Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2022-259

Ilhan Özgen-Xian (Referee)

Referee comment on "LISFLOOD-FP 8.1: New GPU accelerated solvers for faster fluvial/pluvial flood simulations" by Mohammad Kazem Sharifian et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-259-RC2, 2022

The authors present a GPU-accelerated shallow flow solver that is being incorporated into the well-known LISFLOOD framework. This effort to improve on existing and established software used by many practicioners is a timely and relevant endeavour. The improvements presented in the manuscript are (i) GPU-acceleration with specific focus on non-uniform Cartesian grids and (ii) wavelet-based mesh adaptation to generate these grids. The manuscript is well written and easy to follow. The selected test cases are meaningful and support the authors' claims.

Therefore, I suggest accepting the manuscript after minor revisions.

1. Governing equations

1.1 The authors omit showing the governing equations. At least for me, it made the introduction of this paper difficult to follow, specifically the discussion of the ACC solver and its differences to the fully dynamic shallow flow solver (page 1, lines 35—45). I would suggest showing the SWE explicitly, naming the acceleration term and momentum terms in these equations, and then showing which terms drop out in the ACC solver.

1.2 The acronym ACC is being used without explanation. Please provide the full name of this solver the first time you use the acronym.

2. Morton codes

2.1 Out of curiosity, what upper bound does the use of Morton codes give you for the allowable number of cells? I am asking because, if I understood correctly, if you combine the binary representation of two integers into one, you can only use half the length that a computer can store for each representation. So on a 64 bit machine, this would mean that the maximum number of elements that can be used is what can be represented with 32 bits. Is this correct?

3. Lower Triangle catchment

3.1 Source of data should be completed with the source of the raw data:
Wainwright, H. and Kenneth, W. (2017). LiDAR collection in August 2015 over the East River Watershed, Colorado, USA. https://doi.org/10.21952/WTR/1412542

4. Fluvial vs. pluvial test cases

Perhaps some of the answers to the comments below could be placed in the Conclusions and recommendations section.

4.1 From the test cases and my own experience, mesh coarsening seems to "work better" for fluvial runoff, probably because pluvial runoff yields very small water depths that elevate the influence of the topography. This is to some extent supported by the authors' results. Can the authors comment?

4.2 The hydrograph of the Upper Lee catchment shows that coarser grids damp short time-scale events. This has been my experience with multiresolution meshes as well. Are there mitigations the authors suggest that could lead to more accurately capturing these short time-scale events?

4.3 The pluvial flooding in the Glasgow urban area is very well captured, compared to Lower Triangle and Lee catchments. Is this due to the regularity of the urban area?