Geophysical Research Abstracts
Vol. 21, EGU2019-8353, 2019
EGU General Assembly 2019

Using river altimetry for hydrological model calibration for the semi-arid Luangwa river basin

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Reliable rainfall-runoff models are required for various water resources management purposes such as water allocation or flood protection. In poorly gauged regions, the development of hydrological models is challenged by the limited in-situ data availability. Traditionally, discharge time series are used for model calibration. However, if reliable discharge data is unavailable, remotely sensed river characteristics could be used as an alternative. For instance, satellite based river altimetry could be used for model calibration. This data source is still relatively inaccurate, but would allow calibration at multiple sites within the river. This study illustrates the added value of river altimetry for model calibration using the Luangwa River Basin in Zambia as case study area.
The Luangwa River is a large tributary of the Zambezi. This mostly unregulated river flows into the Zambezi River upstream of the Cahora Bassa hydropower dam. Improved flow predictions of the Luangwa River are important for electricity production, flood & drought protection, and water allocation plans. Unfortunately, there are only a limited number of hydro-meteorological ground observations.
To illustrate the added value of river altimetry for model calibration, a process-based distributed hydrological model was developed for the Luangwa basin on daily timescale for the time period 2002 to 2016. As reference, this model was first calibrated to observed discharge. Then, the same model was simultaneously calibrated to remotely-sensed river altimetry data at 21 locations within the basin. To calibrate on altimetry, the modelled discharge was correlated to the altimetry by 1) using the Spearman Rank Correlation Coefficient focusing only on the dynamic changes (WL SRCC), 2) converting the modelled discharge to stream levels using the traditional rating curve equation (WL RC), and 3) converting the modelled discharge to stream levels using the Strickler-Manning equation (WL CS).
First results indicated that altimetry data provide sufficient information to eliminate unfeasible parameter sets, but insufficient information to identify the “best” parameter set as obtained from traditional calibration on observed stream flow. In addition, calibration results improved significantly when incorporating more detailed cross-section information.