Evaluating the one-way coupling of WRF-Hydro for flood forecasting

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A fully-distributed, multi-physics, multi-scale hydrologic and hydraulic modeling system, WRF-Hydro, is used to assess the potential for skillful flood forecasting based on precipitation inputs derived from the Weather Research and Forecasting (WRF) model and the EUMETSAT Multi-sensor Precipitation Estimates (MPEs). Similar to past studies it was found that WRF model precipitation forecast errors related to model initial conditions are reduced when the three dimensional atmospheric data assimilation (3DVAR) scheme in the WRF model simulations is used. A comparative evaluation of the impact of MPE versus WRF precipitation estimates, both with and without data assimilation, in driving WRF-Hydro simulated streamflow is then made. The ten rainfall–runoff events that occurred in the Black Sea Region were used for testing and evaluation. With the availability of streamflow data across rainfall–runoff events, the cal- ibration is only performed on the Bartin sub-basin using two events and the calibrated parameters are then transferred to other neighboring three ungauged sub-basins in the study area. The rest of the events from all sub-basins are then used to evaluate the performance of the WRF-Hydro system with the cali- brated parameters. Following model calibration, the WRF-Hydro system was capable of skillfully repro- ducing observed flood hydrographs in terms of the volume of the runoff produced and the overall shape of the hydrograph. Streamflow simulation skill was significantly improved for those WRF model simula- tions where storm precipitation was accurately depicted with respect to timing, location and amount. Accurate streamflow simulations were more evident in WRF model simulations where the 3DVAR scheme was used compared to when it was not used. Because of substantial dry bias feature of MPE, as compared with surface rain gauges, streamflow derived using this precipitation product is in general very poor. Overall, root mean squared errors for runoff were reduced by 22.2% when hydrological model calibration is performed with WRF precipitation. Errors were reduced by 36.9% (above uncalibrated model performance) when both WRF model data assimilation and hydrological model calibration was utilized. Our results also indicated that when assimilated precipitation and model calibration is per- formed jointly, the calibrated parameters at the gauged sites could be transferred to ungauged neighbor- ing basins where WRF-Hydro reduced mean root mean squared error from 8.31 m3/s to 6.51 m3/s.