3

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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-RC3>, 2021

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The authors present a new ice record extending back several centuries and put this new time series into context with two other rivers in the region with time series extending back centuries. It is clearly a lot of effort to assemble, revise, and validate a new record. The manuscript is quite descriptive and verbose, and could benefit from more formal quantitative analysis to support the data. The manuscript could also use better contextualization for readers outside of Finland who are not familiar with the geography and history to better follow the manuscript. Nonetheless, it is an interesting manuscript and would be a good addition to the literature.

On line 36, the authors state that the "databases are not updated with observations from the first two decades of the 21st century." This is no longer true as the database for the National Snow and Ice Data Centre have been updated in 2020 and there have been a variety of publications using ice databases that have provided their data online from the past 2 decades. Please update this sentence to reflect updated databases and recent publications.

The new time-series at Kokemäki River is amazing! Please provide some historical context of this ice time series. Who collected this time series? How was it discovered? What kinds of observations were made? Where were the observations taken? Was the same methodology used throughout the time series? How long does the breakup process take for the river?

Since one of the goals was to verify this new time-series, please provide further qualitative and quantitative evidence of how the data were verified, how closely they matched between different newspapers/records? I was also curious when there were multiple sources of ice-off, were the dates the same? Also, was the same definition used by each source over time? Did they examine breakup date at the same location and in the same way?

On line 107, thermal breakups were introduced. Please provide more specific details related to the thermal inputs to the river. What thermal breakups are relevant in Kokemaki River and why? This seems interesting, but much too vague for readers not familiar with the detailed geography and history of Finland to follow.

On line 234, could you please clarify what is meant by previously published ice breakup dates and which river is this referring to?

In the methods, it has become clear that there were changes in the location and observations for ice breakup over the years? How were the changes in location and definitions reflected in the dates and patterns of ice-off? Did they coincide with extreme events or breakpoints in the data? And how else could they have impacted the uncertainty around ice-off dates?

I liked the introduction of extreme events, but I was hoping to see a more quantitative analysis than simply identifying the 30 most extreme years. Perhaps more formal analysis could be done here to quantify if there are more extreme years in certain decades/periods than others or expected by chance. Also have the number of extreme events increased over time? Further quantitative analysis would be appreciated here.

On line 283, the analysis with the hydroelectric plant was introduced. Is this power plant only relevant to Kokemaki? It doesn't seem so as earlier it was stated that there are 4 power plants on this river. Are there any other power plants in the other rivers? Why was only 1 power plant included in this analysis and not the others?

I was curious how far these rivers and sites are from one another? If the sites are more than a grid cell apart, I was curious why air temperatures were used from the same station.

Please provide a map of these rivers and also include some of the features that were discussed in the manuscript.

The impact of the power plant is much too descriptive. Please provide some more formal quantitative analysis to illustrate whether findings were significant. Earlier in the manuscript, many other factors that have contributed to land use changes and warming were discussed, but not included in the analysis, including urbanization, land use change, and climate change. How have these factors contributed to the ice-off dates?