

# Response of water balance components to climate change in permanent grassland soil ecosystems

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**Table S 1:** Site-specific cutting dates during 1<sup>st</sup> January 2015 until 31<sup>th</sup> December 2018.

Year	Cutting regimes	Gumpenstein	Rollesbroich	Selhausen
2015	1 <sup>st</sup>	05-27	05-26	05-26
	2 <sup>nd</sup>	07-28	06-29	06-30
	3 <sup>rd</sup>	10-13	08-21	08-21
	4 <sup>th</sup>	-	10-14	10-13
2016	1 <sup>st</sup>	05-31	06-07	06-07
	2 <sup>nd</sup>	07-26	07-12	07-12
	3 <sup>rd</sup>	10-04	08-30	08-30
	4 <sup>th</sup>	-	10-18	10-18
2017	1 <sup>st</sup>	05-30	05-15	05-16
	2 <sup>nd</sup>	07-25	06-21	06-21
	3 <sup>rd</sup>	10-03	08-29	08-29
2018	1 <sup>st</sup>	05-29	05-07	05-08
	2 <sup>nd</sup>	07-24	06-26	06-26
	3 <sup>rd</sup>	10-02	09-11	09-11

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**Table S 2:** Start of the growing and non-growing season as well as the duration of the growing season during 1 January 2015 until 31 December 2018 at the corresponding site Gumpenstein (GS), Rollesbroich (RO), and Selhausen (SE).

Year	Start growing season			Start non-growing season			Duration growing season (days)		
	GS	RO	SE	GS	RO	SE	GS	RO	SE
<b>2015</b>	04-14	04-12	03-13	10-23	11-09	11-18	192	211	250
<b>2016</b>	04-02	04-05	03-05	10-15	10-23	11-02	196	201	242
<b>2017</b>	03-29	03-20	03-08	10-14	10-23	11-05	199	217	242
<b>2018</b>	04-11	04-07	03-14	10-27	10-25	11-08	199	201	239

**Table S 3:** Average amounts of precipitation during growing and non-growing seasons from 1 January 2015 until 31 December 2018. The values were averaged across replicated lysimeter measurements at each test sites Gumpenstein (GS) four treatments C2T0 (CO<sub>2</sub>: +300 ppm, two lysimeter), C0T2 (temperature: +3°C, two lysimeter), C0T0 (ambient, one lysimeter), C2T2 (CO<sub>2</sub>: +300 ppm, and temperature: +3°C, one lysimeter), Rollesbroich (RO) with C0CL0 (original, six lysimeter) and Selhausen (SE) with C0CL2 (translocated, three lysimeter).

Year	Season	Precipitation						20
		Gumpenstein				Rollesbroich	Selhausen	
		C2T0	C0T2	C0T0	C2T2	C0CL0	C0CL2	
		mm						
2015	non-growing	331.0	310.6	308.3	305.4	580.9	225.3	
	growing	700.3	670.4	711.0	648.8	510.9	475.1	
	annual	1031.3	981.1	1019.3	954.2	1091.8	700.4	
2016	non-growing	431.4	406.2	413.7	387.7	492.2	224.1	
	growing	776.0	724.2	747.0	726.9	546.7	445.3	
	annual	1207.3	1130.4	1160.7	1114.5	1038.9	669.4	
2017	non-growing	458.0	459.2	463.9	464.6	506.9	199.6	
	growing	844.5	829.7	842.2	826.9	569.4	402.5	
	annual	1302.5	1288.8	1306.1	1291.4	1076.4	602.2	
2018	non-growing	410.0	427.2	437.2	427.1	484.0	201.5	
	growing	573.9	556.8	575.4	563.1	388.3	283.8	
	annual	983.9	984.1	1012.6	990.3	872.3	485.3	
Average	non-growing	407.6	400.8	405.8	396.2	516.0	212.6	
	growing	723.7	695.3	718.9	691.4	503.8	401.7	
	annual	1131.3	1096.1	1124.7	1087.6	1019.8	614.3	

**Table S 4:** Average amounts of non-rainfall water during growing and non-growing seasons from 1 January 2015 until 31 December 2018. The values were averaged across replicated lysimeter measurements at each test sites Gumpenstein (GS) four treatments C2T0 (CO<sub>2</sub>: +300 ppm, two lysimeter), C0T2 (temperature: +3°C, two lysimeter), C0T0 (ambient, one lysimeter), C2T2 (CO<sub>2</sub>: +300ppm, and temperature: +3°C, one lysimeter), Rollesbroich (RO) with C0CL0 (original, six lysimeter) and Selhausen (SE) with C0CL2 (translocated, three lysimeter).

Year	Season	Non-rainfall water					
		Gumpenstein				Rollesbroich	Selhausen
		C2T0	C0T2	C0T0	C2T2	C0CL0	C0CL2
		mm					
		30					
2015	non-growing	50.8	30.8	30.4	27.7	30.1	18.3
	growing	25.5	18.3	20.9	17.4	26.8	30.4
	annual	76.3	49.1	51.3	45.1	56.9	48.7
2016	non-growing	56.8	32.8	44.0	26.0	36.9	21.5
	growing	36.0	23.9	30.3	22.8	27.0	22.8
	annual	92.8	56.6	74.3	48.8	63.8	44.2
2017	non-growing	45.5	42.4	43.9	40.6	30.5	25.3 <sup>35</sup>
	growing	32.3	22.5	29.2	21.4	26.2	21.4
	annual	77.8	65.0	73.1	62.0	56.7	46.7
2018	non-growing	39.1	40.7	41.4	39.6	26.2	21.5
	growing	19.0	13.2	18.5	13.7	19.1	16.6
	annual	58.1	53.9	59.9	53.3	45.4	38.1
Average	non-growing	48.1	36.7	39.9	33.5	30.9	21.6
	growing	28.2	19.5	24.7	18.8	24.8	22.8
	annual	76.3	56.1	64.6	52.3	55.7	44.4

40 **Table S 5:** Average percentage of non-rainfall water on the total precipitation amounts during growing and non-growing seasons from 1 January 2015 until 31 December 2018. The values were averaged across replicated lysimeter measurements at each test sites Gumpenstein (GS) four treatments C2T0 (CO<sub>2</sub>: +300 ppm, two lysimeter), C0T2 (temperature: +3°C, two lysimeter), C0T0 (ambient, one lysimeter), C2T2 (CO<sub>2</sub>: +300ppm, and temperature: +3°C, one lysimeter), Rollesbroich (RO) with C0CL0 (original, six lysimeter) and Selhausen (SE) with C0CL2 (translocated, three lysimeter).

Year	Season	Non-rainfall water % of precipitation						45
		Gumpenstein				Rollesbroich	Selhausen	
		C2T0	C0T2	C0T0	C2T2	C0CL0	C0CL2	
		% of P						
2015	non-growing	15.3	9.9	9.9	9.1	5.2	8.1	
	growing	3.6	2.7	2.9	2.7	5.2	6.4	
	annual	7.4	5.0	5.0	4.7	5.2	6.9	
2016	non-growing	13.2	8.1	10.6	6.7	7.5	9.6	
	growing	4.6	3.3	4.1	3.1	4.9	5.1	
	annual	7.7	5.0	6.4	4.4	6.1	6.6	
2017	non-growing	9.9	9.2	9.5	8.7	6.0	12.7	
	growing	3.8	2.7	3.5	2.6	4.6	5.3	
	annual	6.0	5.0	5.6	4.8	5.3	7.8	
2018	non-growing	9.5	9.5	9.5	9.3	5.4	10.7	
	growing	3.3	2.4	3.2	2.4	4.9	5.8	
	annual	5.9	5.5	5.9	5.4	5.2	7.9	
Average	non-growing	11.8	9.2	9.8	8.5	6.0	10.2	
	growing	3.9	2.8	3.4	2.7	4.9	5.7	
	annual	6.7	5.1	5.7	4.8	5.5	7.2	

50 **Table S 6:** Average amounts of evapotranspiration during growing and non-growing seasons from 1 January 2015 until 31 December 2018. The values were averaged across replicated lysimeter measurements at each test sites Gumpenstein (GS) four treatments C2T0 (CO<sub>2</sub>: +300 ppm, two lysimeter), C0T2 (temperature: +3°C, two lysimeter), C0T0 (ambient, one lysimeter), C2T2 (CO<sub>2</sub>: +300ppm, and temperature: +3°C, one lysimeter), Rollesbroich (RO) with C0CL0 (original, six lysimeter) and Selhausen (SE) with C0CL2 (translocated, three lysimeter).

Year	Season	Evapotranspiration						55
		Gumpenstein				Rollesbroich	Selhausen	
		C2T0	C0T2	C0T0	C2T2	C0CL0	C0CL2	
mm								
2015	non-growing	128.9	125.3	108.4	114.0	108.5	115.4	
	growing	488.3	684.4	620.4	649.0	550.5	690.6	
	annual	617.2	809.7	728.8	763.0	659.0	806.0	
2016	non-growing	128.0	155.6	114.6	143.3	79.0	80.8	
	growing	510.2	699.6	568.3	656.4	531.5	582.6	60
	annual	638.2	855.2	682.9	799.7	610.6	663.4	
2017	non-growing	106.5	129.7	111.5	117.2	66.3	71.7	
	growing	594.9	741.3	673.2	689.9	577.1	610.8	
	annual	701.4	871.1	784.7	807.0	643.4	682.5	
2018	non-growing	96.2	124.3	103.9	125.4	95.3	86.9	
	growing	573.2	662.0	619.0	584.9	548.8	500.1	65
	annual	669.4	786.3	722.9	710.3	644.1	587.0	
Average	non-growing	114.9	133.7	109.6	125.0	87.3	88.7	
	growing	541.6	696.8	620.2	645.0	552.0	596.1	
	annual	656.5	830.5	729.8	770.0	639.3	684.7	

**Table S 7:** Average amounts of water flux across the lysimeter bottom (NetQ) during the growing and non-growing seasons from 1 January 2015 until 31 December 2018. The values were averaged across replicated lysimeter measurements at each test sites Gumpenstein (GS) four treatments C2T0 (CO<sub>2</sub>: +300 ppm, two lysimeter), C0T2 (temperature: +3°C, two lysimeter), C0T0 (ambient, one lysimeter), C2T2 (CO<sub>2</sub>: +300ppm, and temperature: +3°C, one lysimeter), Rollesbroich (RO) with C0CL0 (original, six lysimeter) and Selhausen (SE) with C0CL2 (translocated, three lysimeter). Positive NetQ values are denoted as seepage water and negative NetQ values as upward directed water from deeper soil layers or groundwater table.

Year	Season	NetQ					
		Gumpenstein				Rollesbroich	Selhausen
		C2T0	C0T2	C0T0	C2T2	C0CL0	C0CL2
		mm					
2015	non-growing	294.7	220.3	259.2	201.2	526.5	16.2
	growing	237.9	11.1	98.0	12.9	-5.6	-45.1
	annual	532.6	231.4	357.2	214.0	521.0	-29.0
2016	non-growing	312.8	198.9	285.6	208.7	382.5	32.8
	growing	287.2	65.9	194.6	93.3	106.3	-21.4
	annual	600.0	264.9	480.2	302.0	488.7	11.4
2017	non-growing	422.4	355.7	381.1	378.2	455.0	25.1
	growing	274.6	137.6	190.1	139.6	40.2	-100.3
	annual	697.0	493.3	571.1	517.9	495.2	-75.2
2018	non-growing	375.9	314.2	378.0	353.2	353.7	45.9
	growing	5.9	3.6	5.6	1.8	-27.7	-66.0
	annual	381.8	317.8	383.6	355.0	325.9	-20.1
Average	non-growing	351.5	272.3	326.0	285.3	429.4	30.00
	growing	201.4	54.5	122.1	61.9	28.3	-58.2290
	annual	552.9	326.8	448.0	347.2	457.7	-28.2

**Table S 8:** Information on the average dry aboveground biomass ( $\text{g m}^{-2}$ ) from 1 January 2015 until 31 December 2018. The values were averaged across replicated lysimeter measurements at each test sites Gumpenstein (GS) four treatments C2T0 ( $\text{CO}_2$ : +300 ppm, two lysimeter), C0T2 (temperature: +3°C, two lysimeter), C0T0 (ambient, one lysimeter), C2T2 ( $\text{CO}_2$ : +300ppm, and temperature: +3°C, one lysimeter), Rollesbroich (RO) with C0CL0 (original, six lysimeter) and Selhausen (SE) with C0CL2 (translocated, three lysimeter).

Year	Cutting regimes	Gumpenstein				Rollesbroich	Selhausen
		C2T0	C0T2	C0T0	C2T2	C0CL0	C0CL2
		$\text{g m}^{-2}$					
2015	1 <sup>st</sup>	287.9	345.7	406.5	299.2	316.3	555.7
	2 <sup>nd</sup>	183.7	197.5	356.7	183.6	121.0	112.0
	3 <sup>rd</sup>	115.8	123.1	188.3	150.9	260.0	111.7
	4 <sup>th</sup>	-	-	-	-	195.2	249.0
2016	1 <sup>st</sup>	284.1	385.2	369.2	224.3	503.5	528.7
	2 <sup>nd</sup>	240.5	255.5	359.3	316.1	226.8	214.3
	3 <sup>rd</sup>	164.2	219.2	415.5	147.6	193.0	69.7
	4 <sup>th</sup>	-	-	-	-	65.3	21.0
2017	1 <sup>st</sup>	351.3	364.4	385.7	280.1	56.5	225.7
	2 <sup>nd</sup>	212.1	234.3	386.5	180.8	424.5	158.3
	3 <sup>rd</sup>	201.1	167.4	346.4	174.5	222.5	217.0
2018	1 <sup>st</sup>	404.7	310.1	655.2	232.0	190.7	240.0
	2 <sup>nd</sup>	204.3	227.9	290.1	186.0	288.2	156.7
	3 <sup>rd</sup>	152.1	142.9	210.4	165.2	113.8	24.0