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Choice of routing scheme considerably influences peak river discharge simulation in global hydrological models

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Global hydrological models (GHMs) have been applied to assess global flood hazards. However, their capacity to capture the timing and amplitude of peak river discharge—which is crucial in flood simulations—has traditionally not been the focus of examination. Here we evaluate to what degree the choice of river routing scheme affects simulations of peak discharge and may help to provide better agreement with observations. To this end we use runoff and discharge simulations of nine GHMs forced by observational climate data (1971-2010) within the ISIMIP2a project. The runoff simulations were used as input for the global river routing model CaMa-Flood. The simulated daily discharges were compared to the discharge generated by each GHM using its native river routing scheme. For each GHM both versions of simulated discharge were compared to monthly and daily discharge observations from 1701 GRDC stations as a benchmark. CaMa-Flood routing shows a general reduction of peak river discharge and a delay of about two to three weeks in its occurrence, probably induced by the buffering capacity of floodplain reservoirs. For most river basins, discharge produced by CaMa-Flood resulted in a better agreement with observations. In particular, maximum daily discharge was adjusted, with a multi-model averaged reduction in bias over more than 60% of the basin area. The increase in agreement was obtained in both managed and near-natural basins. Overall, this study demonstrates the importance of routing scheme in peak discharge simulation, where CaMa-Flood routing accounts for floodplain storage and backwater effects that are not present in most GHMs. Our study provides important hints that an explicit parameterisation of these processes may be essential in future impact studies.