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Geoscientific Model Development Discussions

Interactive comment on "Sedapp: a non-linear diffusion-based forward stratigraphic model for shallow marine environments" *by* Jingzhe Li et al.

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In this manuscript the authors describe a numerical model that transports sediment down slope following a diffusion equation. The model is described as a forward stratigraphic model, as it can simulate the sedimentary deposition within basin settings.

Overall I think the model is OK. It does not break new ground in stratigraphic modelling but it does contain some interesting ideas that might be worthy of publication. The manuscript could however benefit from being restructured to describe better what is new, and to better explain the context of this sort of model.

Major points:

1. The introduction is a bit difficult to follow. The first paragraph introduces sequence

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stratigraphy and then ends with the citation of two papers, Burgess, 2012, and Burges and Prince 2015, that discuss how sequence stratigraphy is a paradigm that is no longer fit for purpose. What point are the authors trying to make here? The second paragraph lists different models. The third paragraph defines forward stratigraphic models, but then discusses solvers for Navier Stokes equations (Delft3D). It then discusses "fuzzy logic" and "deductive models" but not in any detail. I think the whole introduction shuld be re-thought-out. Is there to be a discussion of cellular automata models versus models that solve PDEs? Is there to be a discussion of sequence stratigraphy? Ultimately the point should be what does Sedapp advance, but this is missing.

2. What is new about Sedapp? There exist numerical models that solve for sediment transport where the central equation is diffusive. Admittedly the more applied codes are close source and propriety. Is the only advantage of Sedapp that it is opensource? Why did the authors write it in R? Why not use more parallel libraries, see for example eSCAPE developed by Tristain Salles.

3. The functional form of the diffusion coefficient is not justified in any way. Why is it an exponential of distance? Why should erosion be less efficient compared to deposition? In a transport –limited model such as this, I see no argument for defining regions that will be eroded with the "Der" parameter, as erosion is simply a function of the curvature of the topography. I am not understanding something here, sorry.

Other points:

Line 55: Why are these two papers cited for what Is a simple diffusion equation. The equation could be called an Exner equation, and perhaps of a paper is to be cited, Chris Paola's review from the year 2000 would be more appropriate. In general the citations are a bit lazy. It would be worth being more selective about what statement requires a citation, and choosing the relevant citation. For example, pyBadlands (Salles et al., 2018) does not solve for erosion assuming that it transport-limited. It instead solves for the kinematic wave equation known as the stream power law. Sub marine deposition is a function of slope however. For it to be cited here is out of place.

Equation 1: Has compaction been intentionally left out?

Line 61: The diffusion coefficient can be a function of space and the PDE can still be linear. If however the diffusion coefficient is a function of slope then it would no longer be linear. This statement on this line, “Models with constant Γ values are usually called linear models; otherwise, they are known as non-linear models” is not accurate.

Line 65: What is the point of this list? Sedapp is a diffusive model, so it likewise cannot account for mass wasting or biological agents. The next sentences would appear to imply that a non-linear diffusion model can capture these processes, “on the contrary, non-linear models are relatively more flexible”. Yet this is not the point, because diffusion models simply cannot capture those processes. Therefore I am confused as to the point the authors are trying to get to.

Line 73 (and in the abstract): The models presented are 2D and 1D. They are not 3D.

Line 81: Linux is likewise free. I don’t see an advantage in pushing people to buy a Windows or OS license.

Line 83: “In this paper, we propose a new non-linear model, which is expected to overcome the shortcomings of the existing models”. What are the shortcomings of the existing models? They were not explained in the introduction. In fact the “existing models” were not described. What are the existing models?

Line 94: How does a user chose a value for “Der”? Why assume that the diffusion coefficient varies between erosion and deposition? It is the same process that is transporting the sediment therefore I see no argument for why it should change. In the work of Laure Guerit, https://doi.org/10.1130/G46356.1 the transtion from detachment-limited to transport-erosion is discussed in relation to alluvial fan deposition. This reference might provide a starting point for exploring some arguments for the parameter “Der”.

Unfortunately, as this function is presented here I find no justification for it.

Equation 4: Why is the diffusion coefficient an exponential function of distance? For sub-aerial sediment transport it would most likely be a function of water flux (see Smith and Bretherton, https://doi.org/10.1029/WR008i006p01506). Water flux does increase down-slope, but why as an exponential function?

Line 104: I have been assuming "D" is the distance down slope, but this might not be the case. "D" is the distance from where?

Code implication: is the code explicit or implicit in time? Have any off-the-shelf solvers been used within the implementation in R? What controls code stability, is there a CFL equivalent?

Line 133: "it will be contrary to the geological knowledge that deposition and erosion processes are two distinct processes with different rates". Who says this? They are both due to the transport of grains of sediment by moving water. The same water.

Case studies: Please confirm that the results are not sensitive to the model resolution. Or if they are explain why.

Line 235: Why does the channel migrate?

Line 291: "This is seriously contrary to the common sense". I think common sense is over rated. Please cite some studies that would suggest that the results of Sedapp are more appropriate.

Code availability: the code comes as a "rar" file. It would be better if the code was hosted on a repository, such as github, gitlab etc, and had a readthedocs with information on how to install and test it.

I found that on my French work laptop running linux I had to remove some non-standard characters within the comments of the code so that Example.r would execute. If this code was on an open repository bugs like this could be reported and fixed with the help of the community.

I needed some linux libraries to install the library smoothr and to run the code (udunits2-devel on CentOS), which would mean switching to my personal laptop as I don't have sudo privalages on my work workstation. Therefore I switched to a Windows VM to test it. This extra dependence could be signalled in the documentation.

I found that I needed to install "smoothr", "Rcpp", and "Matrix" libraries for the code to run. 3Rcpp" however was not listed in the dependencies. The code however then fails upon trying to create a directory:

38: In dir.create(wdnow) : cannot create dir 'C:\Users\armitagj\Documents\MATLAB\gaobei20', reason 'No such file or directory'

This comes from: Sedapp to be called.R:247: t1p=i*2;wdnow = paste('~/MATLAB/gaobei',t1p,sep = ");dir.create(wdnow)

With these bugs fixed the code ran on my VM, however given the small processing power the code was very very slow.

The authors could consider creating a Docker container with the code. The point of entry could be a jupyter-notebook that is ready to run Example.r. This would then achieve one of the aims, for a cross-platform model. It would also iron out the small issues I found above.

Summary: Despite all the above issues I think there is something in this work. I find the diffusion equation developed curious and want to understand it better. I therefore hope that my comments are constructive and would be happy to learn more. Furthermore, if the authors do decide to place the code in a repository I can then mark the issues I came up against in getting the code to run.

I hope at the least that this is helpful, John Armitage IFP Energies Nouvelles

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