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Reply on RC5

Pierre Henry et al.

Author comment on "Mass flows, turbidity currents and other hydrodynamic consequences of small and moderate earthquakes in the Sea of Marmara" by Pierre Henry et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-323-AC12, 2022

GENERAL COMMENTS

The manuscript presented by Henry et al., can add a substantial contribution to the knowledge of the response of the sediment to moderate earthquakes in a canyon system of a shelf edge in active margins. One of the main findings of this research is obtaining quantitative measurements in real time of the physical parameters (velocity, Tª…etc) of the water and sediment flows generated by earthquakes with magnitude between 4-6. The methodology used is novel and can add significant findings to the understanding of flow dynamic related to currents (turbidity or not) triggered by earthquakes.

To really test the value of the flow measurements and main assumptions exposed in the proposed text, it would be very valuable to have sediment cores in that location and check the sedimentological features related to the "events" triggered by the 4.7 and 5.8 earthquakes.

We agree, one problem is to get the cores. Hopefully, getting this manuscript through will help convince people that taking cores in this area and studying them is worth the cost.

*The **introduction** encompasses the main crucial aspects to be considered for this study and it is properly referenced. However, the focus of the introduction may be slightly changed. Paleoseismic studies are based on the synchroneity of turbidity currents triggered by big earthquakes (> 7 Mw) and their deposits down the canyon confluences in basins with a wide extension (even hundreds of kms) of active margins in an abyssal context. See several works from Adams 1990, Goldfinger (2003, 2006, 2007…) and Nelson et al. (2000, 2009…etc), Gutierrez-Pastor et al., 2013 or the Japanese Nakajima et al., 2000 and Shiki et al., 2000.*

We agree. One main point of the paper is that smaller earthquakes can also cause

turbidity currents, but these will be weaker and remain local. New references added

Here authors are testing generation of "turbidity currents" triggered by moderate earthquakes in an outlet canyon of the continental shelf edge and their hydrodynamic consequences. From my point of view, I would focus on the study of characteristics of currents triggered by different moderate earthquake magnitudes and think in the possible sceneries (turbidite currents, storms, hyperpycnal flows…etc). I would try to find information in obtained well dated sediment cores in the area and their sedimentological characteristics in relationship with historical earthquakes.

Studies of cores from the Sea of Marmara Central Basin were cited in the manuscript. We now include more details. Cores taken to establish paleoseismological records were taken across the depocenter, but far from the edges of the basin to avoid perturbations by local failures and bris flows. The historical earthquakes correlated with the turbidites homogenites are magnitude M 6.8 or more. No core from the instrument location has been studied but one taken at the base of the slope at a cold seep site contained a debris flow, but no TH acording to description. A logical inference would be that the event we recorded does not have a basin-wide TH signature, but this is still something to be proven with new cores.

One important point that we prove with the temperature record is that the turbidity current does not come from the shelf edge… Probably something we should emphasize.

*I would separate the **discussion** from the **conclusion.** Conclusions may be very clear in a format, preferably, of bullets with the main new insights and findings.*

Agreed

In general, the manuscript is well written although I propose some suggestions in an attempt to improve the content and shape.

SPECIFIC COMMENTS

Lines 37-39: These lines are weakly expressed. I would rephrase them or eliminate in the abstract (maybe include something about it in the introduction, well justified) because here you are comparing small earthquakes recorded just in a proximal site of this margin, with historical big earthquakes (bigger than 7) that trigger turbidites down the canyon confluences in the deep basins.

Agreed, this statement was also misleading for reviewer 1

Lines 57-61: Rephrase this; Actually, seismoturbidites deposit over the hemipelagic

sediment below, that represent a quiet open ocean environment. In the way that is expressed look like the hemipelagic is overlying the sandy/turbidite base?? You may specify that the "layer of apparently homogenous mud with small or gradual, if any, variations in grain size and chemical composition" may correspond to the tail of the turbidite. There is a lot of literature to check the seismoturbidites characteristics as for example Gorsline et al., 2000 (Gulf of California), Nakajima et al., 2000 (Japan Sea), Shiki et al., 2000 (in lakes) and the cited Gutierrez-Pastor et al., 2013…etc.

Guttierrez-Pastor et al. (2013) and Nakajima and Kanai (2000) use the term "tail" instead of "homogenite", but it is the same object. Nakajima was already cited elsewhere in the draft. Other references were added.

"Seismoturbidites are generally described as turbidite-homogenites comprising a basal silt-sand bearing layer under a layer of apparently homogenous mud (named homogenite or tail) with small or gradual, if any, variations in grain size and chemical composition"

Lines 93-97: As said in a comment above, be careful with comparing seismoturbidites triggered by big earthquakes and recorded in the sediment in wide margin areas with this local turbidite flows measured with an artifact locally. You could focus the study in showing the characteristics of the flows and sediment involved in the triggered current to improve the understanding of turbidite currents generated by earthquakes in proximal sites. This is very valuable to understand the hydrodynamic conditions during and at the time of the deposition, and compare with other records (such as storms, hyperpycnal flows…etc).

True. The corresponding sentence regarding the relationship between seismoturbidites and historical earthquakes (M>7) is out of place, it will be moved earlier where the significance of seismoturbidite records is discussed.

Line 114-116: This is extra, eliminate it: "that differ…etc"

It is important to state that the chirp signature is different in the fan an in the basin, "...that differ in seismic character from the reflector sequence in the basin" may be a better wording.

Lines 270-281: The beginning of Section 3.2 is not easy to follow. It is very confusing. You state "main earthquake" (Do you mean the one of Mw 5.8?), "During that event" or during "all three events". You may specify better and express it in a way more under stable.

Yes, these is a small increase in current before the Mw5.8.

Yes, the current comes from the east during all three events

Lines 381-383: This assumption seems to contradict lines 366 and 367, where you state that speed of less than 4 cm/s may have been insufficient to put particles in suspension. However, here you say that several turbid events are observed.

It does not contradict, but suggests (as stated lines 383-385) that these particle clouds have been put in suspension as a consequence of the earthquake, rather than by local currents.

Line 389: specified the seasonal temperature variability ranges, if possible

The seasonnal variability in the surface layer is 15° (5-10° winter 20-25° summer).

Line 422: In this section I miss any table explaining the sequence of events or even a drawing. I suggest to add any table, scheme or draft to improve and clarify the meaning of the events.

Ok for a sketch.

Lines 499-501: You should mention here that a sedimentary record would complement the hydrodynamic interpretations and would support your work. Consider that If there is any sediment core in the area that is well dated, you could look for the historical earthquakes of magnitudes between 4-6 and have a look to the sediment corresponding to the date of that historical earthquake. So, you could test if there is turbidites and their characteristics, as you describe from your observations. To me, this is the most interesting point that can add (really) to the Paleoseismology, in relationship with moderate earthquakes in proximal settings. So, measurements of current turbidite currents can help to calibrate what we observe in the sediment.

Agreed, but we do not have data.

The well dated seismoturbidites found in the Central Basin have all been attributed to large earthquakes (estimated magnitude > 6.8) (McHugh et al., 2014)

One core was taken in the fan in 2007 but not studied in details yet and could perhaps be investigated now, but fresh cores are probably needed as well.

However, one relevant observation made near a canyon outlet in Tekirdag Basin (Zitter et al., 2008) is that both debris flow and turbidites are observed in cores, while cores taken within the basins only contain turbidites.

Lines 512-516: This is not clear. Rephrase.

What was meant is that the maximum velocity in ADCP profiles of turbidity currents is generaly above 1.5 m, so that the maximum current velocity may be higher. Nevertheless, in the early phases of turbidity current development the basal dense flow may move at a higher velocity than the water above (Paul et al., 2018).

Line 513: Which velocity?

Current velocity

Lines 521-523: Specify the magnitude of Earthquakes.

Good point !

Line 534: first time that you mention something about calcium. Please, add any reference.

The reference was already cited: Yakupoglu et al. (2016)

Line 565: So, there is a core taken in the fan??? Which core, please spcify and make the appropriated reference. So, if you have a core and is properly dated, you have opportunity to test what I have suggested in comment above.

No this is an observation on the chirp profile. In Figure 1, it is very clear that the reflector sequences in the fan and basin are different.

Line 570: Please, specified magnitude.

6.8 according to the reference cited (McHugh et al., 2014)

TECHNICAL CORRECTIONS

Line 320: 5 cm/s. Take out the space

Done

Line 355: change turbidity for turbidity currents

No, it is indeed turbidity. Turbidity is a quantity measured with a nephelometer and refers to optical rather than acoustic backscatter.

Line 428: ENE? East North East?

OK

Line 449: Here you define "seiche". Revise in the text where it appears for first time and define it there.

Seiche was defined line 119. The point here is that the relationship between current strength and wave amplitude is the same for a standing and a progressive wave and therefore the same for a seiche and a "normal" tsunami without resonnance effects. It is not about defining a seiche.

Lines 489-491: add a verb "how earthquakes scale influences the hydrodynamic

"How earthquakes scale with their hydrodynamic consequences" scale is the verb

Line 533: "observatory", Do you mean the instrument?

Yes, changed

Line 537: Change earlier by "before".

yes

Line 544: Include "that". The scenario that we propose…

yes

Figure 1: Mark references: North or South and East or West. 1B need labels in the map.

?

Figure 6. If possible, increase the size as Figures 4 and 5.

Difficult&

Figure 8. Add (O2) after oxygen concentration

Why ?

consequences or conditions…." or change the sentence to better make sense.