

Enhancing a Real-Time Flash Flood Predictive Accuracy Approach for the Development of Early Warning Systems: Hydrological Ensemble Hindcasts and Parameterizations

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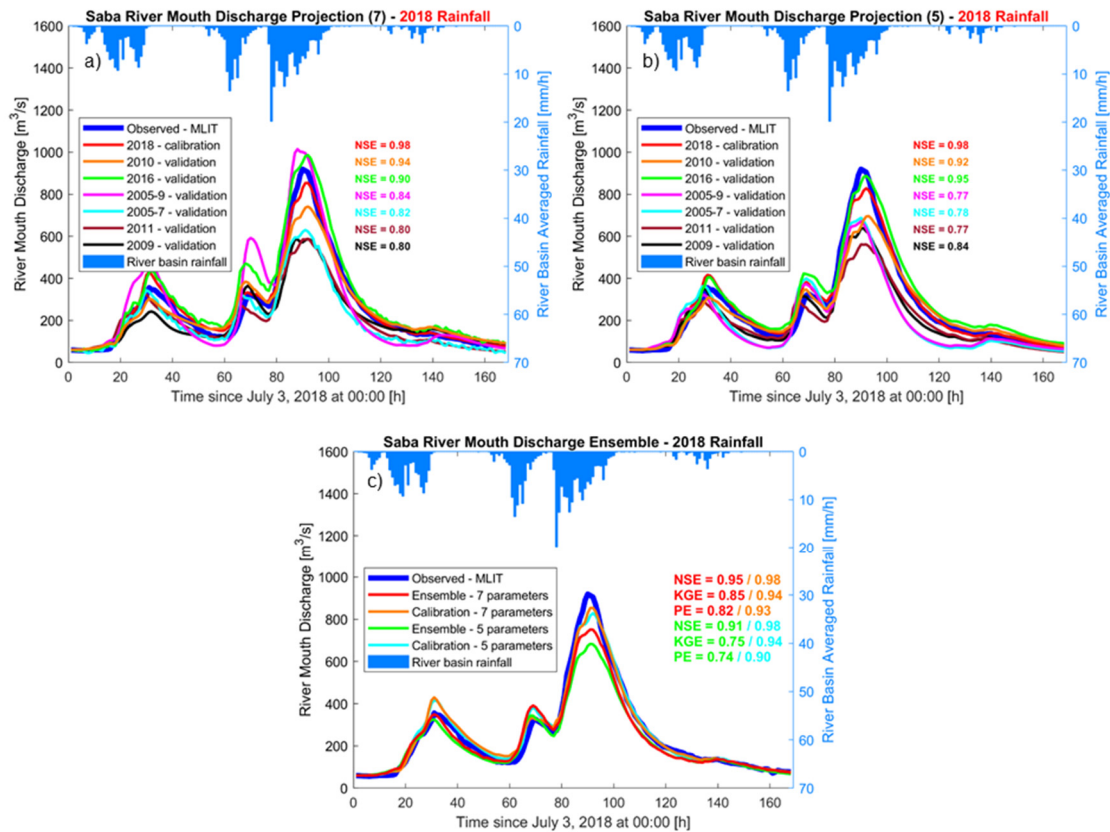
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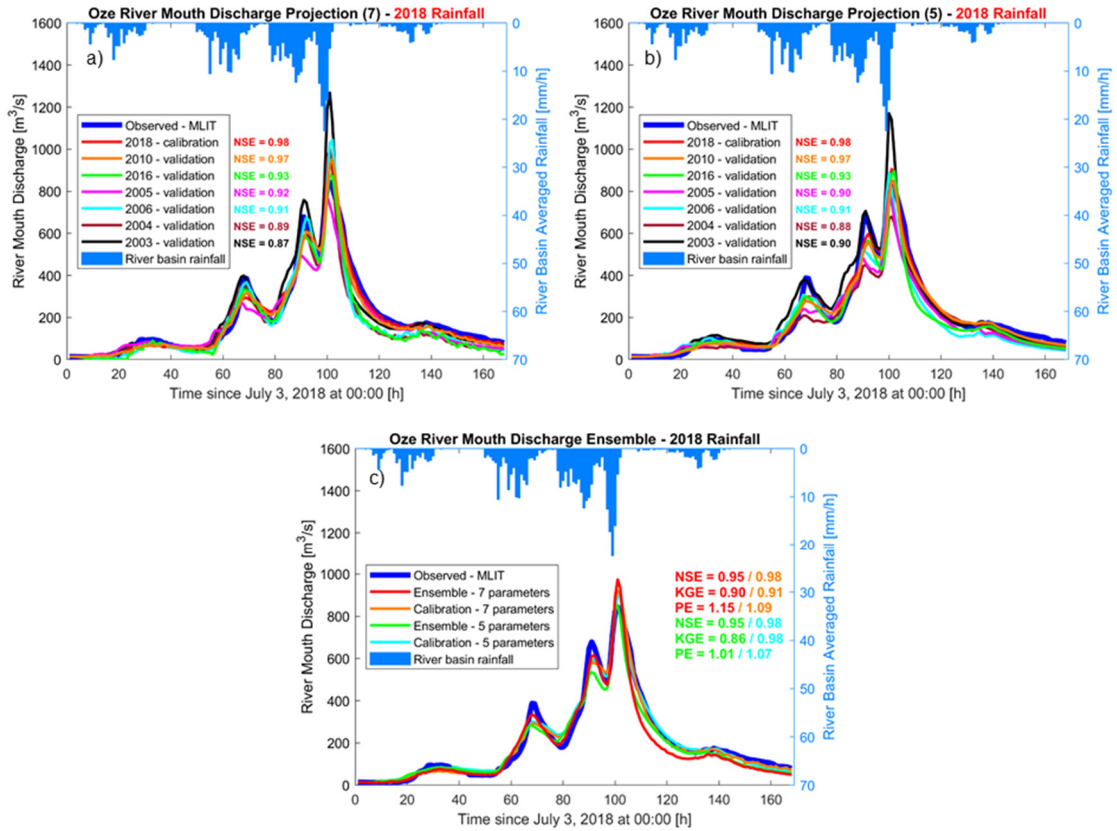
Supplementary Material 1

Supplementary Figure S1 shows the Saba River calibration and validation discharge results for the HRE18 at Shimbashi station, located 8 km upstream from the river mouth, using the 7-CPM and 5-CPM sets with the HRE18 rainfall data and ensemble average validation of all 6 calibrated parameter sets with the 7-CPM and 5-CPM sets compared with observed data.



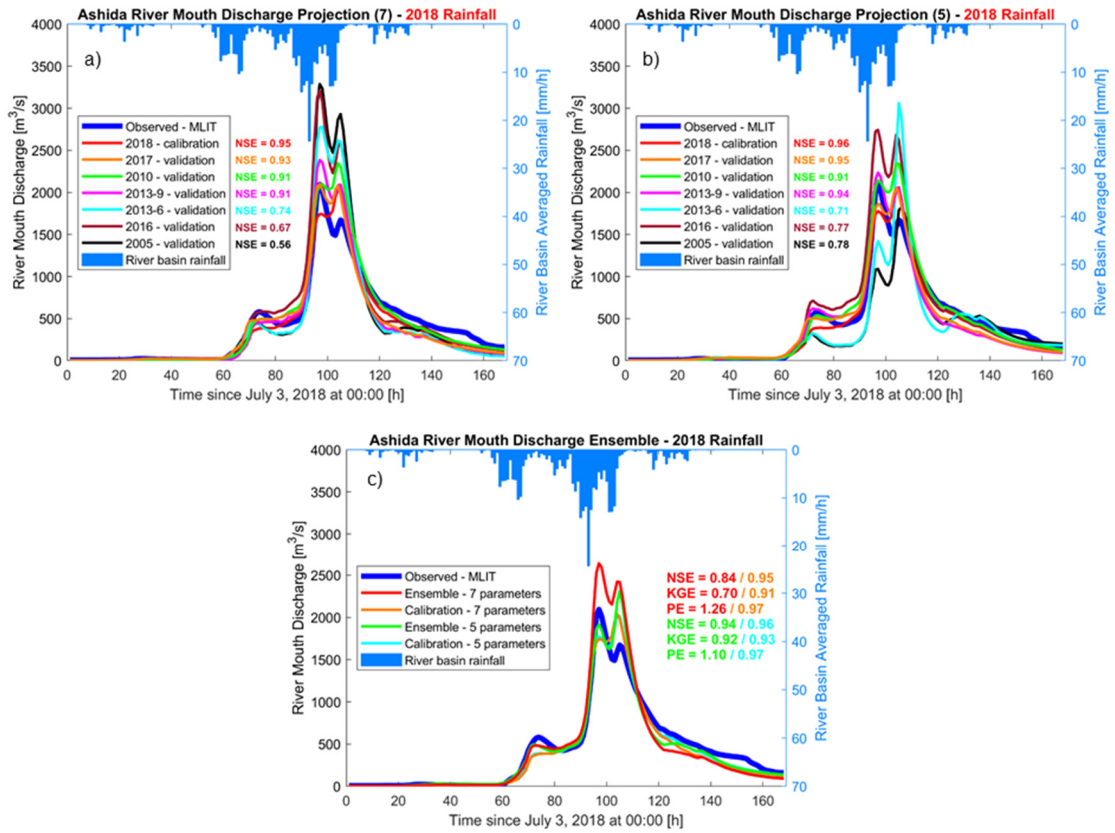
Supplementary Figure S1. Saba River calibration (6a—red and 6b—red) and validation (all others) discharge results for the HRE18 when using (a) the 7-CPM sets and (b) the 5-CPM sets. Panel (c) shows ensemble average validation cases of all 6 calibrated parameter sets with the 7-CPM (red—validation; orange—calibration) and the 5-CPM (green—validation; cyan—calibration) compared with the observed river discharges (blue—60) at a site located 8 km upstream from the river mouth.

Supplementary Figure S2 shows the Oze River calibration and validation discharge results for the HRE18 at Shimogahara station, located just upstream from Yasaka Lake, using the 7-CPM and 5-CPM sets with the HRE18 rainfall data and ensemble average validation of all 6 calibrated parameter sets with the 7-CPM and 5-CPM sets compared with observed data. The Oze River features a dam with associated flood control system at Yasaka Lake located less than 20 km upstream from the river mouth, so we selected the closest station upstream from Yasaka Lake for the observation and simulation location.



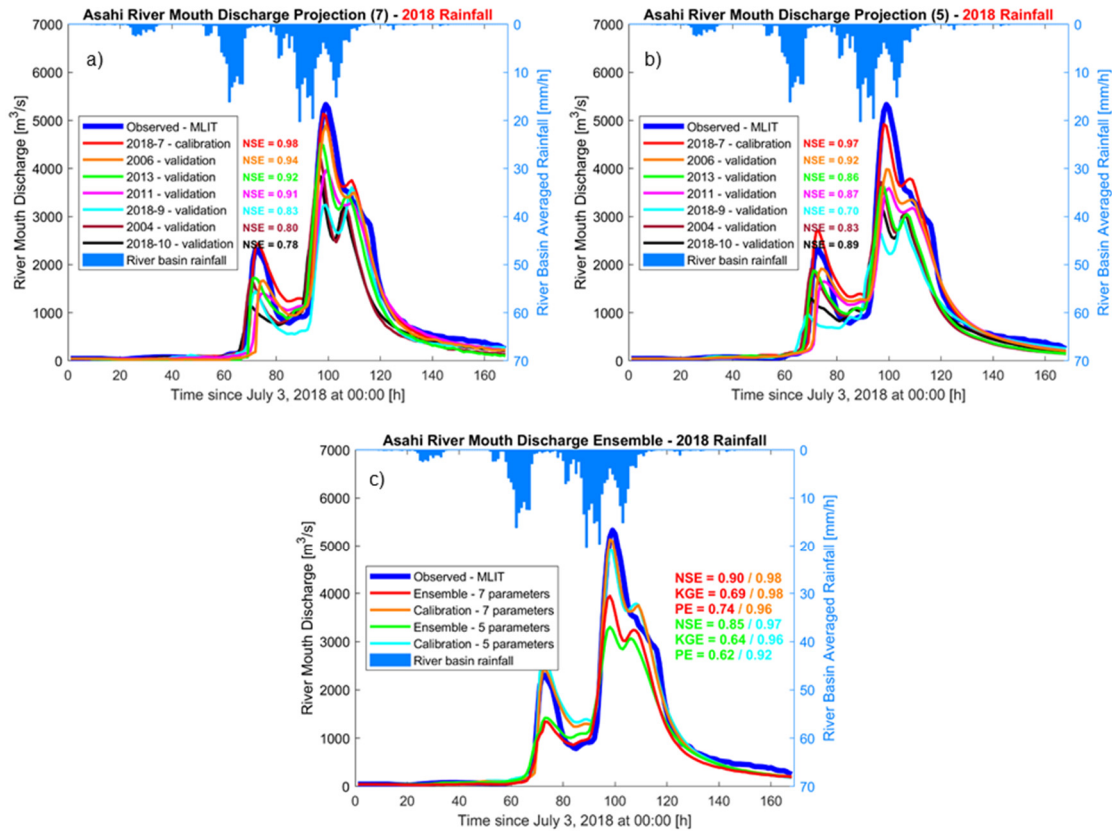
Supplementary Figure S2. Oze River calibration (6a—red and 6b—red) and validation (all others) discharge results for the HRE18 when using (a) the 7-CPM sets and (b) the 5-CPM sets. Panel (c) shows ensemble average validation cases of all 6 calibrated parameter sets with the 7-CPM (red—validation; orange—calibration) and the 5-CPM (green—validation; cyan—calibration) compared with the observed river discharges (blue—60) at a site located just upstream from Yasaka Lake.

Supplementary Figure S3 shows the Ashida River calibration and validation discharge results for the HRE18 at Yamate station, located 9.53 km upstream from the river mouth, using the 7-CPM and 5-CPM sets with the HRE18 rainfall data and ensemble average validation of all 6 calibrated parameter sets with the 7-CPM and the 5-CPM sets compared with observed data.



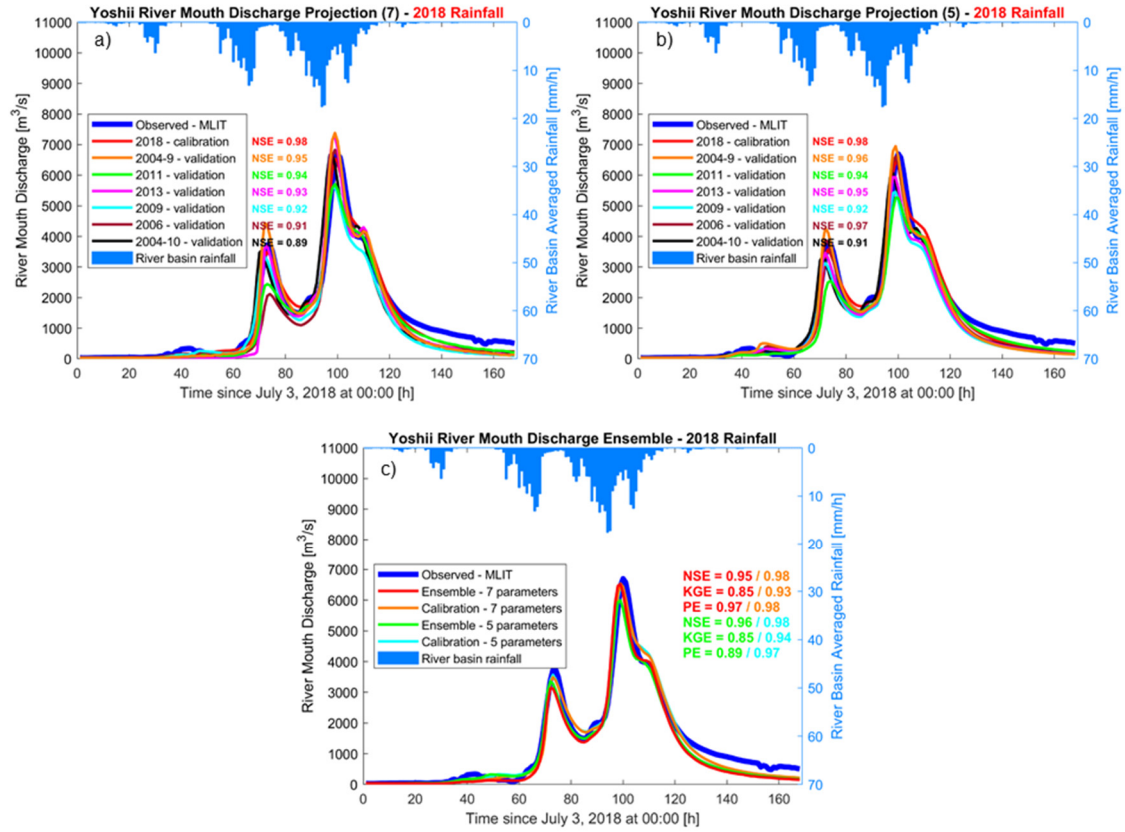
Supplementary Figure S3. Ashida River calibration (6a—red and 6b—red) and validation (all others) discharge results for the HRE18 when using (a) the 7-CPM sets and (b) the 5-CPM sets. Panel (c) shows ensemble average validation cases of all 6 calibrated parameter sets with the 7-CPM (red—validation; orange—calibration) and the 5-CPM (green—validation; cyan—calibration) compared with the observed river discharges (blue—60) at a site located 9.53 km upstream from the river mouth.

Supplementary Figure S4 shows the Asahi River calibration and validation discharge results for the HRE18 at Makiyama station, located 20.4 km upstream from the river mouth, using the 7-CPM and 5-CPM sets with the HRE18 rainfall data and ensemble average validation of all 6 calibrated parameter sets with the 7-CPM and the 5-CPM sets compared with observed data.



Supplementary Figure S4. Asahi River calibration (6a—red and 6b—red) and validation (all others) discharge results for the HRE18 when using (a) the 7-CPM sets and (b) the 5-CPM sets. Panel (c) shows ensemble average validation cases of all 6 calibrated parameter sets with the 7-CPM (red—validation; orange—calibration) and the 5-CPM (green—validation; cyan—calibration) compared with the observed river discharges (blue—60) at a site located 20.4 km upstream from the river mouth.

Supplementary Figure S5 shows the Yoshii River calibration and validation discharge results for the HRE18 at Miyasu station, located 14.05 km upstream from the river mouth, using the 7-CPM and the 5-CPM sets with the HRE18 rainfall data and ensemble average validation of all 6 calibrated parameter sets with the 7-CPM and 5-CPM sets compared with observed data.



Supplementary Figure S5. Yoshii River calibration (6a—red and 6b—red) and validation (all others) discharge results for the HRE18 when using (a) the 7-CPM sets and (b) the 5-CPM sets. Panel (c) shows ensemble average validation cases of all 6 calibrated parameter sets with the 7-CPM (red—validation; orange—calibration) and the 5-CPM (green—validation; cyan—calibration) compared with the observed river discharges (blue—60) at a site located 14.05 km upstream from the river mouth.