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Interactive comment on "Inverse modeling of turbidity currents using artificial neural network: verification for field application" *by* Hajime Naruse and Kento Nakao

Anonymous Referee #1

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Understanding the differences between relatively frequent turbidity currents observed in recent studies and the records of ancient turbidites is the motivating problem of this study. As the authors clearly state in the introduction, this is a critical, long-standing problem that must be solved to fully understand submarine sedimentation processes. In this study the authors propose the use of an artificial neural network to solve the inverse problem, i.e. to determine the characteristics of the turbidity current from the thickness and grain size distribution of the deposit. The neural network is trained using a dataset of numerically-generated turbidity currents and deposits, and the proposed inverse model returns the inlet (upstream boundary) conditions of the model runs, as well as the basin slope, i.e. the slope of the mildest reach in the model domain (Figure

3 of the submitted manuscript). This is an interesting approach to solve a very complex problem. I do not have enough knowledge to comment on the appropriateness of neural networks. However, I can comment on the forward model used to generate the numerical database and on the usefulness of the inverse model output. As I further discuss below, it is critical that the authors fully acknowledge up front (i.e. in section 1 and/or 2) the limitations of the forward model used in their analysis, and further discuss how the upstream boundary conditions may provide information on the local characteristics of the turbidity current that emplaced a certain type of deposit tens of kilometers downslope.

1) Forward model selection The authors should clearly acknowledge in the introduction or at the beginning of section 2 (Forward model description) that the four equation model (Parker. et al., 1986, Kostic and Parker, 2006) is inadequate to model the long runout turbidity currents considered in this study. In section 5.4 (Limitations and future tasks) the authors say that 'various doubts have been recently raised' on the applicability of the four equation model and this is, at best, an understatement. Luchi and co-authors (S. Balachandar, G. Seminara and G. Parker, the author of the 1986 and 2006 models) in 2018 clearly state: 'Parker et al. [1986] proposed a three−equation model and a four−equation model that formulate turbidity current dynamics in terms of layer−averaged equations. Both models treat the current as a single layer below infinite ambient fluid, with parameters depending only on the streamwise direction, x, and time, t. These equations include: a Reynolds−averaged momentum equation, a conservation equation for water, a conservation equation for suspended sediment and a layer−integrated conservation equation for energy of the turbulence. Their solution captures the streamwise evolution of layer-averaged velocity and suspended sediment concentration. However, neither model is able to explain the formation of continuous, long runout turbidity currents.' (Luchi et al., 2018). A thorough discussion on the limitations of the three and four equation models and why they should not be used is presented in the Supporting Information of the Luchi et al. (2018). The authors can say that they propose a methodology and to simplify the computational costs they use

a simplified but physically inadequate model to generate the numerical database.

2) Inverse model output Output of the inverse model are the input parameters of the numerical simulations, which are not representative of local flow conditions that result in the emplacement of a deposit with certain characteristics, e.g. thickness, sediment size distribution and internal fabric. I thus wonder why it is important to predict the upstream boundary conditions of the numerical model to 1) characterize the turbidity current and 2) understand the differences between relatively frequent turbidity currents observed in recent studies and the records of ancient turbidites. Shouldn't an inverse model tell us how the turbidity current velocity, thickness and grain size change in space and time during the event? What am I missing here? Further, the length of the steep reach in the forward model simulations does not seem to be varying from one simulation to the other (Figure 3 of the manuscript). I wonder if this has (it should) any implication on the characteristics of the turbidity current in the basin, and how this can impact the output of the forward model.

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