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Probabilistic rainfall and streamflow prediction in Japanese small basin using EnKF

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Probabilistic rainfall and streamflow forecasts have recently been recognized to have a highest potential for flood warning and disaster mitigation. Those forecast systems were proved to improve forecast skill considerably than deterministic approach. However, the smaller the target basins were chosen, the harder they forecast right amount of rainfall in the right place. The quantitative precipitation forecast (QPF) for strong rainfall in limited areas is still a challenging research targets. Although countries like Japan with complex terrain with steep slopes divided in small river basins needs QPF with high horizontal resolution, no such probabilistic streamflow forecasting system had been developed in Japan.

We developed a probabilistic rainfall and streamflow forecast system, and applied it to a Japanese small basin for two typhoon events. Our objective is to examine the potential of this forecasting system. The numerical weather prediction (NWP) part is based on Weather Research and Forecasting (WRF) model combined with the Local Ensemble Transform Kalman Filter (LETKF) which is a sort of EnKF. The lateral boundary conditions were given by 5km resolution operational mesoscale model by Japan Meteorological Agency. The system assimilates PREPBUFR by NCEP and ground observed wind and air temperature. The WRF were run in 3km and 15km resolution, and 21 member ensemble run and deterministic runs were discussed. Predicted rainfall patterns were applied to our originally developed distributed hydrological model, named Rainfall-Runoff-Inundation (RRI) model, and we obtain streamflow pattern in the target basin, Hiyoshi Dam basin, in the center of Japan with a catchment size of 290km^2. Two typhoon cases, TALAS and ROKE in 2011, were examined which caused severe flood and landslide in this area. We implemented intermittent predictions with predictions updated every 6 hours, during about 5 day long period in both cases.

The fraction skill scores (FSS) of the rainfall forecast results show improvements in forecast skills from 15km ensemble run, 3km deterministic run, to 3km ensemble run, especially in the strong rainfall thresholds. As a result, streamflow forecasts in latter runs decrease forecast errors. The 3km deterministic forecasts sometimes overestimate or underestimate streamflow considerably, on the other hand the 3km ensemble run reduces those errors effectively. This study confirmed that our regional probabilistic rainfall and streamflow forecast system has a potential to improve flood forecasting skill in Japanese small basin.