Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-263-AC2, 2016

Hydrology and Earth System Sciences Discussions

Open Access

EGU

Interactive comment on "A process-based diagnosis of catchment coevolution in volcanic landscapes: synthesis of Newtonian and Darwinian approaches" *by* Takeo Yoshida and Peter A. Troch

Takeo Yoshida and Peter A. Troch

takeoys@affrc.go.jp

Received and published: 2 September 2016

[Comment]

This paper is overall a nice model-based addition to the growing literature on volcanic catchment co-evolution. I really like how the authors have examined the effects of catchment internal properties versus climate on hydrologic response in way that can't be done in the real world. The results conform to the emerging conceptual view of how the hydrology of volcanic catchments changes as they age. However, I am concerned about over-interpretation of the results (because they fit so nicely!) relative to what can

Printer-friendly version

Discussion paper

be said with confidence based on this modeling exercise.

The first referee has provided some really important points about the parameter uncertainty and estimation and fairly low model performance as measured by the NSE. While I respect the authors' point that they are able to reasonably replicate the observed slopes of the flow duration curves (SFDC), as shown in the figure, the overall lack of fit of the model to the data raises questions about how much credence we should give to model results for the simulated combinations of climate and catchment characteristics. How much of the SFDC residual is due to model performance versus the processes actually under study? It seems like a more complete uncertainty analysis that attempts to propagate the model uncertainty through the results would be quite useful in interpreting the findings.

[Response]

We compiled figures that present the various aspects of model performance (flow duration curve for entire period, one-year cumulative streamflow curve and one-year daily hydrograph) with the values of NSE (Q), NSE (logQ), NSE(FDC) and NSE(CF) in the caption (Figures 1-8). All models successfully captured the flow duration curves (top left in each figure) and cumulative flow (top right), but not necessarily good with respect to the daily streamflow (bottom). The NSE values are low partly because of the timing of the simulated flood peaks do not coincide with the observed ones. The timing of flood peaks can be delayed with the flood concentration time, which represent catchments' hydraulic characteristics at the land surface (Carrillo et al., 2011); however, we could not apply the delay function in this study because the flood concentration time is less than the simulation interval of one day.

Overall, we would argue that even though the NSE values with daily streamflow are low, the frequency of flows is captured well. So, the model does poorly on timing the flow but performs well on generating the 'right amount of flow'. While we agree that the model parameters still have uncertainty, they are identified as we intended and the model errors are negligible.

[Comment]

Beyond these major points, I have a few secondary points. The authors have assessed how a large number of catchment parameters change with catchment age and climate. They use a cut of $p<0.05$ as a test of statistical significance of these regressions, without making a correction for multiple comparisons that can lead to false positives. I suggest that the authors apply the standard Bonferroni correction and adjust the p-value for significance accordingly.

[Response]

The reviewer is correct that we tested two hypotheses simultaneously; 1) presence/absence of coevolution (with respect to the catchment age), and 2) degree of catchment/climate controls on flow characteristics (with respect to ΔSFDC by catchment/climate). In Bonferroni correction, the threshold for the statistical significance (i.e., p-value of 0.05) should be divided by the number of hypotheses. With the p-value of 0.025 (= 0.05/2), some of the relations we suggested as significant in the previous version of manuscript should be perceived as not significant (or significant not because of the coevolution only but climate might have affected); those are the relation between catchment age and timescales for emptying root zone by drainage ($p=0.039$) and by transpiration ($p=0.028$), for emptying transmission storage ($p=0.035$), the aridity index ($p=0.033$), and the mean throughfall rate ($p=0.041$). While these relations should be interpreted as not significant, the main conclusion suggested in Figure 5 and 6 would not be altered because their p-values were less than 0.025.

We would add this correction and the consequence in the revised manuscript.

[Comment]

In the paragraph around line 65, the authors make a statement about the changes over time in clay layers, chemical weathering, vertical recharge and shallow subsurface flow in volcanic catchments. They cite Jefferson et al (2010) and their previous paper. It should be noted that neither of these papers actually directly observed those processes. Instead both papers were empirical studies of change in stream hydrographs with catchment age that put forward these ideas as possible explanations for the hydrologic signatures. There is literature on clays and chemical weathering of basalts with respect to soil development (c.f., work by Oliver Chadwick and Peter Vitousek), and the work of Lohse and Dietrich (2005) adds some hydrological context to the soil development story.

[Response]

The references for this part will be changed in the revised manuscript to the papers on soil development in volcanic landscapes as you suggested.

[Comment]

Around line 72, the mention of the aridity index doesn't make sense for readers unfamiliar with the previous paper. Perhaps the authors should provide more context.

[Response]

The description of the aridity index will be added to the revised manuscript.

[Comment]

The conceptualization in Figure 1 is very nice, but mean delta-signature should be defined within the figure or its caption. Also, is the only way to know what the slope of B looks like through an empirical set of watersheds of different ages? How does this limit the utility of the framework you put forward?

[Response]

The 'delta-signature' refers to the deviation of hydrological signature from the empirical line shown as line (B) or (D) in Figure 1. The 'delta-signature' in this study is ΔSFDC as described later; however, we did not use the term, ΔSFDC, here to make this conceptual figure as a general framework of this study. Yes, the only way to know the slope of B is based on the empirical studies at this point.

[Comment]

In Figures 4 and 5, the x-axis is labeled with units of ka. I believe it should be Ma, based on the assembled catchment ages.

[Response]

Thank you for pointing this out.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-263, 2016.

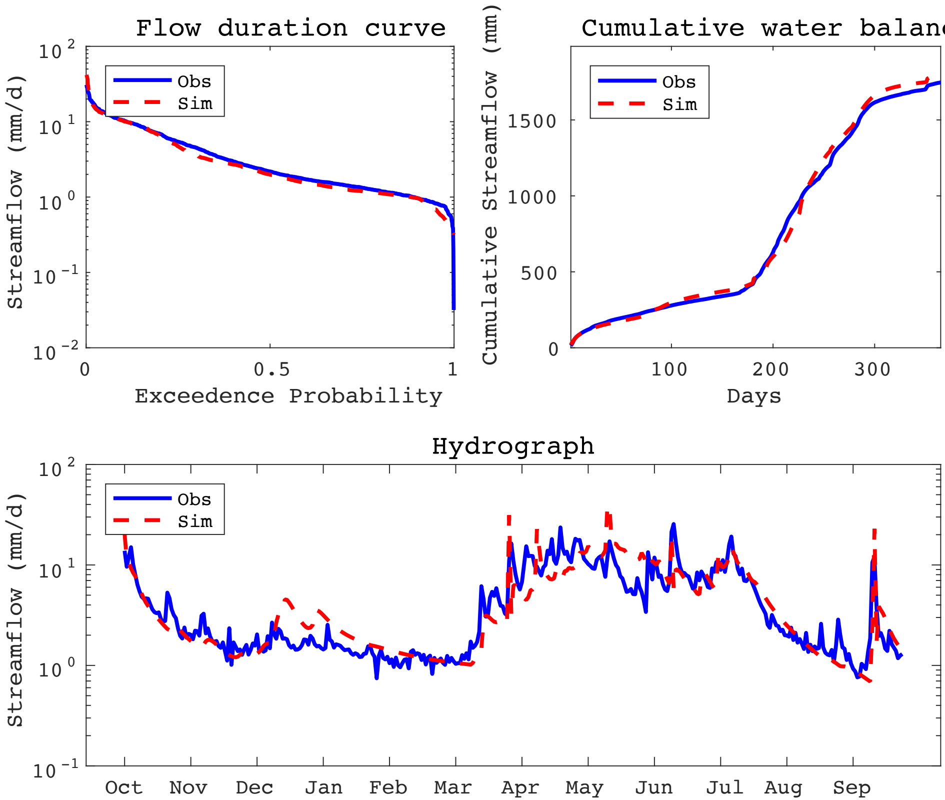

Fig. 1. Combined figures of flow duration curve (top left), cumulative flow (top right) and one-year hydrograph (bottom) in AIM (NSE(Q) = 0.360; NSE(logQ) = 0.633; NSE(FDC) = 0.964; NSE(CF) = 0.995).

Printer-friendly version

Discussion paper

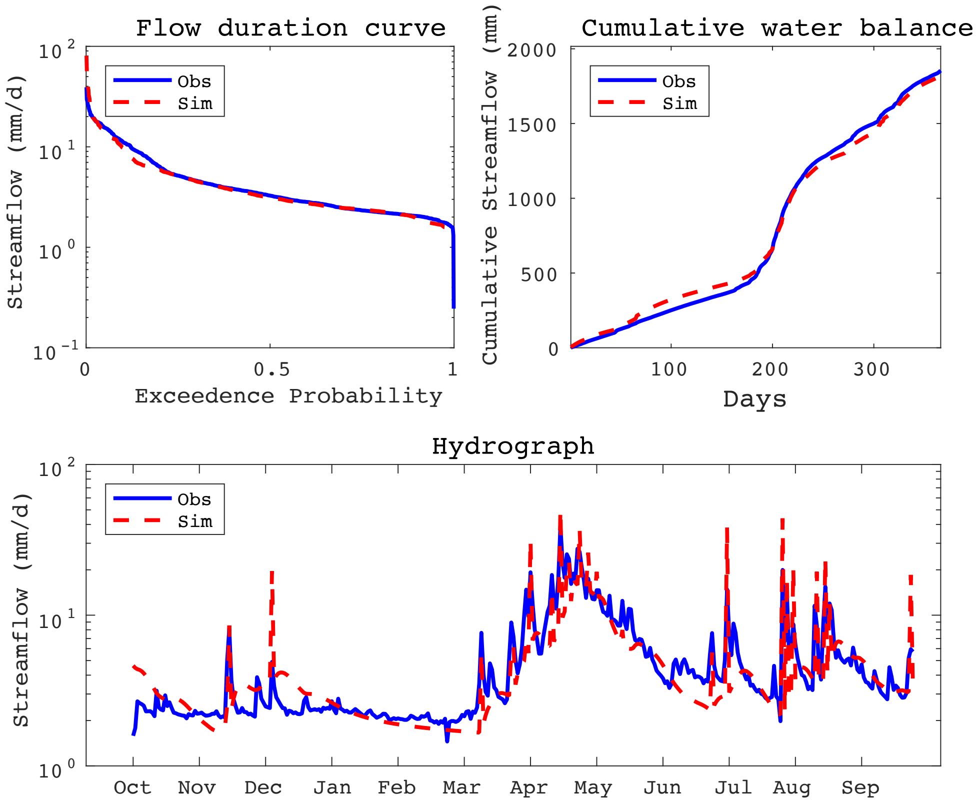

Fig. 2. Combined figures of flow duration curve (top left), cumulative flow (top right) and one-year hydrograph (bottom) in ASE (NSE(Q) = 0.419; NSE(logQ) = 0.689; NSE(FDC) = 0.794; NSE(CF) = 0.994).

Printer-friendly version

Discussion paper

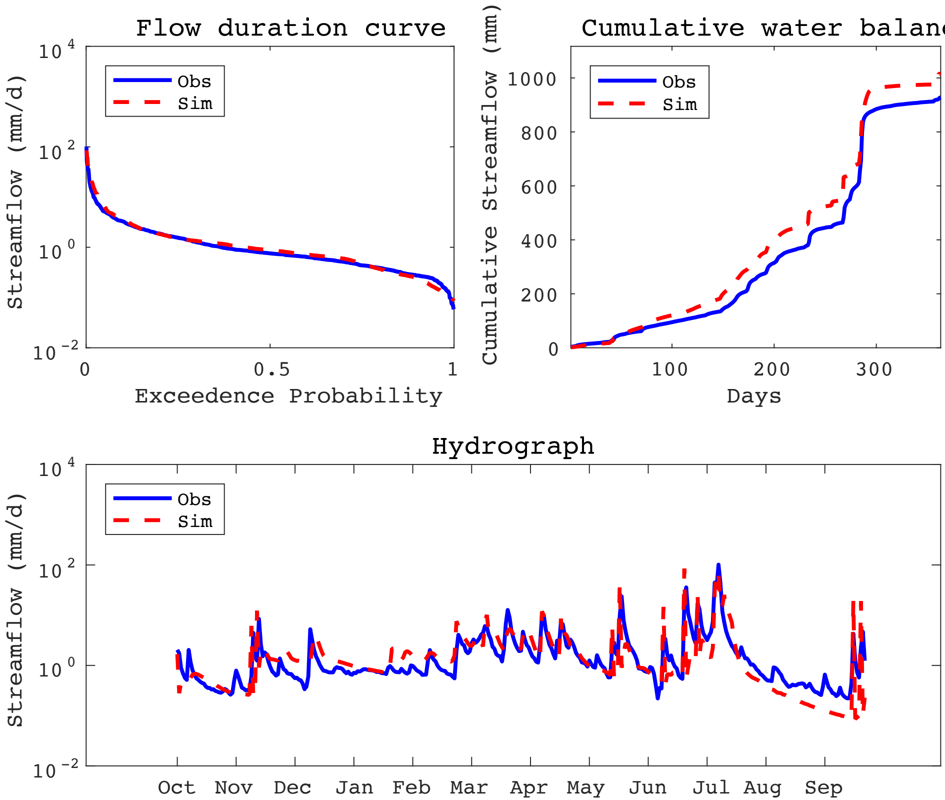

Fig. 3. Combined figures of flow duration curve (top left), cumulative flow (top right) and one-year hydrograph (bottom) in HAZ (NSE(Q) = 0.209; NSE(logQ) = 0.430; NSE(FDC) = 0.894; NSE(CF) = 0.965).

Printer-friendly version

Discussion paper

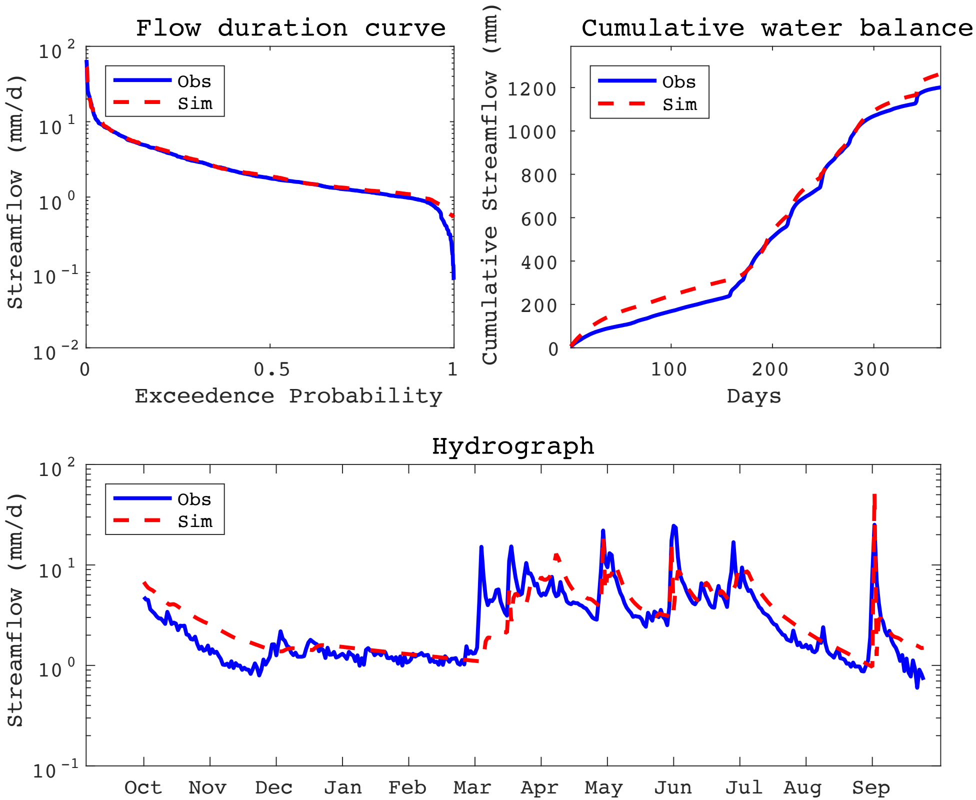

Fig. 4. Combined figures of flow duration curve (top left), cumulative flow (top right) and one-year hydrograph (bottom) in IKR (NSE(Q) = 0.428; NSE(logQ) = 0.510; NSE(FDC) = 0.968; NSE(CF) = 0.985).

Printer-friendly version

Discussion paper

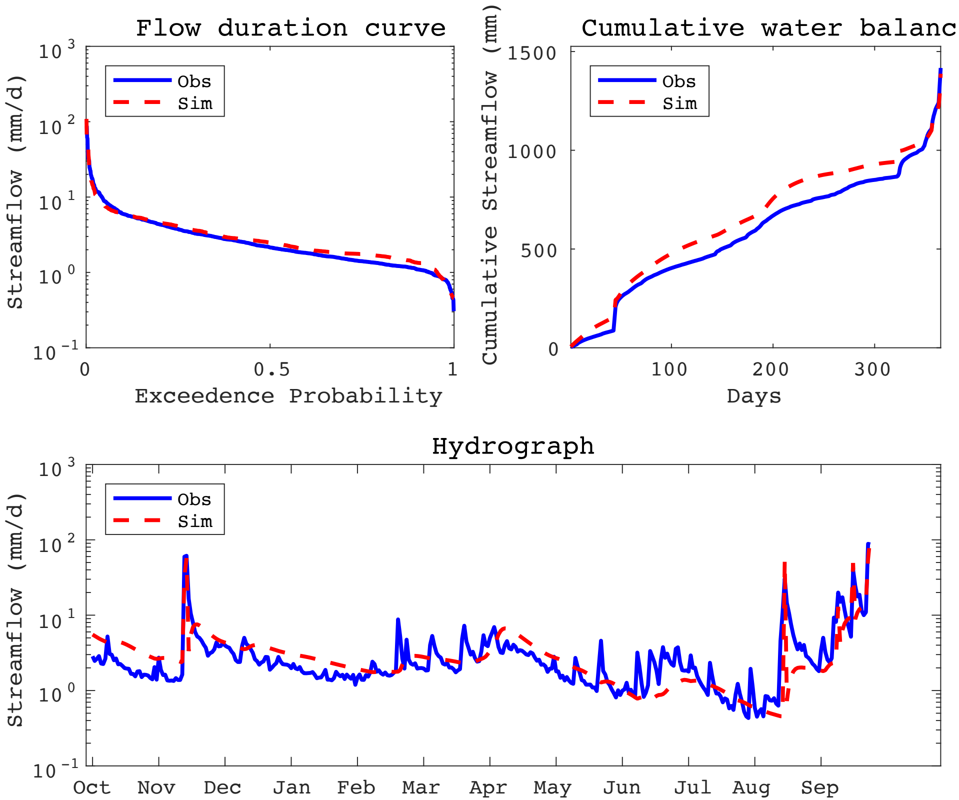

Fig. 5. Combined figures of flow duration curve (top left), cumulative flow (top right) and one-year hydrograph (bottom) in KAM (NSE(Q) = 0.696; NSE(logQ) = 0.422; NSE(FDC) = 0.941; NSE(CF) = 0.934).

Interactive comment

Printer-friendly version

Discussion paper

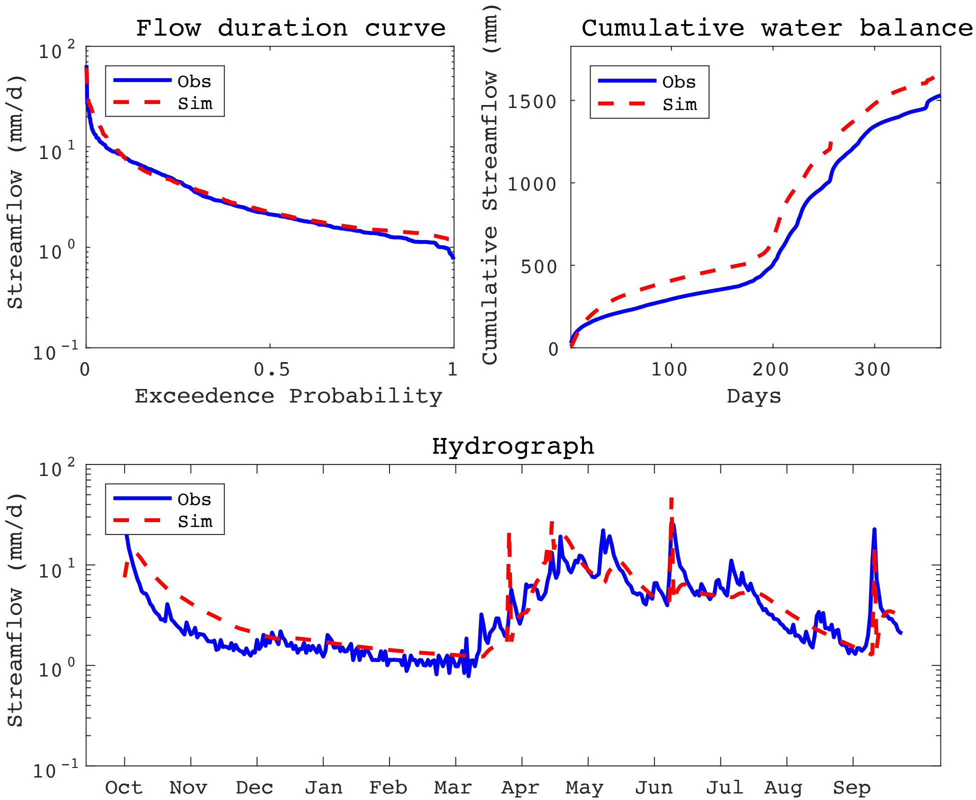

Fig. 6. Combined figures of flow duration curve (top left), cumulative flow (top right) and one-year hydrograph (bottom) in KWM (NSE(Q) = 0.302; NSE(logQ) = 0.613; NSE(FDC) = 0.883; NSE(CF) = 0.916).

Printer-friendly version

Discussion paper

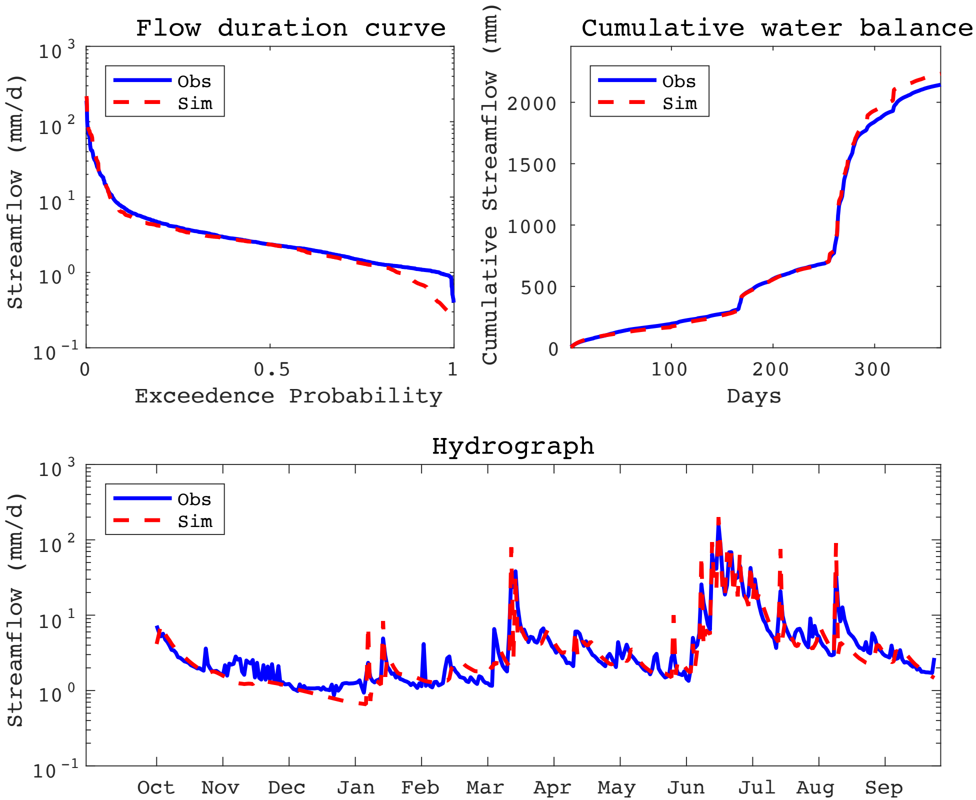

Fig. 7. Combined figures of flow duration curve (top left), cumulative flow (top right) and one-year hydrograph (bottom) in SIM (NSE(Q) = 0.711; NSE(logQ) = 0.647; NSE(FDC) = 0.937; NSE(CF) = 0.996).

Printer-friendly version

Discussion paper

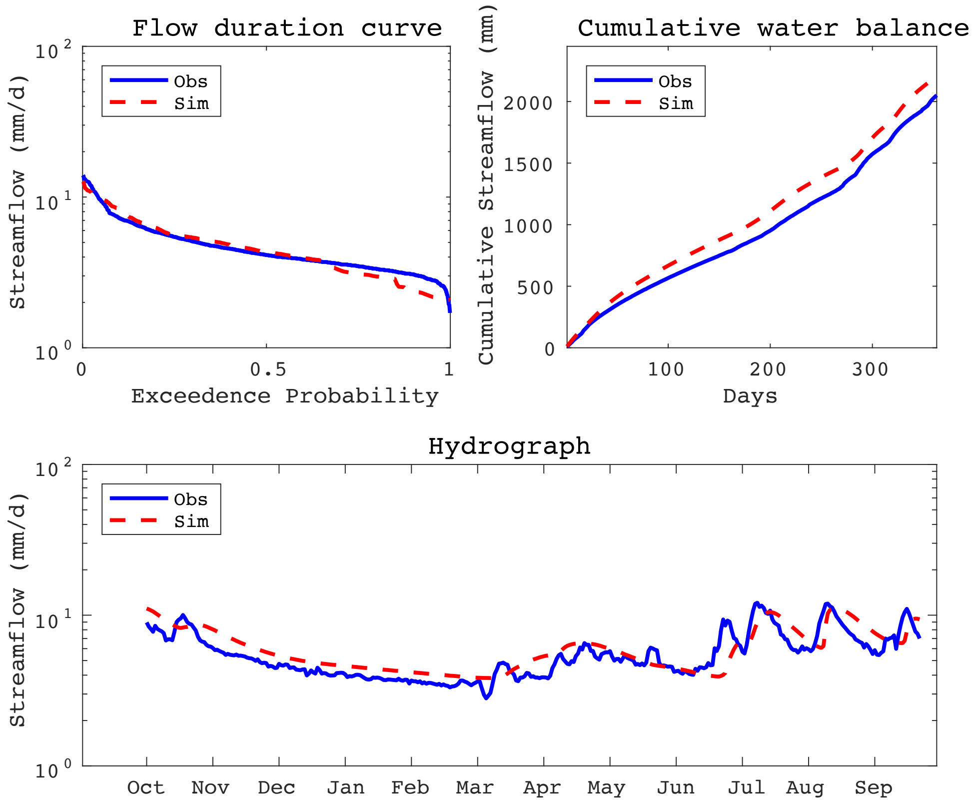

Fig. 8. Combined figures of flow duration curve (top left), cumulative flow (top right) and one-year hydrograph (bottom) in SNK (NSE(Q) = 0.358; NSE(logQ) = 0.365; NSE(FDC) = 0.947; NSE(CF) = 0.941).