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*Supplement of*

## **Behind the scenes of streamflow model performance**

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This supplement contains a comparison of hydro-climatic properties of the calibration and post-calibration periods (Section S1, Figures S1 and S2). Additionally, a visual overview of the model ranks for a selection of criteria is shown in Section S2 (Figure S3).

## S1 Comparison of hydro-climatic properties of calibration and post-calibration periods

This section contains a comparison of hydro-climatic properties of the calibration (2004-2007) and post-calibration (2008-2017) periods in terms of streamflow and overall water balance.

In Figure S1, we show the observed streamflow time series for the Ourthe at Tabreux. The calibration years can be qualified as relatively normal years in terms of streamflow. Also in terms of the overall water balance, differences in the aridity index and runoff coefficient are minor, as shown in the representation of the Budyko framework in Figure S2.

Additionally, there are no substantial differences between both periods for the remote sensing data. Time series of GLEAM evaporation for the period 2008-2017 (Figure 4b of the manuscript) show a relatively constant behavior, which is also representative of the calibration period. Time series of MODIS snow cover (Figure 5a) show that the calibration period contains both years with relatively much and little snow. GRACE total storage anomalies show a relatively constant behavior for the entire period and therefore also during the calibration period (Figure 7a). As the remote sensing soil moisture data are only available since 2015 (Figure 8a,b), no comparison with the calibration years is possible.

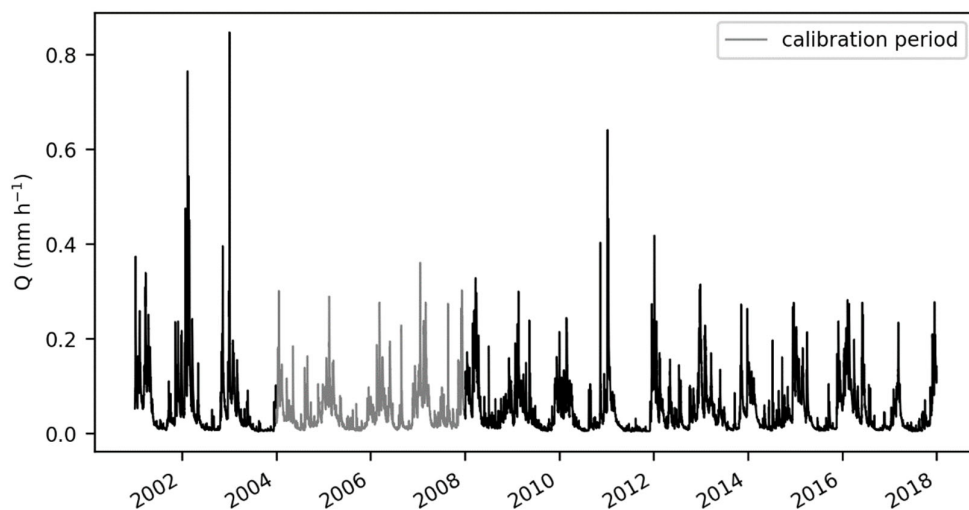


Figure S1: Observed streamflow between 2001 and 2017 for the Ourthe at Tabreux. The grey part of the hydrograph represents the calibration period.

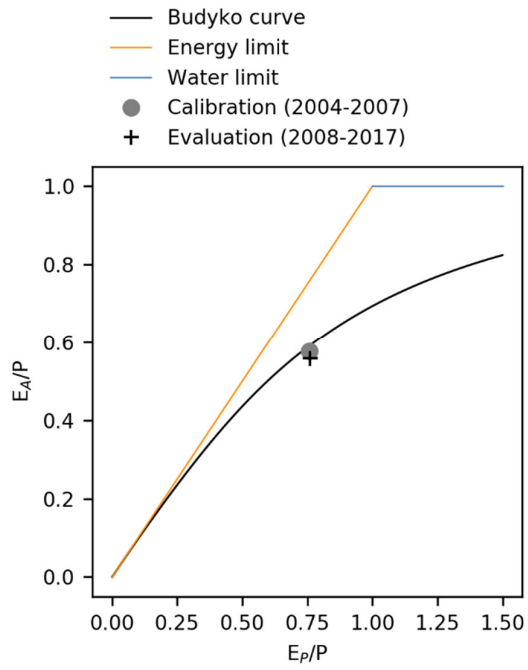


Figure S2: Plotting position of the Ourthe catchment at Tabreux for the calibration and evaluation periods within the Budyko framework, with  $E_a$  actual evaporation,  $E_p$  potential evaporation and  $P$  precipitation.

## S2 Model ranks for selected criteria

The model ranks for a selection of criteria based on observed streamflow, remote-sensing data and expert knowledge are illustrated in a heatmap to provide a visual overview of model performance (Figure S3).

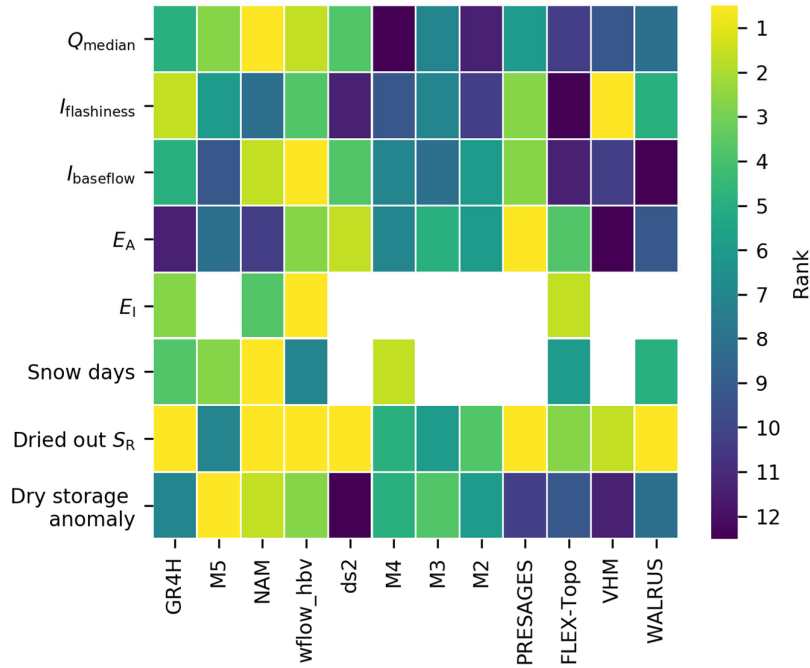


Figure S3: Model ranks for each of the criteria shown in Figure 9 and based on observed streamflow, remote sensing data and expert knowledge. The results are shown for the Ourthe at Tabreux (ID 1), except for the snow days analysis which is shown for the Ourthe Orientale at Mabompré (ID 2). Blank spots indicate that the models do not include a separate interception module or/and a snow module. The symbols are  $Q_{\text{median}}$  for median annual streamflow,  $I_{\text{flashiness}}$  for flashiness index,  $I_{\text{baseflow}}$  for baseflow index,  $E_A$  for median annual actual evaporation,  $E_i$  for median annual interception evaporation and  $S_R$  for root-zone soil moisture.