Geophysical Research Abstracts
Vol. 19, EGU2017-9162, 2017
EGU General Assembly 2017

Improvement of the runoff in the hydrological model ParFlow by a scale-consistent river parameterization

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The study focuses on the improvement of the surface-runoff parametrization in the hydrological ParFlow model. Currently, overland flow is calculated everywhere using the kinematic wave approximation (Manning-Strickler equations). In the implementation, the code does not distinguish between a hillslope and a channel. Thus, rivers and streams are simulated at the resolution of the computational grid (case A). One solution is to change parameters in the model in order to better represent a true river routing (case B) : we decided to modify the Manning's coefficient values. The first step was to determine which is the river width value in every surface grid cell of the model, by assuming that the width is linked to the mean annual discharge. In order to compare the flood wave propagation between case A and case B, a certain discharge in a virtual grid cell was applied ; the impact on the flow velocity in the two cases was analyzed. We assume a rectangular river channel cross section for which in steady state the Manning's equation is valid. Results show that the flow velocity is higher in case B than in case A, simply because the river width is smaller. Assuming this relation between river width and flow velocity, it is possible to calculate how much scaling of the Manning's coefficient is necessary in case A, in order to simulate the same flow velocity than in case B which represents the truth. The conclusion is that it is possible to compensate the error of river widths (because of the coarse resolution of the model) by using scaled parameters allowing to improve the surface mass balance, thanks to a better representation of the flood wave propagation in the river channels.