

Propagation of CMORPH rainfall errors to REW streamflow simulation mismatch in the Upper Zambezi Basin

Webster Gumindoga¹, Tom Rientjes², Alemseged Haile³, Paolo Reggiani⁴, and Hodson Makurira⁵

¹Universiteit Twente Faculteit Geo-Informatie Wetenschappen en Aardobservatie

²University of Twente

³International Water Management Institute

⁴Universitat Siegen

⁵University of Zimbabwe

July 9, 2020

Abstract

This study investigates propagation effects of CMORPH rainfall estimation errors on streamflow simulation for a headwater catchment of the Zambezi River. Model simulations (2006-2012) by the Representative Elementary Watershed (REW) framework are carried out for uncorrected and for bias corrected CMORPH product (the Climate Prediction Center Morphing technique of the National Oceanic and Atmospheric Administration, or NOAA). As a benchmark to assessments, the model is run for in-situ observed rainfall obtained from 6 stations at a daily timestep. Analysis of CMORPH rainfall necessitates bias correction. A suite of performance indicators indicates that uncorrected CMORPH estimates show substantial augmentation of rainfall error to streamflow simulation mismatch whereas bias corrected estimates show attenuation of error. The e-NSGAII algorithm is selected for single and multi-objective calibration to assess CMORPH error propagation to REW streamflow results. Improved hydrograph simulation is achieved by multi-objective calibration. Flow discharge simulation during the dry season shows more substantial error attenuation compared to wet season high flow discharge simulation. Further, this study shows that ratios of model based actual evapotranspiration over rainfall (ETa/R) and stream flow over rainfall (Qs/R) (runoff coefficient) at seasonal base change subject to selected uncorrected and corrected CMORPH. REW water storage (ΔS) is affected as well as calibrated model parameters. The paper provides new insights on propagation effects of satellite based rainfall errors in stream flow modelling.

Hosted file

REW_Error propagation revised_8July2020_without figures.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 1.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 2.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 3.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 4.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 5.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 6.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 7.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 8.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Figure 9.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Table 1.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Table 2.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Table 3.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Table 4.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Table 5.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>

Hosted file

Table 6.docx available at <https://authorea.com/users/341336/articles/468306-propagation-of-cmorph-rainfall-errors-to-rew-streamflow-simulation-mismatch-in-the-upper-zambezi-basin>