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Hydrology and Earth System Sciences Discussions

Interactive comment on "A variable streamflow velocity method for global river routing model: model description and preliminary results" *by* T. Ngo-Duc et al.

B. Fekete (Referee)

balazs.fekete@unh.edu

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General comments

Ngo-Duc et al. presented a new variable river flow routing scheme for large scale applications, which is undeniably novel and deserves publication. The proposed applications of the Dingman-Sharma relationship relating discharge to riverbed geometry (cross-sectional area and hydraulic radius) and slope without the need for riverbed roughness is sound and clearly simplifies the parameterization of the flow routing. While the representation of the spatial and temporal variation of the flow velocity is

a huge step in large scale river flow modeling, the presented paper have serious shortcomings primarily due to the use of very coarse resolution gridded networks. I think, the model deficiencies noted by the authors are mostly due to the inappropriate use of 1 degree resolution networks at daily time step. Such a coarse resolution network does not have the ability to represent the geomorphological properties of the river basins which has less than 2-300 grid cells (see specific comments). The river bed slope derived from DEM is also questionable at those resolutions. While the authors recognized the obvious inconsistencies between their gridded network and the DEM,when the river bed slope was negative, but the proposed constant slope in those regions is probably just as bad as using uniform flow velocity routing (see specific comments). I recommend the paper to be published after major revision, which would either test the routing on a significantly higher resolution network, or demonstrate that the proposed daily simulations at the coarse resolution network represent an improvement to the previous uniform flow velocity simulations when aggregated to monthly values.

Specific comments

The use of 1 degree network for daily river flow simulations seriously limits the value of the present work. As Fekete et al. (2001) showed, gridded networks loose their ability to represent the geomorphological properties (primarily the width function) of the river basins when the number of grid cells fall bellow 2-300 grid cells within the simulated basins. The 300,000ăkm2 basin size doesn't meet that criteria at 1ăŒă1 degree (˜8,000ăkm2) resolution, meaning that the width function (in other world the unit hydrographs assuming uniform flow velocities) will fall apart as shown by Fekete et al. (2001). Perhaps, the only basins, where such a coarse resolution network could work is the Mekong, which is perhaps the most elongated large river basin (therefore the width function is fairly flat and the dominated by a narrow band around the mainstem). As a consequence of the 2-300 grid cell rule, flow routing on gridded network either has to use implicit routing finite difference scheme (like the Muskingum method) or the computational time steps has to be significantly higher than the target time step to sat-

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isfy the Courant condition for explicit schemes (considering only adjacent grid cells as the proposed method). Hydraulically representative riverbed slopes is another area, where the present paper is very weak. While the authors recognize the obvious inconsistencies (when the slopes are negative) between their network and the corresponding DEM that they used to derive slopes along the river, but the applied fix is inadequate. Constant low slopes in those regions will cause the rivers to slow down regardless of the surrounding topography. Slopes has to be steeper when the rivers flow through a narrow valley than in flat regions. Besides the issue of the negative slopes the authors need to address if the slopes are realistic elsewhere. DEM derived slopes could often have water fall like drops that are just as much erroneous as negative slopes. Since, DEMs are not designed to represent the slopes along river channels, adjusting DEMs to provide hydraulically meaningful slopes is a major challenge. Moving from monthly flow simulations to daily will need much more than throwing in some equations to let flow velocities vary along the river channels.

Technical Corrections

The authors should use the same color scheme on Figure 3 (where the observed values are black) and Figure 6 (where the observation is red).

References

Fekete, B. M.; C. J. Vörösmarty and R. B. Lammers: Scaling gridded river networks for macro-scale hydrology: Development and analysis and control of error, Water Resources Research, 37(9), pp.ă1955-1968, 2001

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