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Assessment of the WRF-Hydro uncoupled hydro-meteorological model on flashy watersheds of the tropical island of New Caledonia (South-West Pacific)

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Situated in the South-West Pacific, New Caledonia is a tropical island dominated by a central mountain range and is subject to cyclones, regular intense precipitation events and flash-flooding. Recent fine-scaled projections of climate change in New Caledonia show that the frequency and intensity of extreme precipitation events could be reduced by ~ 20% by 2080-2100 [Dutheil *et al.*, 2020]. This paper investigates the ability of the WRF-Hydro/Noah-MP modelling framework to represent the hydrological regime of six watersheds in New Caledonia. A nearly 2-year long WRF ideal atmospheric forcing was completed with observed precipitations from 24 rain gauges using two rainfall spatial interpolation methods at 0.2 km-resolution. This study mainly seeks to calibrate the uncoupled WRF-Hydro/Noah-MP system as well as to evaluate its performance upon short and contrasted heavy rainfall events between 2012 and 2014. Particular attention was paid to (i) the sensitivity of calibration processes to rainfall spatial interpolation methods, (ii) the consistency in modelled soil moisture storage and (iii) the reliability of hydrograph separation provided by WRF-Hydro.

After automatic calibration relying upon the DDS algorithm [Tolson and Shoemaker, 2007], streamflow simulations show overall good performance with Nash–Sutcliffe efficiencies (NSE) greater than 0.6 on a 21-month period for all watersheds. Standard hydrological features of all studied watersheds are well reproduced. The quality of simulation is found to be decreasing with lower values of runoff coefficient. We show on three watersheds that spatial distribution of rainfall can highly condition the calibration process and thus greatly modify modelled soil moisture storage and in result the shape of simulated flash floods. WRF-Hydro's hydrograph decomposition between surface and underground runoff is presented and compared with known characteristics of watersheds as well as with other quickflow/baseflow separation methods. To our knowledge, this work is the first attempt to use the uncoupled WRF-Hydro hydro-meteorological model for flash flood analysis in New Caledonia and opens a pathway to study multiple hydrological and climatic features in the region in the context of climate change.

Keywords: hydro-meteorological modelling, WRF-Hydro, Noah-MP, flash flood, rainfall spatial

interpolation, hydrograph separation, baseflow, New-Caledonia