



Supplement of

Microclimatic conditions and water content fluctuations experienced by epiphytic bryophytes in an Amazonian rain forest

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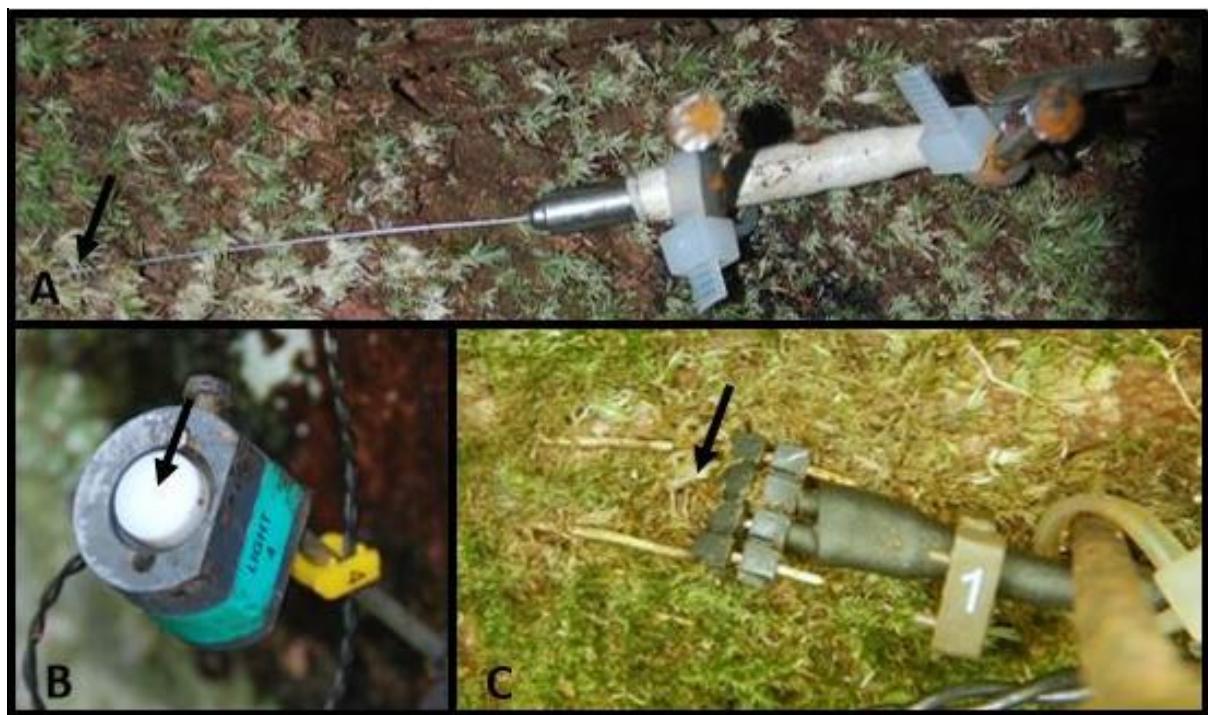
Microclimatic conditions and water content fluctuations experienced by epiphytic bryophytes in an Amazonian rain forest

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15 **Figure S1:** Examples of the temperature sensor (A), light sensor (B), and water content sensor (C) installed in epiphytic bryophytes at the ATTO site. The little arrows show the area of detection, i.e. the sensor tip of the temperature sensor, the area just below the white PTFE cap of the light sensor, and the two inner pins of the water content sensor.

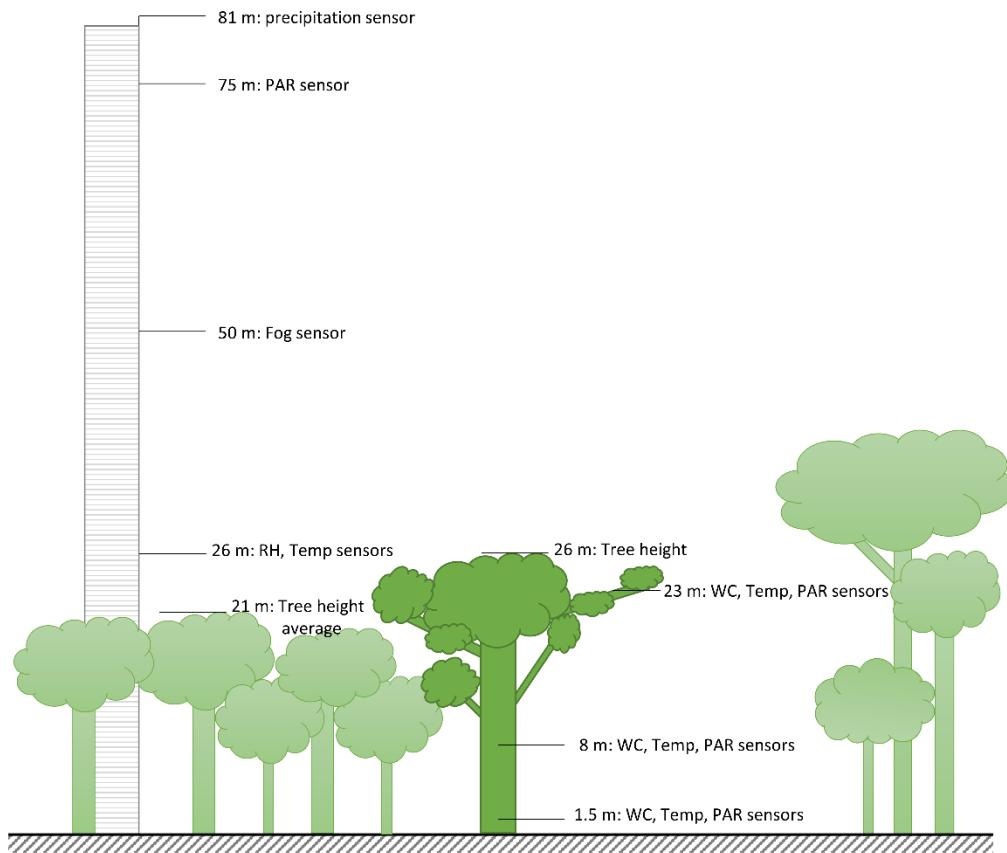


Figure S2: Schematic overview of the sensors installed at different height levels below, within, and above the canopy. The parameters water content (WC) and temperature (Temp) were measured within the bryophyte samples, the light sensors (PAR) were installed directly on top of the thalli. The average tree height of 21 m was determined for the Plateau forest in general.

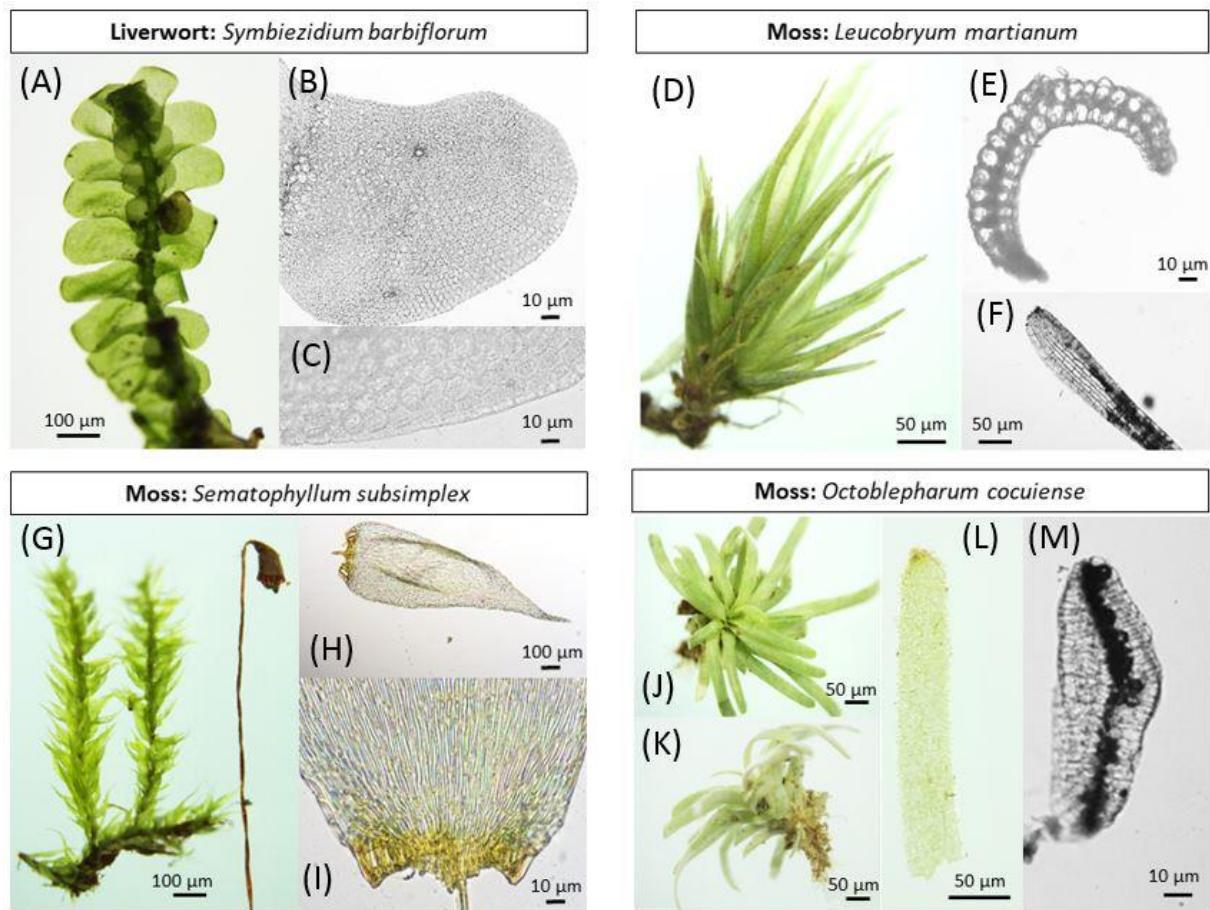
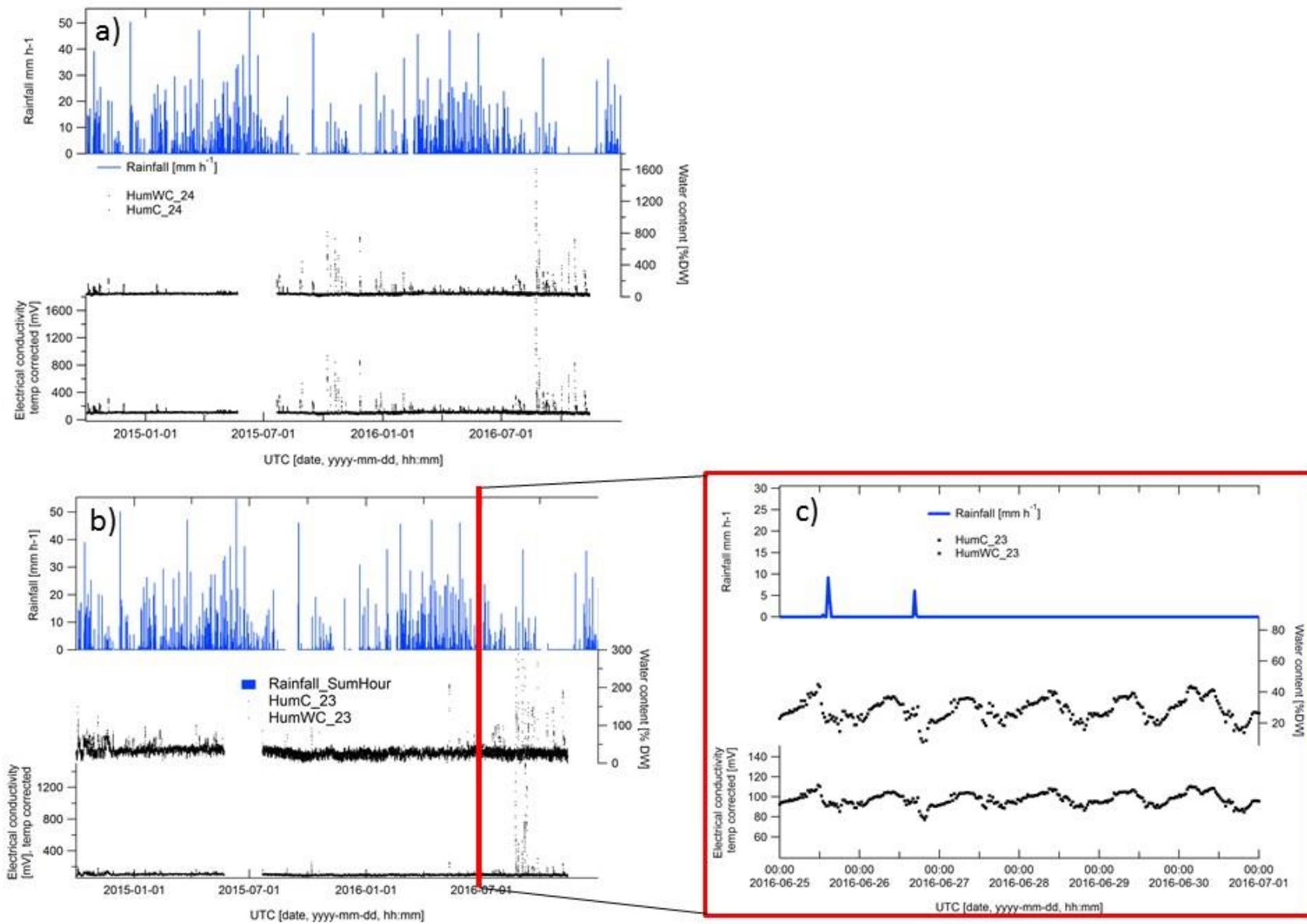
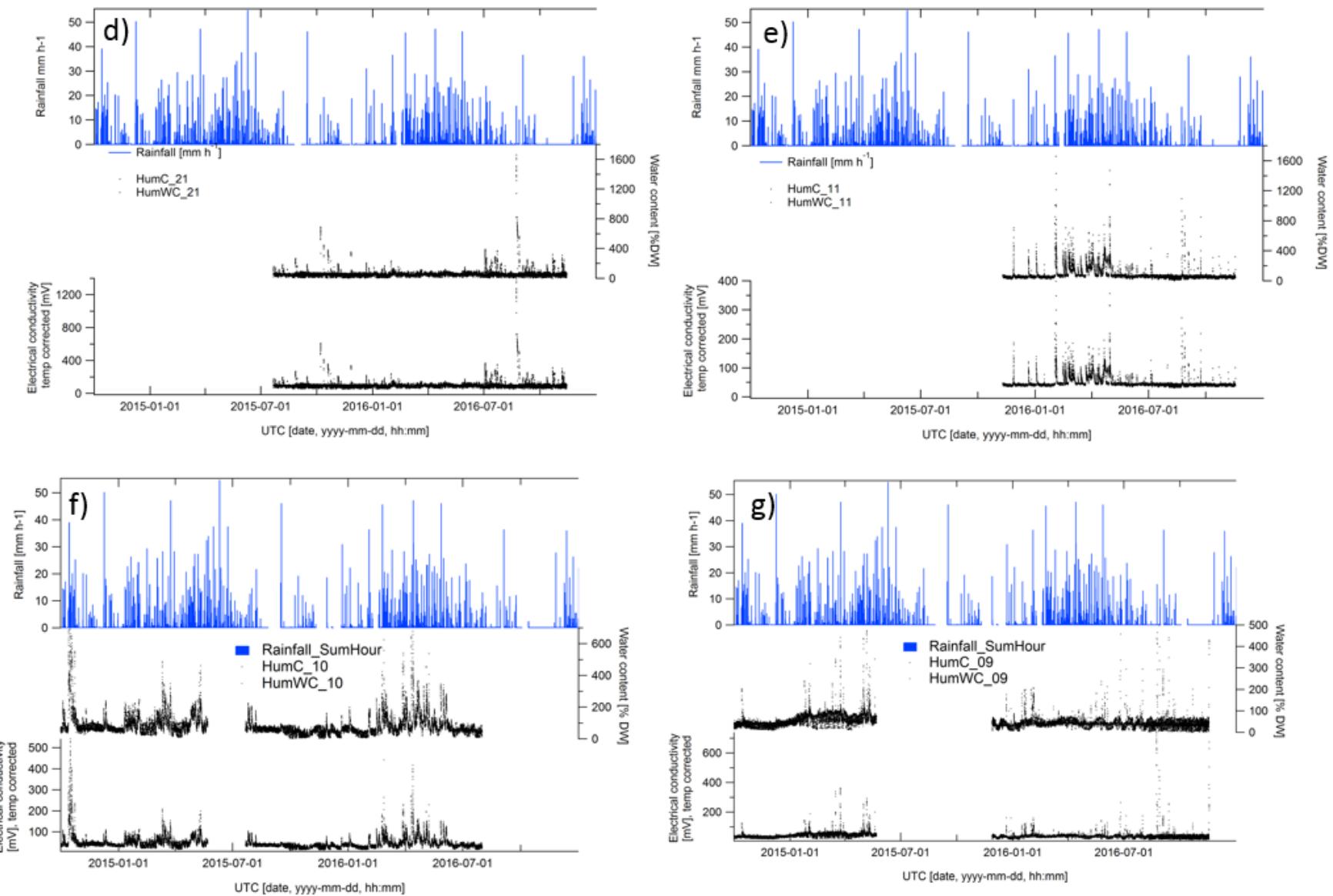


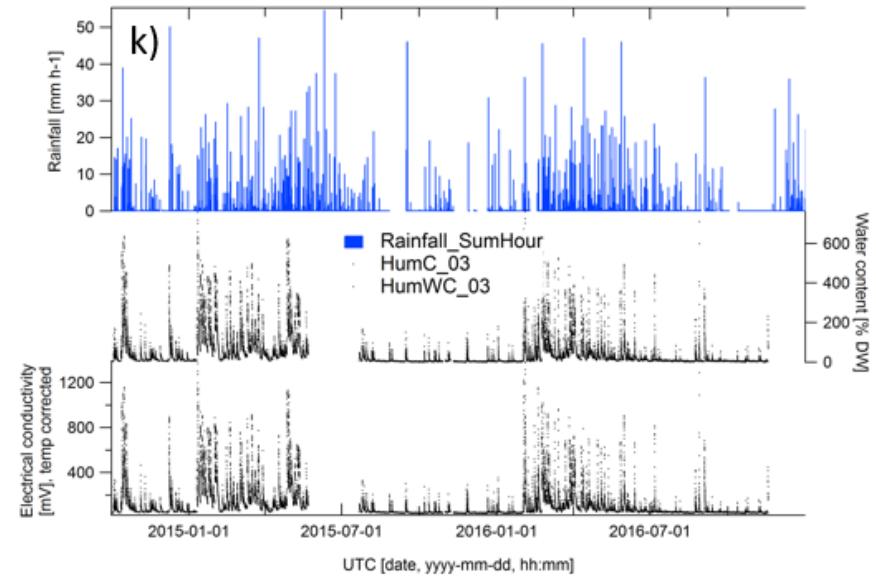
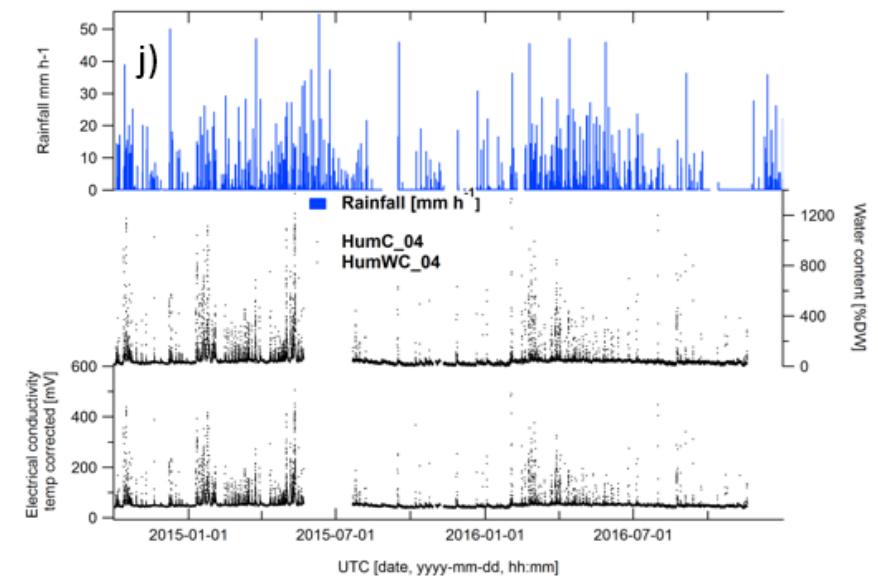
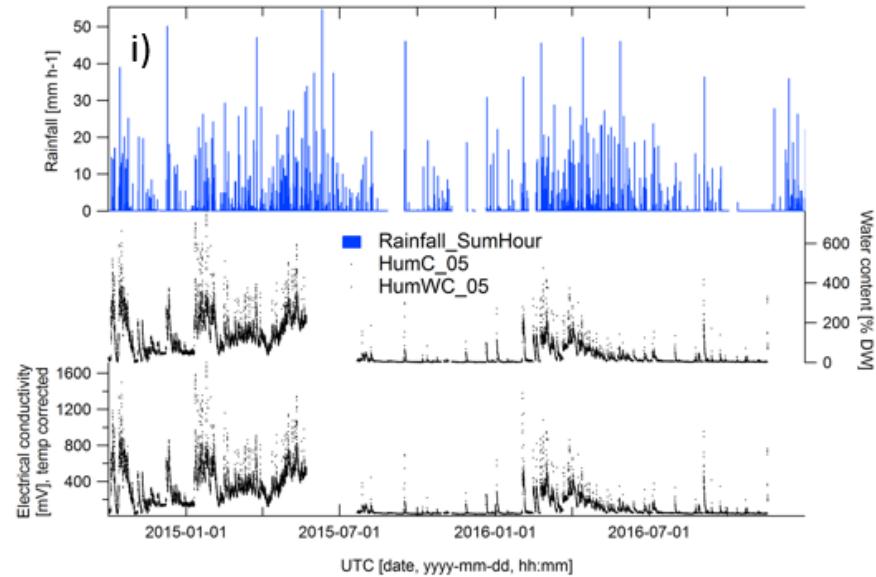
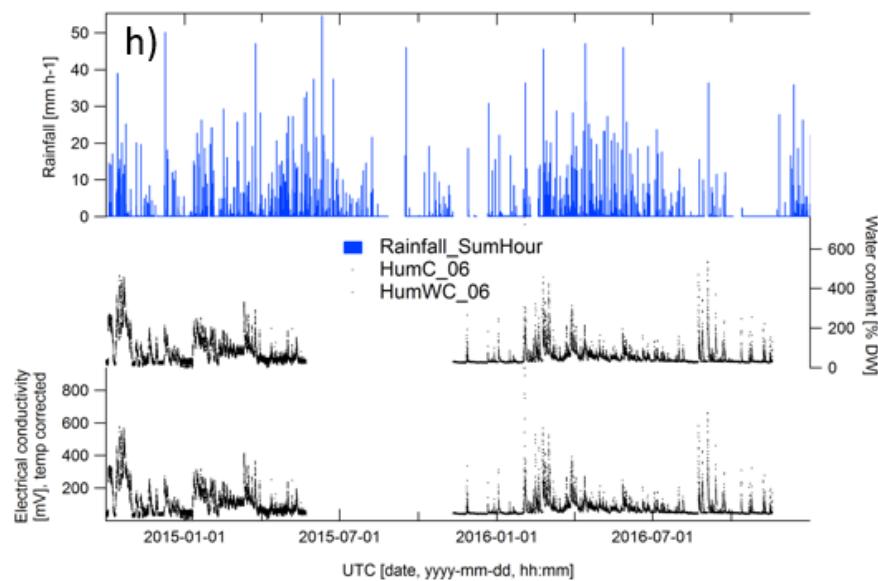
Figure S3: The four bryophyte species being used for installation of the sensors of the microclimate station. (A, D, G, J, K) overview, (B, H, L) leaf, (C, F, I) cell form, and (E, M) cross section of a leaf.



Figure S4: Overview pictures of microsensor tree and exemplary bryophyte samples with installed water content sensors at the three height levels.







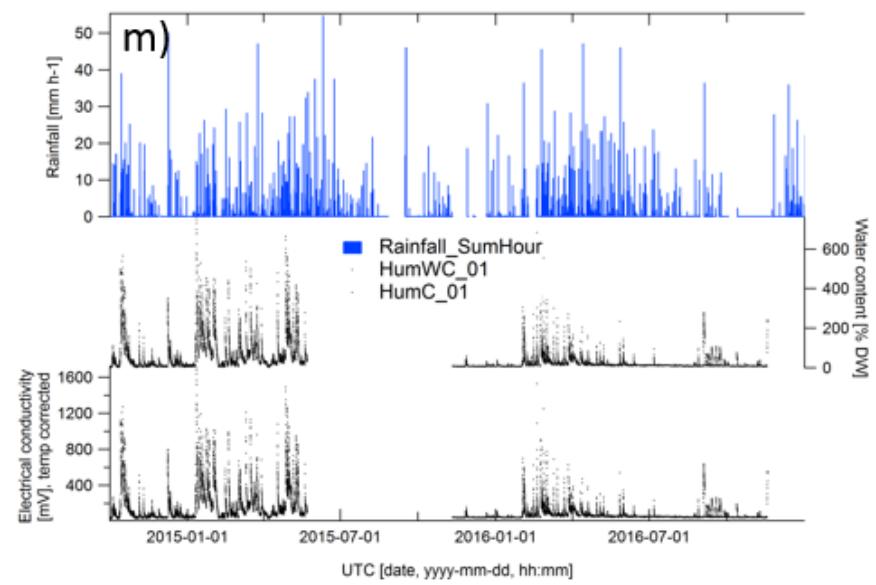
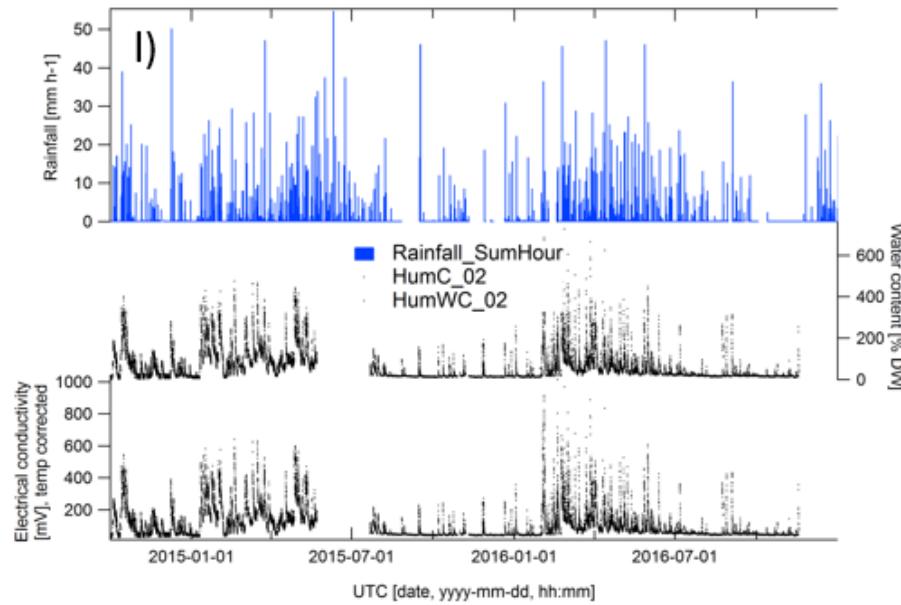


Figure S5: Long-term measurements of precipitation, electrical conductivity, and the calculated water content. All the sensors utilized for further calculations are shown: (a, b, c, d) at 23 m height, (e, f, g) at the 8 m height, and (h, i, j, k, l, m) at 1.5 m height. Gaps in the dataset correspond to maintenance periods.

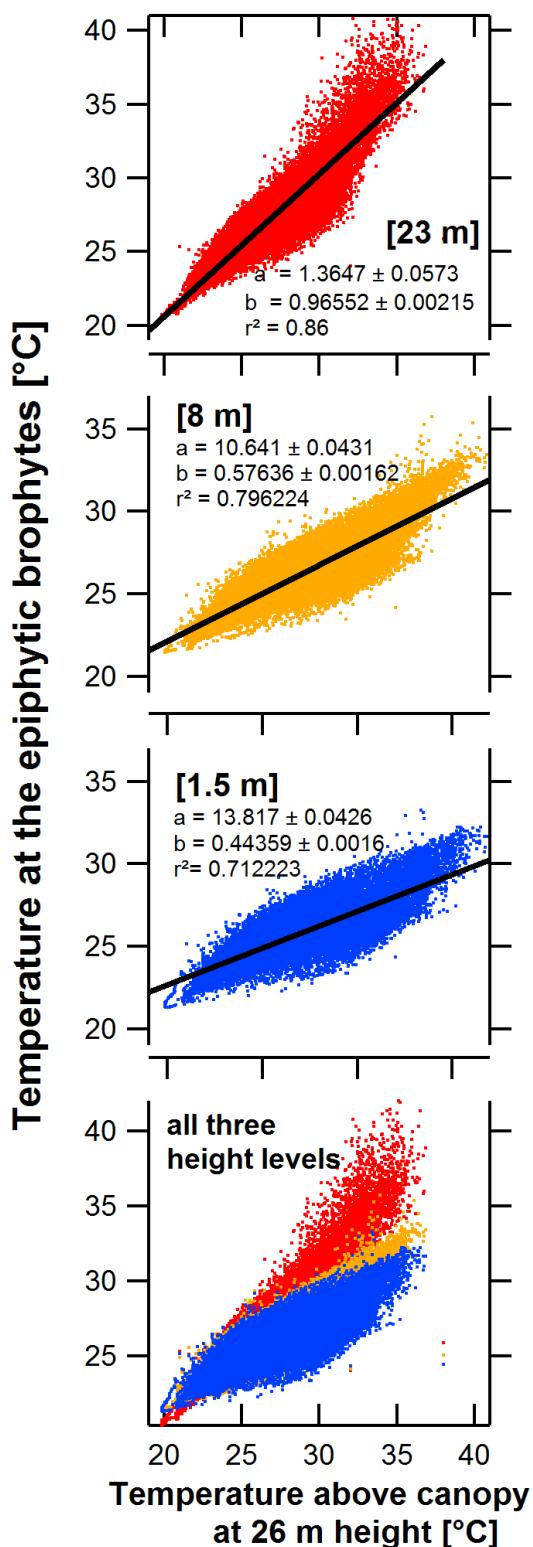
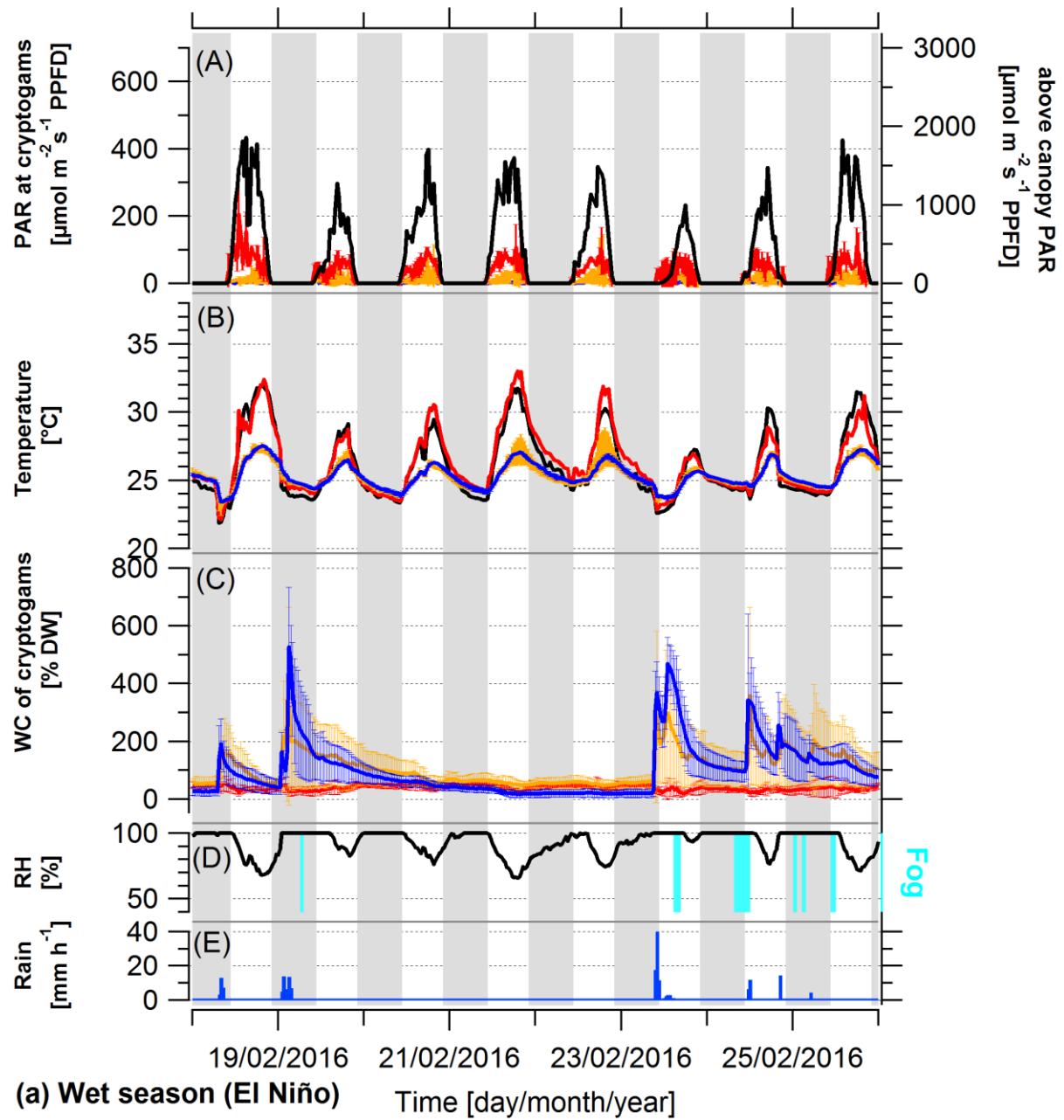


Figure S6: Temperature within bryophytes compared to the above-canopy temperature. The temperature within bryophytes was measured at 1.5 m, 8 m, and 23 m, while the above-canopy temperature was measured at 26 m height on the tower. The data are presented per height zone and also pooled together in the lowest panel. Data present 30-minute averages with linear fits, of the function $y = a + bx$, with the coefficients (± 1 std. dev.) and the R^2 are given in the figure for each height level.

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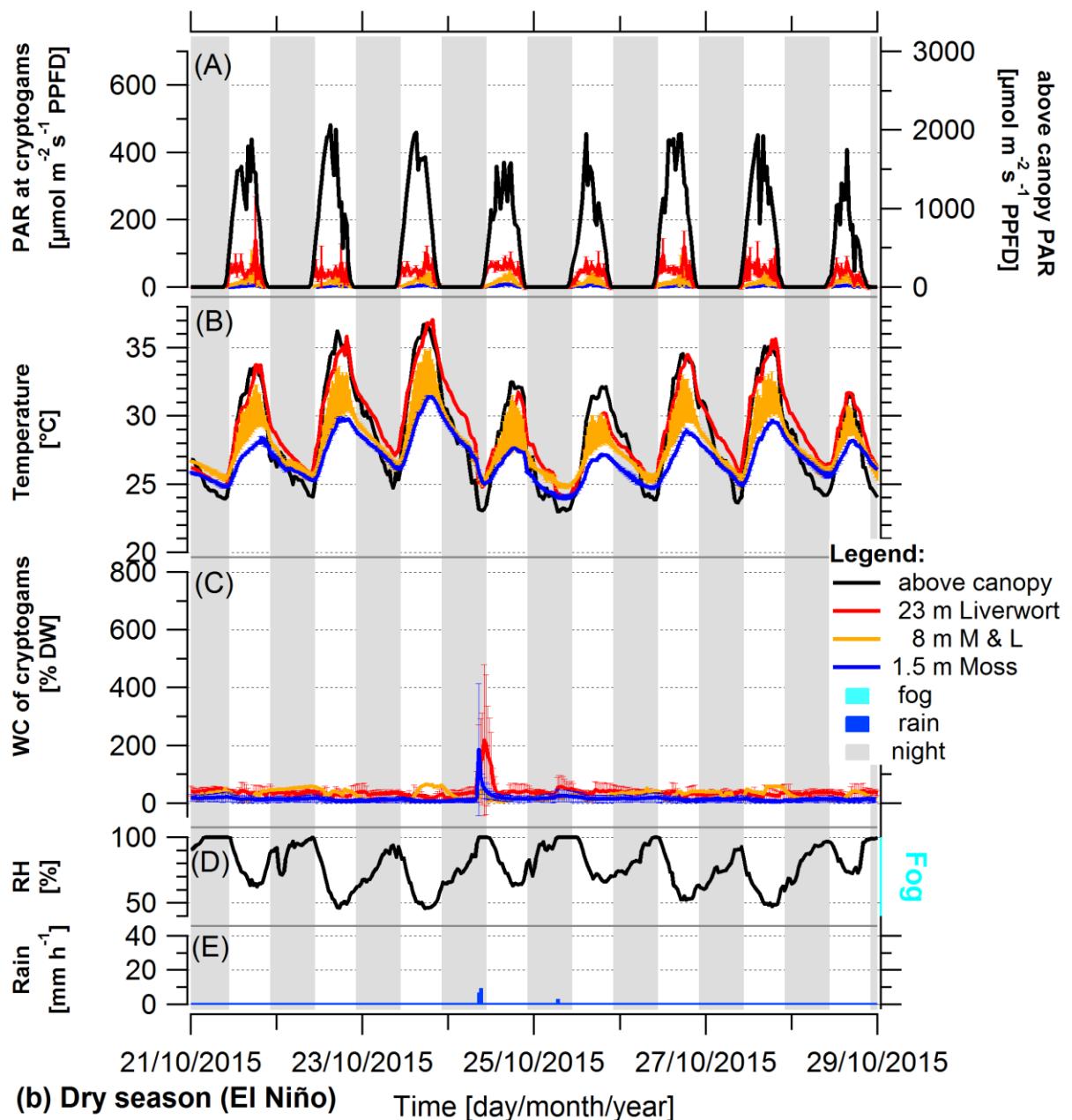


Figure S7: Representative periods during wet and dry season under the influence of El Niño, showing light conditions (PAR), temperature, and water content (WC) experienced by bryophytes, and above-

canopy meteorological conditions in the Amazonian rain forest. Shown are 8-day periods during (a) the wet season 2016 and (b) the dry season 2015. The micrometeorological parameters on top/within

5 epiphytic cryptogamic communities represent (A) the photosynthetically active radiation (PAR) on top, (B) the temperature within, and (C) the water content of cryptogamic communities. The above-canopy

meteorological parameters comprise (A) the above-canopy photosynthetically active radiation (PAR at

75 m), (B) the above-canopy temperature (at 26 m), (D) the relative air humidity (RH at 26 m), the

10 presence of fog events, and (E) the rain amount. The data show 30-minute averages \pm SD except for

rain, which shows hourly sums. Data of replicate sensors installed within communities at the same height

level were pooled, while above-canopy parameters were measured with one sensor each. The nighttime

is shaded in grey color (18:00–06:00 LT).

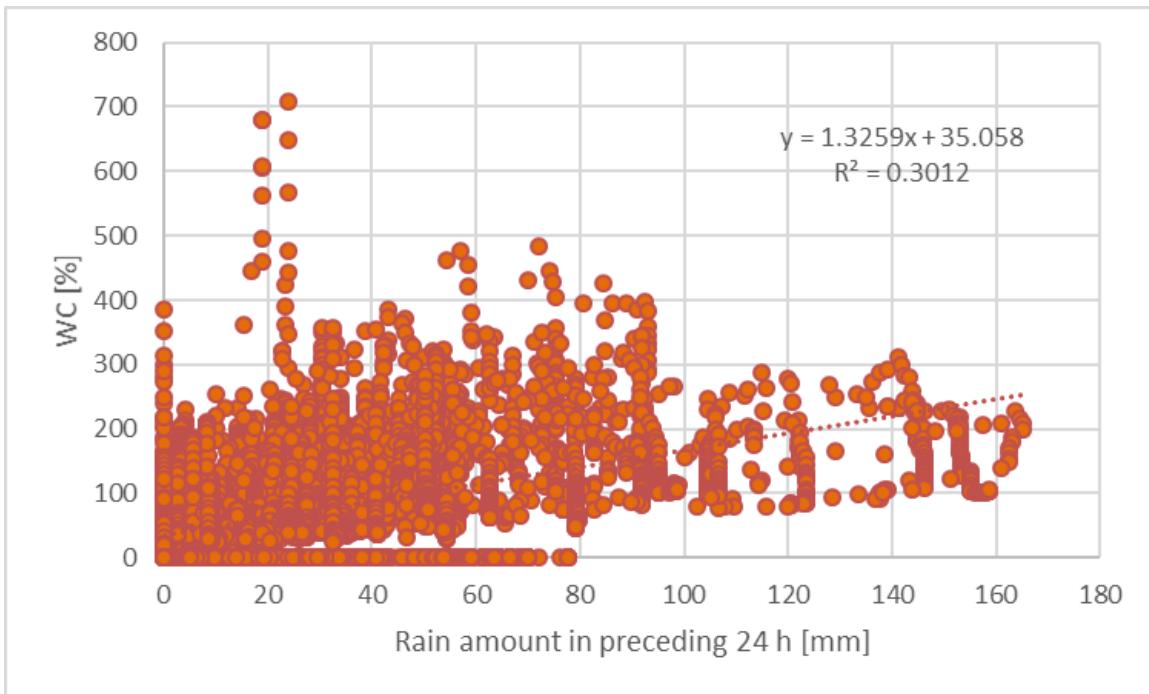


Figure S8: Correlation between the water content (WC) and the rain amount in the preceding 24 h. Linear trendline with formula added to illustrate the relationship between both parameters.

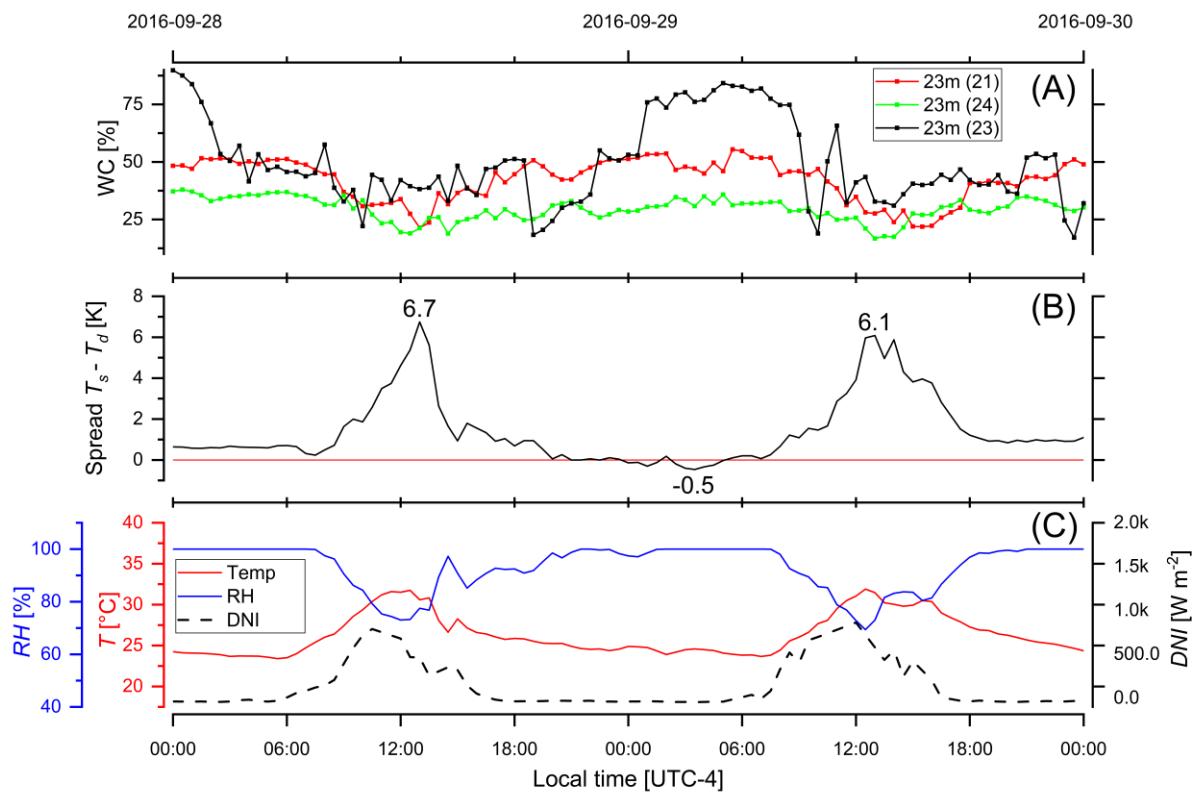


Figure S9: Exemplary daily (micro-) climatic conditions at the canopy level, showing the WC values of the three sensors at 23 m [%] (A), the dew point spread at 23 m [°C] (B), and the environmental factors relative humidity RH[%], temperature T [°C] and direct normal irradiance DNI [W m⁻²] measured at 26 m (C).

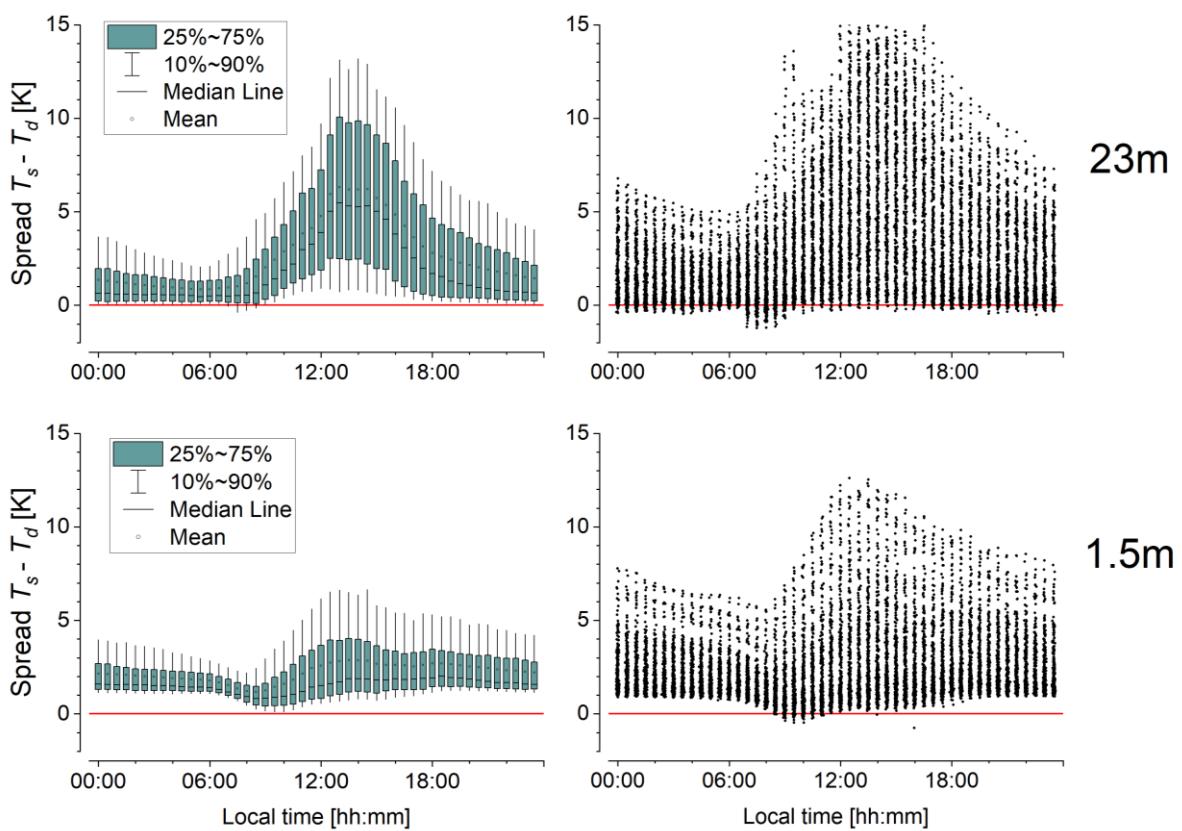


Figure S10: Diel dew point spread at 1.5 m and 23 m height levels in a 24-h cycle, illustrating the difference between the temperature of the substrate (T_s) and the dew point of the surrounding air (T_d). If the surface temperature is lower than the dew point of the surrounding air (values below red line) condensation might occur.

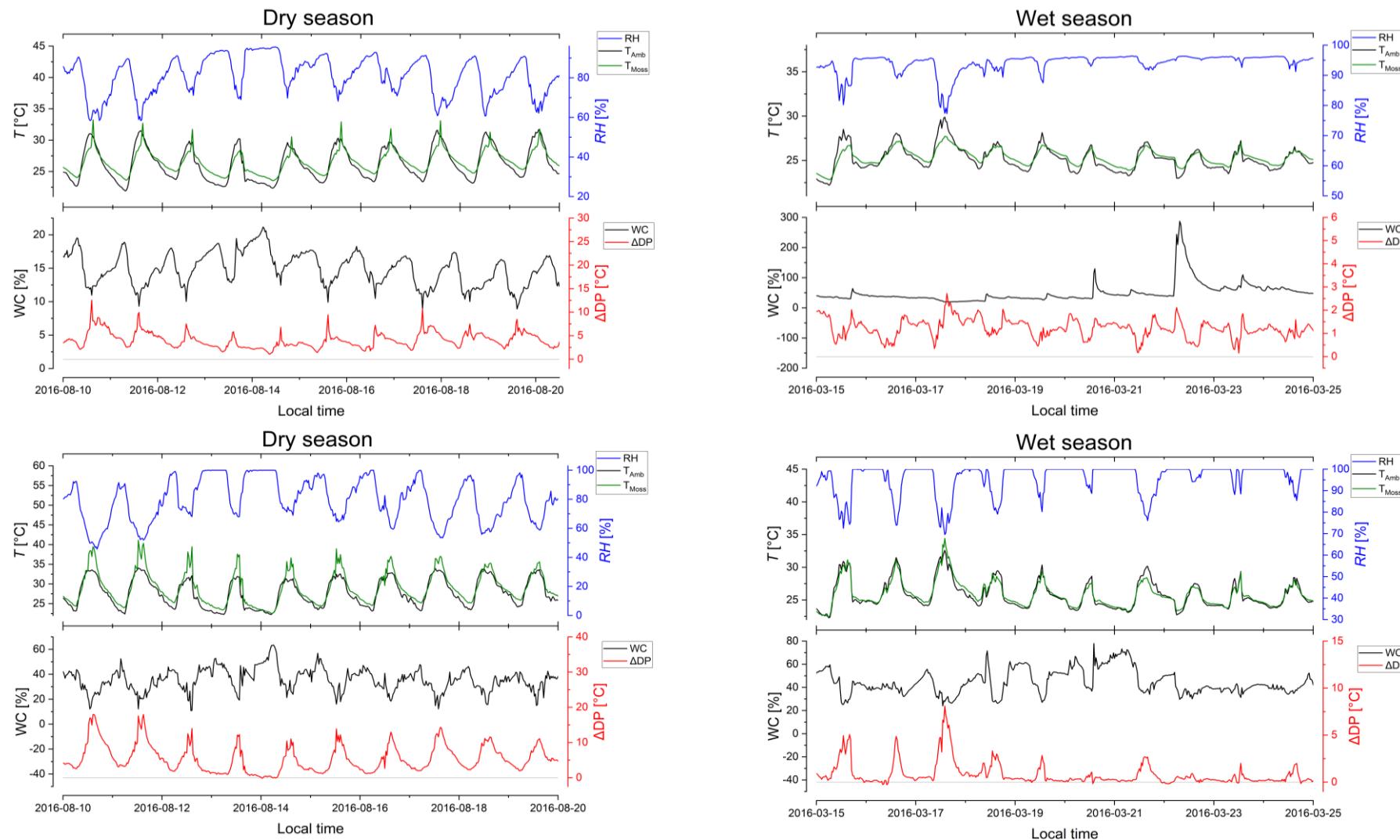


Figure S11: Characteristic sequence of (micro-) climatic conditions during the dry and the wet season at (A) 23 m and (B) 1.5 m height. In the plots the relative air humidity [%], ambient and bryophyte temperature [°C], water content of the bryophytes [% dry weight], and dew point spread [°C] are shown.

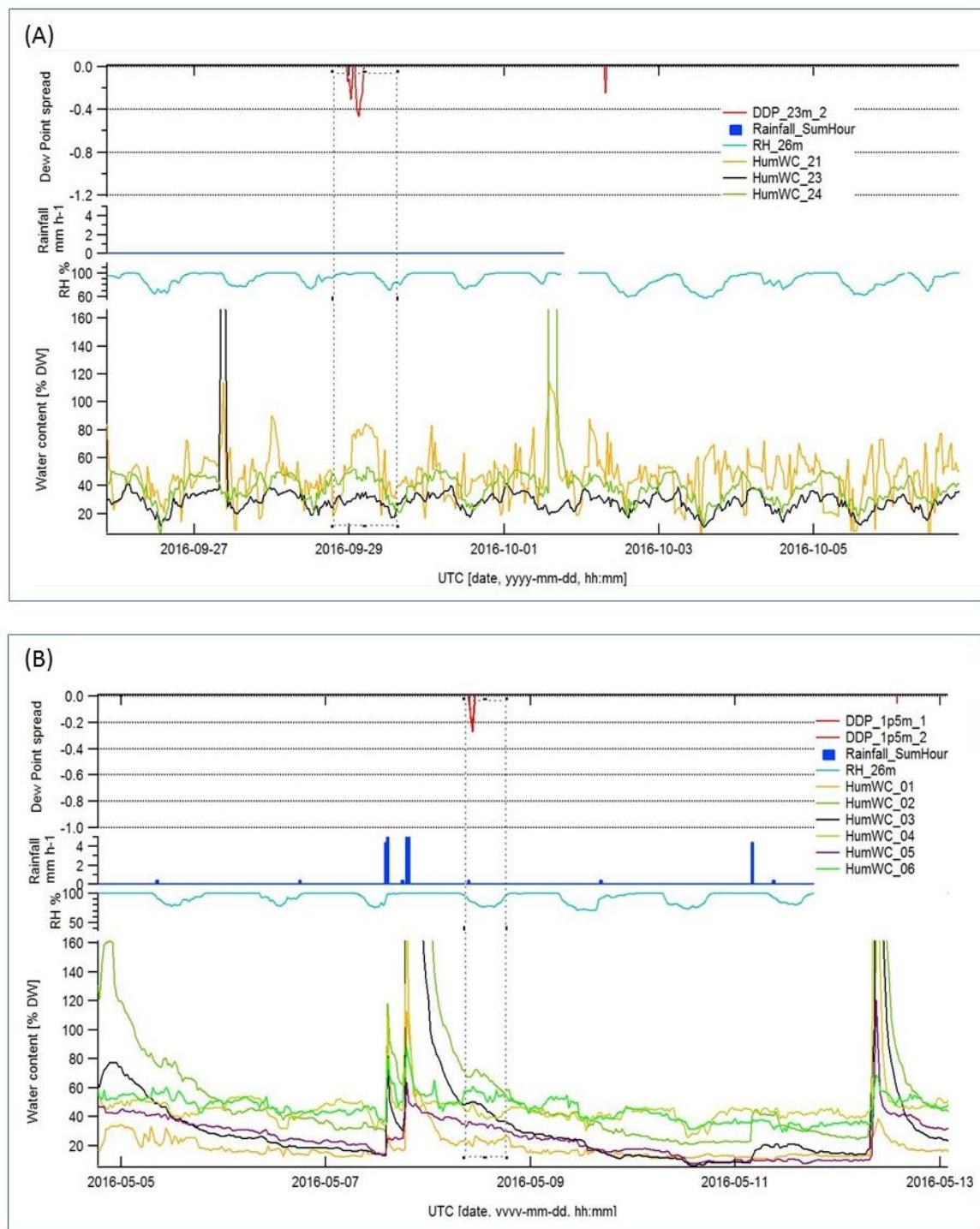


Figure S12: Exemplary (micro-) meteorological data comprising dewpoint events at (A) 23 m and (B) 1.5 m height. In the plots, the dew point spread [$^{\circ}\text{C}$], precipitation [mm h^{-1}], relative humidity [%], and the water content [% dry weight] are shown.

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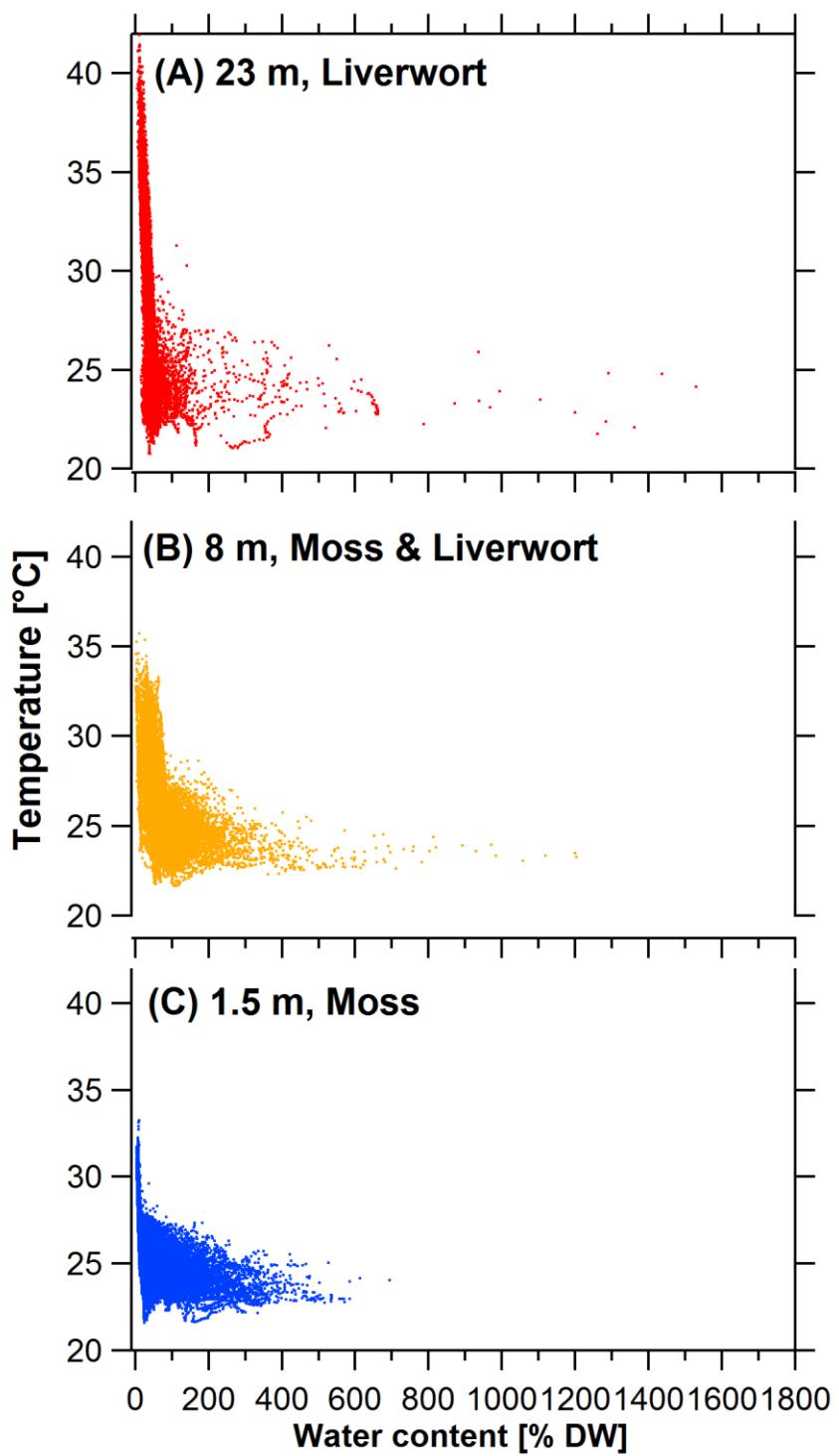


Figure S13: Temperature conditions of bryophytes related to their water content. The temperature was measured in bryophytes at different height levels along the tree. Data presented as 30-minute averages.

Table S1: Height of installation, minimum and maximum values of the individual sensors of the microclimate station measuring water content, temperature, and light. For the water content sensors, also the bryophyte species are given. Based on 30-minute averages.

Sensor No	Height [m]	Water content		Bryophyte species	
		[% DW]			
		min	max		
Sensor 01	1.5	0	763	<i>Sematophyllum subsimplex</i>	
Sensor 02	1.5	0	763	<i>Sematophyllum subsimplex</i>	
Sensor 03	1.5	0	763	<i>Sematophyllum subsimplex</i>	
Sensor 04	1.5	0	1373	<i>Leucobryum martianum</i>	
Sensor 05	1.5	0	763	<i>Sematophyllum subsimplex</i>	
Sensor 06	1.5	0	763	<i>Sematophyllum subsimplex</i>	
Sensor 09	8	0	1318	<i>Octoblepharum cocuiense</i>	
Sensor 10	8	0	1318	<i>Octoblepharum cocuiense</i>	
Sensor 11	8	0	1658	<i>Symbiezidium barbiflorum</i>	
Sensor 21	23	0	1658	<i>Symbiezidium barbiflorum</i>	
Sensor 23	23	0	1658	<i>Symbiezidium barbiflorum</i>	
Sensor 24	23	0	1658	<i>Symbiezidium barbiflorum</i>	
Sensor No	Height [m]	Temperature			
		[°C]			
		min	max		
Sensor 01	1.5	21.1	36.3		
Sensor 02	1.5	21.4	39.4		
Sensor 03	8	21.6	34.7		
Sensor 04	8	20.9	46.3		
Sensor 07	23	20.8	41.2		
Sensor 08	23	20.3	48.7		
Sensor No	Height [m]	PAR			
		[μmol m ⁻² s ⁻¹]			
		min	max		
Sensor 01	1.5	0	634		
Sensor 02	8	0	569		
Sensor 03	8	0	1121		
Sensor 06	23	0	654		
Sensor 07	23	0	767		

Table S2: Water content range measured during the calibration in the laboratory for the different replicates of the four bryophyte species. Listed are the minimum and maximum water content values (WC) measured at full water saturation (WC_{max}) and in the end of drying when weight stability was reached over more than 5 minutes (WC_{min}). Data shown for each replicate (1–4) and the species average (all).

Species	Replicate sample	WC _{min}	WC _{max}
<i>Leucobryum martianum</i>	1	32	1487
<i>Leucobryum martianum</i>	2	10	931
<i>Leucobryum martianum</i>	3	10	1241
<i>Leucobryum martianum</i>	4	7	1834
<i>Sematophyllum subsimplex</i>	1	14	614
<i>Sematophyllum subsimplex</i>	2	14	698
<i>Sematophyllum subsimplex</i>	3	14	468
<i>Sematophyllum subsimplex</i>	4	14	459
<i>Sematophyllum subsimplex</i>	5	7	1576
<i>Symbiezidium barbiflorum</i>	1	15	1657
<i>Symbiezidium barbiflorum</i>	2	15	1982
<i>Symbiezidium barbiflorum</i>	3	15	1581
<i>Symbiezidium barbiflorum</i>	4	22	1412
<i>Octoblepharum cocuiense</i>	1	23	742
<i>Octoblepharum cocuiense</i>	2	16	870
<i>Octoblepharum cocuiense</i>	3	6	2342
<i>Leucobryum martianum</i>	all	15	1373
<i>Sematophyllum subsimplex</i>	all	13	763
<i>Symbiezidium barbiflorum</i>	all	16	1658
<i>Octoblepharum cocuiense</i>	all	15	1318

Table S4: Parameters determining the time range of photosynthesis and respiration. The ranges of values defining the lower water compensation point (WCP), the lower light compensation point (LCP_1), the temperature for optimal net photosynthesis (T_{opt}), and the upper temperature compensation point (TCP) as relevant parameters have been extracted from published studies conducted at various study sites in the tropical rain forest.

Parameter	Range of values	Reference	Study site
WCP	30–80 % DW	Wagner et al 2013	Panama, lowland rain forest, 0 m
LCP_1	3–12 $\mu\text{mol m}^{-2} \text{s}^{-1}$	Lösch et al. 1994	Zaire, lowland rain forest, 800 m
T_{opt}	24–27 °C	Wagner et al 2013	Panama, lowland rain forest, 0 m
TCP	30–36 °C	Wagner et al 2013	Panama, lowland rain forest, 0 m

Table S6: Mean values and standard deviations (\pm SD) of the daily maxima of photosynthetically active radiation (PAR_{\max}) for each height level shown for 2015 and 2016, considering that 2015 was an El Niño year (additional information to Table 1).

Height	$\text{PAR}_{\max} [\mu\text{mol m}^{-2} \text{s}^{-1}]$			
	2015		2016	
	Mean	\pm SD	Mean	\pm SD
above canopy	1766	415	1842	364
23 m	125	123	226	140
8 m	186	195	68	90
1.5 m	49	89	29	45

Table S7: Mean values and standard deviations (\pm SD) of the daily maxima of photosynthetically active radiation (PAR_{max}) for each height level shown for the different seasons (additional information to Table 2).

Height [m]	PAR _{max} [$\mu\text{mol m}^{-2} \text{s}^{-1}$]	
	Mean	\pm SD
Wet season		
above-canopy	1687	431
23 m	245	82
8 m	210	151
1.5 m	191	206
Transitional season Wet-Dry		
above-canopy	1855	233
23 m	318	183
8 m	471	363
1.5 m	66	68
Dry season		
above-canopy	1924	370
23 m	457	147
8 m	314	184
1.5 m	172	177
Transitional season Dry-Wet		
above-canopy	1691	407
23 m	496	165
8 m	324	95
1.5 m	146	61