Table S1. Calibration characteristics for each sub-basin and values of the components of the objective functions used for the automatic calibration of the hydrological model. NSE_{chrono} and NSE_{regime} correspond to the Nash-Sutcliffe Efficiency criterion applied to the discharges time series and the interannual daily regimes respectively. d_{KS} is the Kolmogorov-Smirnov distance, i.e. the maximum difference between the simulated and observed distributions of the annual discharge maxima. Fd_{KS} refers to the second part of the objective function $F_{altered}$ in Eq. (2).

Sub-basins	Gauging station	Calibration type	Calibration period(s)	NSE_{chrono}	NSE_{regime}	d_{KS}	Fd_{KS}
1	Rhône@Brigue	Chronological	1965-2015 for obs/sim	0.82	-	-	-
2	Rhône@Viège	Climatological	1922-1963 for obs 1961-2015 for sim	-	0.99	48	0.17
3, 4	Rhône@Sion	Climatological	1916-1956 for obs 1961-2015 for sim	-	0.98	163	0.19
5	Rhône@Branson	Climatological	1941-1956 for obs 1961-2015 for sim	-	0.33	45	0.32
6, 7	Rhône@Porte-du-Scex	Climatological	1941-1956 for obs 1961-2015 for sim	-	0.93	35	0.12
8, 9, 10, 11, 12	Rhône@Genève, HDI	Chronological	1961-1970 for obs/sim	0.72	-	-	-
13	Arve@Sallanches	Chronological	1965-2015 for obs/sim	0.67	-	-	-
14	Arve@Taninges	Chronological	1961-2015 for obs/sim	0.65	-	-	-
15, 16	Arve@Genève, BDM	Chronological	1965-2015 for obs/sim	0.44	-	-	-
17, 18	Rhône@Bognes	Climatological	1923-1947 for obs 1961-2015 for sim	-	0.33	62	0.10

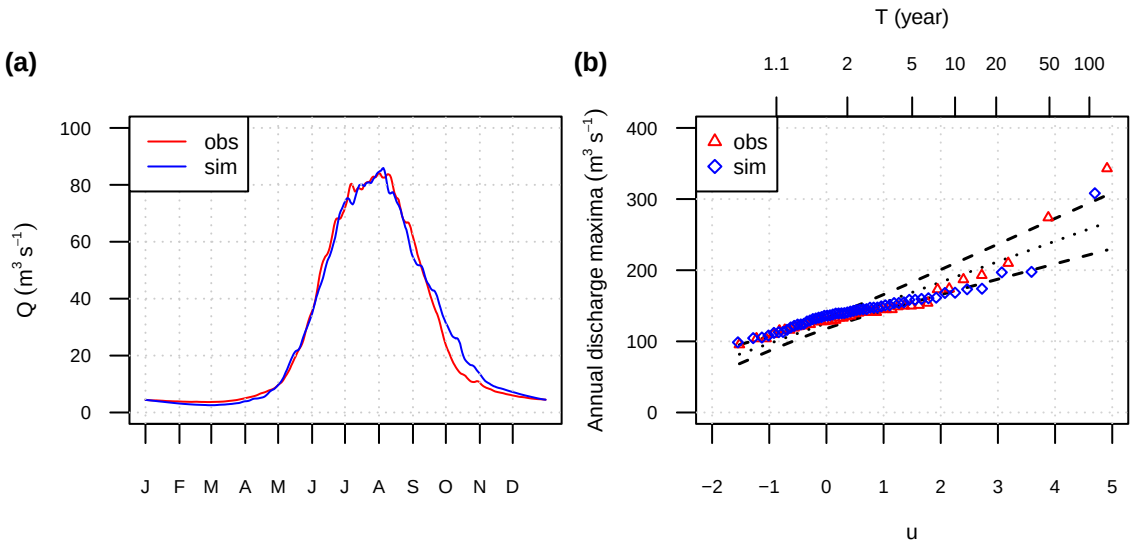

Figure S2. Example of calibration of a sub-basin with an altered hydrological regime (Viège sub-basin). Observation period: 1922–1963. Simulation period: 1961-2015. **(a)** Interannual daily regime. (**b**) Gumbel plot for annual discharge maxima. The x-axis is the reduced variate u for the given return period T, i.e. $\mathrm{u} = -\ln(-\ln(1-1/\mathrm{T}))$. Dashed lines correspond to 90 % confidence bounds of the Gumbel distribution estimated on observed data.

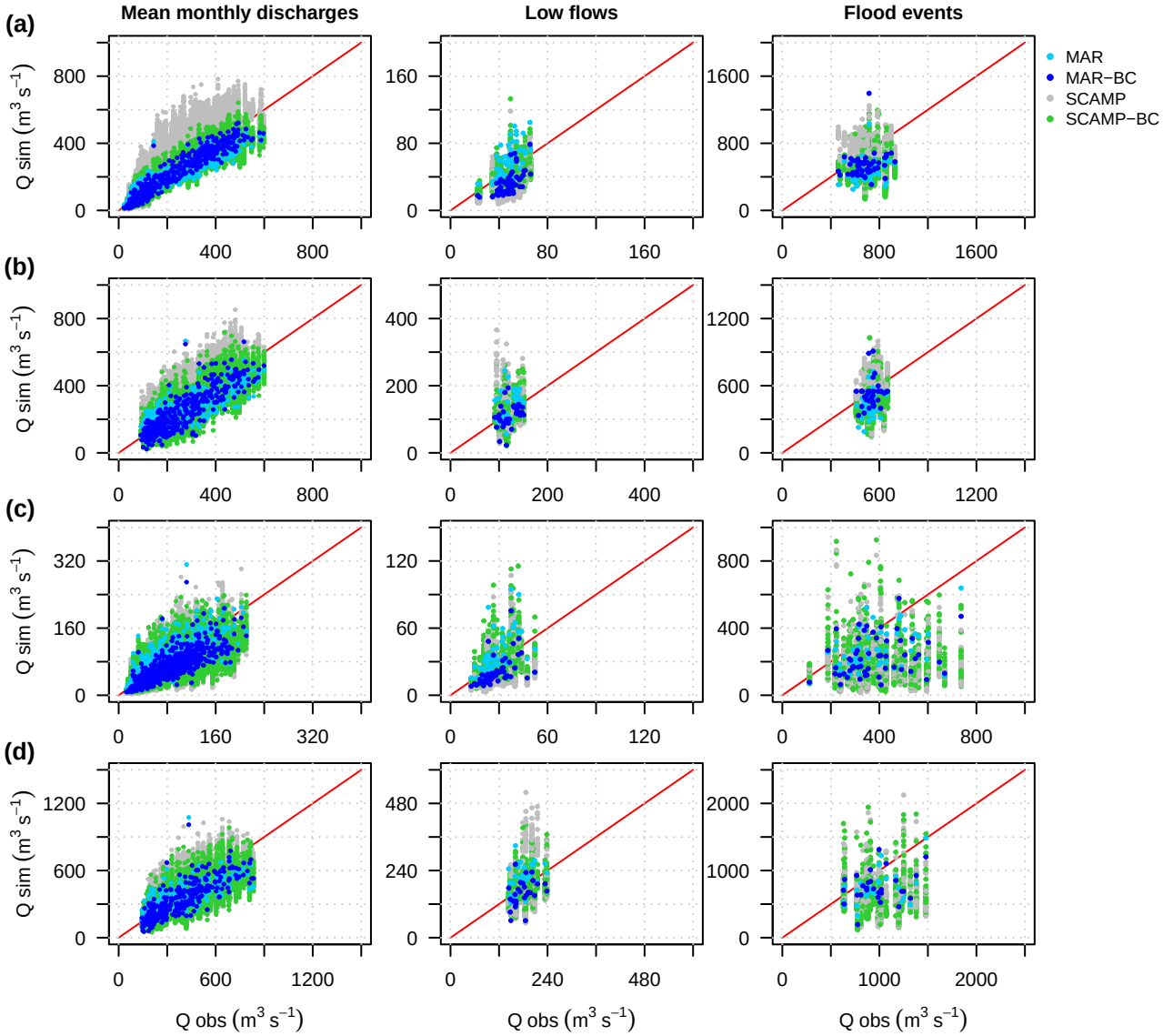

Figure S3. Scatter plots of mean monthly discharges, low flows and flood events at (**a**) Rhône@Porte-du-Scex (1905-1956), (**b**) Rhône@Genève, Halle-de-l'Ile (1923-1956), (**c**) Arve@Genève, Bout-du-Monde (1904-1960), and (**d**) Rhône@Bognes (1920-1947).

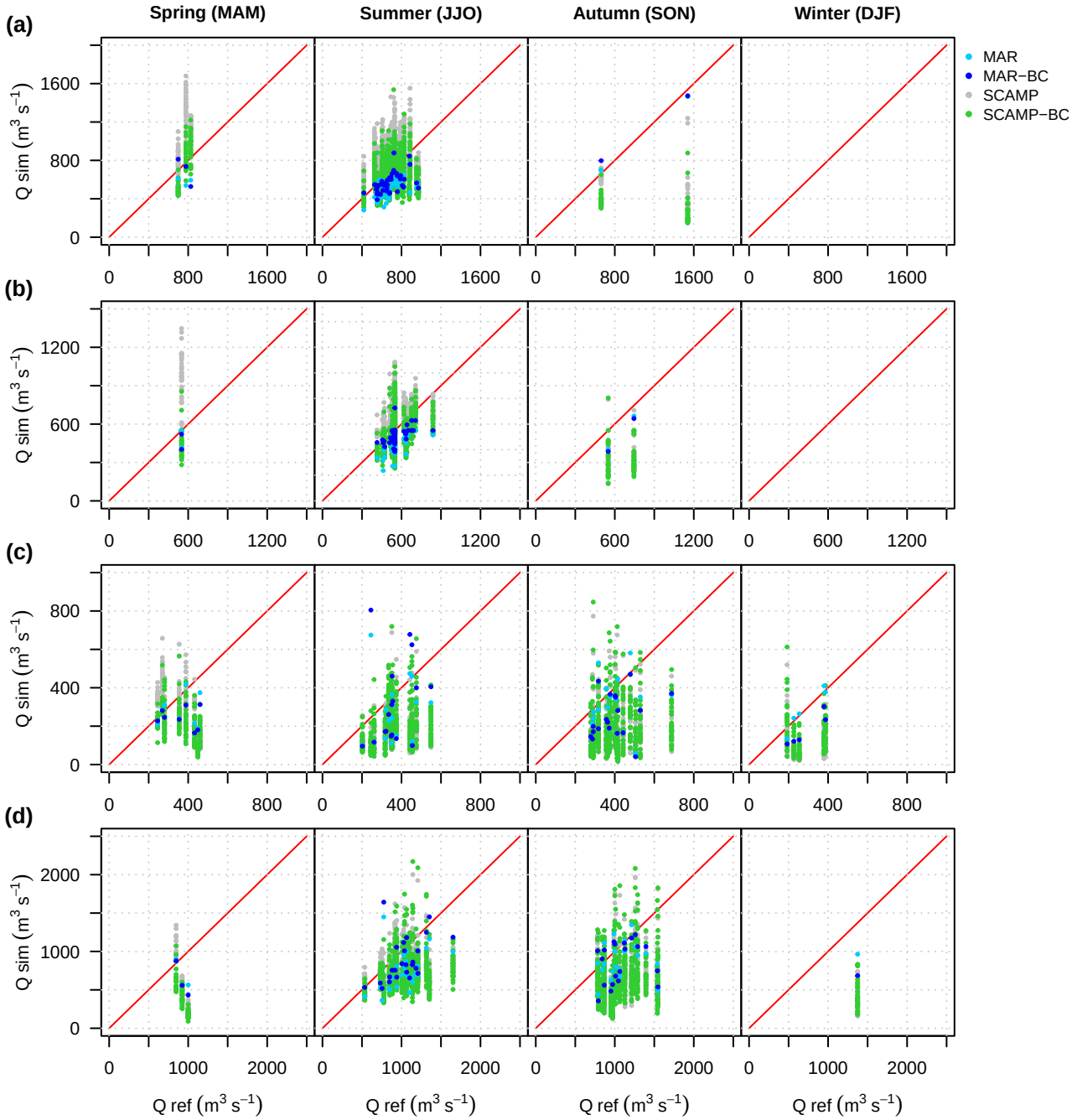

Figure S4. Scatter plots of flood events by season at (**a**) Rhône@Porte-du-Scex, (**b**) Rhône@Genève, Halle-de-l'Ile, (**c**) Arve@Genève, Bout-du-Monde, and (**d**) Rhône@Bognes for the 1961-2009 period.