

Interactive comment on “Application of the adjoint approach to optimise the initial conditions of a turbidity current” by Samuel D. Parkinson et al.

Anonymous Referee #1

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1 General remarks

This paper addresses the problem to find optimal turbidity current parameters in the initial condition that reproduce sediment deposits in real world through computer simulation. Solving this interesting inverse problem would improve the interpretation of sedimentary successions. A gradient-based optimization method has been used to minimize the misfit between modeled and observed field sediment deposits. The gradient calculation, which is the most challenging part, is obtained using the adjoint approach with the adjoint model being automatically generated by the high-level automatic differentiation tool *dolfin-adjoint*. Although the solution found cannot make the modeled deposit exactly match the measured deposit, the paper demonstrates the power of gradient-based optimization and the automatic tools based on high-level ab-

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straction such as *dolfin-adjoint* and *FEniCS*. It is well written and easy to follow. The main weakness is the poor solution found by the optimization, but it can be improved, or at least compensated. Considering the novelty of the work, I think this paper merits publication in *GMD* after minor revisions.

1. The objective function can be considerably improved. Figure 5 shows that the Bed 1.1 profile has a depth around 0.5 cm at the right boarder. But in the simulated results the deposit depth is always zero at the right boundary ($y=1$) according to (17). This can also be noticed from Figure 7. So the target profile used in the objective function (53) does not represent a complete profile, while the simulation always provides a complete one. One possible way for a better comparison is to extrapolate the target profile further to the right until the depth becomes zero, and then define the functional on the range $[0, \hat{x}_N]$ instead of $[0, \hat{x}_{max}]$

$$J = \int_0^{\hat{x}_N} (\tilde{\eta} - \eta^T)^2 d(\hat{x}). \quad (1)$$

This will make the calculation easier and avoid the difficulty with discontinuities. Originally discontinuity may arise when $\hat{x}_N > \hat{x}_{max}$ because the model profile is truncated at \hat{x}_{max} in the integral evaluation and then the functional depends on only part of the system states. Furthermore, there would be no need to use the scaled filters and the nasty approximation of max and min functions.

2. It may be worth trying different end times for the simulation. The optimal modeled profile found in this work looks much shorter than it should be compared to the target profile, leaving a significant gap towards the end. An ideal model profile that matches well with the observation would be expected to have longer length than the extent of measured data ($\hat{x}_N > \hat{x}_{max}$). Is it possible to get a longer profile by increasing the end time t_f ? If so, the quality of the solution would be improved.

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3. More evidence should be provided to support the claim that the gradient-based optimization methods are powerful for solving the inverse problem of find turbidity current parameters. Why not generate a reference profile with a known initial condition and run the same code with different initial guesses to see if the reference profile can be reproduced in the optimal solution? This artificial test will give more insight on the performance of the optimization techniques. And hopefully this will also make it clear if there are local minimums that lead to low-quality solutions.
4. There are not enough instructions on how to run the code. For example, FEniCS is suggested to be run with Docker, however, it is not clear how to get all the components work with Docker, or without Docker. The specific commit of libadjoint described on the bitbucket page does not compile with gfortran 5.3 on my mac, but the latest commit compiles without any problem. It would be beneficial for the readers who want to play with the code if the workflow could be simplified (e.g. wrap everything into a FEniCS Docker image) and described in more detail. Based on the current available resource, I am not able to confirm the reproducibility of the results, although I have no doubt with them.

2 Specific remarks

1. Some entries in the references use abbreviations for journal names but some others use full names. Whatever format is preferred, it should be consistent.
2. ηT should be η^T .
3. Line 26: “spent in” should be “spent on”.
4. Line 28: what does “similarity solution” mean? Is it “similar solution”?
5. Line 323: “that improve on” should be “to improve”.

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6. Line 450: “ $\max(\hat{x}_N, \hat{x}_{max})$ ” should be “ $\min(\hat{x}_N, \hat{x}_{max})$ ”.
7. \sim is misplaced in the caption on (e) in Figure 11.
8. Units are missing in Figures 7, 9 and 10.
9. Line 643: “the addition of parameterisations” should be “additional parameters”.

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