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Investigating the effects of rainfall uncertainty on flood prediction across scales

L. Cunha, B. Seo, W. Krajewski, and R. Mantilla
The University of Iowa, IIHR - Hydroscience & Engineering, Iowa City, United States (luciana-cunha@uiowa.edu)

A new Global Precipitation Mission (GPM) is planned to be launched in 2013 which goal is to provide high-resolution, frequent, global, and accurate precipitation measurements. However, due to the indirect relationship between satellite measurements and precipitation, to the limited temporal sampling frequency, and coarse spatiotemporal resolution, uncertainty on satellite-based precipitation will remain a challenge for local and regional-scale flood simulation. While expected retrievals uncertainties are unknown at this point, other data features, as resolution, and sampling frequency, are well defined. The aim of this study is to investigate how uncertainties in rainfall fields propagate through hydrological models across scales. Hydrological simulations are performed based on a physically based, hillslope-link, calibration-free hydrological model, called CUENCAS. Model parameters are directly linked to physical properties of the watershed. The model predicts flow for each link in the river network allowing a multi-scale evaluation of hydrological processes. The case study is the Cedar River basin during the Iowa 2008 extreme flood event. We start demonstrating an undesired featured in the Stage IV data that arises from different calibration offsets among merged radars. We use hydro-NEXRAD system to produce a new rainfall product (HN-RP) based on a novel approach that corrects this feature and on the overall bias correction using daily rain gauge values. The results from the hydrological simulations improve when HN-RP is used as input to the model. We then use HN-RP as a reference to investigate the whole of rainfall resolution and sampling frequency on hydrological prediction. HN-RP is systematically aggregated in space (from 1 km to 25 km) and time (from 5 min to 3 hours) to generate rainfall maps with lower spatial and temporal resolution. We use a simulation approach to mimic the effects of sampling frequency. The generated rainfall fields are used to force the hydrological model. We base our conclusions on the comparison of the simulations results using different rainfall products. Our results indicate that the effect of rainfall resolution is scale dependent, and there is a range of scales for which satellite-borne rainfall estimation, at the resolution currently available, can be applied for hydrological prediction. However, low sampling frequency impose large errors on flood simulation that are do not decrease as basin scale. This reveals the importance of using retrieval algorithms that combine geostationary infrared and polar-orbiting passive microwave data to minimize the effects of sampling errors.