Hydrology and Earth System Sciences

Supplemental Material for

Adaptation and Application of the large LAERTES-EU RCM Ensemble for Hydrological Modeling: A pilot study of the Rhine basin

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0. Contents of this file

1. Validation of the Bias Correction
    Fig. S1
2. Validation of the hydrological model
    Fig. S2 - S6
3. Added Value of Bias Correction for hydrological applications
    Fig. S7 - S11

1. Added Value of the Bias Correction

Figure S1 shows the bias of the corrected and uncorrected model data of block 4. In the uncorrected model precipitation, a positive bias towards E-OBS is visible within the Rhine catchment (Fig. S1 a). There are only a few places with negative bias. Overall, there is a clear improvement after bias correction (Fig. S1 b). The remaining bias of LAERTES-EU data block 4 towards E-OBS, which is below 0.5 mm, is mostly negative. Similar to E-OBS, the uncorrected model precipitation is overestimated towards observed precipitation in HYRAS (Fig. S1 c). Again, bias correction leads to a reduction of this overestimation, however, by resulting in a slight under-representation of rainfall (Fig. S1 d).

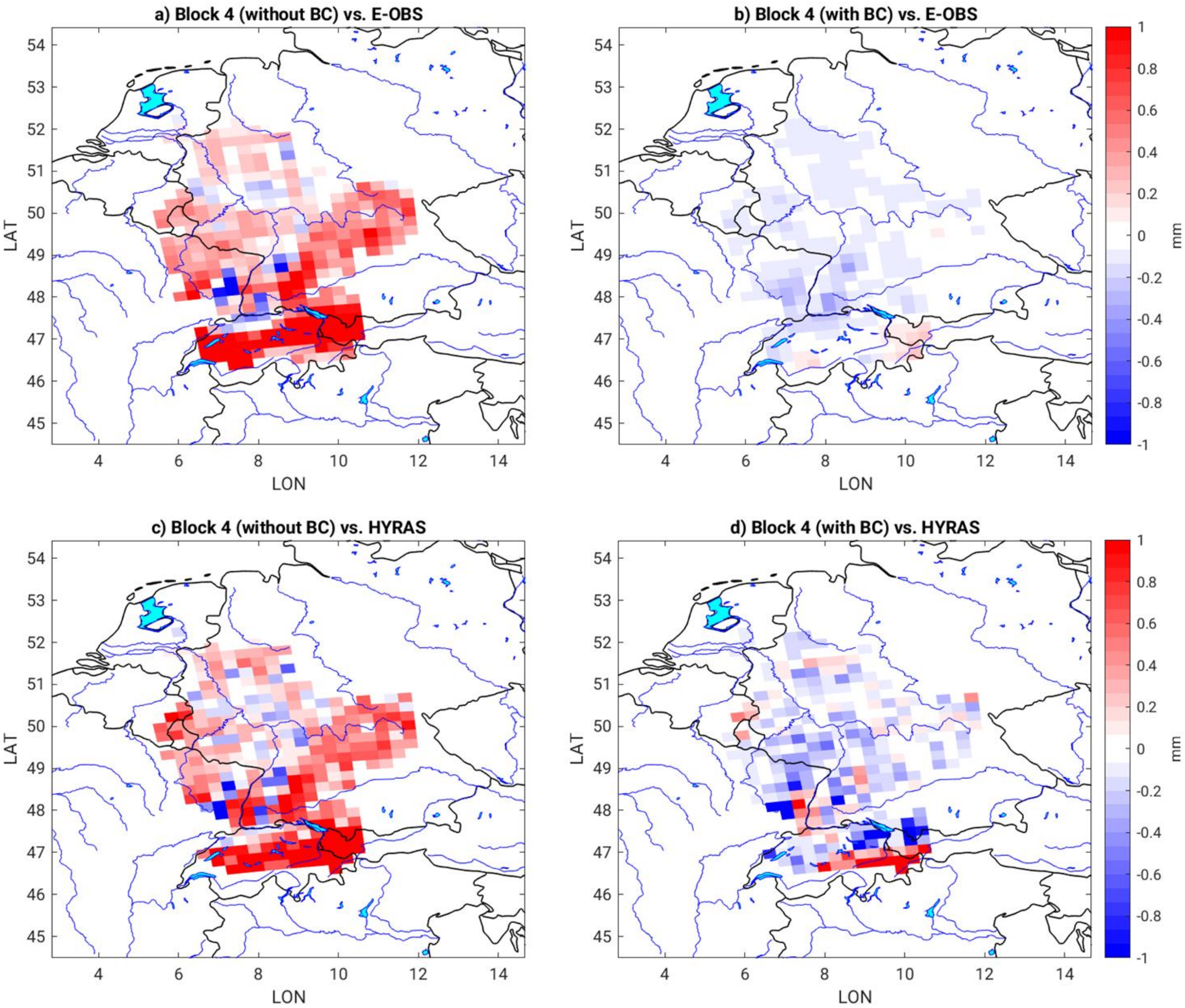


Figure S1. Bias within in the Rhine catchment in daily precipitation [in mm] for ensemble mean based on a), c) block 4 without bias correction, and b), d) block 4 with bias correction in comparison to E-OBS (top) and HYRAS (bottom). Black lines show country borders, blue lines indicate rivers, and cyan shaded areas show lakes.

2. Validation of the hydrological model

Figures S2-S6 show the time series for different gauging station within the Rhine basin for three historical flood events capturing different catchment sizes. Displayed are the observed discharges and the simulation results of the HBV model driven by precipitation amounts of the observational data sets HYRAS and E-OBS. The overall temporal evolution of the events is well captured with some deviations at the peak discharges, especially for the smaller catchments. The model runs on a daily time step with daily input data and these smaller catchments have a higher sensitivity to the inter-day variability of precipitation. Furthermore, the differences between the E-OBS driven simulations and the HYRAS driven runs are more distinct for the smaller catchments due to the higher resolution of the HYRAS data set.

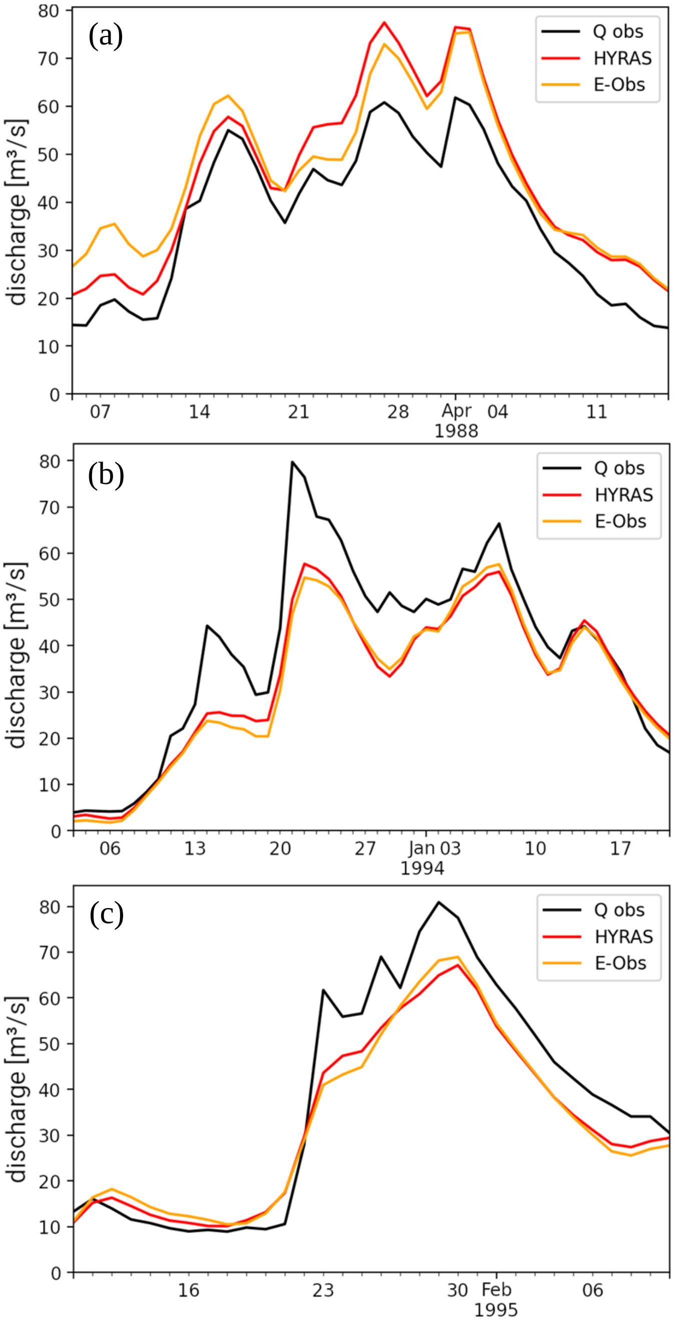
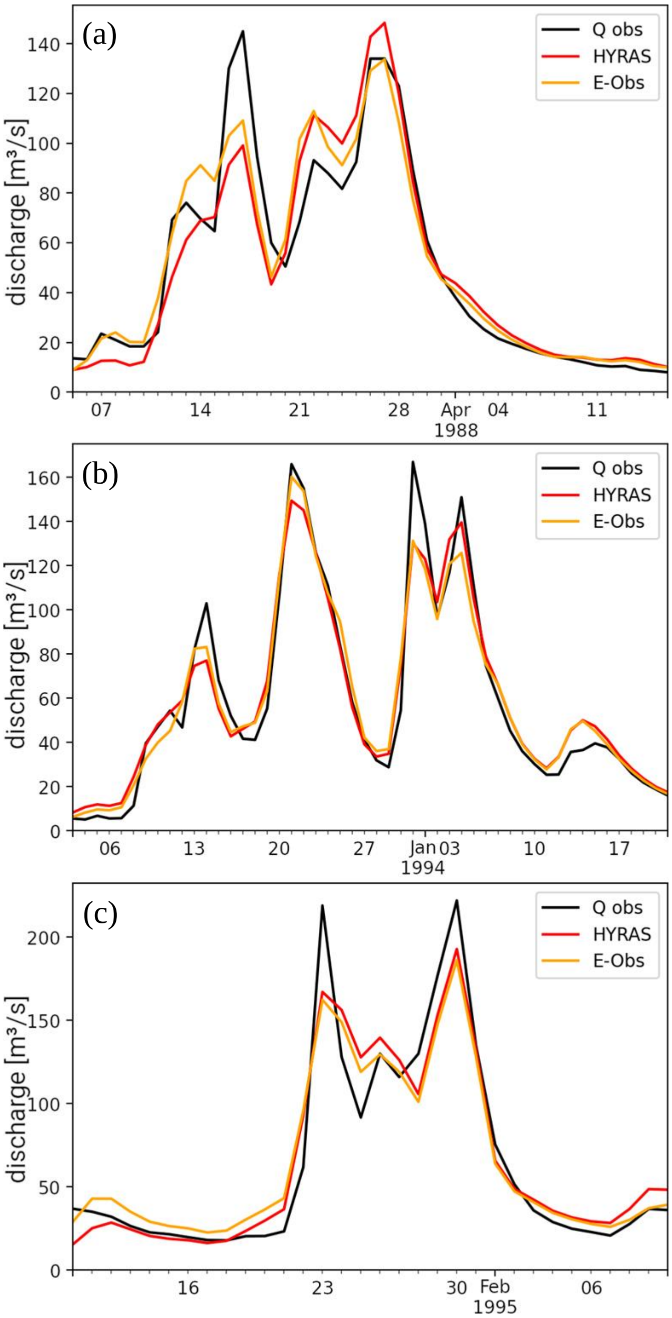
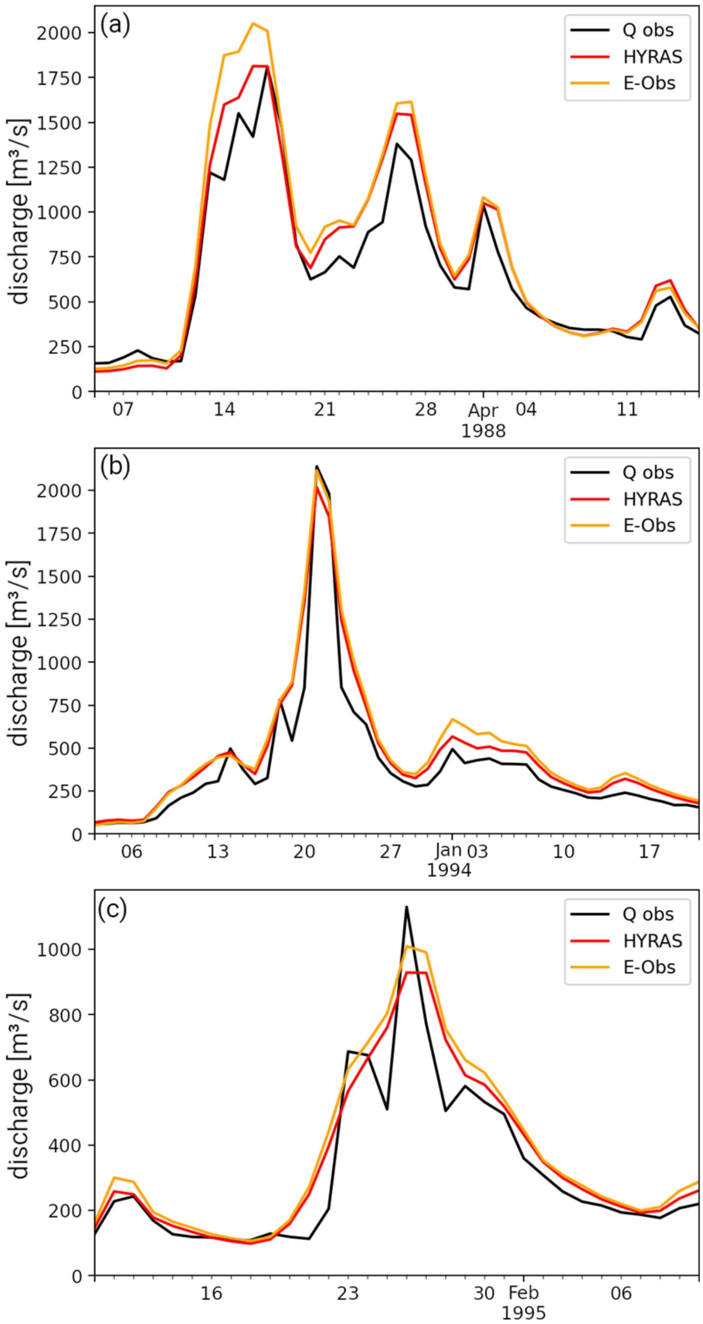


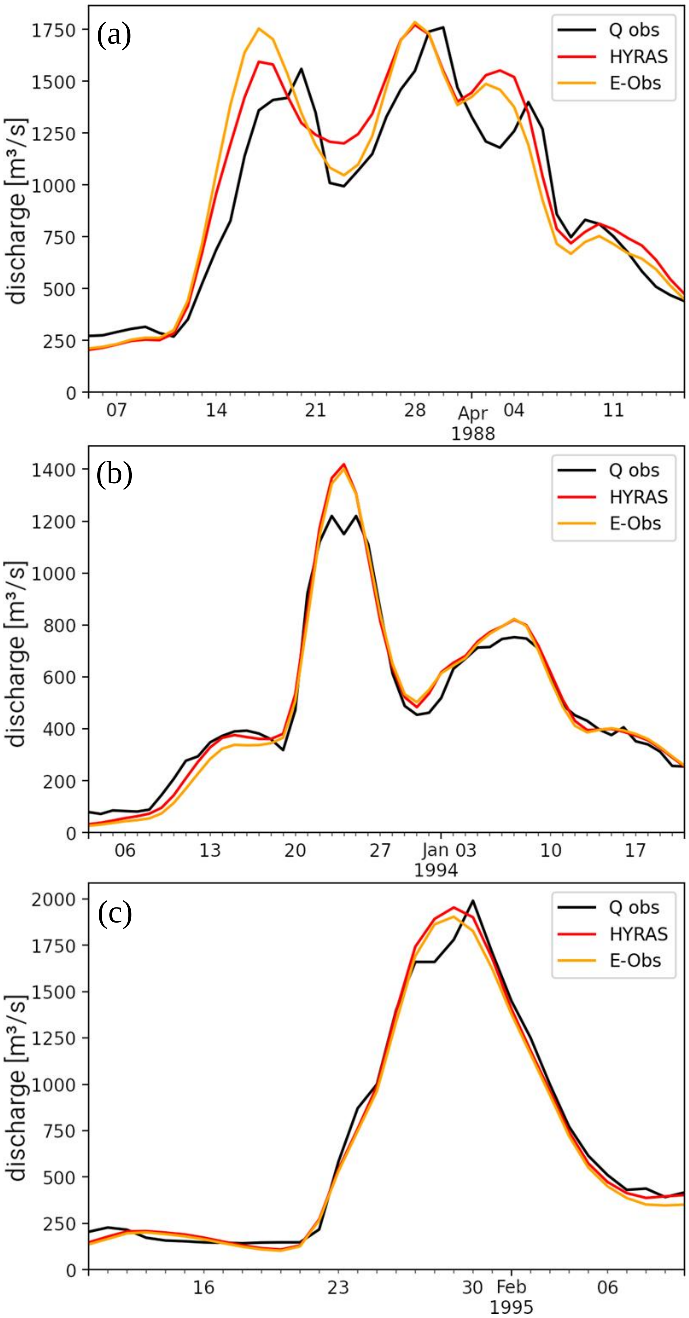
Figure S2. Time series of simulated and observed discharges (black) at Bad Vilbel station (BADV) for the flood events (a) March 1988, (b) December 1993, and (c) January 1995. The simulations are forced with HYRAS (red), and E-OBS (yellow), respectively.



46 **Figure S3.** Same as Fig. S2 but for Betzdorf station (BETZ).



47 **Figure S4.** Same as Fig. S2 but for Rockenau station (ROCK).



48 **Figure S5.** Same as Fig. S2 but for Frankfurt Osthafen station (FRAN).

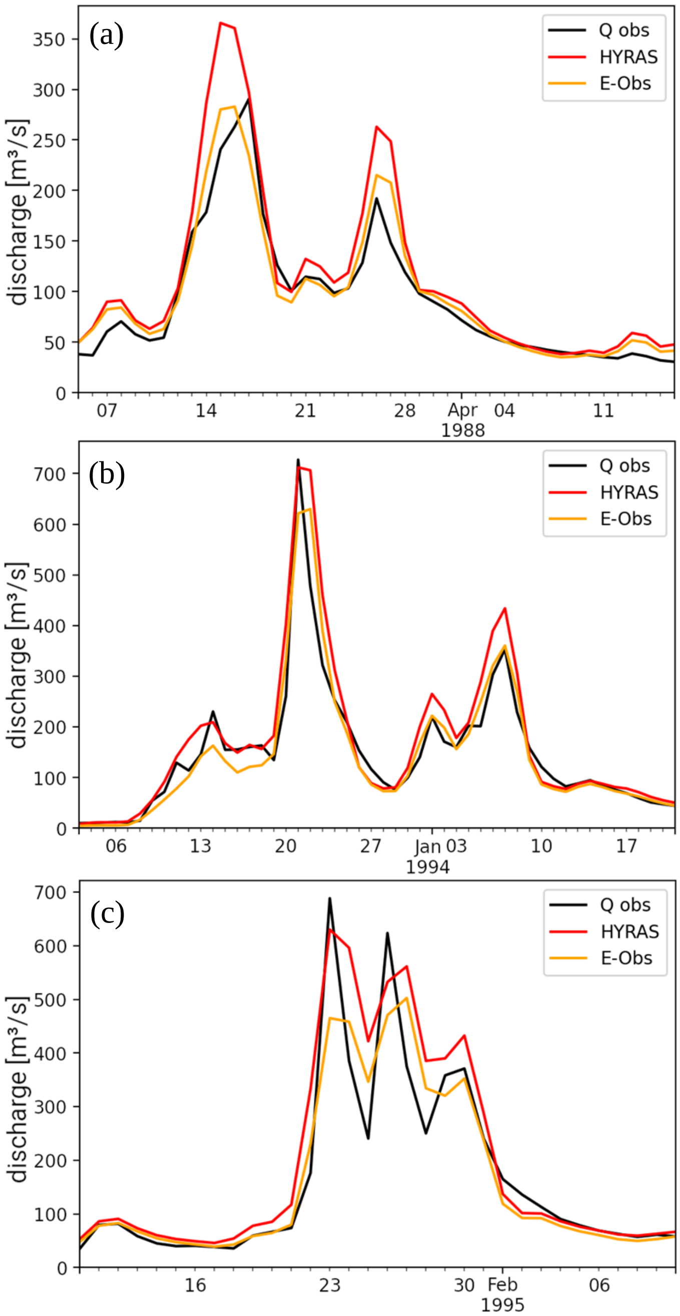


Figure S6. Same as Fig. S2 but for Grolsheim station (GROL).

3. Added Value of Bias Correction for hydrological applications

Figures S7-S11 show the discharge for different return periods (RPs) estimated from observations, simulations driven with observed precipitation, and simulations driven by LAERTES-EU. The RPs from observations are calculated using different distributions, namely Weibull, Gamma, and Gumbel. The RPs from the observational forced simulations are estimated via Weibull distribution.

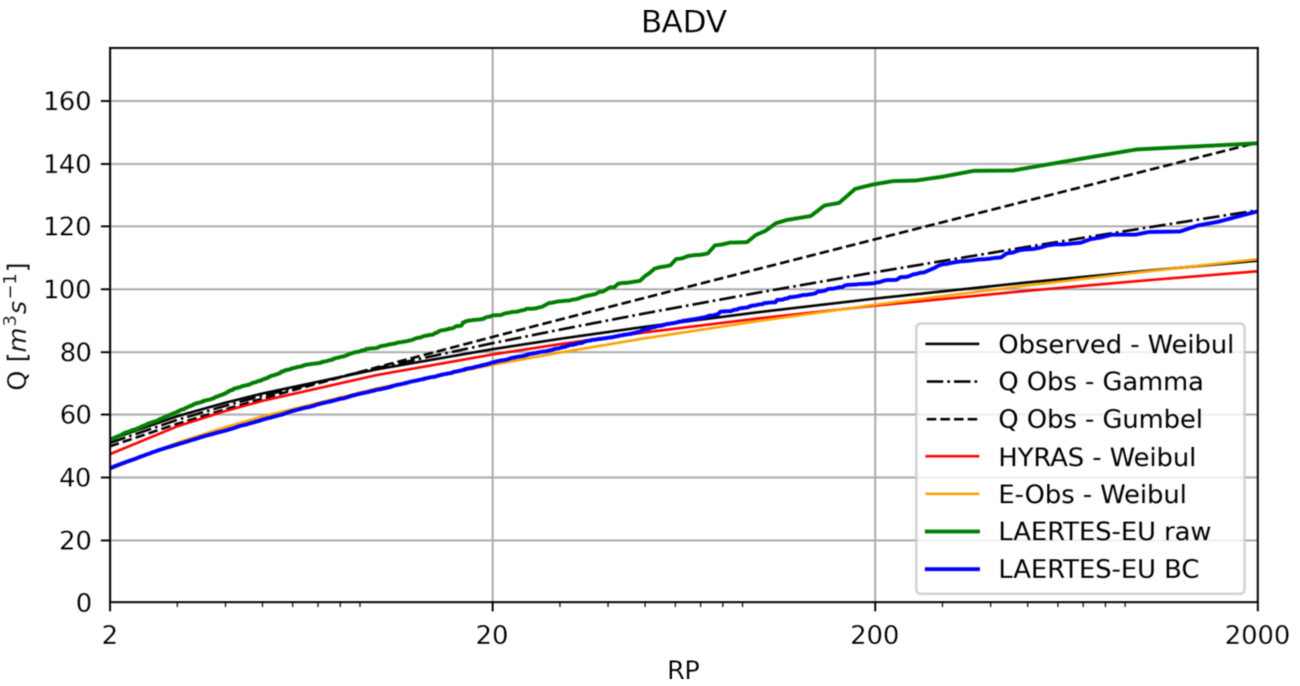


Figure S7: Return values of observed and simulated discharges at Bad Vilbel (BADV) station. Given are the Weibull (black solid), Gumbel (black dashed), and Gamma distributions (black dot-dashed) for observed discharges as well as the Weibull distributions for the simulation forced with observed precipitation from E-OBS (orange) and HYRAS (red). The results from uncorrected LAERTES-EU driven simulations are given in green and those driven by corrected LAERTES-EU data are shown in blue.

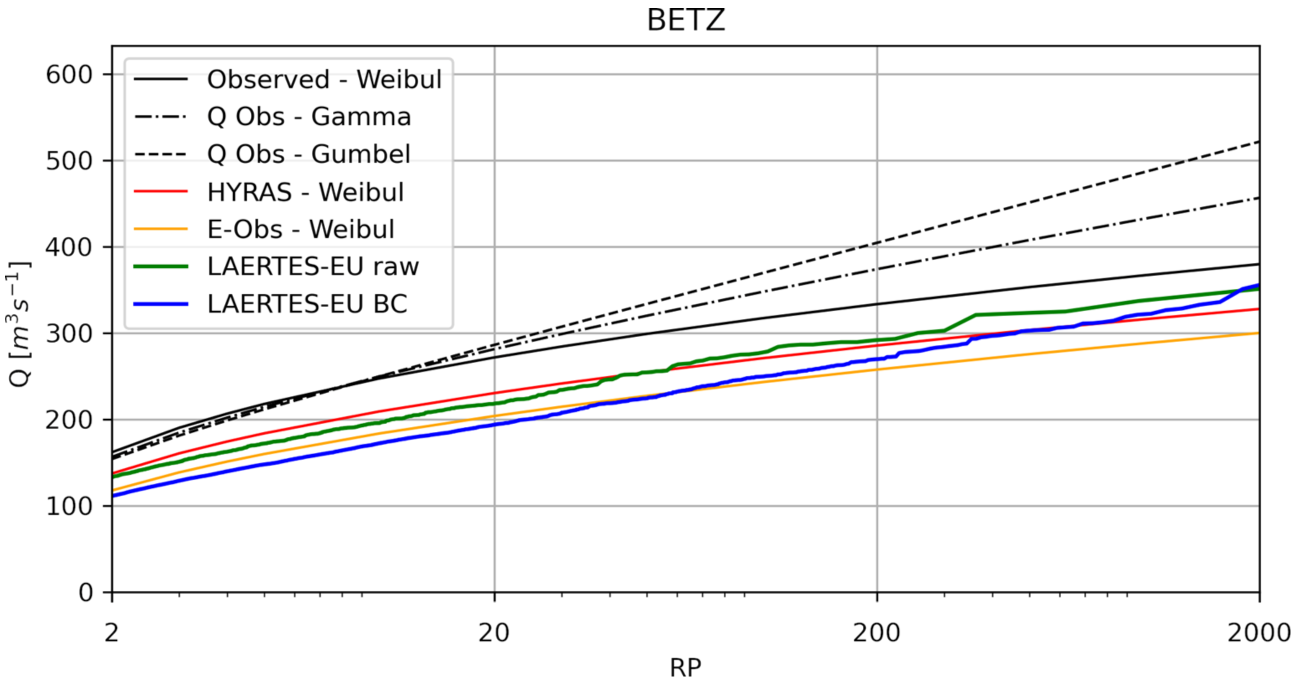
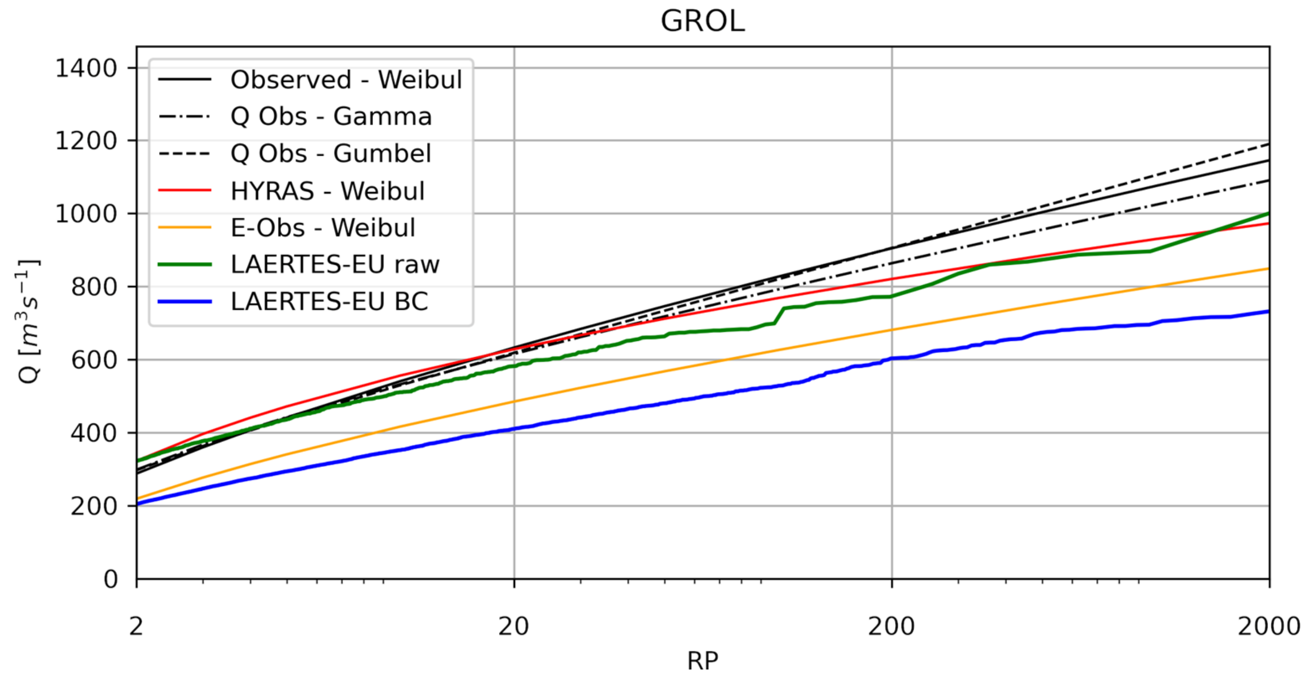
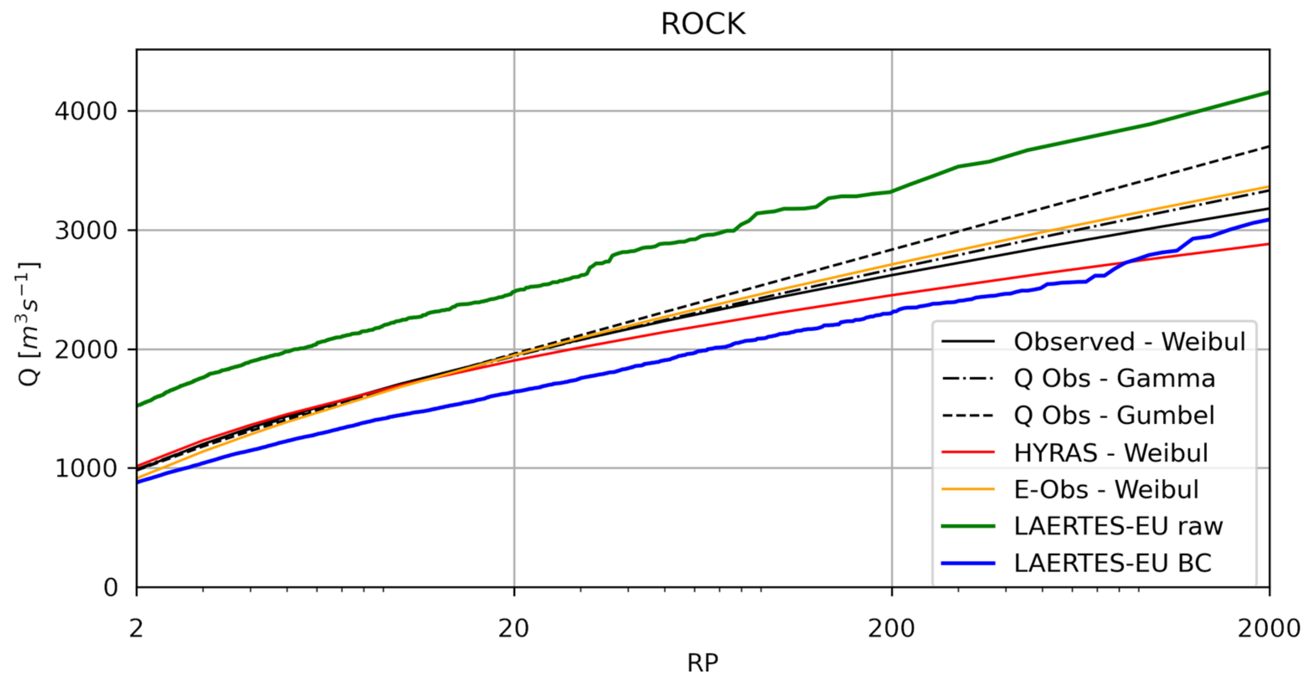


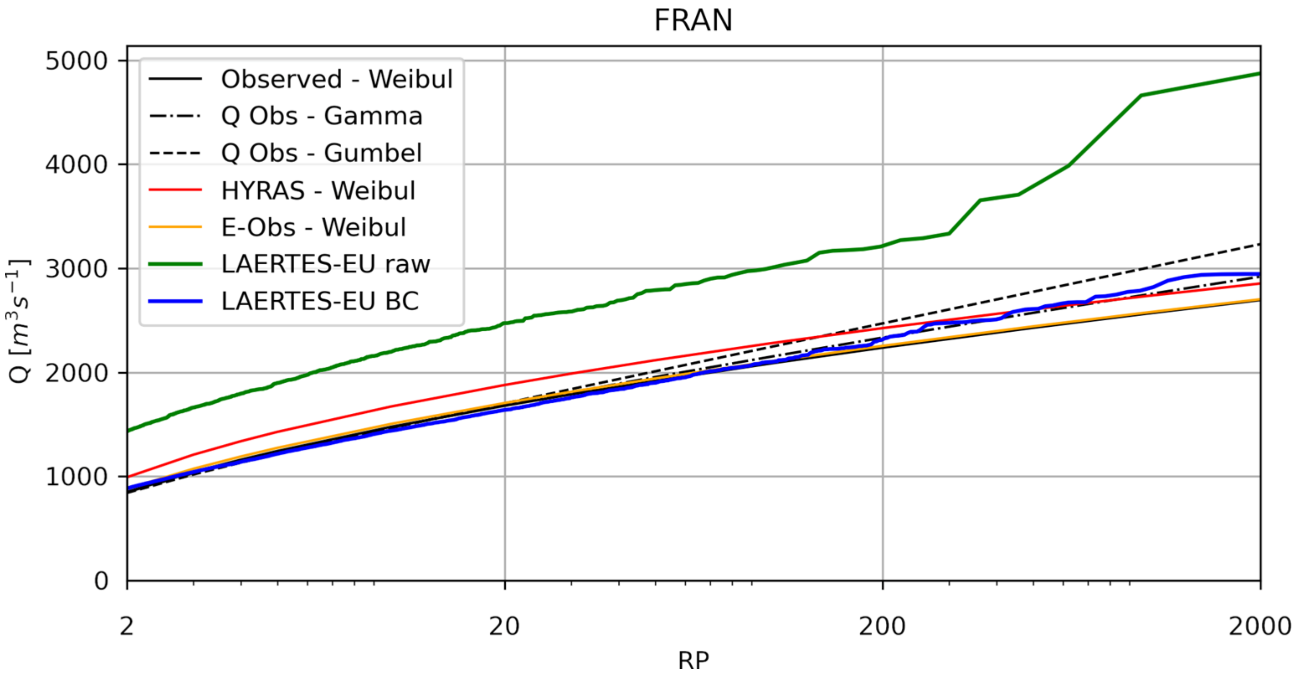
Figure S8: Same as Figure S7, but for Betzdorf (BETZ).



62 **Figure S9:** Same as Figure S7, but for Grolsheim (GROL).



63 **Figure S10:** Same as Figure S7, but for Rockenau (ROCK).



64 **Figure S11:** Same as Figure S7, but for Frankfurt Osthafen (FRAN).