

# ***Interactive comment on “A computationally efficient depression-filling algorithm for digital elevation models applied to proglacial lake drainage” by Constantijn J. Berends and Roderik S. W. van de Wal***

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This submission offers 3 relatively simple ways to make depression (ie lake) filling in surface drainage solvers significantly more computationally efficient at  $O(1 \text{ km})$  horizontal resolutions. With current efforts by a number of modelling groups to fully couple ice sheet and climate models, this is a topical issue.

This study contrasts with my approach, briefly described in T & P 2006 that focussed on coarsening the hydrological DEM resolution to the resolution of the ice sheet grid while preserving routing pathways. It would be worth a few sentences comparing the

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two approaches with respect to computational speed and accuracy given the different tradeoffs between the two approaches and the contextual accuracy of the ice margin. The last point needs to be underlined as the uncertainties in paleo ice sheet margins will always be much larger than 1 km (and I don't see 1 km grid resolution continental scale ice sheet models running glacial cycles anytime soon). Heck, there are few locations along the Laurentide ice sheet where we will confidently never know the ice margin location to even +/- 40 km resolution at any given time (barring some new dating technique).

Once the few specific comments below are addressed, this paper does deliver some significant improvements to lake filling algorithms on high-resolution grids, and as such is worth publishing in GMD.

# specific comments

:: 29 Tarasov and Peltier, 2004).

# inappropriate reference, should be Tarasov and Peltier, 2005 and 2006

:: Lake Agassiz.... 6 It is therefore important to accurately model the extent and volume of the lake over time

# Tarasov and Peltier, 2006 would I think be a relevant reference for this since they model Lake Agassiz (other other North Am pro-glacial lake) evolution

::the largest of which is Lake Agassiz, along the southern margin of the ice-sheet. Lake Agassiz ... :: Doing this requires an accurate treatment of the large changes in the land/ocean-mask that occur where the ice-sheet covers most of the Canadian Arctic Archipelago and blocks the Hudson Strait. This changes the location where lake outflow reaches the sea over time

# The above is geographically/geologically incorrect and has no relevance to Lake Agassiz. Neither the Canadian Arctic Archipelago (CAA) nor Hudson Strait ice were drainage blocks for Lake Agassiz. The possible northern drainage outlet for Lake

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Agassiz is the Mackenzie River delta which is outside of the CAA. Ice across Hudson Bay and Northern Ontario is what dammed the lake in the direction of Hudson Strait drainage according to consensus geological inferences (cf eg, Dyke, 2004). And the 8.2 ka (not 8.4) drainage was for proglacial Lake Ojibway not Agassiz.

:: we consider the lake formation in the North American region 30,000 years ago as a second example. At this time, large parts of the North American continent were covered by the Laurentide ice-sheet. The depression left in the bedrock by the weight of the ice, combined with the mass of ice damming off the Hudson Strait lead to the formation of a massive proglacial lake over the area of what is now known as the Hudson Bay :: and figure 4 # Should make clear that this lake and ice configuration is from your model and has no geological validation for that time (or if it does, then do provide the relevant citation)

:: In the example given in this study, the ice thickness, bedrock deformation and geoid anomaly all initially had a 40 km resolution. In order to do a 1 km lake fill, these fields were interpolated onto a 1 km grid, which is computationally expensive. If all input fields are already at high resolution, they only need to be downscaled to a low resolution for the block inspection step, which takes considerably less time. For this reason, the computation time for this interpolation step is not included in the results

#Given that no one will be running 1km grid resolution ice sheet models for glacial cycle contexts (given "proglacial" in the title) in the foreseeable future, give the interpolation time to provide a complete time budget.

:: Supplement

I have not been able to test the code since the required netcdf files are not on this server. But I have a few suggestions:

1) the ReadMe.txt should provide command line examples how to run the scripts (so that the reader doesn't have to dig right away into the code to see if there are any

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arguments that need passing).

2) Verify that the code runs on octave. What is the point of using open source publishing to publish something that requires a close source app especially when an open source alternative is available?

3) add the required net-cdf files for the sample scripts on the GMD page (as a separate supplement...)

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