Supplemental Material

Table S1 Literature review of differential responses of production and respiration to drought in field observations and manipulative experiments across different biomes

Site	Biome type	Results	Mechanisms	Reference	Note
European forests and one grassland	Pine, oak, beech, spruce, fir, juniper, and grassland	In most sites, extreme drought induced more reduction in GPP than ER except a few Mediterranean ecosystems where the drought effect was smaller for GPP than ER	Not specified	Ciais et al., 2005	Eddy flux
East coast of japan	Temperate evergreen and deciduous broadleaved tree	GPP was reduced more than ER	Not specified	Kosugi et al., 2005	Eddy flux
Saskatchewan Canada	Southern boreal forests including aspen, spruce and jack pine	In aspen, first-year drought suppressed ER, but enhanced GPP whereas second- and third-year drought reduced GPP and ER with more reduction in GPP; In spruce and jack pine forests, drought did not significant affected GPP and ER	The enhanced GPP in aspen was due to warmer spring in that year; the lack of response to drought in the two coniferous forests was because of summer rainfall, low topographic position and low soil water holding capacity	Kljun et al., 2006	Eddy flux
European forests	Beech, Douglas-fir, Scots pine, Spruce, mixed coniferous	Drought inhibited GPP greater than ER	Not specified	Granier et al., 2007	Eddy flux
Hungaria	Semi-arid sandy grassland	Drought is more effective in reducing plant CO2 uptake than in reducing ER	Uncoupled heterotrophic respiration to photosynthesis is more resistant to drought	Nagy et al., 2007	Eddy flux
Southern Portugal	Evergreen oak woodland, grassland, and eucalyptus plantation	Severe drought affected more GPP than ER	Not specified	Pereira et al., 2007	Eddy flux

Interior Alaska, USA	Black spruce and aspen	GPP was reduced in the two forests, but ER increased	Drought-associated temperature increase might cause ER to rise	Welp et al., 2007	Eddy flux
Northwest Ohio, USA	Oak and red maple	Greater suppression of GPP than of ER by drought	Drought caused lower leaf area, lower apparent quantum yield and lower canopy conductance	Noormets et al., 2008	Eddy flux
Global network of eddy flux towers	Grassland, forest, shrubland, wetland, savannas	Overall, production is 50% more sensitive than respiration to drought, with a few exceptions	Not specified	Schwalm et al., 2010a	Eddy flux
Kendall grassland, USA	Semi-desert grassland	Drought reduced more gpp than ER	Not specified	Scott et al., 2010	Eddy flux
Southern Portugal	semi-natural Mediterranean grassland	Drought reduced GPP more than ER	Not specified	Jongen et al., 2011	Eddy flux
Western North America	Grassland, evergreen needle forest (ENF), woody savannas	GPP of grassland and ENF were more sensitive to drought, whereas in woody savannas GPP was less sensitive	Not specified	Schwalm et al., 2012	Eddy flux
Inner-Mongolia, China	Arid grassland	GPP was more sensitive to seasonal drought than ER	None but suggested drought might have lasted longer for assimilation than respiration in this ecosystem	Yang and Zhou, 2013	Eddy flux
Southwestern US	Ponderosa pine and grassland	GPP was more sensitive to summer drought than ER in the forest, but less sensitive in the grassland/shrubland	Not specified	Kolb et al., 2013	Eddy flux
France	Mediterranean evergreen oak forest	Drought inhibited GPP greater than ER	Shallow soil water content was not strongly affected by drought and thus soil respiration was less affected than GPP	Misson et al., 2010	Manipulative experiment
Wyoming, USA	High Plains Grassland	GPP was more sensitive to reduced rainfall than ER	Not specified	Chimner et al., 2010	Manipulative experiments
Northern Arizona	Desert grassland, pinyon-juniper, ponderosa pine forest, mixed conifer forest	Precipitation reduction did not impact both GPP and ER	Not specified	Wu et al., 2011	Manipulative experiments
Cairngorms, Scotland	Grassland	Drought reduced more reduction in GPP than in ER	Not specified	Johnson et al., 2011	Manipulative experiment
Southern California	Coastal grassland	Imposed drought reduced GPP more than ER	Not specified	Potts et al., 2012	Manipulative experiment

Table S2 Results (p values) of paired-sample T test in reduction of C variable (ΔNPP, ΔRh, ΔNEE, ΔSoil C) between the two drought types (even size reduction and reduced event number) in the four grassland sites

Sites	Konza	Hays	Cheyenne	Sevilleta
NPP	0	0	0	0
Rh	0	0	0	0
NEE	0	0.044	0.098	0.412
Soil C	0	0	0	0

Table S3 Slopes of the linear regression between rainfall and C variables (NPP, Rh, and NEE) in each of three rainfall scenarios, and the significance (p) in slope difference between ambient and rainfall treatments. "-" means not applicable.

	Sites	Konza		Hays		Cheyenne		Sevilleta	
	Rainfall scenarios	Slopes	p	Slopes	p	Slopes	p	Slopes	p
Rainfall vs. NPP	Ambient	0.16	-	0.27	-	0.15	-	0.24	-
	ESR	0.46	0.002	0.48	0.0016	0.23	0.0646	0.75	<.0001
	REN	0.55	0.0001	0.5	0.0011	0.23	0.0858	0.46	<.0001
Rainfall vs. Rh	Ambient	0.04	-	0.06	-	0.04	-	0.07	-
	ESR	-	-	-	-	-	-	-	-
	REN	-	-	-	-	-	-	-	-
Rainfall vs. NEE	Ambient	-0.14	-	-0.25	-	-0.12	-	-0.21	-
	ESR	-0.56	0.0005	-0.45	0.0076	-0.23	0.0443	-0.85	<.0001
	REN	-0.63	<.0001	-0.48	0.0028	-0.23	0.0309	-0.55	0.001

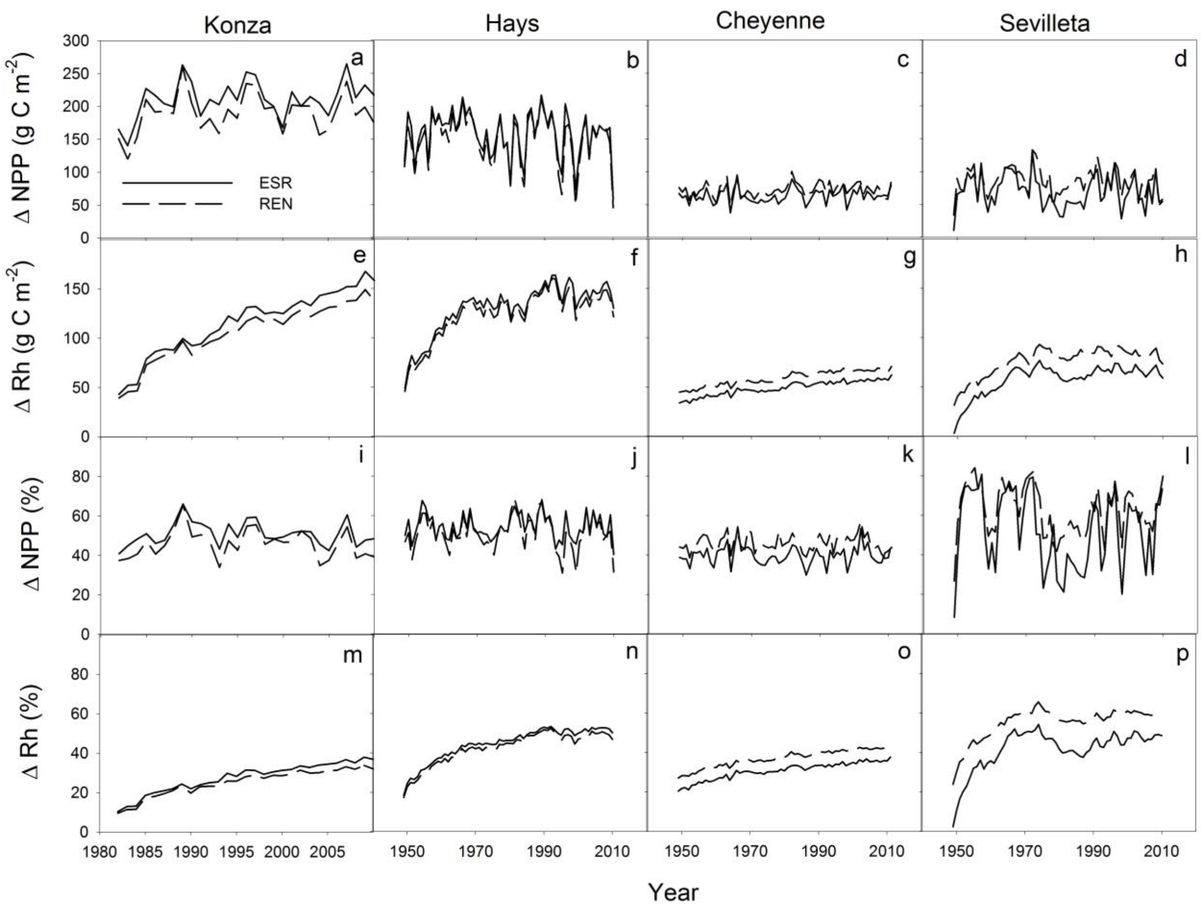

Figure S1 Drought-induced reductions in NPP and Rh along modeled years in four North American grasslands (Konza: a, e, i and m; Hays: b, f, j and n; Cheyenne: c, g, k and o; Sevilleta: d, h, l and p). ESR is rainfall event size reduction and REN is reduced rainfall event number. Solid line represents ESR treatment and dash line represents REN treatment.

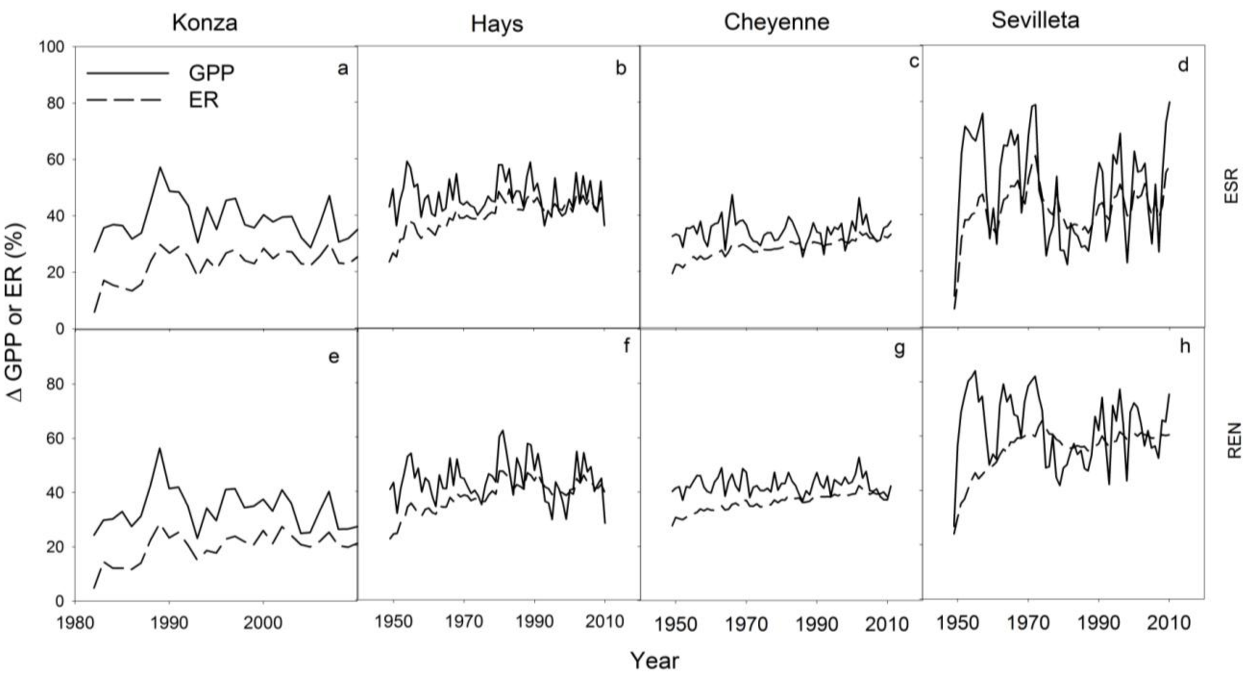

Figure S2 Drought-induced reductions in GPP and ER along modeled years in four North American grasslands (Konza: a and e; Hays: b and f; Cheyenne: c and g; Sevilleta: d and h). ESR is rainfall event size reduction and REN is reduced rainfall event number. Solid line represents GPP and dash line represents ER.