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Comparing One-way and Two-way Coupled Hydrometeorological Forecasting Systems for Flood Forecasting in the Mediterranean Region

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A pair of hydro-meteorological modeling systems were calibrated and evaluated for the Ayalon basin in central Israel to assess the advantages and limitations of one-way versus two-way coupled modeling systems for flood prediction. The models used included the Hydrological Engineering Center-Hydrological Modeling System (HEC-HMS) model and the Weather Research and Forecasting (WRF) Hydro modeling system. The models were forced by observed, interpolated precipitation from rain-gauges within the basin, and with modeled precipitation from the WRF atmospheric model. Detailed calibration and evaluation was carried out for two major winter storms in January and December 2013. Then both modeling systems were executed and evaluated in an operational mode for the full 2014/2015 rainy season.
Outputs from these simulations were compared to observed measurements from hydrometric stations at the Ayalon basin outlet. Various statistical metrics were employed to quantify and analyze the results: correlation, Root Mean Square Error (RMSE) and the Nash–Sutcliffe (NS) efficiency coefficient. Foremost, the results presented in this study highlight the sensitivity of hydrological responses to different sources of precipitation data, and less so, to hydrologic model formulation. With observed precipitation data both calibrated models closely simulated the observed hydrographs. The two-way coupled WRF/WRF-Hydro modeling system produced improved both the precipitation and hydrological simulations as compared to the one-way WRF simulations. Findings from this study suggest that the use of two-way atmospheric-hydrological coupling has the potential to improve precipitation and, therefore, hydrological forecasts for early flood warning applications. However more research needed in order to better understand the land-atmosphere coupling mechanisms driving hydrometeorological processes on a wider variety precipitation and terrestrial hydrologic systems.