Supporting information

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

<table>
<thead>
<tr>
<th>Site</th>
<th>Biome type</th>
<th>Results</th>
<th>Mechanisms</th>
<th>Reference</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>European forests and one grassland</td>
<td>Pine, oak, beech, spruce, fir, juniper, and grassland</td>
<td>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</td>
<td>Not specified</td>
<td>Cias et al., 2005</td>
<td>Eddy flux</td>
</tr>
<tr>
<td>East coast of Japan</td>
<td>Temperate evergreen and deciduous broadleaved tree</td>
<td>GPP was reduced more than ER</td>
<td>Not specified</td>
<td>Kosugi et al., 2005</td>
<td>Eddy flux</td>
</tr>
<tr>
<td>Saskatchewan Canada</td>
<td>Southern boreal forests including aspen, spruce and jack pine</td>
<td>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</td>
<td>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</td>
<td>Kljun et al., 2006</td>
<td>Eddy flux</td>
</tr>
<tr>
<td>European forests</td>
<td>Beech, Douglas-fir, Scots pine, Spruce, mixed coniferous</td>
<td>Drought inhibited GPP greater than ER</td>
<td>Not specified</td>
<td>Granier et al., 2007</td>
<td>Eddy flux</td>
</tr>
<tr>
<td>Hungaria</td>
<td>Semi-arid sandy grassland</td>
<td>Drought is more effective in reducing plant CO2 uptake than in reducing ER</td>
<td>Uncoupled heterotrophic respiration to photosynthesis is more resistant to drought</td>
<td>Nagy et al., 2007</td>
<td>Eddy flux</td>
</tr>
<tr>
<td>Southern Portugal</td>
<td>Evergreen oak woodland, grassland, and eucalyptus plantation</td>
<td>Severe drought affected more GPP than ER</td>
<td>Not specified</td>
<td>Pereira et al., 2007</td>
<td>Eddy flux</td>
</tr>
<tr>
<td>Location</td>
<td>Species/Environment</td>
<td>Results</td>
<td>Change in Production</td>
<td>Method</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Interior Alaska, USA</td>
<td>Black spruce and aspen Oak and red maple</td>
<td>GPP was reduced in the two forests, but ER increased</td>
<td>Drought-associated temperature increase might cause ER to rise</td>
<td>Welp et al., 2007 Eddy flux</td>
<td></td>
</tr>
<tr>
<td>Northwest Ohio, USA</td>
<td></td>
<td>Greater suppression of GPP than of ER by drought</td>
<td>Drought caused lower leaf area, lower apparent quantum yield and lower canopy conductance</td>
<td>Noormets et al., 2008 Eddy flux</td>
<td></td>
</tr>
<tr>
<td>Global network of eddy flux towers</td>
<td>Grassland, forest, shrubland, wetland, savannas</td>
<td>Overall, production is 50% more sensitive than respiration to drought, with a few exceptions</td>
<td>Not specified</td>
<td>Schwalm et al., 2010 Eddy flux</td>
<td></td>
</tr>
<tr>
<td>Kendall grassland, USA</td>
<td>Semi-desert grassland</td>
<td>Drought reduced more GPP than ER</td>
<td>Not specified</td>
<td>Scott et al., 2010 Eddy flux</td>
<td></td>
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<tr>
<td>Southern Portugal</td>
<td>semi-natural Mediterranean grassland</td>
<td>Drought reduced GPP more than ER</td>
<td>Not specified</td>
<td>Jongen et al., 2011 Eddy flux</td>
<td></td>
</tr>
<tr>
<td>Western North America</td>
<td>Grassland, evergreen needle forest (ENF), woody savannas</td>
<td>GPP of grassland and ENF were more sensitive to drought, whereas in woody savannas GPP was less sensitive</td>
<td>Not specified</td>
<td>Schwalm et al., 2012 Eddy flux</td>
<td></td>
</tr>
<tr>
<td>Inner-Mongolia, China</td>
<td>Arid grassland</td>
<td>GPP was more sensitive to seasonal drought than ER</td>
<td>None but suggested drought might have lasted longer for assimilation than respiration in this ecosystem</td>
<td>Yang and Zhou, 2013 Eddy flux</td>
<td></td>
</tr>
<tr>
<td>Southwestern US</td>
<td>Ponderosa pine and grassland</td>
<td>GPP was more sensitive to summer drought than ER in the forest, but less sensitive in the grassland/shrubland</td>
<td>Not specified</td>
<td>Kolb et al., 2013 Eddy flux</td>
<td></td>
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<tr>
<td>France</td>
<td>Mediterranean evergreen oak forest</td>
<td>Drought inhibited GPP greater than ER</td>
<td>Shallow soil water content was not strongly affected by drought and thus soil respiration was less affected than GPP</td>
<td>Misson et al., 2010 Manipulative experiment</td>
<td></td>
</tr>
<tr>
<td>Wyoming, USA</td>
<td>High Plains Grassland</td>
<td>GPP was more sensitive to reduced rainfall than ER</td>
<td>Not specified</td>
<td>Chimner et al., 2010 Manipulative experiments</td>
<td></td>
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<tr>
<td>Northern Arizona</td>
<td>Desert grassland, pinyon-juniper, ponderosa pine forest, mixed conifer forest</td>
<td>Precipitation reduction did not impact both GPP and ER</td>
<td>Not specified</td>
<td>Wu et al., 2011 Manipulative experiments</td>
<td></td>
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<tr>
<td>Cairngorms, Scotland</td>
<td>Grassland</td>
<td>Drought reduced more reduction in GPP than in ER</td>
<td>Not specified</td>
<td>Johnson et al., 2011 Manipulative experiment</td>
<td></td>
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<tr>
<td>Southern California</td>
<td>Coastal grassland</td>
<td>Imposed drought reduced GPP more than ER</td>
<td>Not specified</td>
<td>Potts et al., 2012 Manipulative experiment</td>
<td></td>
</tr>
</tbody>
</table>
Table S2 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.

<table>
<thead>
<tr>
<th>Sites</th>
<th>Rainfall vs. NPP</th>
<th>Rainfall vs. Rh</th>
<th>Rainfall vs. NEE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Konza</td>
<td>Hays</td>
<td>Cheyenne</td>
</tr>
<tr>
<td>Rainfall scenarios</td>
<td>Slopes</td>
<td>p</td>
<td>Slopes</td>
</tr>
<tr>
<td>Ambient</td>
<td>0.16</td>
<td>-</td>
<td>0.27</td>
</tr>
<tr>
<td>ESR</td>
<td>0.46</td>
<td>0.002</td>
<td>0.48</td>
</tr>
<tr>
<td>REN</td>
<td>0.55</td>
<td>0.001</td>
<td>0.5</td>
</tr>
<tr>
<td>Ambient</td>
<td>0.04</td>
<td>-</td>
<td>0.06</td>
</tr>
<tr>
<td>ESR</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>REN</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ambient</td>
<td>-0.14</td>
<td>-</td>
<td>-0.25</td>
</tr>
<tr>
<td>ESR</td>
<td>-0.56</td>
<td>0.0005</td>
<td>-0.45</td>
</tr>
<tr>
<td>REN</td>
<td>-0.63</td>
<td>&lt;.0001</td>
<td>-0.48</td>
</tr>
</tbody>
</table>
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