Geophysical Research Abstracts
Vol. 21, EGU2019-12007-1, 2019
EGU General Assembly 2019

Real-time flood prediction utilizing a particle filter combined with RRI model

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In recent years, flood damage caused by flash floods in small mountainous rivers has frequently reported in Japan. In order to ensure a sufficient lead time for safe evacuation, it is necessary to predict river water levels in real time utilizing a hydrological model. In this study, we conducted real-time flood prediction using the hydrological models and data assimilation for the next six hours in a Japanese small river (A = 136.1 km2). We use a Particle Filter (PF), which is one of data assimilation techniques and estimates state-space or parameters in the model by the filter theoretic based on simulation. A system equation is the RRI model, which is a two-dimensional hydrological model capable of simulating rainfall-runoff process and flood-inundation process simultaneously on a river-basin scale. The states estimated by PF is the water depth on the slope in the RRI model. Since it is difficult to independently estimate the water depth for all cells, the water depth is uniformly corrected in the river-basin using a parameter of coefficient. Observation equation is Gaussian-distribution according the observed water levels, the number of particle is 64, calculation time is nine hours total; back time is three hours and prediction time is six hours from the present time; likelihood is evaluated by RMSE. In this study, since we aim to improve the reproducibility of hydrological models, we do not use the forecasted rainfall; instead simulated the prediction water level under the condition forecasting rainfall is perfectly predictable for the next six hours. As a result, the calculated water level was able to assimilate with the observed water level, it improved greatly especially when the water level is rising. Therefore, we succeeded in improving not only the reproducibility of the present time but also the flood prediction accuracy by using PF-RRI. Moreover, in order to evaluate quantitatively real-time flood prediction accuracy, we perform two simulations using forecasts rainfall; one case is PF combined with the RRI model, the other case is the RRI model without the data assimilation. From the results of the two cases, we focused on the maximum prediction error for each lead-time including the present time. As a result, we succeeded in reducing the maximum error range with all lead-time; the maximum error range at the present time is reduced from 3.78 meters to 0.58 meters; at the next 2 hours from 4.39 meters to 2.21 meters. Overall, the study suggested that flood prediction accuracy can be improved by PF with the RRI model.