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A water-level based calibration of rainfall-runoff models using satellite altimetry data

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Abstract: Recent studies demonstrated the efficacy of calibrating rainfall-runoff models using continuous measurements of water level in rivers. The water-level based calibration, that implements an inversed rating curve function in conventional rainfall-runoff models and incorporates a small number of regionalized discharge indices in the calibration (hereafter referred to as IRC_reg method), has important implications for extending rainfall-runoff modelling to basins with no discharge observations. However, the method is applicable only to basins equipped with water level sensors if we rely on ground-based observations.

In this work, we demonstrate the efficacy of using remotely sensed water level data collected by an altimetry satellite, Jason 2, to calibrate a rainfall-runoff model. The altimeter-based calibration is applied to five study catchments in Australia, resulting in Nash Sutcliffe Efficiency (NSE) values of 0.31-0.66 (excluding one outlier), which are comparable with NSE values of 0.66-0.87 (daily observations) and 0.22-0.62 (10-day observations) for ground-based calibration. The altimetry-satellite-based calibration performance is highly correlated with river width. Previous studies recommended that the cross-sections of rivers along the satellite tracks should be wider than 350 meters to enable Jason 2 to estimate accurate water levels (Dumont et al., 2009; Markert et al., 2019). However, all rivers in this study are narrow rivers with widths ranging from 7 meters to 85 meters, which influence the accuracy of altimetry-based water level measurements and the subsequent calibration performances. Also, the 10-day temporal frequency of the Jason 2 is expected to affect the calibration performance.

In order to further examine the influence of both altimetry measurement accuracy and frequency on the calibration performance of rainfall-runoff models, a series of analyses are conducted to examine the sensitivity of the altimeter-based calibration performance to temporal frequency and observation accuracy. Results from large samples (130 catchments) show that the altimeter-based calibration performance is not significantly influenced by the low observation frequency up to 15 days. It is, however, highly sensitive to observation errors. With anticipated improvements in the accuracy of future altimetry observations, the water-level based calibration method, IRC_reg, is expected to significantly expand our capability to predict streamflow to significantly larger coverages.

REFERENCES

Dumont, J., Rosmorduc, V., Picot, N., Desai, S., Bonekamp, H., Figa, J., Lillibridge, J., & Scharroo, R., 2009. OSTM/Jason-2 products handbook. CNES: SALP-MU-M-OP-15815-CN, EUMETSAT: EUM/OPS-JAS/MAN/08/0041, JPL: OSTM-29-1237, NOAA/NESDIS: Polar Series/OSTM J, 400(1).

Markert, K. N., Pulla, S. T., Lee, H., Markert, A. M., Anderson, E. R., Okeowo, M. A., & Limaye, A. S., 2019. AltEx: An open source web application and toolkit for accessing and exploring altimetry datasets. Environmental Modelling & Software, 117, 164-175.

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