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# *Interactive comment on* "Characterizing the complexity of seismic signals at slow-moving clay-rich debris slides: The Super-Sauze (Southeastern France) and Pechgraben (Upper Austria) case studies" *by* Naomi Vouillamoz et al.

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General comments:

The authors do a great job analyzing and categorizing the seismic emissions of very complex source processes. It is a laborious task, but essential to be able to use seismic monitoring as a reliable tool to forecast the behavior of debris slide. The authors try to establish an objective and consistent processing scheme, which of course has its limitations for such a complex seismic record. The paper is well-written and presents



in most parts conclusive and comprehensive results, giving all the necessary details. However, some clarification are necessary and there are issues that should be discussed in more detail. My main concern is the temporally varying completeness of the seismic event record resulting from the manual processing scheme applied. This could have important implications on the interpretation of how well the seismic rates correlate with measured displacement of the slide.

Specific comments:

(1) Page 4, section "3 Methods": I would suggest to remove the sub-section 3.1 since only a single method is introduced.

(2) Only sonograms on night time measurements were screened to minimize false detections: What implications does this have on the fact that you use the seismic rate in the end and compare it to slide displacement? Or does it not matter because the displacement data has daily resolution (see also comment about Fig. 14 below)? Is there any process that could lead to an increase of seismic emissions from the landslide body during daytime which you would miss (e.g. diurnal temperature forcing)? Is there a changing noise level at nighttime that could affect the observed seismic emission rate (change of "visual" detection threshold)?

(3) Features presented on Page 5: Maybe it is worth a try to use an automatic clustering method in the feature space. That would open up the possibility to use some sort of STA/LTA network trigger and then perform post-classification afterwards. Showing some scatter plots would help to evaluate if the feature distribution from all events actually shows a clustering related to your event classes, or if the classes rather represent end-members of a continuous distribution. Even if implementing an automatic clustering method is beyond the scope of this paper, the potential of such an approach could be discussed.

(4) Array processing: How reliable is beamforming here given that source-receiver distances are rather short compared to the array apertures (non-planar wavefronts)?

(5) Page 8: 4.3.1 change to 4.3.2.

(6) Page 6: If Type IV are most likely events outside the landslide, wouldn't it be better to describe them in section 4.1. (local earthquakes)? In this case section 4.2. "quakes" could be renamed to something like "seismic landslide signals" or "slidequakes" (which has been used previously).

(7) Page 10, line 9: Since you wrote you just used nighttime records for manual data inspection and there are signals corresponding to "geophysicist walking": Is this consistent? (Of course geophysics might also work at night sometimes . . .)

(8) Page 11: Please explain what you mean with "the domain of existence of the hypolines was tested ..."

(9) Page 11: Line 23-27: See previous comments (consider non-planar wavefronts in addition to scattering and inhomogeneities)

(10) Page 12, Section 5.2: "normalized difference between the maximum amplitudes of the signals and the median value of all maximum amplitudes": This is a bit unclear. I would suggest to add an equation to define your variable "scatter about the median amplitude". Then, you could refer to this quantity simply with a letter. Also, what is the percentage of this variable being larger than 200% for each of the 4 event types? Here you just give percentage of all events (type I-IV (?) quakes and tremors). I would expect a clear difference for Type I and II compared to Type IV.

(11) I suggest to discuss some potential methods for automatizing the event detection. You mentioned template matching. What about cross-correlation of (array) envelopes instead of waveforms? See also comment above about clustering. It could be an option to introduce a separate discussion chapter which includes the issues of catalog completeness, automatization, and correlation of event rate with slide displacement.

(12) Table 2: Is this Vp or Vs?

(13) Fig 3: Why are Type II events absent for stations S1.1-S1.5 ?



(14) Figure 10d: This panel is a bit hard to read, especially because you use two colors (red and black) with two different meanings (Red for picked stations and model 2). Maybe I misunderstand, but it looks like the hyperbolas intersect always close to the center of the array used for beamforming, but the true location is outside the array. Is this coincidence and what could be the reason?

(15) Figure 11: It is not clear how you defined the three thresholds. I can follow the choice for T3, but T2 and T1 seem a bit arbitrary. Please explain in more detail.

(16) Figure 14: The comparison between seismic rates and displacements from this figure is very difficult, especially to prove your statement on Page 14, line 19-20, that seismicity rates show a clear increase with increasing displacement. Consider to increase the size of the sub-figure. Also, red symbols (slidequake) may be hidden by tremor symbols. As far as I understood, all events only occurred at nighttime. In this case you could indicate the data time periods you did not screen. Please also indicate where you see correlation between seismicity and displacement. I suppose "endogenous events" is the same as "land-side induced events" and includes both tremors and slidequakes?

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