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Earth Surface Dynamics Discussions

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

Anonymous Referee #2

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General comments:

In this paper, the authors proposed a method for reconstructing paleo-flow condition of turbidity currents from submarine deposits using neural network technique. To obtain the data for supervising the neural network and showing the performance of the model, the authors used a layer-averaged model of turbidity currents as a forward model and performed a lot of numerical calculations regarding turbidity currents and their deposits under the different initial conditions. The supervised neural network provides a robust relationship between initial conditions of the turbidity current and resultant sediment deposit in the modeled basin. By using this method, the authors suggested that the

paleo-flow condition can be reconstructed by calculating a forward model of turbidity current with the initial conditions estimated from the deposit using the neural network. The authors also presented some implications of this method to field-scale sedimentary deposit, suggesting that the proposed method can be used to field-scale cases.

We can not get sufficiently large dataset regarding the turbidity current characteristics and their deposit in the field for supervising the neural network. Instead, physically-based numerical model might be able to provide such dataset. The presented method seems robust enough for field application. In addition, this modeling may provide something interesting things for numerical modelers. We also use forward model to reproduce the phenomena we observed and predict what will happen future. In this process, generally we perform a lot of calculation to get best result and sometimes only the best result is presented without failure cases of numerical calculations. The inverse modeling the authors did also need a lot of computational effort, but might be useful to show clear relationship of the model input parameters and output results. Overall, the paper is well fitted the scope of the Esurf and the results are interesting and clearly presented. I have some comments about the concept of the modeling and application for field cases, which need to be addressed for acceptance.

In this modeling, the authors focused on one event of turbidity current and subsequent sediment deposit and use these numerical results to supervise the neural network. But it will be possible that the sediment deposit we will sample in the field has been generated by several turbidity currents. In addition, the sediment deposits that were created by one turbidity current will be affected by many other physical processes such as erosional event by self-accelerating turbidity current and soil compaction etc, so that some information might be missing in the current condition. Is the proposed model still robust for such cases for inversion analysis? The factors I mentioned above are just small compared to the random noise the authors obtained in the analysis? Some discussion about this kind of uncertainty might be useful to show the model performance as well.

The authors mentioned about self-accelerating turbidity current in section 5.1, saying that some errors of the initial conditions caused by the inversion analysis might not be significant for estimating paleo-flow condition. I am not sure that this is also valid if the authors include some calculations of self-accelerating case. Here, the initial bed is treated as an immobile bed, so that there is no possibility of happening the self-accelerating turbidity current in this model. Since the turbidity current the authors are thinking in this paper is extremely big one, so that small differences in initial conditions might be able to cause self-accelerating turbidity current, resulting in big differences in model prediction.

As a last statement of this paper, the authors concluded that the method proposed can be applicable field-scale problem, and the application for real turbidites will be future work. Indeed, the discussion about the effect of measurement errors on the result (section 5.2) suggested that the model is robust against to such error. Also, the modeling framework of this model (section 5.3) will have some advantages to predict paleo-flow condition, which can not be reasonably reconstructed by previous studies (e.g., Parkinson et al., 2017). However, it is still not obvious that the proposed model can provide reasonable paleo-flow condition from real-turbidites. I guess that the performance of this model is highly dependent on the forward model. Since Parkinson et al. (2017) used similar types of layer-averaged model and failed to give reasonable result, I suspect that proposed model also gives such unrealistic result even though some optimization method has been improved in the present model. Some further discussion might be useful for understanding the model performance.

Lastly, I am not sure about the most important contribution of this study. The author's team already performed similar analysis, i.e., Mitra et al. (2020) for tsunami case, so that it is not clear that this study proposed new method and apply it to the turbidity current case, or the authors just applied the model, which is already proposed, to the turbidity current case. A brief introduction of the significance of this study will be merit.

Line-by-line comments:

Line 7: I feel that term "shallow water equation" should be used for river flow model, instead, for turbidity current case, "Layer-averaged model" will be better expression (actually, throughout the paper, the authors use both). This should be consistent, although these models are mathematically very similar.

Line 11: I am not sure the number "3500" has specific meaning. Is it small or large number?

Lines 279-280: What is the reason of unstable behavior of the result when the sampling window is shorter than 5 km? In addition, does it mean that detailed field measurement with the less than 1km spatial sampling window does not improve or help for inversion?

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