

Interactive comment on “Non-additive effect of day and night warming on soil respiration in a temperate steppe” by J. Xia et al.

Anonymous Referee #1

Received and published: 7 June 2009

General comments

This paper describes an interesting study addressing differential effects of day vs. night warming on soil respiration. The paper shows that nighttime warming potentially has very different (opposite) effects on soil respiration and gross ecosystem exchange than daytime warming and that effects of night- and daytime warming are not additive. The authors ascribe these differential effects to substrate supply and use net photosynthesis and net ecosystem exchange measurements as supporting evidence. Overall, the study is well executed and the results are interesting. The introduction makes a clear case for the need of studying effects of day- vs. nighttime warming on ecosystem processes and as such this paper represents an interesting contribution to the existing literature on effects of climate change on soil respiration. Overall, the methods are

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clear and the experiment appears to be well designed and thought out. There were a few issues however that I feel need to be addressed. One issue that is not discussed is the fact that net ecosystem exchange (NEE) and ecosystem respiration (RE) were only measured during the daytime while other parameters were measured around the clock so inferences made about gross ecosystem exchange (GEE) and correlations between various parameters and GEE are based only on daytime measurements. The overall conclusion appears to be that GEE increases with nighttime warming and decreases with daytime warming. This may be true but how about effects of day- and nighttime warming on nighttime GEE? Soil respiration obviously represents the belowground part but what about aboveground nighttime respiration? This aspect is not discussed so I would be a little bit careful about making sweeping statements regarding GEE. Another issue that was somewhat confusing to me was that the authors claim that effects of day and nighttime warming are non-additive. Yet, when looking at the ANOVA results presented in Table 1, effects on absolute rates appear to be additive since no interactions between day- nighttime warming are found. It appeared that the authors base their analysis on the regressions of observed vs. predicted GEE as presented in Fig. 5. This may be correct but this is not in agreement with the ANOVA results. In addition, it was not entirely clear what data were used for the ANOVAs compared to the data used in Fig 5. In the ANOVA did the authors use all data from all rings at every single measurement time or were data aggregated in some way? I assume each plot was used as an experimental unit and the two measurements conducted in each plot were averaged. In the discussion the authors mention using a repeated-measures ANOVA while the ANOVA carried out to produce the results presented in Table 1 does not appear to be a repeated-measures ANOVA according to the methods section. Why was one chosen over the other?

Specific comments

Page 4389, line 4-7: Do the authors have estimates for % cover and/or biomass for these species? This would be helpful to know in order to determine how representative

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the leaf-level gas exchange data measured for *S. Krylovii* were on an ecosystem level. The authors state that *S. Krylovii* it is the dominant species but this is rather vague.

Page 4389, line 20-21: What ecosystem C fluxes were compared?

Page 4390, line 15: I assume the soil moisture was volumetric. This would be good to add.

Page 4390, line 19-20: Why was GEE only measured during the daytime while all other parameters were measured during the night as well? I can understand there were logistical issues that prevented the authors from measuring GEE at night but for the overall story it is important to emphasize that GEE was not measured during the night. Potentially, increased GEE during the day in response to nighttime warming could be offset by increased RE during the night.

Page 4391, line 12-13: The authors mention that GEE is measured as the difference between NEE and ER. This would be the case if either NEE or ER were considered to be negative. The general convention would be though that $NEE = GEE - RE$. As a result GEE would equal $NEE + RE$.

Page 4392, line 23: More details are needed on the ANOVA analysis in terms of number of replicates, temporal/spatial aggregation of data, etc. It looks like annual data were used. If so, why didn't the authors include monthly data? It would have been interesting to determine during what time of the year effects of treatments were most prevalent.

Page 4393, line 1-3: I am not convinced that volumetric moisture measurements are accurate enough to make a distinction between 0.31% and 0.39% changes in soil moisture. In addition, the ANOVA results suggested no difference in response between day- and nighttime warming so I would not emphasize these small, if at all measurable, changes. In addition, given the already low soil moisture, are reductions by 0.3% ecologically relevant. In the discussion, the authors discuss the possibility that direct

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effects of increases in temperature are off-set by temperature-induced reductions in soil moisture. Yet, changes in moisture seem rather small.

Page 4393, line 8: The % changes in GEP mentioned in the text do not appear to match those presented in Fig. 1. Especially, according to Fig. 1 the changes in GEP in response to nighttime warming seems to be much larger than 4.24%. Perhaps the y-axis on the right side of the graph is off.

Page 4393, line 15: The authors talk about seasonal mean soil respiration. It was unclear how the authors defined the seasons. It almost appears that the authors talk about annual mean soil respiration rather than seasonal. In Fig. 2 it would be helpful to include some indication of significant differences between the treatments for each month using different letters identifying significant differences. Even though some of the statistical analyses indicate overall significant differences, it would be informative to know if these differences occur throughout the year or if they are restricted to certain periods. One possibility explaining the absence of any significant effects of day warming on soil respiration may be that relative effects of temperature are higher at low temperatures, i.e. a 4 degree increase in temperature has a larger effect when the ambient temperature is 2 degrees vs. 30 degrees.

Page 4393, line 22: What do the authors mean with pooling all data together? Do the authors mean to say that they used all data including control and treatment data? Were the relations between soil respiration, temperature, moisture and GEE the same for control and warming treatments?

Page 4394, line 3-22: Although the authors show several significant correlations between soil respiration, temperature, moisture, and GEE, many of these parameters explain a relatively low amount of the variability. In the discussion, the authors emphasize that the substrate supply may be an important factor in explaining differential day- and nighttime warming effects. This may be true but still GEE (which is used as a proxy for substrate supply) only explains 21% of the spatial variation observed in soil

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respiration. As a result I would be a little bit careful with emphasizing this too much.

Page 4397, line 20-22: The authors discuss presence/absence of additive effects of day and night warming on GEE stating that effects are non-additive. However, according to the ANOVA presented in Table 1 there were no interactions so the analysis presented in Fig. 5 appears to contrast the ANOVA results. This needs to be clarified and explained. Why do these analyses come up with different results? Looking at Fig 5 I was wondering if the individual regressions were significant given the large amount of scatter and the regression between observed and predicted appears to be highly non-linear.

Page 4398, line 2: The authors present results from a repeated-measures ANOVA. How is this analysis different from the ANOVA presented in Table 1? Since the same measurement locations are being used for GEE and soil respiration, repeated-measures ANOVA would be appropriate for these parameters.

Minor comments

Title: I would probably change the title to 'Differential effect of day and night'

Page 4386 line 6: Replace 'neutral' with 'no'. line 9: Insert 'of increased temperature' after 'positive effects'. line 16: Insert 'most likely' after 'was'.

Page 4387 line 2: Insert 'surface' after 'land'? line 4-5: Delete 'it is theoretically reasonable to expect' and replace 'can' by 'may'. line 6: Replace 'consequent' by 'subsequent'. line 18: Add 'to date' after "However" and replace 'were' by 'have been'. line 20: Insert 'been' after 'have'. line 26: Replace 'in combination' with 'combined' and insert 'of' after 'effects'.

Page 4388 line 13-15: Remove the symbols for the different treatments and insert these in the methods section. line 16: Replace 'record' with 'data records'. Replace 'that' with 'the'. line 18: Replace 'contradictory' by 'opposite' or 'differential'. line 20: Delete 'whether'. line 22: Replace 'drives' with 'what are the main drivers for'

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Page 4389 Line 8: Replace 'distributing' with 'of the precipitation falling' How much of the precipitation falls as snow? Line 14-16: Insert the symbols for the various treatments. Line 16: Insert 'each treatment was' before '6 times'.

Page 4390 Line 7: Start sentence with 'A'. Line 9: Start sentence with 'Any' and delete '(if there are)'. Line 13: Delete 'Diurnal cycle'. Line 27: Delete 'some'.

Page 4391 Line 25: Start sentence with 'Effects of the experimental treatments on soil respiration were presented. . .'. Line 27: Replace 'with' by 'compared to'.

Page 4392 Line 3: Replace 'whether' by 'to determine if'. Line 4: Replace 'infers' by 'suggest'. Line 7: Delete the second 'and'. Line 11: Delete 'the depth of' and add 'depth' after 'cm'. Line 19: Replace 'increased greater' by 'showed a large increase'. Line 21: Replace 'to affect' by 'on'.

Page 4393 Line 1: Replace 'slight' by 'slightly'. Line 4: Replace 'to influence' by 'on'. Line 17: Delete 'its'.

Page 4395 Line 16: Replace 'aggravate' by 'exacerbate'.

Page 4396 Line 11: Delete 'In'. Line 19: Insert 'the' before 'Southeastern'.

Page 4397 Line 14: Replace 'could' by 'should' and replace 'additively' by 'additive'. Line 22: Not sure if 'antagonistic' is the right word here.

Page 4398 Line 4: Insert 'be' after 'could'.

Page 4399 Line 20: Replace 'helps' by 'help'.

Interactive comment on Biogeosciences Discuss., 6, 4385, 2009.

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