

## ***Interactive comment on “1997 Kronotsky earthquake and tsunami and their predecessors, Kamchatka, Russia” by Joanne Bourgeois and Tatiana K. Pinegina***

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### General comments

The Authors propose new data on tsunami deposits and supply a history of tsunami events occurred in the northern segment of the Kamchatka subduction zone during the past 1700 years. Methods and results are very interesting and well presented, starting from the introduction, where the aim of the paper is well addressed, and following in results and discussion. The paper deals with relevant scientific questions about the source of the 1997 earthquake, starting from tsunami deposit data and discusses a method applicable in other tsunamigenic areas. The title clearly and unambiguously

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reflects the contents of the paper. The abstract must be revised because some results are not clearly exposed (see comments). The size, quality and readability of each figure is adequate to the type and quantity of data presented, but some few implementations are needed (see comments). Authors give proper credit to previous and/or related work, and they clearly indicate their own contribution. References are appropriate and quite (some papers are in Russian) accessible by fellow scientists. Few parts of the paper (main text, figures and their captions) need to be revised (See specific comments). The technical language is precise and understandable and the English language is of good quality, fluent, simple and easy to read and understand, except for some parts (see specific comments). The amount and quality of supplementary material is appropriate.

My first remark is for the Abstract, which should be reformulated because there are some inconsistencies: The Authors affirm that: “A reevaluation of the April 1923 earthquake (and its tsunami) suggests that its moment magnitude should be revised upward to  $M_w \sim 8$ ”. How did Authors reevaluate the April 1923 earthquake, if they cannot distinguish its deposit from the one of February 1923 in southern Kamchatsky? When Authors describe the 1923 events, it is better to discuss that the April one was located north and the February one occurred southmost. The last one was observed in the study sites, whereas no run-up of the April event was observed; but this not necessary means that the tsunami did not flooded. Indeed, it is possible that it was not observed as the 1997 one. Furthermore looking at Fig. 6, I see that in the south of the bay the 1923 tsunami flooded more than in the northern part, although the coast was higher. Probably, the southern part was hit by the February 1923 tsunami and the northern part by the April tsunami, as also shown by observed data in Table S2.

My second remark concerns the “Interpreted rupture locations of 20th century tsunamigenic (except 1923.II.24) earthquakes along the Kamchatka portion of the Kuril-Kamchatka subduction zone” shown in Fig. 1. The reevaluation of the 1997 earthquake is not clear. Indeed, Authors show many source models (Fig. S1 and S9) but

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it is not easy to understand the new proposed model. Figure 1 shows the proposed tsunamigenic areas, but without a direct comparison with the previous models; therefore, differences are not evident. The Authors start with this figure, which is actually the conclusion, where it is not evident the difference with the previous source model. Therefore, I suggest marking differences with the previous models.

Finally, I suggest separating historic from prehistoric records in the abstract. Indeed, the historic record suggests a more northerly location of the 1997 rupture and a revision of the size of the April 1923 earthquake; whereas prehistoric record suggests, in agreement with previous works, that the northern KSZ ruptures are in smaller sections than the southern KSZ.

#### Specific comments

Lines 36 -38. "References to the modest or small tsunami of 15 December 2006 central Kurils (Ammon et al., 2008; Liu, 2009), when in fact this tsunami generated an average of 9.6 m runup over an along-rupture length of 390 km (MacInnes et al., 2009), remind us that without post-tsunami or tsunami-deposit surveys, remote spots in the world may experience large events without a written record". Please rephrase. It is a long and not clear sentence. I understand that MacInnes et al. (2009) studied this tsunami with either post-tsunami or tsunami-deposit surveys and demonstrated that the 15 December 2006 central Kurils tsunami was not modest or small but large because before the study was not observed.

Line 81 "at least one of which was locally larger than 1997". Do you refer either to the earthquake, or to the tsunami? Why do you state this?

Page 4 lines 115 "Locations of epicenters and hypocenters": what is the differences? I see only epicentres, depths are not shown. Please delete hypocenters.

Lines 218 -221. The discussion about the two 1923 tsunamis is not clear. I do not understand if tsunamis were observed or if data are from tsunami deposits. In any

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case, it is not easy to distinguish in a post tsunami survey the effects of two events, so near in time and location, unless the survey was before the occurrence of the April earthquake. The Zayakin and Luchinina's catalogue records that the February 1923 tsunami went 4-5 km up the Chazhma River. Was this record achieved considering a post tsunami survey, or tsunami deposits? In any case, from table S1 in your study area runup was higher for the 1923 April tsunami and it is possible that nobody observed in Chazhma River the April 1923 tsunami. Therefore, since the February source is located southmost the deposit you find, it is likely the main deposit of April. It is better to specify this clearly, so that you may revise the size of the April 1923 earthquake.

Page 6 lines 225-227, it is not clear: I suggest referring to table S3 and to add a graph showing temporal distribution of earthquakes and related tsunamis

Page 7 "Methods" Please, refer to the detailed map of the field (Fig. S2) and add on this map profile tracks, because it is difficult to follow the description of the sites and localities from the small scale of Fig. 1. Please zoom in the area of fieldwork.

Page 7 line 254: "the final limit of a deposit is not always located in the field" It is not clear; I suggest changing with "the final limit of a deposit cannot always be found within the considered profile"

Table 2. Marker tephra layers younger than 2000 years old in shoreline profile sections, southern Kamchatsky Bay. In order to simplify age control I suggest using always the same age style: either B.P. or calendar years. It is more easy to understand what stays above and what stays below: HSht3 = KS1907; SH2 = SH~1130; SH1450 = SH~600; KS1 = KS~300

Figure 5, lines 261. "The 1923 tsunami had to have been higher to generate greater inundation". Have you considered the possibility that in the 1923 the topography was lower than in 1997? Furthermore, flooding distance can be related to wave period. Distribution of tsunami deposits is related to the inundation along the coast that, in turn, is related to the dimension of the seismogenic source. Flooding distance can be related

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to wave period (long period=more ingression), whereas run-up is also influenced by coast morphology (see for example Cox and Machemehl (1986) and Noormets et al. (2004)

Cox, J.C., Machemehl, J., 1986. Overland bore propagation due to overtopping wave. *Journal of the Waterway Port Coastal and Ocean Engineering* 112, 161–163.  
Noormets, R., Crook, K.A.W., Felton, E.A., 2004. Sedimentology of rocky shorelines: 3. Hydrodynamics of megaclast emplacement and transport on a shore platform, Oahu, Hawaii. *Sedimentary Geology* 172, 41–65.

Figure 6. Please mark location of the area shown in this figure with a box on Figure 1.

Line 337 “In the few cases where our field observations did not distinguish the two by sediment runup or inundation, the “1923” deposit was coarser and/or thicker than 1997”. It is not clear However, they are two tsunamis. It is possible that you found the deposit of the two inundations.

Page line 356-361 Check please Table 1 where the 1952 tsunami was larger than 1960 Chile tsunami. If the table is correct, the deposit you found can be the 1952 tsunami. The only evidence supporting that the intermediate tsunami is the Chile tsunami deposits can be that it lies above the Bezymianny 1955 tephra layer.

Line 368. “Thus, we cannot assign a specific event to this deposit”. Why did not you perform any absolute dating (radiocarbon dating or OSL) of your deposits in order to constrain age?

Line 379. “Any source model must explain low runup on the peninsula and relatively high runup north of the peninsula.” Looking at Figure 6. I see that south runup is similar or larger than the northern one and that, in some sites, there is not deposit of the 1997 tsunami. Furthermore, also the 1923 tsunami deposits seem to be more extended in the south, with respect to the one in the Storozh River profile 160.

Lines 412. The tables (Table 1 and TableS1) with records of tsunami runup show

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observed data. It is not clear to me the meaning of the “clean” boxes (where no value is reported). Is this because nobody observed it (as for the 1997 tsunami) or because nothing occurred? This is an important point because if we said that the 1960 tsunami was observed and we selected it just for this motivation we can do a mistake, indeed the 1952 had a higher runup in Tables S1 in Olga Bay

Line 421. Have you not absolute dating of your deposits? i.e. by radiocarbon and Optically Stimulated Luminescence dating. see for example Gerardi F., Smedile A., Pirrotta C., Barbano M.S., De Martini P.M., Pinzi S., Gueli A.M., Ristuccia G. M., Stella G., Troja S.O., 2012: Geological record of tsunami inundations in Pantano Morghella (south-eastern Sicily) both from near and far-field sources. *Nat. Hazards Earth Syst. Sci.*, 12, 1185–1200, doi:10.5194/nhess-12-1185-2012.

Figure 2. In the key what are Kamchatka EMSD and Europe & N. AM.

Please check Table S1: What is MAX KAM? = maximum in Kamchatka? Date of tsunamis: please use always the same UTC as reference, i.e. 3 Feb 23 and 13 Apr 1923; G&S = Gusev and Shumilina, 2004; Zayakin & Luchinina = Zayakin and Luchinina, 1987.

Please check Table S2: KEMSD GS RAS ? Zobin& Levina 2001; Slavina et al. 2007 = Zobin and Levina, 2001; Slavina et al., 2007; S&al 162.55 ? Engdahl, vonderHilst & Buland, 1998 = Engdahl et al., 1998 not in reference.

Please check Table S3: Runup max (where?); 1923 2 2?? = 1923 2 3; Steller f.z.?? Gusev & Shumilina, 2004 = Gusev and Shumilina, 2004.

Table S4: Chazhma River, south Kamch Bay, Regarding the 13 April 1923 at this site: was the tsunami not observed or there was no post tsunami survey?

Please, see also marked manuscript.

Please also note the supplement to this comment:

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<https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2017-172/nhess-2017-172-RC1-supplement.pdf>

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2017-172>, 2017.