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Biogeosciences Discussions

Interactive comment on "Response of temperate grasslands at different altitudes to simulated summer drought differed but scaled with annual precipitation" *by* A. K. Gilgen and N. Buchmann

Anonymous Referee #2

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General Comments

The author's evaluate the impact of experimentally imposed drought on grasslands along an altitudinal gradient in Switzerland. In general, the paper is nicely written and well organized. The topic of the paper is highly relevant. The main conclusion is that sites with lower annual precipitation are more susceptible to summer drought. As mentioned by the authors, this result was somewhat unexpected and considerable discussion was used to rationalize the findings. However, the experiment suffered from a critical flaw in design that probably created misleading results. The rain shelters were only 3x3.5 m in area and no subsurface barriers were installed at the chambers pe-

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riphery. Thus, it is highly probably that rainfall and subsequent infiltration of water in the area next to the chambers resulted in horizontal water flow under the shelters. The authors only monitored soil moisture from 5 to 30 cm so there is no way to determine if roots below 30 cm were absorbing water that came from outside the shelter. The encroachment of water at lower depths is especially likely at sites with greater rainfall and less probable at drier sites. This is probably why the Fruebuel site always showed greater productivity under the "drought imposing" shelter (lower evaporative demand by plenty of subsurface soil water). That is, at Fruebuel, the shelters where not imposing a drought but actually creating more favorable plant water relations. The potential for subsurface horizontal water flow was less likely at the drier sites – locations that showed lower productivity under the shelter. Thus, the main conclusion of the paper is likely the result of the relative effectiveness of the shelters at sites with different precipitation. The findings are probably not an ecophysiological response to drought, but an artifact of the flawed experimental design . If different rain shelters had been used, the results might have been exactly opposite of what the authors observed. Unless the authors can present additional data to address this concern, the paper should not be published as presented here.

Specific Comments

P 5220, L 23-24. The lack of grazing or mowing of the plots would seem to have important consequences on the results and interpretation. Are not these grasslands normally grazed or used for hay production. Please explain the potential implications of not removing any aboveground biomass over the course of the study.

P5221 amd Table 1. More discussion of the soils and vegetation among sites is needed. Most important is the soil profiles characteristics (water holding capacity, % clay, etc). Also, it would be nice to know the historical max LAI at these sites. Please add information on rooting depth at each site.

Table 2. Please add another column with the long-term historical avg. precipitation at

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each site.

P5221. The design of the rainfall shelters appears to be inadequate. The shelters are small (3 x 3.5 m). Rain outside the shelter could have infiltrated and moved horizontally under the shelter by unsaturated or saturated flow (saturated flow is especially likely if the site had even a mild slope). The investigators only used the 1 x 2m interior for the sampling to avoid edge effects. However, it is likely that water moved horizontally under the entire sheltered area at lower portions of the profile. We have conducted experiments of this type and found that its very difficult to prevent horizontal water movement at deeper depth of the profile – even when horizontal barriers were used to depth of 1 m. The researchers indicate that soil water was only measured to depth of 30 cm so they do not know if rood below 30 cm were tapping water lower in the profile – water that could have be transported from outside the shelter. Thus, plants in the 1x2 m sampling area may not have been water stressed, especially at the higher rainfall sites. This weakness in the shelter design could have greatly confounded the results.

P5223. What was the rooting depth among sites. P5223. Did you calibrate the LI-2000 using areas outside the shelter (make LI-2000 measurements and then harvest). This is very important when comparing sites with different canopy structure and size.

Fig. 1. The precipitation data is very hard to view in the plots. Likewise, Tair, Tsoil, and PAR don't provide much information and and not integral to the discussion. Perhaps only precipitation and soil moisture should be shown at larger scales.

P5226, L14-15. This statement seems illogical – would you not expect greater impact of the shelter in wet climates. The use of "% reductions" to describe the results is misleading, especially on a variable like soil moisture that is bounded by zero. For example, if the shelter had be used in a desert, perhaps the water content would have be changed from 10 to 5 m3/m3 – a reduction of 50 % but the effect on desert vegation would have likely been trivial. In a mesic ecosystem, the rainout shelter might have reduced water content from 30 to 15 m3/m3 – again a 50 % reduction but the effect

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on vegetation would have been dramatic. It would have been better to describe the drought treatment as -5 m3/m3 in the desert and -15 m3/m3 in the mesic zone. In the study, it would be better to describe the reductions in soil water in terms of mass and/or volume of the water.

P5227, L3. At the Fruebuel site the biomass under the shelter was always greater. It is likely that lower radiation and perhaps lower wind speeds reduced evaporative demand but undocumented horizontal movement of water under the shelter kept the plants well watered – especially those species with deeper roots. So the plants under the shelter actually had less water stress and greater productivity – opposite of the desired treatment effect.

Fig. 4, P5230. Why was the root depth pooled with the aboveground data – or does the area under zero line represent belowground biomass. If so, the number on the y-axis label shoud still be positive , not 200 to -800. Please explain.

Interactive comment on Biogeosciences Discuss., 6, 5217, 2009.