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How sensitive are rainfall interception models to the canopy parameters of semi-arid forests?

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Quantifying rainfall interception can be a difficult task because the canopy storage has high spatial and temporal variability. The aim of this study is to examine the sensitivity of three commonly used rainfall interception models (Rutter, Gash and Liu) to the canopy storage capacity (S) and to the free throughfall coefficient (p). The research was carried out in a semi-arid Pinus brutia forest, located in Cyprus. One meteorological station and 15 manual throughfall gauges were used to measure throughfall and to compute rainfall interception for the period between January 2008 and July 2016. Additionally, one automatic and 28 manual throughfall gauges were installed in July 2016. We ran the models for different sets of canopy parameter values and evaluated their performances with the Nash-Sutcliffe Efficiency (NSE) and the bias, for the calibration period (July 2016 - December 2019). We validated the models for the period between January 2008 and July 2016. During the calibration period, the models were tested with different temporal resolutions (hourly and daily). Total rainfall and rainfall interception during the calibration period were 1272 and 264 mm, respectively. The simplified Rutter model with the hourly interval showed a decrease of the NSE with an increase of the free throughfall coefficient. The bias of the model was near zero for a canopy storage between 2 and 2.5 mm and a free throughfall coefficient between 0.4 and 0.7. The Rutter model was less sensitive to changes in the canopy parameters than the other two models. The bias of the daily Gash and Liu models was more sensitive to the free throughfall coefficients than to the canopy storage capacity. The bias of these models was near zero for free throughfall coefficients over 0.7. The daily Gash and Liu models show high NSE values (0.93 – 0.96) for a range of different canopy parameter values (S: 0.5 – 4.0, p: 0 – 0.9). Zero bias was achieved for a canopy storage capacity of 2 mm and above and a free throughfall coefficient between 0 and 0.7. Total rainfall and rainfall interception during the validation period were 3488 and 1039 mm, respectively. The Gash model performed better than the Liu model when the optimal parameter set (highest NSE, zero bias) was used. The interception computed with the Gash model was 987 mm, while 829 mm with the Liu model. This study showed that there is a range of canopy parameter values that can be used to achieve high model performance of rainfall interception models.