



*Supplement of*

## **Throughfall spatial patterns translate into spatial patterns of soil moisture dynamics – empirical evidence**

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## Supplement

**Table S1:** Correlation coefficient ( $\rho$ ) between variables included in the mixed effects models, for the topsoil (top) and subsoil (bottom)

	$\delta\theta_{pre}$	$\delta\theta_{post}$	$\theta_{pre}$	$\theta_{post}$	$\Delta\theta$	$\hat{P}_{TF}$	$\delta P_{TF}$	$\theta_{MP}$	$\theta_{FC}$	$P_g$
<b>topsoil</b>										
$\delta\theta_{pre}$	1	<b>0.93</b>	0.00	0.00	0.08	0.00	0.00	-0.23	0.15	0.00
$\delta\theta_{post}$		1	-0.02	-0.02	0.22	0.00	0.00	-0.23	0.17	0.00
$\theta_{post}$			1	<b>0.89</b>	0.02	-0.02	0.00	0.00	0.01	0.00
$\theta_{post}$				1	0.28	0.28	0.17	-0.02	0.02	0.30
$\Delta\theta$					1	<b>0.66</b>	0.10	-0.06	0.06	<b>0.64</b>
$\hat{P}_{TF}$						1	0.01	-0.06	0.04	<b>0.98</b>
$\delta P_{TF}$							1	-0.01	0.02	0.01
$\theta_{MP}$								1	<b>-0.65</b>	-0.06
$\theta_{FC}$									1	0.04
$P_g$										1
<b>subsoil</b>										
$\delta\theta_{pre}$	1	<b>0.96</b>	-0.01	-0.01	-0.04	0.00	0.00	-0.37	0.35	0.00
$\delta\theta_{post}$		1	-0.03	-0.03	0.02	0.00	0.00	-0.37	0.36	0.00
$\theta_{post}$			1	<b>0.95</b>	-0.14	0.10	0.00	-0.01	0.00	0.11
$\theta_{post}$				1	0.02	0.21	0.17	-0.02	0.00	0.22
$\Delta\theta$					1	<b>0.50</b>	0.03	-0.06	0.03	<b>0.48</b>
$\hat{P}_{TF}$						1	0.02	-0.03	0.02	<b>0.99</b>
$\delta P_{TF}$							1	-0.07	0.04	0.02
$\theta_{MP}$								1	<b>-0.79</b>	-0.03
$\theta_{FC}$									1	0.02
$P_g$										1

$P_g$ : gross precipitation;  $\delta\theta_{pre}$ : Spatial pattern of pre-event soil water content (see Eq. 1 and surrounding text);  $\delta\theta_{post}$ : spatial pattern of post-event soil water content (Eq. 1);  $\Delta\theta$ : soil water content increase after rain event ( $\Delta\theta = \theta_{post} - \theta_{pre}$ );  $\theta_{MP}$ : Macroporosity;  $\theta_{FC}$ : Field capacity;  $\hat{P}_{TF}$ : Spatial median of throughfall;  $\delta P_{TF}$ : Spatial pattern of throughfall (Eq 1).

**Table S2:** Parameters for exploratory spatial analysis (Step 1) for throughfall and canopy density (as indicated). Listed are for the precipitation events the gross precipitation ( $P_G$ ), the collection **Date**, the **event size** class, the **octile skew** of the spatial distribution, as well as the p-values of the regression testing for a spatial **trend** in the East to West (**Trend EW**) as well as in the North to South (**Trend NS**) direction. Transform indicates whether the data was transformed to remove the skew.

$P_G$	Date	Event size	Octile skew	Trend EW	Trend NS	transform
<b>Throughfall</b>						
1.6	21.07.2015	small	0.11	<b>0.010</b>	0.029	no
2.1	20.06.2015	small	0.20	0.086	0.049	no
2.8	30.05.2015	small	0.08	1.000	0.007	no
3.3	18.06.2015	medium	0.00	<b>&lt;0.001</b>	0.082	no
3.3	13.07.2015	medium	0.06	0.050	<b>&lt;0.001</b>	no
3.7	02.06.2015	medium	0.06	0.785	0.100	no
4.1	13.05.2015	medium	0	0.585	0.212	no
4.6	11.07.2015	medium	-0.08	0.129	0.280	no
5.7	25.07.2015	medium	0.03	0.089	0.660	no
10.5	15.07.2015	large	0.14	0.074	0.001	no
13.3	08.07.2015	large	0.04	<b>0.002</b>	0.144	no
20.1	28.07.2015	large	0.17	<b>0.040</b>	<b>0.001</b>	no
23.0	24.06.2015	large	0.11	0.334	<b>0.037</b>	no
35.2	20.07.2015	large	0.14	0.890	0.239	no
5.3	28.06.2016	medium	-0.04	<b>0.018</b>	<b>0.033</b>	no
13.7	21.06.2016	large	0.04	0.473	0.151	no
16.9	06.06.2016	large	0.03	0.422	0.114	no
19.6	02.08.2016	large	0	0.177	0.387	no
19.8	04.07.2016	large	0.03	<b>0.01</b>	0.220	no
20.8	25.05.2016	large	0.08	0.557	0.334	no
23.2	16.06.2016	large	0.02	0.344	0.019	no
24.1	14.07.2016	large	0.01	<b>0.012</b>	0.061	no
25.0	31.05.2016	large	0	0.068	0.477	no
33.5	25.07.2016	large	0.02	<b>0.045</b>	0.768	no
<b>Canopy density</b>			0.20	0.687	0.454	no

**Table S3:** Final variogram model parameters used for kriging of throughfall. Also indicated are the parameters for canopy density (bottom line) for comparison.

Date	Event size	$\theta_{REML}$	Nugget	Sill	Partial sill	Nugget/Sill	Effective range (m)
<b>Throughfall</b>							
21.07.2015	small	0.428	0.009	0.097	0.088	0.09	9.6
20.06.2015	small	0.384	0.001	0.018	0.017	0.07	9.8
30.05.2015	small	0.418	0.014	0.254	0.240	0.06	9.2
18.06.2015	medium	0.383	0.029	0.469	0.440	0.06	5.8
13.07.2015	medium	0.294	0.015	0.365	0.350	0.04	8.6
02.06.2015	medium	0.446	0.017	0.477	0.460	0.04	8.0
13.05.2015	medium	0.439	0.037	0.468	0.431	0.08	7.6
11.07.2015	medium	0.447	0.019	0.339	0.320	0.06	8.9
25.07.2015	medium	0.442	0.049	0.669	0.620	0.07	4.6
15.07.2015	large	0.222	0.130	3.66	3.53	0.04	5.9
08.07.2015	large	0.402	0.140	1.74	1.60	0.08	4.8
28.07.2015	large	0.415	0.507	11.42	10.91	0.04	7.5
24.06.2015	large	0.391	0.320	12.88	12.56	0.02	7.0
20.07.2015	large	0.414	0.700	7.40	6.70	0.09	5.9
28.06.2016	medium	0.425	0.017	0.88	0.86	0.02	7.8
21.06.2016	large	0.357	0.570	3.40	2.83	0.17	8.9
06.06.2016	large	0.384	0.370	5.27	4.90	0.07	3.0
02.08.2016	large	0.322	0.286	6.02	5.73	0.05	5.7
04.07.2016	large	0.472	0.700	5.76	5.06	0.12	9.5
25.05.2016	large	0.439	0.540	6.21	5.67	0.09	6.5
16.06.2016	large	0.392	0.261	8.03	7.77	0.03	7.3
14.07.2016	large	0.598	0.690	10.49	9.80	0.07	5.0
31.05.2016	large	0.471	1.070	9.93	8.86	0.11	4.6
25.07.2016	large	0.434	0.160	24.41	24.25	0.01	3.5
<b>Canopy density</b>		0.414	0.032	3.41	3.28	0.01	7.5

**Table S4:** Factors driving spatial patterns of throughfall. Statistical results for the best linear mixed effects model. Significant effects in bold.

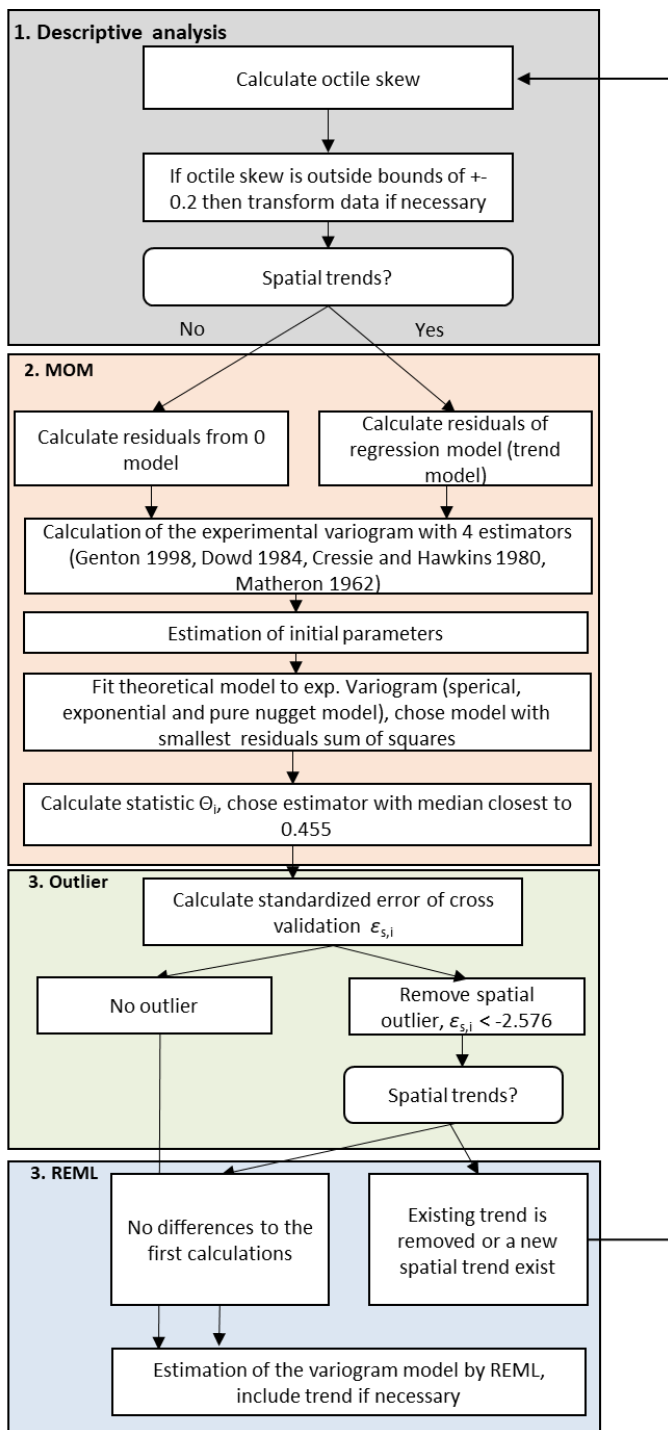
R <sup>2</sup> model	0.340	
R <sup>2</sup> fixed	0.057	
R <sup>2</sup> random	0.283	
Parameter	slope	p-value
Median event throughfall, $\hat{P}_{TF}$	-0.03	0.221
Number of cover trees, $n_{tree}$	0.07	0.089
Canopy density	<b>-0.23</b>	<b>&lt;0.001</b>
<b>Interactions</b>		
$\hat{P}_{TF} \times n_{tree}$	<b>0.03</b>	<b>0.023</b>

**Table S5:** Factors influencing soil water content after a precipitation event ( $\theta_{\text{post}}$ ). Results for the best linear mixed effects model including all data (left columns) and grouped by event size (small, medium and large, right columns). Significant effects are shown in bold and effects that were significant in both soil depth (based on all events) are highlighted in grey. Variables are z-scaled such that the slope estimate indicates the effect strength. Pseudo  $R^2$  values are given separately for fixed and random effects.

	topsoil								subsoil							
	All events		Small events		Medium events		Large event		All events		Small events		Medium events		Large events	
	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value
Full model $R^2$	0.90		0.99		0.96		0.83		0.89		0.86		0.92		0.92	
Fixed effects $R^2$	0.87		0.99		0.96		0.76		0.88		0.86		0.92		0.91	
Random effects $R^2$	0.03		0.00		0.00		0.07		0.00		0.00		0.00		0.01	
<i>Fixed effects</i>																
Median event throughfall, $\hat{P}_{\text{TF}}$	<b>0.173</b>	<b>&lt;0.001</b>	-0.117	0.390	<b>0.032</b>	<b>0.017</b>	0.049	0.049	<b>0.162</b>	<b>&lt;0.001</b>	<b>0.008</b>	<b>0.008</b>	0.010	0.380	0.000	0.982
Spatial throughfall pattern, $\delta P_{\text{TF},i}$	<b>0.016</b>	<b>0.041</b>	-	-	<b>0.018</b>	<b>0.013</b>	<b>0.030</b>	<b>0.014</b>	<b>0.013</b>	<b>0.012</b>	-	-	-	-	<b>0.039</b>	<b>0.004</b>
Initial median soil water content, $\hat{\theta}_{\text{pre}}$	<b>0.680</b>	<b>&lt;0.001</b>	<b>0.627</b>	<b>&lt;0.001</b>	<b>0.743</b>	<b>&lt;0.001</b>	<b>0.695</b>	<b>0.054</b>	<b>0.652</b>	<b>&lt;0.001</b>	<b>0.502</b>	<b>&lt;0.001</b>	<b>0.681</b>	<b>&lt;0.001</b>	-0.038	0.055
Spatial initial soil water content pattern, $\delta \theta_{\text{pre}}$	<b>0.655</b>	<b>&lt;0.001</b>	<b>0.878</b>	<b>&lt;0.001</b>	<b>0.649</b>	<b>&lt;0.001</b>	<b>0.628</b>	<b>0.016</b>	<b>0.722</b>	<b>&lt;0.001</b>	<b>0.886</b>	<b>&lt;0.001</b>	<b>0.723</b>	<b>&lt;0.001</b>	<b>0.899</b>	<b>&lt;0.001</b>
Tree distance, $d_{\text{tree}}$	0.014	0.246	-	-	<b>0.021</b>	<b>0.009</b>	<b>0.011</b>	<b>0.021</b>	-	-	-	-	-	-	-	-
Macroporosity, $\theta_{\text{MP}}$	-	-	-	-	<b>-0.015</b>	<b>0.049</b>	-	-	<b>-0.017</b>	<b>0.014</b>	-	-	-	-	<b>-0.038</b>	<b>0.019</b>
<i>Interactions</i>																
$\hat{P}_{\text{TF}} \times \delta P_{\text{TF}}$	<b>0.012</b>	<b>0.035</b>	-	-	-	-	-	-	<b>0.015</b>	<b>&lt;0.001</b>	-	-	-	-	-	-
$\hat{P}_{\text{TF}} \times d_{\text{tree}}$	<b>-0.014</b>	<b>0.021</b>	-	-	-	-	<b>-0.032</b>	<b>0.011</b>	-	-	-	-	-	-	<b>-xx</b>	<b>0.026</b>
$\hat{P}_{\text{TF}} \times \hat{\theta}_{\text{pre}}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$\hat{P}_{\text{TF}} \times \delta \theta_{\text{pre},i}$	<b>0.017</b>	<b>0.005</b>	<b>-2.101</b>	<b>&lt;0.001</b>	-	-	-	-	<b>-0.03</b>	<b>&lt;0.001</b>	<b>0.018</b>	<b>&lt;0.001</b>	<b>-0.012</b>	<b>&lt;0.001</b>	<b>-0.031</b>	<b>0.004</b>
$\theta_{\text{MP}} \times \hat{P}_{\text{TF}}$	-	-	-	-	-	-	-	-	<b>-0.015</b>	<b>0.002</b>	-	-	-	-	-	-
$\theta_{\text{MP}} \times \delta P_{\text{TF}}$	-	-	-	-	-	-	-	-	<b>-0.017</b>	<b>0.002</b>	-	-	-	-	<b>-0.051</b>	<b>&lt;0.001</b>
$\theta_{\text{MP}} \times d_{\text{tree}}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$\theta_{\text{MP}} \times \hat{\theta}_{\text{pre}}$	-	-	-	-	<b>-0.019</b>	<b>0.005</b>	-	-	-	-	-	-	-	-	-	-
$\theta_{\text{MP}} \times \delta \theta_{\text{pre},i}$	-	-	-	-	-	-	-	-	<b>0.019</b>	<b>0.001</b>	-	-	-	-	<b>0.048</b>	<b>0.004</b>
$\hat{\theta}_{\text{pre}} \times \delta P_{\text{TF},i}$	-	-	-	-	<b>0.019</b>	<b>0.004</b>	<b>-0.023</b>	<b>0.010</b>	<b>-0.033</b>	<b>&lt;0.001</b>	-	-	-	-	-	-
$\hat{\theta}_{\text{pre}} \times d_{\text{tree}}$	<b>0.012</b>	<b>0.048</b>	-	-	-	-	-	-	-	-	-	-	-	-	<b>-0.023</b>	<b>0.033</b>
$\hat{\theta}_{\text{pre}} \times \delta \theta_{\text{pre}}$	<b>0.034</b>	<b>&lt;0.001</b>	<b>2.160</b>	<b>&lt;0.001</b>	-	-	<b>xx</b>	<b>&lt;0.001</b>	<b>-0.033</b>	<b>&lt;0.001</b>	<b>-0.025</b>	<b>&lt;0.001</b>	<b>-0.022</b>	<b>&lt;0.001</b>	-	-
$\delta \theta_{\text{pre}} \times \delta P_{\text{TF}}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<b>-0.052</b>	<b>&lt;0.001</b>

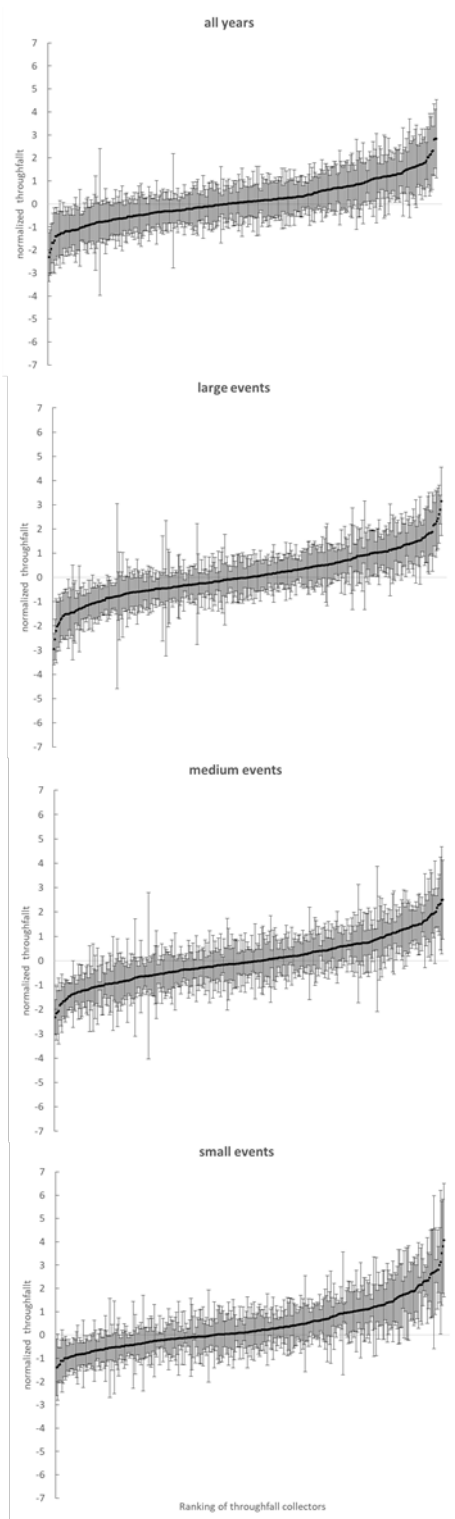
**Table S6:** Factors influencing local soil water content response after rainfall ( $\Delta\theta_i$ , difference between soil water content after and before each event). Results for the best linear mixed effects model including all data (left columns), and grouped according to event size (small, medium and large, right columns). Significant effects are shown in bold and factors with significant effects in both depth (based on all events) are highlighted in grey. Variables are z-scaled such that the slope estimates indicate the effect strength. Pseudo  $R^2$  values are given separated for fixed and random effects.

	topsoil								subsoil							
	All events		Small events		Medium events		Large event		All events		Small events		Medium events		Large events	
	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value	slope	p-value
Full model $R^2$	0.57		0.10		0.32		0.54		0.62		0.38		0.46		0.55	
Fixed effects $R^2$	0.25		0.09		0.12		0.10		0.38		0.38		0.04		0.27	
Random effects $R^2$	0.32		0.01		0.20		0.43		0.24		0.00		0.42		0.28	
<i>Fixed effects</i>																
Median event throughfall, $\hat{P}_{TF}$	<b>0.460</b>	<b>&lt;0.001</b>	-	-	<b>0.217</b>	<b>0.014</b>	0.149	0.215	<b>0.611</b>	<b>&lt;0.001</b>	<b>0.224</b>	<b>&lt;0.001</b>	0.134	0.205	<b>0.459</b>	<b>0.001</b>
Spatial pattern throughfall, $\delta P_{TF}$	<b>0.041</b>	<b>0.044</b>	-	-	<b>0.085</b>	<b>0.073</b>	<b>2.2</b>	<b>0.031</b>	<b>0.057</b>	<b>0.003</b>	-	-	-	-	<b>0.101</b>	<b>&lt;0.001</b>
Initial median soil water content, $\hat{\theta}_{pre}$	0.036	0.712	<b>0.295</b>	<b>&lt;0.001</b>	0.097	0.241	0.134	0.382	-0.026	0.787	<b>-0.722</b>	<b>&lt;0.001</b>	-	-	0.025	0.843
Spatial pattern of initial soil water content, $\delta\theta_{pre}$	<b>0.102</b>	<b>&lt;0.001</b>	-	-	-	-	<b>0.125</b>	<b>0.001</b>	<b>-0.088</b>	<b>&lt;0.001</b>	<b>-0.123</b>	<b>0.017</b>	-	-	<b>-0.153</b>	<b>&lt;0.001</b>
Tree Distance, $d_{tree}$	0.038	0.211	-	-	<b>0.141</b>	<b>0.004</b>	0.028	0.569	-	-	-	-	0.045	0.144	-	-
Macroporosity, $\theta_{MP}$	-	-	-	-	-0.040	0.398	-	-	<b>-0.063</b>	<b>0.016</b>	-0.068	0.173	0.029	0.337	<b>-0.104</b>	<b>0.007</b>
<i>Interactions</i>																
$\hat{P}_{TF} \times \delta P_{TF}$	<b>0.037</b>	<b>0.016</b>	-	-	-	-	-	-	<b>0.058</b>	<b>&lt;0.001</b>	-	-	-	-	-	-
$\hat{P}_{TF} \times d_{tree}$	<b>-0.034</b>	<b>0.020</b>	-	-	-	-	<b>-0.073</b>	<b>0.005</b>	-	-	-	-	<b>0.074</b>	<b>0.012</b>	-	-
$\hat{P}_{TF} \times \hat{\theta}_{pre}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$\hat{P}_{TF} \times \delta\theta_{pre}$	<b>0.072</b>	<b>&lt;0.001</b>	-	-	-	-	-	-	<b>-0.091</b>	<b>&lt;0.001</b>	<b>0.238</b>	<b>&lt;0.001</b>	-	-	<b>-0.076</b>	<b>&lt;0.001</b>
$\hat{P}_{TF} \times \theta_{MP}$	-	-	-	-	<b>-0.108</b>	<b>0.003</b>	-	-	<b>-0.058</b>	<b>0.001</b>	<b>0.132</b>	<b>0.011</b>	<b>0.078</b>	<b>0.009</b>	-	-
$\theta_{MP,i} \times \delta P_{TF}$	-	-	-	-	-	-	-	-	<b>-0.082</b>	<b>&lt;0.001</b>	-	-	-	-	<b>-0.118</b>	<b>&lt;0.001</b>
$\theta_{MP,i} \times d_{tree}$	-	-	-	-	<b>0.115</b>	<b>0.012</b>	-	-	-	-	-	-	-	-	-	-
$\theta_{MP,i} \times \delta\theta_{pre}$	-	-	-	-	-	-	-	-	<b>0.074</b>	<b>&lt;0.001</b>	-	-	-	-	<b>0.107</b>	<b>&lt;0.001</b>
$\hat{\theta}_{pre} \times \delta P_{TF}$	-	-	-	-	<b>0.073</b>	<b>0.034</b>	<b>-0.205</b>	<b>0.033</b>	-	-	-	-	-	-	-	-
$\hat{\theta}_{pre} \times d_{tree}$	<b>0.034</b>	<b>0.032</b>	-	-	<b>0.079</b>	<b>0.018</b>	-	-	-	-	-	-	-	-	-	-
$\hat{\theta}_{pre} \times \delta\theta_{pre}$	<b>-0.105</b>	<b>&lt;0.001</b>	-	-	-	-	<b>-0.190</b>	<b>&lt;0.001</b>	<b>-0.041</b>	<b>0.011</b>	<b>-0.158</b>	<b>0.020</b>	-	-	<b>-0.063</b>	<b>0.011</b>
$\delta\theta_{pre} \times \delta P_{TF}$	-	-	-	-	-	-	-	-	<b>-0.050</b>	<b>0.016</b>	-	-	-	-	<b>-0.063</b>	<b>0.048</b>

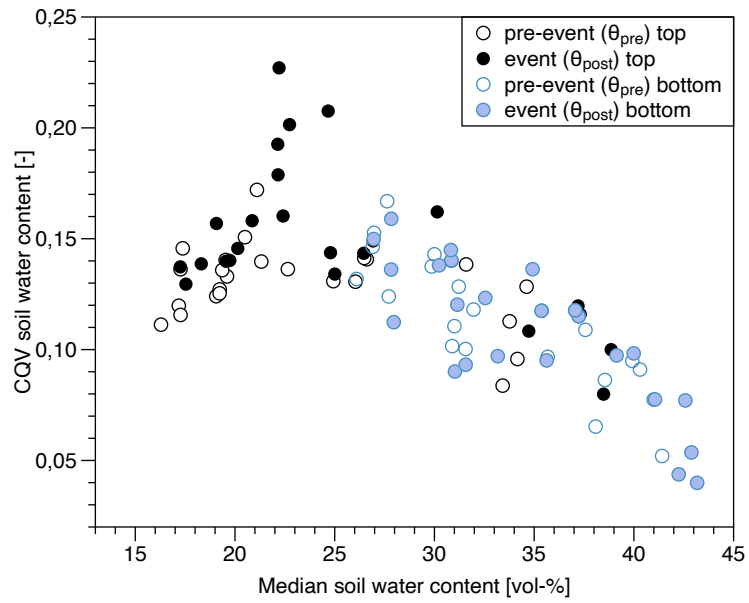


**Fig. S1:** Workflow for involved steps estimating the variogram parameters for throughfall, soil moisture and soil properties

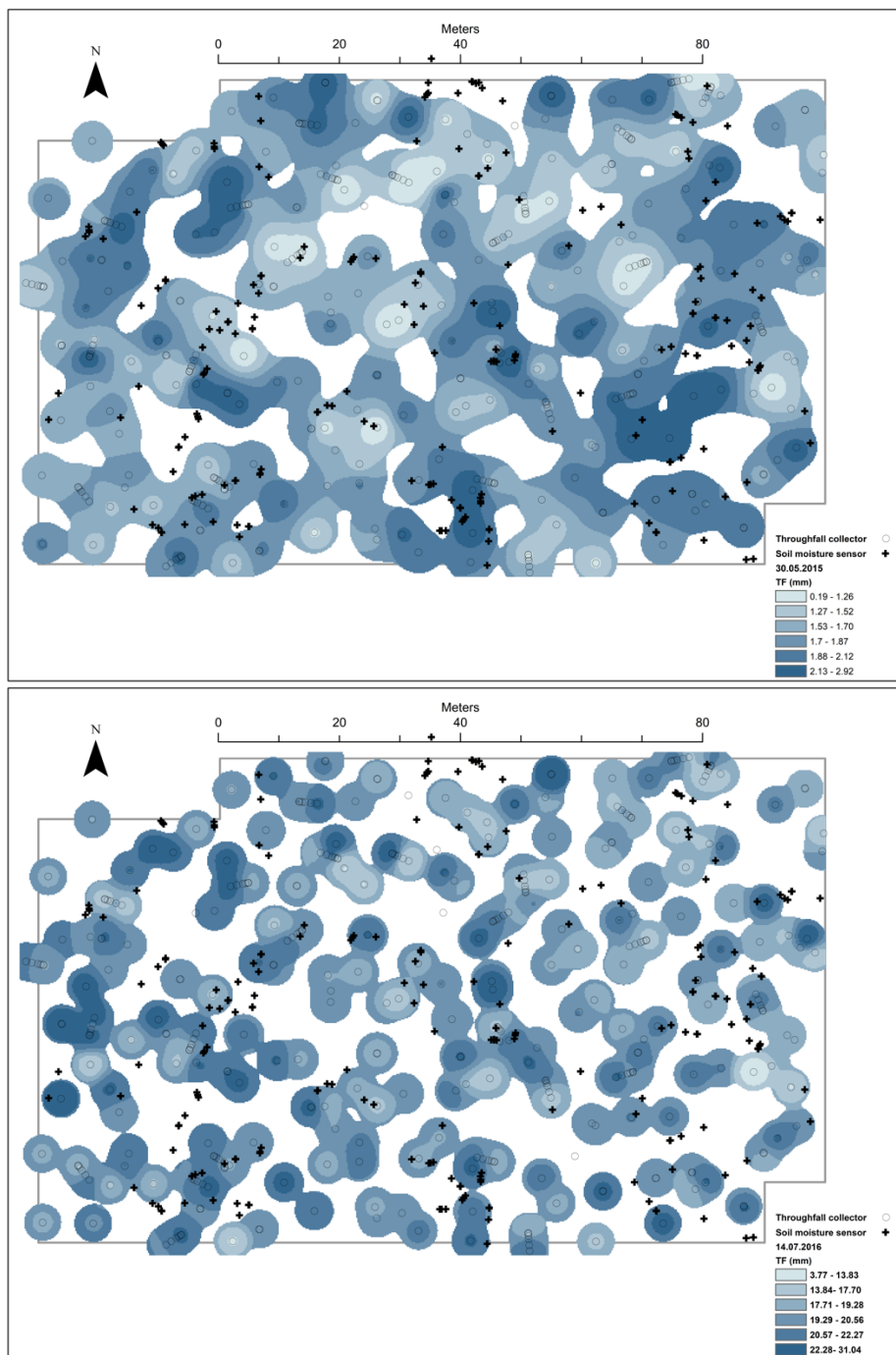




**Fig. S2:** Time stability plots for throughfall ( $\delta P_{TF}$ ) separately for all, small, medium and large event sizes. Error bars indicate one standard deviation.



**Fig. S3:** Change of the spatial variation (expressed as coefficient of quartile variation) of soil water content with the spatial average soil water content for pre-event (drained) and post event (just recharged) soil water conditions.



**Fig. S4:** Examples of two kriged fields of throughfall for events on (**top**) May 30 2015 (small event, large correlation length) and (**bottom**) July 14 2016 (large event, small correlation length), with areas masked, where the kriging variance exceeds 95% of the sample variance.