This paper by Parkinson provides a great insight into the primary drivers of the sediment transport process from continental shelf to deep ocean. The choice of the shallow water sediment-laden density current model and its numerical solution using finite element mixed DG method with adaptive time-stepping are quite appropriate. The crucial features of this paper that make it original and unique are the use of adjoint based assimilation to derive optimal initial parameters that best fit the field measurements, and its application to a real world problem. The paper is very well organized and the mathematical equations are clearly stated which make it easy to follow. The paper deserves publication in the journal of Geoscientific Model Development with few major and minor corrections stated as follows

Major:

1. In line 69-71, the authors claim that the paper represents first published work with optimization applied to turbidity currents. However, this needs to be reworded to state that this is first published work of application of adjoint based optimization applied to turbidity currents demonstrated through real world example. The reason is that the article *"Towards inverse modeling of turbidity currents: The inverse lock-exchange problem"* published in Computers and Geosciences, authored by Lutz Lesshafft et. al., 2011 (http://www.off-ladhyx.polytechnique.fr/people/lutz/pdfs/Lesshafft_CAGEO_2011.pdf) provides a similar approach, however, their approach is gradient-free optimization. It is also suggested to include reference to this article.

2. As seen in sections 4.4 and 4.6, the model based deposit profile does not match completely the target profile. The authors are suggested to perform the following tests to assess their setup

    a. For every adjoint model code produced through automatic differentiation or manually, it is important to validate it. The authors have provided verification of gradient calculations in section 4.3, however, it would be useful to perform box model testing and generate scatter plots similar to the plots presented in section 1.1.5 of the article "*Towards the construction of a standard adjoint GEOS-Chem model*", Proceedings of the 2009 Spring Simulation Multiconference (paper draft: http://people.cs.vt.edu/asandu/Deposit/draft_2009_gc-adj.pdf). This would ensure that the adjoint code produced by dolphin-adjoint tool is correct.

    b. Although this step is not mandatory for publication of this article, it would also be useful to set up a reference profile and conduct an experiment similar to Lesshafft et. al. to test if the implementation of all the numerical methods solving the shallow water model and the adjoint are in fact working correctly, before applying it to the deposit profile of Marnoso Arenacea Formation.

Minor:

1. Line 83: "which takes account of the" -> "which takes into account the"

2. Line 84: “retarding” -> “impeding”

3. η^T, ηT and η_T have been used interchangeably in figures 7 and 9, and in Section 4.2 onwards

4. unit missing in height (h_0) in the optimized values on line 576 and input parameter on line 593, should be meters