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Interactive Comment

Interactive comment on "Multi-method observation and analysis of an impulse wave and tsunami caused by glacier calving" *by* M. P. Lüthi and A. Vieli

Anonymous Referee #2

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This is a valuable contribution to the field of landslide-tsunamis given that a real event was documents (video) and measured (terrestrial radar interferometer, tide gauge) in great detail including slide and tsunami properties at various locations from the impacting mass. Field data about landslide-tsunamis are rare indeed, and the data presented by the Authors are perhaps the best documented data set of its kind so far. The Authors further describe the field data with empirical methods based on laboratory data, and make prognoses for potential future events. The article is well written and most figures are nicely presented. Before the article may be considered for publication, however, the comments below should be addressed by the Authors.

Specific comments:

The Authors do not fully appreciate the effect of the water body geometry. Based on Fig. 1, the presented case is clearly a three-dimensional (3D) event (the waves propagate on semi-circle from the source), in contrast to most studies investigating landslide-tsunamis in two-dimensional (2D) geometries representing narrower water body geometries such as narrow lakes or reservoirs. The wave magnitude between 2D and 3D easily changes by 1, 2 or even more order of magnitudes, particularly far away from the ice impact location (see recent contributions to this field such as Heller and Spinneken 2015). In Section 5.1 the Authors got it right as they apply mainly empirical equations derived for 3D cases. However, Eq. (3) is based on 2D and should not be applied to this 3D event due to several reasons such as the incorrect geometry of the water body, the fact that this formula was derived for rock slides (density of 2745 kg/m3) rather than ice and also the violation of parameter limitations; however, later studies conducted in the same institution (Zweifel et al. 2006, Heller and Hager 2010) include a much wider parameter range including densities lighter than water.

Title, P6472/L2/3, P6473/L14, P6475/L10/11/12, P6479/L18, P6482/L3, P6483/L4: The terms “impulse wave” and “tsunami” are very much related and indicate basically the same phenomena. The terms “impulse wave” and “tsunami” differ only in the sense that “impulse wave” is the general term, while a “tsunami” is an impulse wave in an open water body such as an ocean. For restricted water bodies such as a lake or reservoir, the term “impulse wave” should be used. However, the application of these terms is changing over time and more and more scientists use the term “tsunami” also to describe waves in lakes. Anyway, in the present study the wave may just be called “tsunami”. E.g. the title may be written as “Multi-method observation and analysis of a tsunami caused by glacier calving” to avoid repetition. This needs to be revised in the entire manuscript.

P6477/L18: The water depth on its own is not the most important parameter, it is rather its relation to the ice impact velocity, the ice thickness etc. which matters. Generic scale modelling is essentially based on dimensionless parameters (Froude scaling, dimensional analysis). The Authors may cover this if they write "...is one of the most important parameters which..." rather than "...is the most important parameter which...". Further, it is unclear what the Authors try to say with the term "scaling factor", as this term carries a clear meaning in physical modelling, which seems out of context here. The Authors may replace "scaling factor" with "reference parameter" (the water depth is one of the reference parameters in the dimensional analysis to derive the dimensionless parameters later used in Section 5.1).

P6478/L18: Waves traveling along the shore are expected to be considerable slower than direct waves and they are thus an important, but not the main contributor for the "messy" signal at the tidal gauge. The main reason may be (i) frequency dispersion (wave components may separate and overtake one another, however, whether this happens depends on the wave type, see e.g. Heller and Spinneken 2015) and (ii) reflections from the shoreline.

Gabl et al. (2015) conducted a similar study as presented by the Authors.

Section 5.2 (1st paragraph): It is not fully clear if this sensitivity analysis is conducted by keeping all other parameters constant or not. On L5 it is written "...all other quantities equal...", but does this apply to the later sentences (water depth, slide thickness) as well? This needs to be communicated clearer.

Technical corrections:

P6472/L24: The YouTube link for the video is incorrect, it refers to a video from 2010.

P6474: Some specifications of the measurement accuracy of the terrestrial radar interferometer and the tide gauge should be added.

P6475/L7: Consider replacing "slide" with "ice mass".

P6476/L4: There is good evidence of all selected parameters in Eq. (1) apart from the friction coefficient f, and it would be good to mention why 0.1-0.2 for f was selected.

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Eq. (2): The parameter ac should be defined.

P6479/L26: Again, it is unclear what the term “scaling parameter” specifies. Please revise.

Eq. (9): The term describing the wave propagation angle is absent. Which angle was selected? This angle may considerable change the wave height as landslide-tsunamis show a different height in different propagation directions.

P6481/L11: Some research in recent years looked into the wave types in different water body geometries and while the 2D study Heller and Hager (2011) may still give a good estimate in the slide impact zone, it would be better to apply a 3D study, such as Heller and Spinneken (2015), to quantify the wave type in the 3D configuration of the present case. It is better understood in the meantime that wave types in 3D tend to be less nonlinear than it 2D.

References (if not included in the manuscript):

Gabl, R., Seibl, J., Gems, B., Aufleger, M. (2015). 3-D-numerical approach to simulate an avalanche impact into a reservoir. Natural Hazards and Earth System Sciences, Discussion paper, 4121-4157.

Heller, V., Spinneken, J. (2015). On the effect of the water body geometry on landslide-tsunamis: Physical insight from laboratory tests and 2D to 3D wave parameter transformation. Coastal Engineering 104(10):113-134.

Zweifel, A., Hager, W. H., Minor, H.-E. (2006). Plane impulse waves in reservoirs. Journal of Waterway, Port, Coastal, and Ocean Engineering 132(5):358-368.

Interactive comment on The Cryosphere Discuss., 9, 6471, 2015.