nature plants

SUPPLEMENTARY INFORMATION

DOI: 10.1038/NPLANTS.2016.132

Intensifying drought eliminates the expected benefits of elevated carbon dioxide for soybean

Supplementary Information:
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DOI: 10.1038/NPLANTS.2016.132

Supplementary Table 1. ANCOVA results showing p-values for direct effects of day of year (DOY), CO_2 treatment (CO_2), and interactive effects of DOY and CO_2 (DOY × CO_2) on soil volumetric moisture content (soil $H_2O\%_{v/v}$) at depths of 5-75 cm in plots of soybean cv 93B15 growing only under control precipitation from 2004 to 2011. Significant treatment effects ($p<0.1$) are shaded grey to indicate greater soil $H_2O\%_{v/v}$ in elevated CO_2, or black to indicate greater soil $H_2O\%_{v/v}$ in ambient CO_2.

Depth	Effect	2004	2005	2006	2007	2008	2009	2010	2011
5–15 cm	DOY	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	CO_2	0.413	0.902	0.398	0.903	0.141	0.501	0.204	0.983
	DOY × CO_2	<0.001	0.899	0.993	0.002	0.341	0.886	0.006	0.673
15–25 cm	DOY	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	CO_2	0.591	0.624	0.794	0.429	0.726	0.124	0.644	0.236
	DOY × CO_2	<0.0001	0.319	0.163	0.028	0.587	0.155	0.079	0.999
25–35 cm	DOY	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	CO_2	0.275	0.020	0.589	0.155	0.367	0.042	0.159	0.790
	DOY × CO_2	<0.0001	<0.0001	0.254	0.030	0.544	<0.0001	<0.0001	0.701
35–45 cm	DOY	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	CO_2	0.062	0.009	0.234	0.094	0.876	0.029	0.100	0.424
	DOY × CO_2	<0.0001	<0.0001	0.926	<0.001	0.037	<0.0001	<0.0001	0.973
45–55 cm	DOY	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	CO_2	0.289	0.028	0.829	0.060	0.483	0.137	0.135	0.050
	DOY × CO_2	0.142	<0.001	0.230	0.008	0.981	0.279	<0.0001	0.008
55–65 cm	DOY	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	CO_2	0.552	0.082	0.358	0.223	0.458	0.161	0.328	0.078
	DOY × CO_2	0.843	0.003	0.548	0.162	0.948	<0.001	0.002	0.527
65–75 cm	DOY	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	CO_2	0.003	0.221	0.899	0.444	0.733	0.506	0.532	0.346
	DOY × CO_2	0.597	0.070	0.569	0.405	0.894	<0.01	0.022	0.973

Supplementary Table 2. ANOVA table showing the within-year effects of CO_2 treatment, measurement date (day of year; DOY), and the interaction of CO_2 and measurement date (CO_2×DOY) on leaf area index (LAI) of soybean cv 93B15. Significant effects are shown in bold type.

Year	CO_2		DOY		CO_2×DOY	
	F-statistic	P-value	F-statistic	P-value	F-statistic	P-value
2004	**51.01**	**<0.0001**	**282.36**	**<0.0001**	1.15	0.33
2005	**10.21**	**<0.01**	**448.86**	**<0.0001**	**2.05**	**0.02**
2006	**27.10**	**<0.0001**	**225.48**	**<0.0001**	0.46	0.77
2007	**3.79**	**0.06**	**254.43**	**<0.0001**	0.48	0.82
2008	**32.71**	**<0.0001**	**303.57**	**<0.0001**	**3.16**	**<0.01**
2009	**12.34**	**<0.001**	**201.88**	**<0.0001**	0.45	0.89
2010	**71.94**	**<0.0001**	**217.45**	**<0.0001**	1.57	0.13

DOI: 10.1038/NPLANTS.2016.132

Supplementary Table 3. Average canopy temperature during daylight (where PAR>50 μmol m^{-2} s^{-1}) during the period after canopy closure (LAI>3) of soybean cv 93B15 grown at ambient and elevated [CO_2] (data are means ± SE), and ANOVA results showing the within-year effects of CO_2 treatment, measurement date (day of year; DOY), and the interaction of [CO_2] and measurement date (CO_2×DOY). Significant treatment effects are shown in bold type. 2008 data are excluded due to sensor malfunction.

Year	Average Canopy Temperature (°C) ± SE		% Effect of Elevated CO_2	CO_2 p-value	DOY p-value	CO_2×DOY p-value
	Ambient CO_2	Elevated CO_2				
2004	22.8±0.1	23.3±0.1	+2.2%	**<0.0001**	**<0.0001**	0.43
2005	25.8±0.1	25.8±0.1	+0.0%	0.67	**<0.0001**	0.29
2006	24.9±0.2	25.1±0.2	+0.8%	**<0.01**	**<0.0001**	0.90
2007	25.2±0.1	25.3±0.1	+0.4%	0.60	**<0.0001**	0.75
2008	-	-	-	-	-	-
2009	22.0±0.1	22.0±0.1	+0.0%	0.49	**<0.0001**	**<0.0001**
2010	29.1±0.1	29.2±0.1	+0.3%	**0.09**	**<0.0001**	0.44
2011	24.4±0.3	24.8±0.3	+1.6%	**0.05**	**<0.0001**	0.90

Supplementary Table 4. ANOVA table showing the season average effect of elevated [CO_2] on midday stomatal conductance (g_s) of soybean cv 93B15 and ANOVA tests for within-year effects of CO_2 treatment, measurement date (day of year; DOY), and the interaction of [CO_2] and measurement date (CO_2×DOY) on g_s for data from 2004-2011. Significant treatment effects are shown in bold type.

Year	Average effect of	CO_2		DOY		CO_2×DOY	
	elevated CO_2 on g_s	F-statistic	P-value	F-statistic	P-value	F-statistic	P-value
2004	-35%	**15.11**	**<0.01**	**3.23**	**0.03**	1.03	0.42
2005	-25%	**3.32**	**0.09**	**18.69**	**<0.0001**	0.21	0.89
2006	-32%	**20.11**	**0.001**	**49.98**	**<0.0001**	0.63	0.61
2007	-29%	**9.13**	**<0.01**	**28.93**	**<0.0001**	0.91	0.48
2008	-28%	**39.48**	**<0.0001**	**15.96**	**<0.0001**	0.38	0.85
2009	-36%	**70.36**	**<0.0001**	**25.14**	**<0.0001**	**2.97**	**0.03**
2010	-34%	**34.51**	**0.0003**	**48.38**	**<0.0001**	0.31	0.87
2011	-40%	**24.64**	**0.0009**	**14.86**	**<0.0001**	0.61	0.69

DOI: 10.1038/NPLANTS.2016.132

Supplementary Table 5. Information on planting and harvesting dates for soybean cv 93B15 and weather in the reduced precipitation (RP) and control precipitation (CP) treatments during the 2009-2011 growing seasons at SoyFACE. Departures from average temperature and precipitation data were by comparison to the long-term (1901-2011) average data for Urbana, IL obtained from Illinois State Water Survey. Estimates of maximum possible shading in RP plots were calculated as the sum of incoming PAR above the awnings when they were deployed. This is therefore an over-estimate of shading because, during these periods of rain, plants received significant diffuse irradiance from around the edges of the awning.

Variable	**2009**	**2010**	**2011**
Planting date	9 June	27 May	8 June
Harvest date	1 October	23 September	22 October
Mean growing season temperature (planting-harvest)	20.3°C	23.2°C	20.6°C
Departure from average June – Sep temperature	-1.2°C	+0.9°C	+0.2°C
Time awnings were deployed	279 hours	109 hours	183 hours
Estimate of maximum total shading in RP plots	2%	0.05%	2.6%
Growing season precipitation in CP treatment	384 mm	442 mm	274 mm
Departure from average June-Sep precipitation	+4 mm	+70 mm	-142 mm
Growing season precipitation in RP treatment	140 mm	260 mm	179 mm
Reduction in precipitation in RP plots	64%	41%	35%

Supplementary Table 6. ANCOVA for the direct and interactive effects of [CO_2], reduced precipitation treatment (H_2O) and day of year (DOY) on soil H_2O% at 5-75 cm soil depth in plots of soybean cv 93B15 in the factorial experiment of CO_2 × drought. Significant treatment effects are in bold type.

Soil Depth	Effect	2009		2010		2011	
		F-value	P-value	F-value	P-value	F-value	P-value
5 – 15 cm	CO_2	0.73	0.45	**7.99**	**0.06**	0.18	0.71
	H_2O	**127.31**	**<0.0001**	**115.65**	**<0.0001**	**15.03**	**<0.01**
	CO_2×H_2O	0.15	0.70	**4.71**	**<0.05**	0.32	0.59
	DOY	**62.99**	**<0.0001**	**243.15**	**<0.0001**	**73.76**	**<0.0001**
	DOY×CO_2	0.61	0.96	1.34	0.12	0.99	0.49
	DOY×H_2O	**15.87**	**<0.0001**	**61.39**	**<0.0001**	**6.71**	**<0.0001**
	DOY×CO_2×H_2O	0.57	0.97	0.56	0.97	0.75	0.85
15 – 25 cm	CO_2	1.07	0.34	0.38	0.55	0.06	0.80
	H_2O	**51.14**	**<0.0001**	**37.95**	**<0.0001**	2.08	0.17
	CO_2×H_2O	1.21	0.29	0.14	0.72	0.33	0.58
	DOY	**21.71**	**<0.0001**	**123.35**	**<0.0001**	**37.69**	**<0.0001**
	DOY×CO_2	0.42	0.99	0.68	0.89	0.57	0.98
	DOY×H_2O	**4.58**	**<0.0001**	**44.85**	**<0.0001**	**3.68**	**<0.0001**
	DOY×CO_2×H_2O	0.56	0.97	0.48	0.99	0.33	1.00
25 – 35 cm	CO_2	1.62	0.22	**3.57**	**<0.10**	0.03	0.87
	H_2O	**33.64**	**<0.0001**	**81.96**	**<0.0001**	**3.03**	**0.10**
	CO_2×H_2O	0.52	0.48	**5.08**	**0.04**	0.60	0.45
	DOY	**18.74**	**<0.0001**	**114.63**	**<0.0001**	**26.80**	**<0.0001**
	DOY×CO_2	0.98	0.50	**1.65**	**0.02**	0.44	0.99
	DOY×H_2O	**3.25**	**<0.0001**	**45.02**	**<0.0001**	**3.32**	**<0.0001**
	DOY×CO_2×H_2O	1.02	0.44	**1.50**	**0.05**	0.27	1.00
35 – 45 cm	CO_2	2.26	0.19	2.45	0.13	0.23	0.64
	H_2O	**30.76**	**<0.0001**	**32.19**	**<0.0001**	0.17	0.69
	CO_2×H_2O	0.36	0.56	**4.04**	**0.06**	0.07	0.80
	DOY	**19.97**	**<0.0001**	**58.59**	**<0.0001**	**22.16**	**<0.0001**
	DOY×CO_2	0.87	0.67	**1.76**	**0.01**	0.56	0.98
	DOY×H_2O	**2.65**	**<0.0001**	**16.46**	**<0.0001**	**2.86**	**<0.0001**
	DOY×CO_2×H_2O	0.85	0.70	0.74	0.83	0.29	1.00

DOI: 10.1038/NPLANTS.2016.132

Supplementary Table 6, continued. ANCOVA for the direct and interactive effects of [CO_2], reduced precipitation treatment (H_2O) and day of year (DOY) on soil H_2O% at 5-75 cm soil depth in plots of soybean cv 93B15 in the factorial experiment of CO_2 × drought. Significant treatment effects are in bold type.

Soil Depth	Effect	2009		2010		2011	
		F-value	P-value	F-value	P-value	F-value	P-value
45 – 55 cm	CO_2	2.14	0.16	2.03	0.20	0.34	0.57
	H_2O	**44.26**	**<0.0001**	**21.56**	**<0.001**	0.49	0.50
	CO_2×H_2O	0.21	0.65	2.37	0.15	0.89	0.37
	DOY	**14.47**	**<0.0001**	**38.36**	**<0.0001**	**24.66**	**<0.0001**
	DOY×CO_2	0.51	0.99	**1.54**	**0.04**	0.68	0.92
	DOY×H_2O	**1.99**	**<0.01**	**9.37**	**<0.0001**	**1.85**	**0.003**
	DOY×CO_2×H_2O	0.64	0.94	0.55	0.97	0.63	0.95
55 – 65 cm	CO_2	0.84	0.37	1.08	0.33	0.94	0.35
	H_2O	**20.03**	**<0.001**	**6.20**	**0.03**	0.73	0.41
	CO_2×H_2O	0.35	0.56	0.45	0.52	0.63	0.45
	DOY	**9.21**	**<0.0001**	**24.06**	**<0.0001**	**26.36**	**<0.0001**
	DOY×CO_2	0.49	1.00	0.87	0.66	0.63	0.95
	DOY×H_2O	1.25	0.17	**6.06**	**<0.0001**	**1.50**	**0.04**
	DOY×CO_2×H_2O	0.80	0.77	0.55	0.97	0.89	0.66
65 – 75 cm	CO_2	0.07	0.80	0.70	0.42	1.42	0.25
	H_2O	2.63	0.13	1.22	0.29	1.09	0.32
	CO_2×H_2O	0.08	0.78	0.03	0.87	0.05	0.83
	DOY	**5.26**	**<0.0001**	**15.93**	**<0.0001**	**21.09**	**<0.0001**
	DOY×CO_2	0.38	0.99	0.67	0.91	0.73	0.87
	DOY×H_2O	0.78	0.80	**3.20**	**<0.0001**	**1.34**	**<0.1**
	DOY×CO_2×H_2O	0.95	0.55	0.70	0.88	0.81	0.78

Supplementary Table 7. Results of linear regression analysis of leaf intercellular [CO_2] (C_i, μmol mol^{-1}) versus xylem ABA concentration (nmol ml^{-1}) for soybean cv 93B15 grown at ambient [CO_2] and elevated [CO_2] 2009-2011.

Response Variable	Effect	p-value
C_i (μmol mol^{-1})	Xylem ABA	**P<0.001**
	CO_2	**P<0.0001**
	Xylem ABA × CO_2	**P<0.001**

DOI: 10.1038/NPLANTS.2016.132

Supplementary Table 8. ANOVA for the direct and interactive effects of [CO_2] and drought treatment (H_2O) and day of year (DOY) on root length density (RLD) at 5-90 cm soil depth of soybean cv 93B15 in the factorial experiment of CO_2 x drought. Significant treatment effects are in bold type.

Soil Depth	Effect	2009		2010		2011	
		F-value	P-value	F-value	P-value	F-value	P-value
5 – 15 cm	CO_2	2.30	0.15	0.94	0.40	0.10	0.76
	H_2O	0.94	0.35	1.66	0.23	2.05	0.17
	CO_2×H_2O	0.93	0.35	0.29	0.60	0.84	0.37
	DOY	**14.45**	**<0.0001**	**12.62**	**<0.0001**	**4.75**	**<0.01**
	DOY×CO_2	1.04	0.40	1.69	0.15	0.09	0.99
	DOY×H_2O	**3.39**	**0.02**	**2.49**	**0.04**	1.28	0.29
	DOY×CO_2×H_2O	0.06	0.99	0.58	0.71	0.84	0.50
15 – 25 cm	CO_2	**5.24**	**0.04**	2.70	0.12	2.62	0.13
	H_2O	0.41	0.53	0.96	0.34	1.22	0.29
	CO_2×H_2O	0.05	0.83	0.01	0.92	2.78	0.11
	DOY	**7.33**	**0.0001**	**14.24**	**<0.0001**	**26.45**	**<0.0001**
	DOY×CO_2	1.91	0.12	1.23	0.31	1.48	0.22
	DOY×H_2O	0.85	0.50	1.44	0.22	1.04	0.40
	DOY×CO_2×H_2O	1.54	0.21	0.35	0.88	0.91	0.47
25 – 35 cm	CO_2	1.22	0.31	2.14	0.19	2.04	0.25
	H_2O	0.03	0.86	0.04	0.85	0.02	0.89
	CO_2×H_2O	1.35	0.28	0.00	0.99	0.03	0.87
	DOY	**13.47**	**<0.0001**	**37.58**	**<0.0001**	**29.67**	**<0.0001**
	DOY×CO_2	0.92	0.46	**1.97**	**<0.1**	0.85	0.50
	DOY×H_2O	1.77	0.15	0.32	0.90	0.26	0.90
	DOY×CO_2×H_2O	1.21	0.32	0.36	0.87	0.09	0.98
35 – 45 cm	CO_2	**13.34**	**<0.01**	3.10	0.10	**7.10**	**0.02**
	H_2O	2.01	0.18	**6.59**	**0.03**	0.04	0.84
	CO_2×H_2O	0.83	0.38	0.85	0.37	0.00	0.98
	DOY	**16.56**	**<0.0001**	**35.67**	**<0.0001**	**14.06**	**<0.0001**
	DOY×CO_2	**2.06**	**0.10**	**2.24**	**0.06**	1.59	0.19
	DOY×H_2O	0.78	0.55	1.53	0.19	0.11	0.98
	DOY×CO_2×H_2O	0.68	0.61	0.41	0.84	0.43	0.78

Supplementary Table 8 (continued). ANOVA for the direct and interactive effects of [CO_2] (CO_2) and drought treatment (H_2O) and day of year (DOY) on root length density (RLD) at 5-90 cm soil depth of soybean cv 93B15 in the factorial experiment of CO_2 × drought. Significant treatment effects are in bold type.

Soil Depth	Effect	2009		2010		2011	
		F-value	P-value	F-value	P-value	F-value	P-value
45 – 55 cm	CO_2	**7.08**	**0.02**	1.45	0.31	**8.68**	**<0.01**
	H_2O	2.97	0.11	0.13	0.73	0.10	0.75
	CO_2×H_2O	0.61	0.45	0.01	0.91	0.05	0.82
	DOY	**13.82**	**<0.0001**	**20.44**	**<0.0001**	**17.95**	**<0.0001**
	DOY×CO_2	1.40	0.25	1.70	0.15	**2.48**	**0.06**
	DOY×H_2O	1.03	0.40	0.21	0.96	1.45	0.23
	DOY×CO_2×H_2O	0.59	0.67	0.35	0.88	0.34	0.85
55 – 65 cm	CO_2	0.90	0.36	1.62	0.22	**4.15**	**0.06**
	H_2O	0.19	0.67	0.03	0.87	0.80	0.38
	CO_2×H_2O	0.54	0.48	0.52	0.48	1.04	0.32
	DOY	**14.57**	**<0.0001**	**21.18**	**<0.0001**	**10.27**	**<0.0001**
	DOY×CO_2	0.52	0.72	1.47	0.21	1.59	0.19
	DOY×H_2O	0.29	0.88	0.26	0.94	0.66	0.62
	DOY×CO_2×H_2O	0.23	0.92	0.64	0.67	0.40	0.81
65 – 75 cm	CO_2	0.00	0.96	0.47	0.51	0.03	0.88
	H_2O	0.33	0.58	0.76	0.40	1.36	0.27
	CO_2×H_2O	1.10	0.32	0.13	0.73	0.04	0.84
	DOY	**12.49**	**<0.0001**	**13.59**	**<0.0001**	**11.71**	**<0.0001**
	DOY×CO_2	0.10	0.98	0.58	0.71	0.64	0.64
	DOY×H_2O	0.34	0.85	0.19	0.96	0.75	0.57
	DOY×CO_2×H_2O	1.46	0.23	0.11	0.99	0.06	0.99
75 – 85 cm	CO_2	0.08	0.79	0.04	0.85	**3.04**	**<0.1**
	H_2O	0.45	0.52	0.01	0.94	0.57	0.46
	CO_2×H_2O	0.87	0.37	1.29	0.29	0.02	0.89
	DOY	**8.51**	**<0.0001**	**8.00**	**<0.0001**	**8.82**	**<0.0001**
	DOY×CO_2	0.11	0.98	0.48	0.79	0.91	0.47
	DOY×H_2O	0.48	0.75	0.07	1.00	0.63	0.65
	DOY×CO_2×H_2O	1.15	0.35	0.39	0.85	0.41	0.80
85 – 90 cm	CO_2	0.36	0.57	0.01	0.92	0.87	0.36
	H_2O	0.13	0.73	0.45	0.52	0.99	0.33
	CO_2×H_2O	0.22	0.65	0.52	0.49	0.01	0.93
	DOY	**9.40**	**<0.0001**	**5.41**	**<0.001**	**6.61**	**<0.001**
	DOY×CO_2	0.55	0.70	0.23	0.95	**2.09**	**<0.1**
	DOY×H_2O	0.21	0.93	0.62	0.69	0.20	0.94
	DOY×CO_2×H_2O	0.48	0.75	0.51	0.77	0.04	1.00

DOI: 10.1038/NPLANTS.2016.132

Supplementary Table 9. ANOVA table showing the direct and interactive effects of [CO_2] treatment (CO_2), drought treatment (H_2O), and day of year (DOY) on soil $H_2O\%_{v/v}$, weighted by distribution of root length with depth in plots of soybean cv 93B15 in the factorial experiment of CO_2 × drought. Bold type indicates statistically significant treatment effects at P<0.1.

Variable	Effect	2009		2010		2011	
		F-value	P-value	F-value	P-value	F-value	P-value
Weighted Soil $H_2O\%_{v/v}$	CO_2	0.27	0.61	**5.14**	**0.04**	0.00	0.96
	H_2O	**6.61**	**0.03**	**33.68**	**<0.0001**	0.12	0.74
	$CO_2 \times H_2O$	0.18	0.68	1.24	0.29	0.00	0.99
	DOY	**9.02**	**<0.001**	**37.46**	**<0.0001**	**6.38**	**<0.01**
	DOY×CO_2	**3.66**	**0.03**	**2.41**	**0.06**	**5.02**	**<0.01**
	DOY×H_2O	**3.82**	**0.02**	**18.23**	**<0.0001**	**3.29**	**0.03**
	DOY×CO_2×H_2O	0.32	0.81	0.78	0.54	0.40	0.75

Supplementary Table 10. Linear regression analysis of log-transformed leaf [ABA] (ng g^{-1} dry weight, corrected for starch content; log-transformed xylem sap [ABA] (nmol ml^{-1}); and xylem sap pH versus average soil $H_2O\%_{v/v}$ at 5-75 cm depth for soybean cv 93B15 in growing seasons 2009-2011 at ambient and elevated [CO_2].

Response Variable	Effect	p-value
Log leaf ABA (ng g^{-1} dry weight, corrected for starch)	**Soil H_2O**	**p<0.0001**
	CO_2	**p=0.07**
	CO_2 × Soil H_2O	p=0.12
Log xylem ABA (nmol ml^{-1})	Soil H_2O	**p<0.0001**
	CO_2	p=0.67
	CO_2 × Soil H_2O	p=0.77
Xylem pH	Soil H_2O	p=0.95
	CO_2	p=0.33
	CO_2 × Soil H_2O	p=0.32

DOI: 10.1038/NPLANTS.2016.132

Supplementary Table 11. ANOVA table showing the direct and interactive effects of [CO_2] and precipitation (H_2O) treatments, day of year (DOY) on daily average stomatal conductance (g_s), photosynthetic carbon assimilation (A), leaf intercellular CO_2 concentration (Ci), and the ratio of leaf intercellular CO_2 concentration to atmospheric CO_2 concentration (Ci/Ca) of soybean cv 93B15 in the factorial experiment of CO_2 × drought. Bold type indicates significant treatment effects at P<0.1.

Effect	Year	Stomatal Conductance (g_s)		Photosynthetic Carbon Assimilation (A)		Leaf Intercellular CO_2 (C_i)		Leaf intercellular CO_2 to atmospheric CO_2 ratio (C_i/C_a)	
		F-value	P-value	F-value	P-value	F-value	P-value	F-value	P-value
CO_2	2009	**439.10**	**<0.0001**	**14.76**	**0.0003**	**3004.36**	**<0.0001**	**162.60**	**<0.0001**
	2010	**90.03**	**<0.0001**	**71.17**	**<0.0001**	**658.62**	**<0.0001**	**40.03**	**<0.001**
	2011	**64.16**	**<0.0001**	**140.72**	**<0.0001**	**378.84**	**<0.0001**	**5.71**	**0.02**
H_2O	2009	**21.12**	**<0.0001**	**19.04**	**<0.0001**	**25.53**	**<0.0001**	**24.77**	**<0.0001**
	2010	**28.79**	**<0.0001**	**32.39**	**<0.0001**	**5.58**	**0.02**	**7.30**	**0.009**
	2011	**2.74**	**0.10**	**32.04**	**<0.0001**	**3.50**	**0.07**	**3.46**	**0.07**
CO_2×H_2O	2009	**3.48**	**0.07**	2.14	0.15	**16.62**	**0.0001**	**11.38**	**0.001**
	2010	0.00	0.96	0.01	0.91	2.50	0.12	1.45	0.23
	2011	0.07	0.79	**3.23**	**0.08**	0.03	0.86	0.05	0.82
DOY	2009	**82.18**	**<0.0001**	**105.49**	**<0.0001**	**23.54**	**<0.0001**	**26.03**	**<0.0001**
	2010	**159.03**	**<0.0001**	**201.72**	**<0.0001**	**59.95**	**<0.0001**	**80.95**	**<0.0001**
	2011	**214.65**	**<0.0001**	**673.57**	**<0.0001**	**39.30**	**<0.0001**	**35.78**	**<0.0001**
CO_2×DOY	2009	**4.64**	**0.001**	1.62	0.17	**3.63**	**0.006**	1.18	0.33
	2010	**3.02**	**0.02**	**3.25**	**0.01**	**6.66**	**<0.0001**	**2.11**	**0.08**
	2011	**8.73**	**<0.0001**	**9.53**	**<0.0001**	**7.36**	**<0.0001**	**3.45**	**0.01**
H_2O×DOY	2009	1.85	0.11	0.65	0.66	1.22	0.31	1.18	0.33
	2010	1.43	0.22	**2.14**	**0.07**	1.26	0.29	1.30	0.27
	2011	1.20	0.32	**3.59**	**0.01**	0.42	0.79	0.45	0.77
CO_2×H_2O×DOY	2009	0.67	0.65	0.16	0.98	1.05	0.40	0.93	0.47
	2010	0.17	0.97	0.32	0.90	0.75	0.59	0.56	0.73
	2011	1.33	0.27	**4.52**	**0.0031**	0.41	0.80	0.49	0.75

Supplementary Table 12. ANOVA table showing the direct and interactive effects of [CO_2] and precipitation (H_2O) treatments, day of year (DOY) on leaf water potential, osmotic potential, and turgor pressure of soybean cv 93B15 in the factorial experiment of CO_2 × drought. Bold type indicates significant treatment effects at P<0.1.

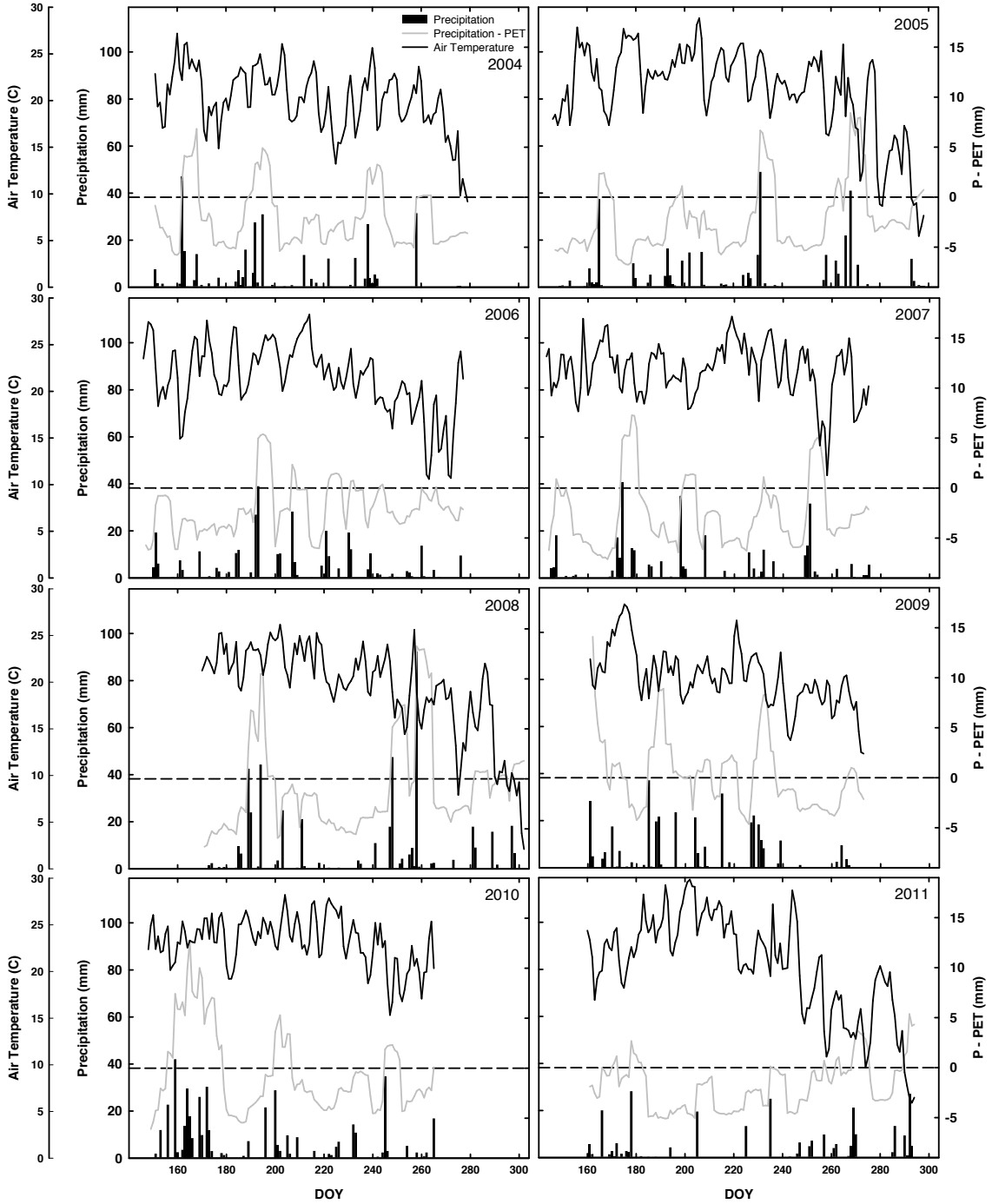
Variable	Effect	2009		2010		2011	
		F-value	P-value	F-value	P-value	F-value	P-value
Water Potential	CO_2	0.00	0.99	0.05	0.84	**6.42**	**0.01**
	H_2O	0.13	0.72	1.27	0.27	0.35	0.55
	CO_2×H_2O	0.71	0.40	0.01	0.94	0.00	0.96
	DOY	**9.78**	**<0.0001**	**12.88**	**<0.0001**	**9.31**	**<0.0001**
	DOY×CO_2	0.45	0.77	0.83	0.49	0.95	0.42
	DOY×H_2O	0.21	0.93	1.62	0.20	0.48	0.70
	DOY×CO_2×H_2O	0.16	0.96	0.72	0.55	0.44	0.73
Osmotic Potential	CO_2	**5.61**	**0.02**	0.32	0.57	0.04	0.84
	H_2O	1.83	0.18	**7.61**	**<0.01**	2.08	0.16
	CO_2×H_2O	0.96	0.33	1.37	0.25	0.57	0.64
	DOY	**6.36**	**<0.001**	**9.73**	**<0.0001**	**8.38**	**<0.001**
	DOY×CO_2	0.16	0.96	0.93	0.43	**2.56**	**0.07**
	DOY×H_2O	0.33	0.86	1.18	0.33	0.57	0.64
	DOY×CO_2×H_2O	0.42	0.79	1.11	0.36	0.51	0.68
Turgor Pressure	CO_2	**6.68**	**0.01**	0.42	0.54	**5.66**	**0.03**
	H_2O	1.69	0.20	**5.78**	**0.02**	0.39	0.54
	CO_2×H_2O	0.13	0.72	0.34	0.56	0.30	0.59
	DOY	**12.07**	**<0.0001**	**7.37**	**<0.001**	**8.92**	**<0.001**
	DOY×CO_2	0.49	0.74	0.80	0.50	2.07	0.12
	DOY×H_2O	1.14	0.35	0.30	0.83	0.29	0.83
	DOY×CO_2×H_2O	0.99	0.42	1.04	0.39	1.51	0.23

DOI: 10.1038/NPLANTS.2016.132

Supplementary Table 13. ANOVA table showing direct and interactive effects of [CO_2] and precipitation (H_2O) treatments, day of year (DOY) on maximum carboxylation capacity of Rubisco ($V_{c,max}$); maximum potential linear electron flux through photosystem II (J_{max}); and the ratio of $V_{c,max}/J_{max}$ of soybean cv 93B15 in the factorial experiment of CO_2 x drought. Bold type indicates significant effects at P<0.1.

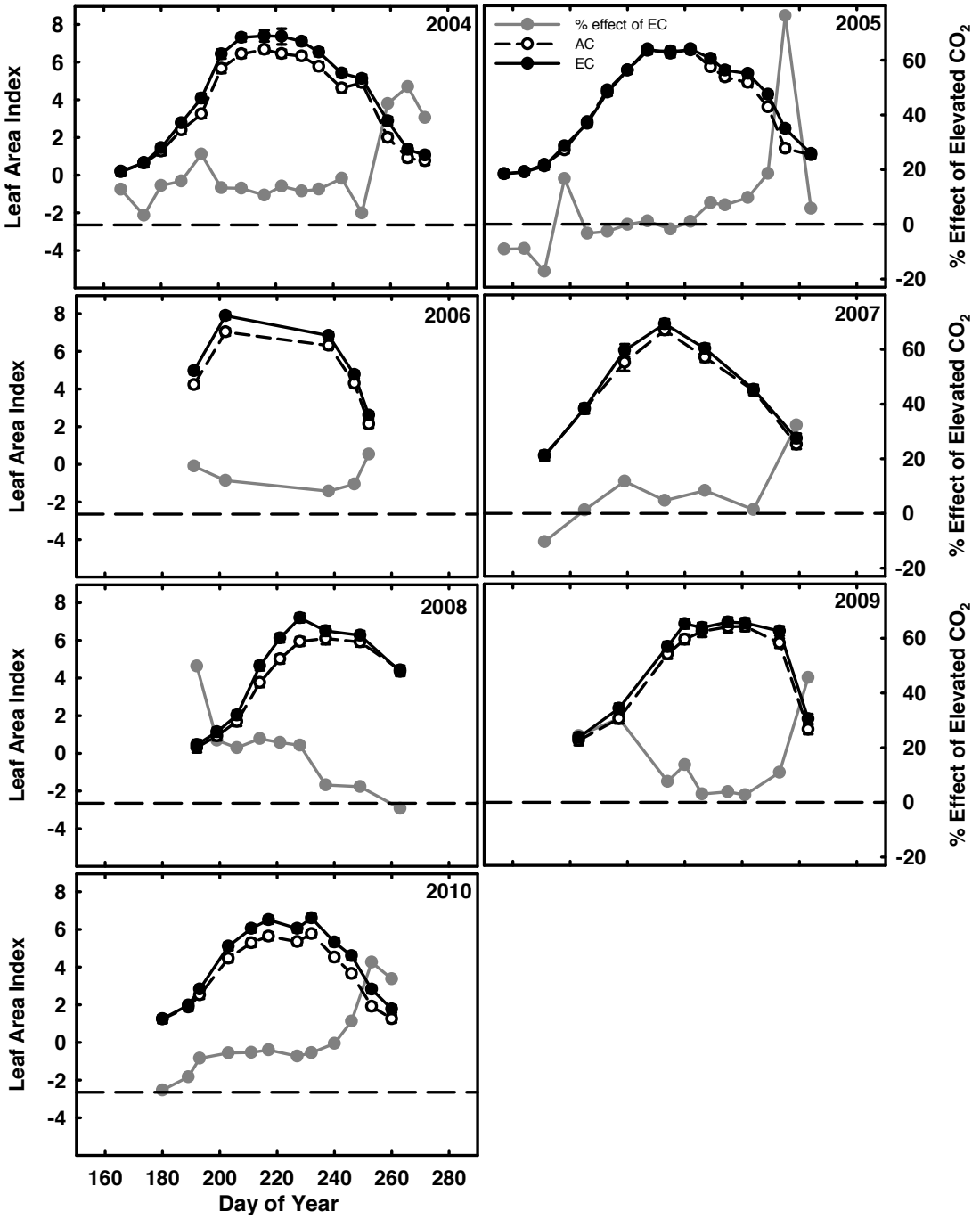
Variable	Effect	2009		2010		2011	
		F-value	P-value	F-value	P-value	F-value	P-value
$V_{c,max}$	CO_2	**15.34**	**<0.01**	**27.22**	**<0.01**	**23.36**	**<0.01**
	H_2O	2.34	0.15	21.19	**<0.01**	7.16	**0.04**
	$CO_2 \times H_2O$	0.34	0.57	0.12	0.73	0.06	0.81
	DOY	**4.33**	**<0.01**	**33.08**	**<0.0001**	**89.13**	**<0.0001**
	DOY×CO_2	1.62	0.17	0.2	0.94	1.17	0.34
	DOY×H_2O	1.93	0.10	**2.2**	**0.08**	**2.83**	**0.03**
	DOY×CO_2×H_2O	0.23	0.95	1.12	0.36	1.35	0.27
J_{max}	CO_2	0.51	0.49	0.2	0.67	0.98	0.36
	H_2O	**4.8**	**0.05**	**47.83**	**<0.01**	**17.38**	**0.01**
	$CO_2 \times H_2O$	0	0.95	1.09	0.34	0.03	0.87
	DOY	**16.64**	**<0.0001**	**16.91**	**<0.0001**	**37.54**	**<0.0001**
	DOY×CO_2	**3.53**	**0.01**	0.38	0.82	0.9	0.47
	DOY×H_2O	1.02	0.42	**4.18**	**0.01**	**5.41**	**<0.01**
	DOY×CO_2×H_2O	0.11	0.99	0.73	0.58	1.6	0.19
$V_{c,max}/J_{max}$	CO_2	**12.84**	**0.01**	**17.49**	**<0.01**	**52.31**	**0.01**
	H_2O	2.26	0.17	0.02	0.90	2.07	0.20
	$CO_2 \times H_2O$	0.29	0.60	0.03	0.87	0.08	0.78
	DOY	**24.46**	**<.0001**	**54.76**	**<.0001**	**66.25**	**<.0001**
	DOY×CO_2	0.74	0.60	0.22	0.93	0.64	0.64
	DOY×H_2O	0.84	0.52	1.95	0.12	1.25	0.30
	DOY×CO_2×H_2O	0.22	0.95	0.89	0.48	0.14	0.97

Supplementary Figure 1. Daily average temperature (black lines), daily precipitation (black bars), and running 7-day average precipitation minus potential evapotranspiration (grey lines) at the SoyFACE field site from planting through harvest for 2004-2011.

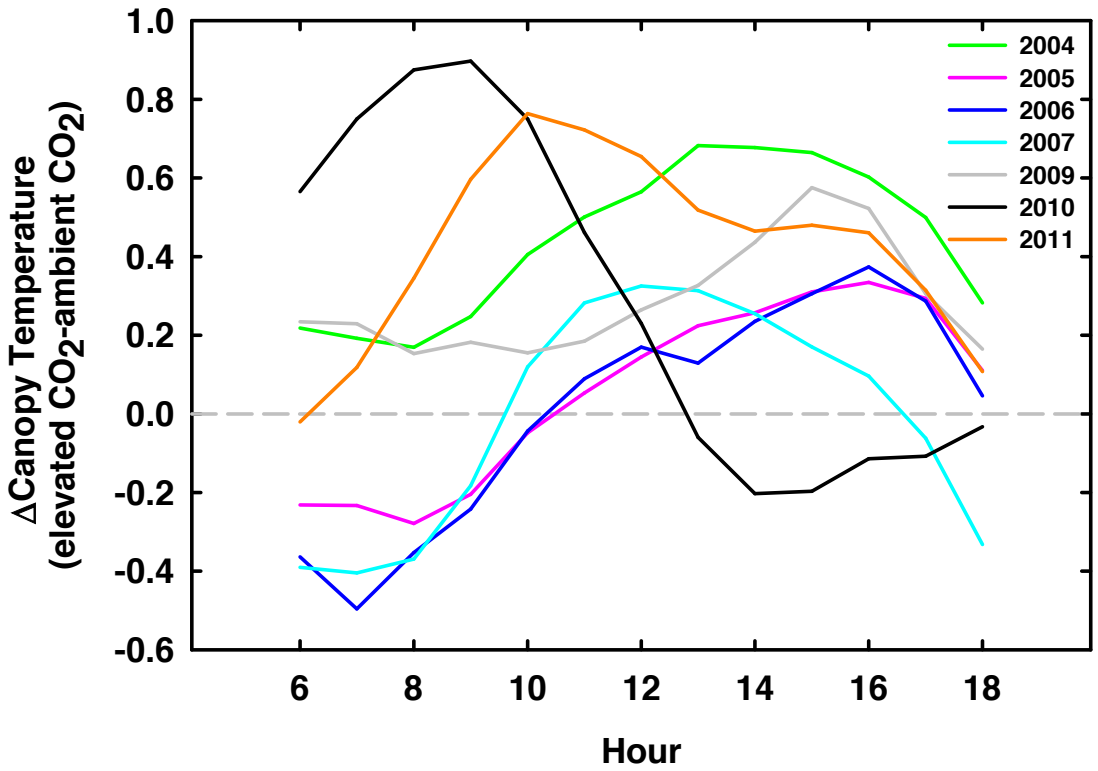


DOI: 10.1038/NPLANTS.2016.132

Supplementary Figure 2. Leaf area index (LAI) of soybean cv 93B15 grown at ambient [CO_2] treatment (open circles, dashed lines) and elevated [CO_2] treatment (filled circles, solid lines) in 2004-2010. Data shown are lsmeans ± standard errors. Grey circles and lines represent the % effect of elevated [CO_2] on LAI for each measurement date. Results of statistical tests are reported in Supplementary Table 2.

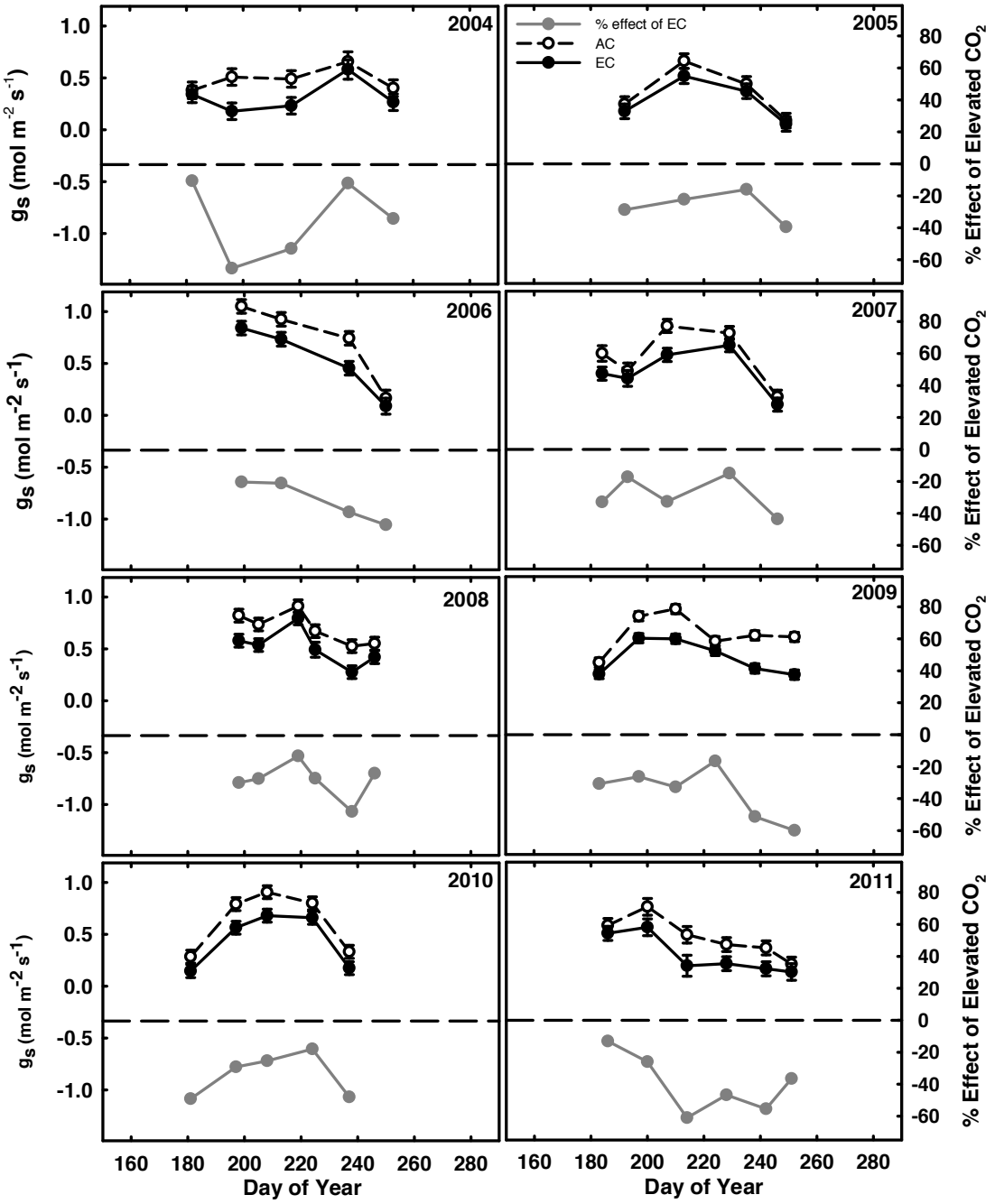


Supplementary Figure 3. Seasonal means of the difference between elevated [CO_2] and ambient [CO_2] in the timecourse of canopy temperature during daylight hours for the period when the canopy was closed (LAI>3) for soybean cv 93B15. 2008 data were unreliable due to sensor malfunctions and are excluded from analysis and figures. Results of statistical tests are reported in Supplementary Table 3.

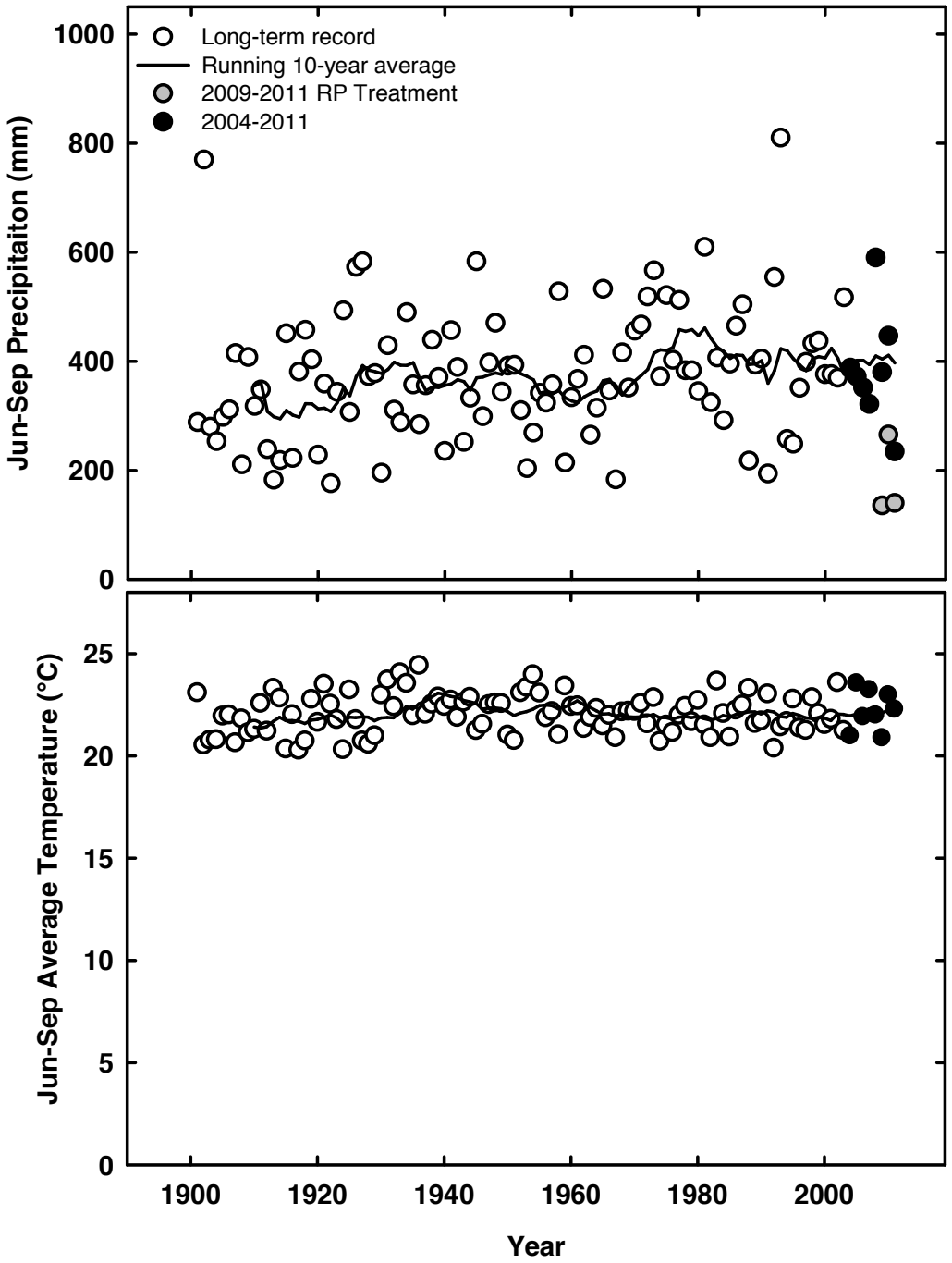


DOI: 10.1038/NPLANTS.2016.132

Supplementary Figure 4. Midday stomatal conductance (g_s) of soybean cv 93B15 grown ambient [CO_2] (open circles, dashed lines) and elevated [CO_2] treatment (filled circles, solid lines) from 2004 - 2011. Data shown are lsmeans ± standard errors. Grey circles and lines represent the % effect of elevated [CO_2] on g_s for each measurement date. Results of statistical tests are reported in Supplementary Table 4.

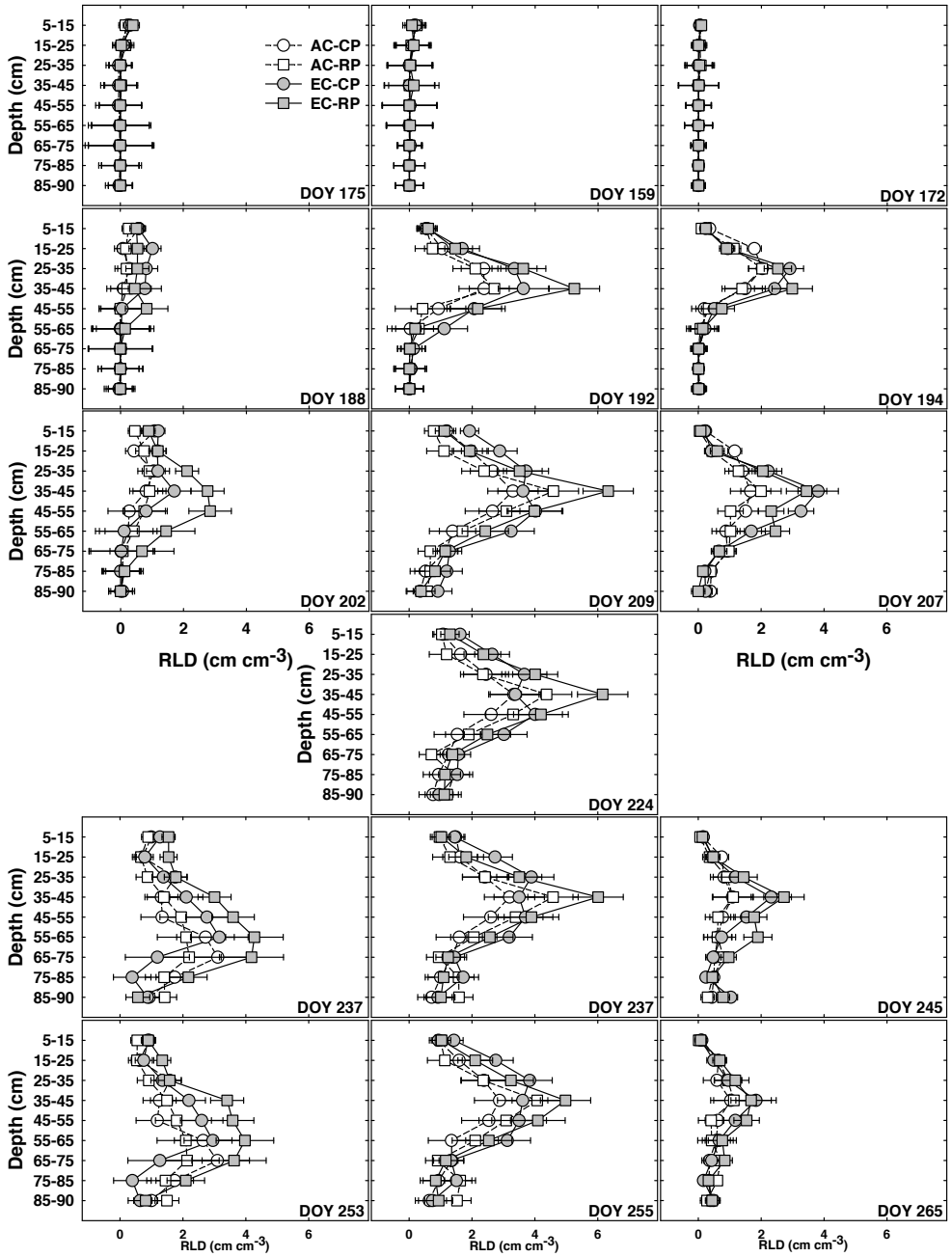


Supplementary Figure 5. Long-term record of June-September precipitation and daily average temperature in Urbana, IL. For both plots, open circles represent data from the long-term record for 1901-2003, while black circles represent temperature and precipitation (in control precipitation treatment) during 2004-2011. Grey circles represent precipitation in the reduced precipitation (RP) treatment for 2009-2011. The running 10-year average is represented by a black line in each plot.

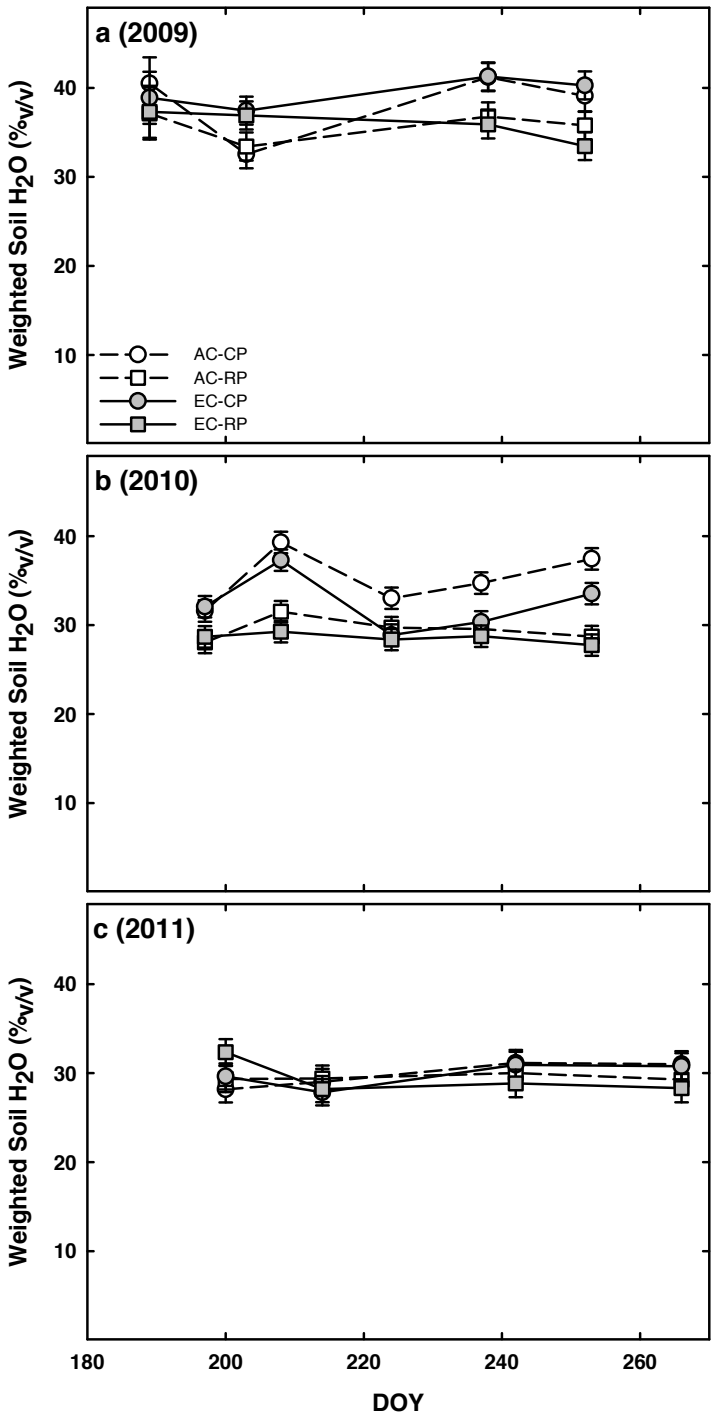


DOI: 10.1038/NPLANTS.2016.132

Supplementary Figure 6. Root length density (RLD; cm cm^{-3}) of soybean cv 93B15 at depths of 5-90 cm on mutliple days of year (DOY) in each of the 2009-2011 growing seasons. The sequence of measurement days within each season is shown from top to bottom in each column. Ambient [CO_2], control precipitation (AC-CP) is shown in white circles with dashed lines; ambient [CO_2], reduced precipitation (AC-RP) is shown in white squares with dashed lines; elevated [CO_2], control precipitation (EC-CP) is shown in grey circles with solid lines; elevated [CO_2], reduced precipitation (EC-RP) is shown in grey squares with solid lines. Data shown are lsmeans ± standard errors. Results of statistical tests are reported in Supplementary Table 7.

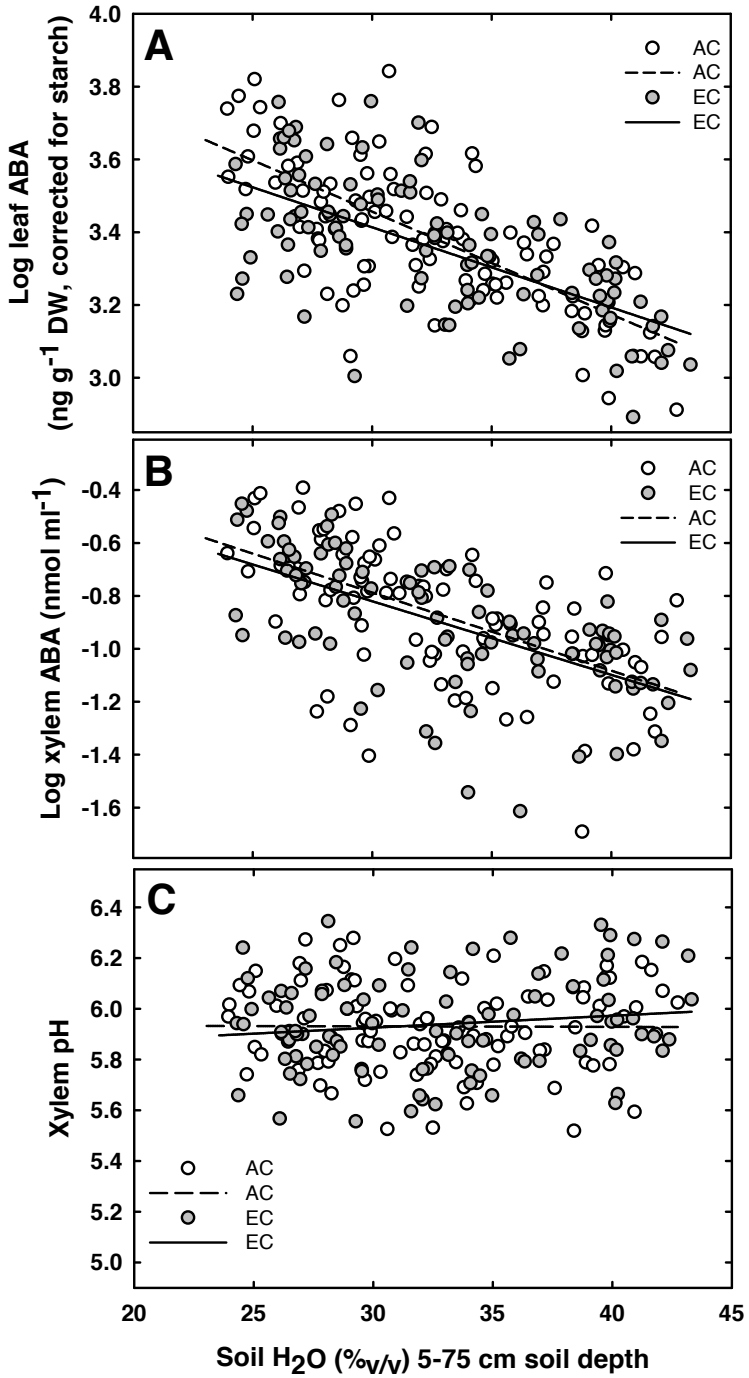


Supplementary Figure 7. Mean volumetric water content (soil $H_2O\%_{v/v}$) of the soil profile (5-90 cm) weighted by the proportion of root length in each of the 10-cm soil layers in plots of soybean cv 93B15. White circles and dashed lines represent ambient [CO_2], control precipitation (AC-CP); white squares with dashed lines represent ambient [CO_2], reduced precipitation (AC-RP); grey circles with solid lines represent elevated [CO_2], control precipitation (EC-CP); grey squares with solid lines represent elevated [CO_2], reduced precipitation (EC-RP). Symbols represent lsmeans ± standard error. Results of statistical tests are reported in Supplementary Table 8.

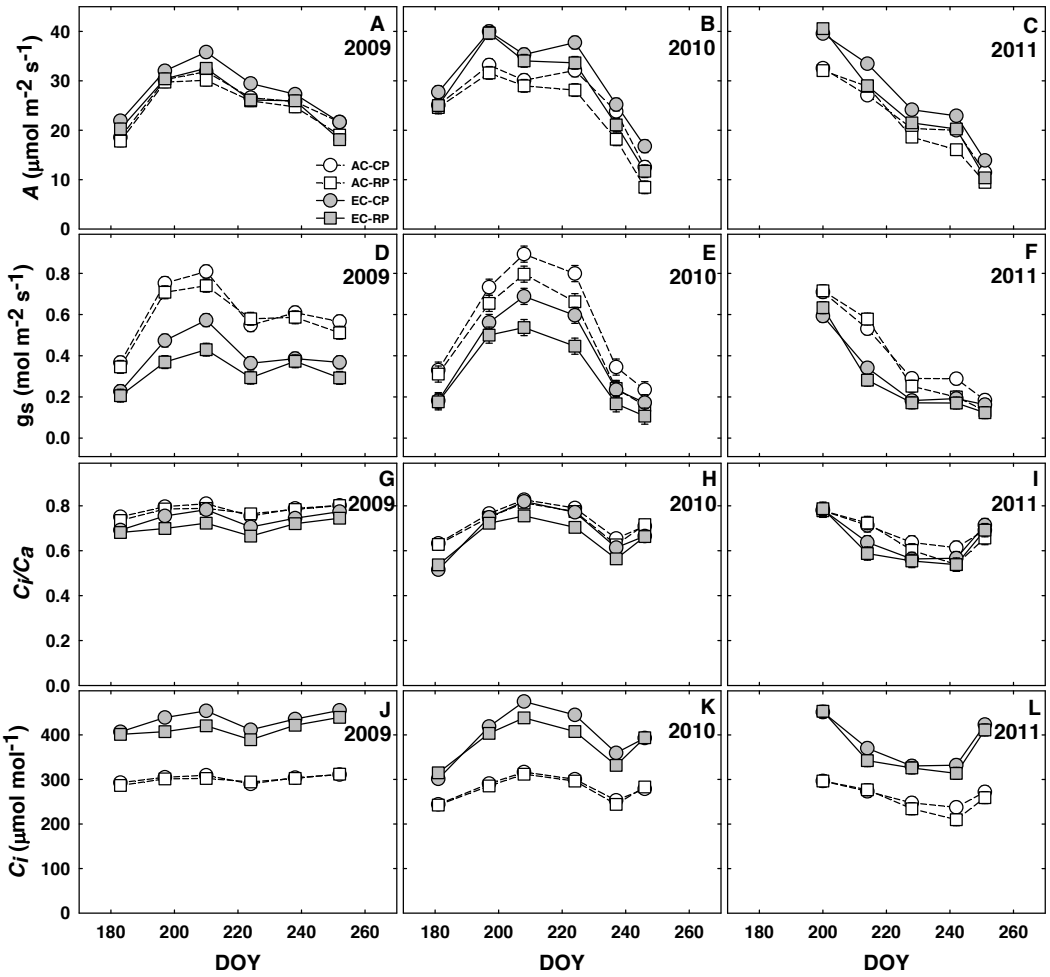


DOI: 10.1038/NPLANTS.2016.132

Supplementary Figure 8. Linear regression of: **(A)** log-transformed leaf [ABA] (ng g^{-1} dry weight, corrected for starch content;**(B)** xylem sap [ABA] (nmol ml^{-1}); and **(C)** xylem sap pH versus average soil $H_2O\%_{v/v}$ at 5-75 cm depth for soybean cv 93B15 in growing seasons 2009-2011. Points represent subplot means. Ambient [CO_2] data are shown in white, with dashed line of best fit (R^2=0.50, R^2=0.32, and R^2<0.0001 for panels A, B, and C, respectively), and elevated [CO_2] data are shown in grey, with solid line of best fit (R^2=0.42, R^2=0.39, and R^2=0.02 for panels A, B, and C, respectively. Statistical results of linear regression analysis are shown in Supplementary Table 10.



Supplementary Figure 9. Daily average photosynthetic carbon assimilation (*A*; μmol m^{-2} s^{-1}), stomatal conductance (*gs*; mol m^{-2} s^{-1}); ratio of leaf intercellular to atmospheric [CO_2] (*Ci/Ca*), and leaf intercellular [CO_2] concentration (*Ci*) for soybean cv 93B15. Ambient [CO_2], control precipitation (AC-CP) is shown in white circles with dashed lines; ambient [CO_2], reduced precipitation (AC- RP) is shown in white squares with dashed lines; elevated [CO_2], control precipitation (EC-CP) is shown in grey circles with solid lines; elevated [CO_2], reduced precipitation (EC-RP) is shown in grey squares with solid lines. Symbols represent lsmeans ± standard error. Results of statistical tests are reported in Supplementary Table 11.



DOI: 10.1038/NPLANTS.2016.132

Supplementary Figure 10. Maximum carboxylation capacity of Rubisco ($V_{c,max}$; panels A-D); maximum potential linear electron flux through photosystem II (J_{max}; panels E-H); and the ratio of $V_{c,max}/J_{max}$ (panels I-L) of soybean cv 93B15. All parameters were measured at 25°C. Symbols represent lsmeans ± standard error for individual measurement dates (A-C, E-G, I-K), or for seasonal means (D, H, L). Ambient [CO_2], control precipitation (AC-CP) is represented by white circles or white bars; ambient [CO_2], reduced precipitation (AC-RP) is represented by white squares or white bars with hatching; elevated [CO_2], control precipitation (EC-CP) is represented by grey circles or grey bars; and elevated [CO_2], reduced precipitation (EC-RP) is represented by grey squares or grey bars with hatching. Results of statistical tests are reported in Supplementary Table 12.