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Biogeosciences Discussions

Interactive comment on "Large regional-scale variation in C3/C4 distribution pattern of Inner Mongolia steppe is revealed by grazer wool carbon isotope composition" *by* K. Auerswald et al.

Anonymous Referee #1

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General comments

The manuscript by Auerswald et al. builds upon prior efforts to collect carbon isotope data from a variety of sources to infer variations in the C3/C4 composition of Mongolian grasslands. This is a very interesting and useful contribution. Using organic matter pools (vegetation and wool samples) to infer C4 fractions is an obvious strength of the study, as its large geographic extent. The geostatistical techniques are novel for this particular application, although they could use a little more explanation and justification. Terms from the geo-statistical literature are likely to be unfamiliar to most readers.

The introduction and results section (#4.4), where the authors set their observations

within an ecophysiological context, is useful and interesting. Too often, people will report a relationship like that between C4 percentage and temperature, and then not try to explain or justify it based on our ecological knowledge. So this section is a refreshing change. However, the discussion needs some refreshing to accord with the latest ecophysiological understanding of C3 and C4 competition and ecological sorting. Specifically, the discussion should refer to the photorespiration effect on net C3 photosynthesis across a range of light levels (from light limited to light saturated). While it is true that a higher quantum yield should translate to a higher efficiency of light utilization, and thus a higher capacity for growth and reproduction, this is only true if most carbon gain occurs under light-limited conditions (see the discussion in Collatz et al. 1998, as well as in Still et al. 2003 Glob. Biogeochem. Cycle, and in Sage and Kubien 2003 Photosynth. Res.). The quantum yield in C3 plants decreases sharply with increasing temperature, reflecting the sharp increase in photorespiration (the wasteful oxygenase reaction in Rubisco).

The quantum yield in C3 plants is thus directly proportional to photorespiratory inhibition, which occurs at all light levels a plant experiences, and thus the quantum yield-based crossover model is most likely a proxy for the underlying physiological determinant of C3 and C4 ecological sorting along temperature gradients. Indeed, the modeled crossover temperature for both light-limited and light-saturated (i.e., Rubisco-limited) photosynthesis (not just quantum yield) falls within the quantum yield crossover temperature range of ˜21-24 C (Still et al. 2003). These combined effects likely explain the fundamental mechanism influencing C3/C4 distributions (Sage and Kubien 2003).

Specific comments to authors Page 550, lines 23-29 Describe in more detail your paired hair-vegetation sampling so readers do not have to consult the Zhao et al. (2007) paper.

Page 555, line 24 Remove the word Evidently from the beginning of the sentence.

Page 556, line 11 Delete one repetition of area in this sentence.

BGD

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Interactive Comment

Page 557, lines 14-15 Yes, but the temperature also probably decreases with increasing MAP; thus the two effects are confounded.

Page 560, line 20 This sentence is too strong. The direct competition is not controlled just by these factors (this statement would need to include a variety of other factors and processes to be correct). You should re-state it o

Page 561, lines 5-6 You should cite Taubs work in the American Journal of Botany (2000).

Page 561, line 7 I think you mean the 13C discrimination will decrease with precipitation as the proportion of NADP-ME species (with lower 13C discrimination) increases.

Interactive comment on Biogeosciences Discuss., 6, 545, 2009.