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Comment on nhess-2021-281

Anonymous Referee #1

Referee comment on "Magnitude and source area estimations of severe prehistoric earthquakes in the western Austrian Alps" by Patrick Oswald et al., Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2021-281-RC1>, 2021

Review

Magnitude and source area estimations of severe prehistoric earthquakes in the western Eastern Alps
By Oswald et al.

The paper summarizes the paleoseismic record of 3 lakes situated in the western Austrian Alps, an area currently experiencing moderate seismicity with a few larger historic earthquakes. Sedimentary horizons indicating earthquake induced deformation were identified throughout the 3 lake records in seismic reflection and core data. The lacustrine record spans the entire Holocene and Late Pleistocene since deglaciation of the area about 15,000 – 17,000 years ago. This long record allows for some statistical analysis of earthquake recurrence intervals. A strength of the paper is the integration of the 3 lake records to determine the timing and extent of earthquake-induced deformation. This leads to an estimate of paleo-magnitudes and source areas for prehistoric events and the presentation of shakemaps for 4 larger prehistoric events. These shake scenarios can provide important input into seismic hazard maps for western Austria as well as neighboring Germany and Switzerland and are the most important message of the paper.

The paper is well suited for publication in "Natural Hazards and Earth System Sciences". However, I would suggest a few modifications to further highlight the strengths of the paper.

1. The paper seems to serve two purposes, a presentation of the Late Pleistocene sediment and earthquake record for two of the lakes and the integration of the Holocene and Late Pleistocene records of all three lakes to determine characteristics of paleoearthquakes. While the Holocene lake sediments and related earthquake horizons are probably presented in detail in earlier papers by Oswald et al., the criteria for assigning an earthquake origin to certain horizons is not well explained or cited in this manuscript. Several terms such as multiple MTD (mass transport deposit) horizons, SSDS (soft sediment deformation structures) are used throughout the text but I think there needs to

be a short introduction to these features earlier in the text similar to the distinction of flood-generated and mass movement related turbidites presented in section 4.1.1.

2. It seems that event scaling for Holocene earthquake horizons uses similar principles for the Holocene and Late Pleistocene record. I am wondering if the Late Pleistocene sediments are different enough to exhibit different thresholds for deformation (I am thinking of organic matter content, sedimentation rates etc.). Can you explain more?

3. I think it would help to describe the lake sediments more and to point out similarities and/or differences between the Holocene and Late Pleistocene sequence. Adding a section summarizing the sedimentology of the lake deposits as well as the associated deformation features (see above) might work.

4. I think a little rearranging could make the manuscript flow better.

Detailed comments

Title: and elsewhere. I am wondering if there is a better term for "western Eastern Alps"? Could you say western Austrian Alps?

Abstract:

Line 9-16: This seems a little lengthy and repeats in the introduction. Maybe shorten. I would add a sentence on the methods used.

Introduction

Line 54: here and throughout text: please translate abbreviations when first introduced.

Figure 1

Can you enlarge the inset map and show adjacent country boundaries? I would also label countries.

Settings

Line 75-78: I think the seismicity of the region has to be described in more detail e.g. the size/impact of historic events. Otherwise, it is quite difficult to compare the paleoearthquakes to the more recent events later on.

I think here is an opportunity to add a paragraph and describe lake formation, lake sedimentology, Holocene versus Late Pleistocene sediments, age model etc. Some of the

information in the next paragraph would fit nicely here.

Methods

I am wondering if you could briefly give an idea of your data base, such as extent of reflection seismic data, number of cores etc.

Before going into the event scaling, there should be an explanation of how event horizons look like. Please translate abbreviations and maybe add a short explanation of SSDS, multiple MTD, turbidites etc. Otherwise, it is quite difficult to follow the scaling arguments. Line 112 and following: I am wondering if not only the slope and basin areas but also differences in lake sediments, the slope itself etc. influence the size of event layers. Maybe you can explain further why slope and basin area ratios are sufficient. Also is there a difference between the Holocene and Late Pleistocene record?

Results

Line 192: Maybe better than "extension of..": The paleoseismic record of Tyrol Lakes. I would include a quick summary on the Piburger See in this paragraph.

199-205: This information might be better earlier under lake setting. Please add reference for homogeneous turbidite formation.

Figure 2: b and c are hard to see. Maybe show 2b and c earlier when explaining event horizon characteristics.

Figure 3: The age constraints for the lower record seem a little rough but probably the best available.

Line 265: if there is a magnitude range for "severe" maybe this can be specified here or earlier

Line 269-270: I am not clear about this sentence.

Fig. 4: add and explain grey solid and dashed line in legend. Mention that numbers indicate timing of event.

Line 273 and following: All these lakes seem to be outside of Figure 1. Could they be added?

Line 297: maybe better: Paleoearthquake scenarios

Line 308: Mention Figure 5a first

Line 312: violet triangles are hard to see. M 5.7/5.8 seems very close to the threshold for lake sediments to show traces. I find it interesting that you found deformation. Maybe you can discuss this somewhere?

Figure 6: I really like these shakemaps – very important information for hazard assessment.

Discussion:

Line 400: Maybe say: Late Pleistocene paleoseismic record. Also, I would put this whole section 5.1. earlier.

Line 427 and following: This paragraph might also fit better earlier in the text, maybe under event scaling?

Line 480 and following: This seems a little tentative with just three events that are spaced far apart. Maybe leave out?

Conclusions

Line 548: maybe rephrase: "...indicated by the regional paleo-earthquake catalogue"

References not checked, sorry.