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Discussions

Interactive comment on "Formation time and mean movement velocities of the 7 August Zhouqu debris flows extracted from broadband seismic records" *by* Z. Li et al.

Anonymous Referee #1

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Thank you for your rapid and thorough response to my comments and it seems that if you incorporate some of the explanations and responses you gave to my comments, it would greatly improve the rigor of your manuscript. However, I first want to say that it seems from the first paragraph of your response that you misunderstood what I was trying to say. I never suggested that the signal recorded was not from the debris flow, it is quite clear that it is, the signal you show has all the typical characteristics of a debris flow signal. What I have a problem with is the method you choose to identify a start time on a signal with an emergent onset where the noise level dictates when the signal actually appears above the noise level. You just quantified a choice with

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arbitrary thresholds and this is no better than just picking it by eye (actually, looking at the non-normalized spectrogram in the figure you attached, I would put the start time at least 2 minutes earlier by eye, and in reality it was probably even earlier since that is just when it emerges from the noise). The choice of start time is highly dependent on the background noise level and source to station distance, it seems from your response that you agree so this should be reflected in your manuscript, but it also means that since your methods depend on using this start time to estimate debris flow speeds, you need to take all these uncertainties into consideration in your calculations.

Regarding your response to problem 2 of my review – the normalized frequency content is indeed different before your defined start time, I don't dispute that and it seems from your response that we are in agreement that the reason is because beforehand we are just looking at the background noise, the signal is too low to contribute substantially at that stage. But in your manuscript the wording implies that the frequency content observed in the time before your chosen start time, reflects the development stage of the debris flow whereas it seems from your response that we agree that it is just noise. You should just say it is noise.

The idea that you rely on in this study and repeat here in this comment that the N-S orientation of the path means that the N-S component has a higher signal level, and that variations in the relative amplitudes of different components can be used to assign arrival times to parts of the path needs to be rigorously justified. Different types of seismic waves have different polarizations, it's not simply a function of the direction of the moving source, and though no one has hammered out the theoretical details yet, generally people agree that a debris flow generates seismic waves both from shear stresses at the bed and from normal stresses due to vertical impacts of blocks, and there can also be random variation in the directions of the individual impacts. The nature and direction of the seismic source affects the radiation pattern and relative contribution from different components as well. Additionally, when you are looking at such high frequencies, the waves are so scattered and altered by the time they arrive at

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the seismic station you would not expect a simple direct correspondence between flow direction and polarization. One more contribution to the chaos is that debris flows are generally elongated so half it may still be moving in a N-S direction while the other half may have turned slightly. Your interpretation seems to ignore all of these unknowns and uncertainties. If you are going to rely so heavily on the relative amplitudes of different components to interpret your signals, as you do in your original manuscript, you need to back it up with seismic theory – and I'm not sure you can.

Regarding your response to problem 3 in my review – first of all I don't know what you mean by "average increasing velocities" and the main point that I don't follow is the scale function used to "equally show peaks and troughs." It is still not clear enough from your description where that comes from and how you know enough about the relative energy contributions from different parts of the flow (I assume it has some connection to attenuation, which seems to be an unknown here) to justify doing that. This could be potentially an interesting idea that others could use if it could be backed up scientifically and explained clearly enough to be reproducible.

Regarding your response about the Doppler effect, these calculations you included need to be included in the manuscript to strengthen your point, but you need to specify what type of wave the velocities you propose are for, I'm guessing the number you give is for shear wave velocities? In the case of a debris flow the waves should be mostly surface waves, which have variable velocities, but also body waves. The velocities you give seem too low because the source area is far from the station (until it is destroyed). Many of the body waves arriving at the station probably are not traveling through the highly attenuating low velocity loose material, but through higher velocity material below or next to the loose alluvial material, and the surface waves that arrive without being attenuated are probably not the ones with short wavelengths that are only sensitive to the shallow loose deposits, but those with longer wavelengths that are more sensitive to the higher velocity subsurface below the loose material at the surface. These are just suggestions for factors that I think you need to consider in the calculations for your

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revisions.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 675, 2015.