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Climate of the Past Discussions

Interactive comment on "Causes for increased flood frequency in central Europe in the 19th century" *by* Stefan Brönnimann et al.

Anonymous Referee #1

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This paper brings together a wide range of data types in researching the causes of changes in multi-decadal changes in flood frequencies in Europe. This is an interesting topic and I particularly appreciate that it brings together a wide range of data types–observational data, lake level records, paleoclimate reconstructions, and climate model simulations–in addressing the scientific questions.

I have two primary concerns with the present manuscript:

(1) It's not clear to me that the "weather types" and the statistical tools employed here are the best tools for the job. In particular, as discussed at lines 222-228 (and seen in several of the figures), the index that they create has a high rate of false alarms for floods, which the authors attribute to the weather classification scheme only having 7 "types". Doesn't this result imply that a more diverse classification scheme should

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be used and that the 7 weather types don't resolve what actually causes floods? It's clear that floods only occur when a cyclone/storm system passes over the area, but the real question is why is it that some storms produce major floods while others do not? That would get at the heart of what really causes floods. A guess based on what I know about the causes of floods in other areas of the world is that the floods may be ultimately caused by something like atmospheric rivers. Atmospheric rivers are "carried" along by mid-latitude cyclones, but many mid-latitude cyclones aren't associated with atmospheric rivers. Something like this could potentially explain the result that the authors see. But if something like this is what's going on, then it seems to me that the authors aren't really looking at the right phenomena. Relatedly, note that also at lines 233-235 you say that the floods in different locations (all within or adjacent to Switzerland) do not occur synchronously, which seems to imply that the causes in each area are very specific and unlikely to be captured by a simple set of 7 types or the even more broad single anomaly pattern shown in Fig 8; furthermore, if floods are extreme or rare events wouldn't you expect their causes to also be rare and not obviously expressed in a set of basic patterns and almost certainly not in a single mean anomaly pattern?

(2) I don't think that the two time scales of analysis are sufficiently bridged. The authors first perform a series of analyses using daily weather data. This time scale makes a lot of sense because that's the time scale over which floods occur. But then the authors jump to a multidecadal analysis using the climate model simulations and the paleoclimate reconstruction, without clearly linking the two very different time scales. It's not obvious to me at all that daily weather patterns should have anything to do with the differences between 30-year climate anomalies. And furthermore, it's not clear that these 30-year climate anomalies have anything to do with the presumably rare mechanism that may actually be underlying the flood events (as suggested by me above in 1). I think the authors need to lay out a very clear and specific set of logical steps that link the underlying daily causes with longer time scales. It's not clear to me, but perhaps the authors are assuming that multidecadal changes in flood frequency implies that there's some driving climate phenomena acting on those scales? That

of course doesn't have to be the case and so the authors may not even have to link the shorter scales to the longer scales. I wouldn't be surprised to see "multidecadal variability" in a rare phenomena (that actually occurs on daily time scales) being due solely to chance. In fact I think that should probably be the null hypothesis here and could explain why the authors find no strong connection to the AMO or PDO.

Minor comments:

I found it somewhat frustrating that the weather types weren't shown in the current manuscript. The explanation in words wasn't really enough for me to clearly see what dynamics were actually going on and I had to pull up the Schwander paper to make sense of what the authors are talking about. Also because the 7 weather types are not shown in this manuscript, it makes it very hard to assess the physical processes going on and how they connect to the model analysis in Fig 8. If the weather types are kept in the analysis here, I would suggest including them among the figures.

For the lake level data, is there reason to be concerned about evaporative effects and the memory of the lake system having an impact on the lake levels? From my reading of the text, it seems like the authors are assuming that the lake levels can be somewhat straightforwardly interpreted as indicating flood events. Maybe they can be, but it's not obvious to me.

Lines 226-228: I don't see the logic of how this sentence follows from what was said previously. Why are 50th and 75th percentiles useful here?

Line 251: I think 1868 is meant here instead of 1968.

Lines 337-339: How does a difference between the two periods imply that there's forced multidecadal variability in the model?

Fig 8: It would be helpful to indicate in the caption where the data and from and which periods are flood-rich vs. flood-poor.

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