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Supplement of

Stochastic modelling of spatially and temporally consistent daily precipitation time-series over complex topography

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Occurrence

Observed correlation
 $\Phi_{AB, OBS} = 0.8$ $u_A(t)$
 $u_B(t)$

0.47	-1.88	0.43	-1.40	1.48	-0.61	0.18	0.71	0.80	-1.67	...
-0.03	-1.45	1.15	-0.86	1.95	-0.37	0.51	0.85	0.87	-1.74	...

Transition probabilities
 $p_{11,A} = 0.60$ $p_{01,A} = 0.40$
 $p_{11,B} = 0.55$ $p_{01,B} = 0.45$

Simulated precipitation occurrence

Simulated correlation
 $\Phi_{AB, Sim} = 0.6$ $J_A'(t)$
 $J_B'(t)$

0	1	0	1	0	1	1	0	0	1	...
1	1	0	1	0	1	0	0	0	1	...

time

Amount

Observed correlation
 $r_{AB, OBS} = 0.5$ $v_A(t)$
 $v_B(t)$

-1.04	-0.05	-1.34	0.69	0.20	-0.01	1.09	1.53	0.19	-1.20	...
0.25	0.54	-1.64	0.11	-0.1	0.76	2.25	1.39	1.20	0.01	...

Distribution parameters
 $\beta_{1,A} = 1.2$ $\beta_{1,B} = 1.5$
 $\beta_{2,A} = 7.2$ $\beta_{2,B} = 8.0$
 $\alpha_A = 0.7$ $\alpha_B = 0.6$

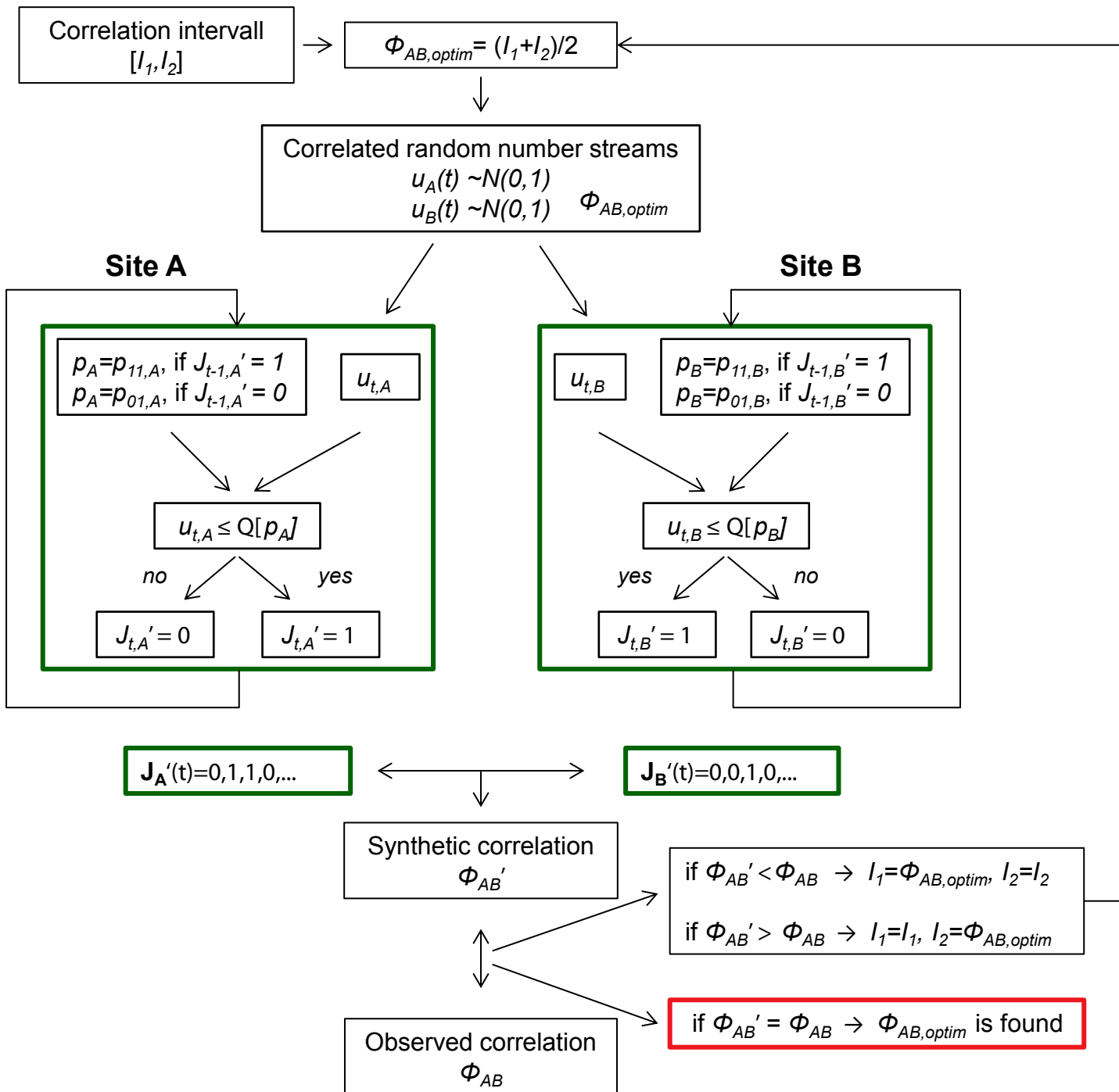
Simulated precipitation amount [mm/day]

Simulated correlation
 $r_{AB, Sim} = 0.38$ $X_A'(t)$
 $X_B'(t)$

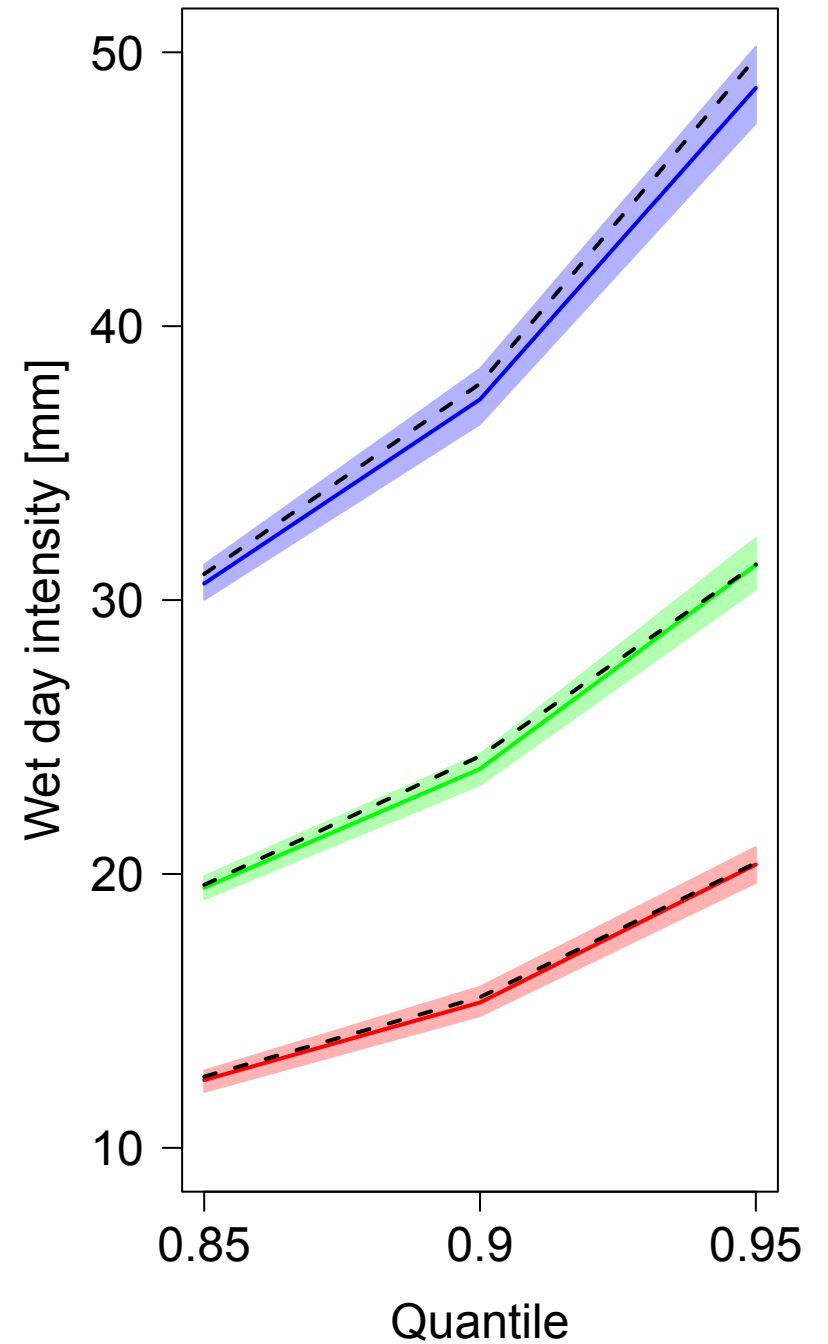
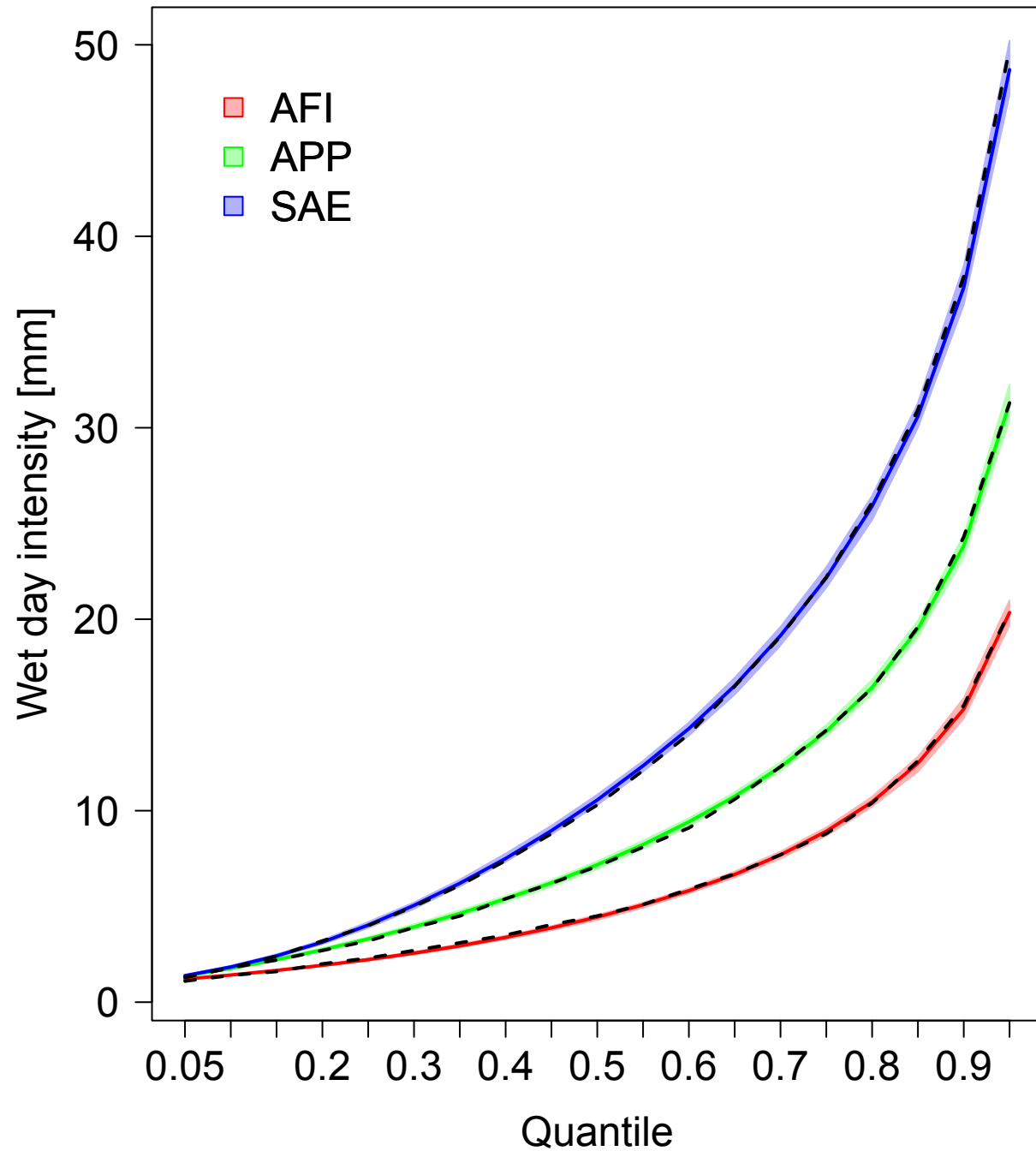
0	1.3	0	1.88	0	1.32	2.35	0	0	1.04	...
1.32	1.49	0	1.26	0	1.66	0	0	0	1.22	...

time

Supplementary Figure 1. The issue of simulating spatially correlated time-series in a Richardson-type WG for two stations A and B . The observed spatial correlation (solid box) as input for the occurrence (green) and amount (blue) process is partly destroyed by the stochastic step-by-step simulation of precipitation that is calibrated at single stations (transition probabilities and distribution parameters). This results in a simulated spatial correlation that is lower than observed (dashed box). On the right-hand side, a fictitious example of correlated random number streams and simulated time-series are shown. The pink boxes indicate instances of dry conditions.



Supplementary Figure 2. Iterative procedure to find an optimal spatial correlation coefficient between two stations A and B ($\Phi_{AB,optim}$) in case of precipitation occurrences. The synthetic correlation is derived from the binary series ($J_A'(t)$ and $J_B'(t)$) and compared to the observed target correlation (Φ_{AB}). A similar procedure is used for precipitation amounts.



Supplementary Figure 3. Quantiles of daily non-zero precipitation amounts, aggregated over 51 years (1961-2011) for the three stations *Andelfingen* (AFI), *Appenzell* (APP) and *Saentis* (SAE). The coloured areas (lines) show for each quantile the estimates of the 95% interval (median) across the 100 model realizations. The black dashed lines represent the observed quantiles.