Biogeosciences Discuss., 11, C8260–C8269, 2015
www.biogeosciences-discuss.net/11/C8260/2015/


Biogeosciences
Discussions
Open Access

# *Interactive comment on* "Vegetation heterogeneity and landscape position exert strong controls on soil $CO_2$ efflux in a moist, Appalachian watershed" *by* J. W. Atkins et al.

**J. W. Atkins et al.**

jeffatkins@virginia.edu

Received and published: 23 January 2015

AUTHOR RESPONSE:

We would like to thank Dr. Bond-Lamberty for reviewing our manuscript and offering constructive comments and suggestions. We have included an annotated response to the points highlighted in his review along with a revised/marked-up copy of the BGD version of the manuscript reflecting Dr. Bond-Lamberty's suggestions.

REPLY TO GENERAL COMMENTS

"There are a number of significant problems, however. First, this is an observational



study, and the authors need to be much more careful about (not) inferring casuality–starting, for example, with the ms title! You have no proof that vegetation and position "exert strong controls" on Fsoil, only that they're correlated with it."

This study is in fact an observational study. We agree that inferring causality where and when it cannot be tested is an issue. We suggest changing the title to "Vegetation heterogeneity and landscape position influence soil CO2 efflux in a moist, Appalachian watershed."

"In a similar vein, the landscape position "treatment" (see note #6 below) seems to be unreplicated (one high area, one mid area, one low area), so need to be doubly careful with this."

As highlighted in response to specific comments later, we have clarified our study design to note that our elevation levels have been reconsidered as a "classes" rather than treatments as we are not making direct manipulations or pre/post treatments. We feel that discretizing the landscape into these three elevation classes, as explained in the manuscript, accurately represents our watershed.

"Much of the analysis hinges around breaking the Fsoil at 11 âŮęC, for example, but it's unclear why this point was selected–this really needs to be done in a reproducible, i.e algorithmic, way."

This point is a valid one and is discussed at length in response to specific comment no. 9.

"In addition, I don't understand why Fsoil wasn't tested *directly* against bulk density, PAI, etc., rather than simply against the elevation and vegetation categories."

This is an excellent suggestion that we feel adds to this paper. We have run these tests and will include them as in an additional supplement to this author comment and plan to incorporate them into the revised manuscript if they meet approval (these are added here as Figure 3).

REPLY TO SPECIFIC COMMENTS

1. Page 17632, line 9-10: no need to give data source in abstract

-This has been eliminated in the supplement.

2. P. 17632, l. 15: don't define Fsoil again

-This has been corrected.

3. P. 17632, l. 23-26: odd sentence, feels out of place

–Original sentence:

"With possible changing rainfall patterns as predicted by climate models, it is important to understand the couplings between water and carbon cycling at the watershed and landscape scales, and their potential dynamics under global change scenarios."

The intent is to highlight the necessity for understanding the coupling between carbon and water cycling in areas of significant topographic complexity that are predicted to be subject to changing rainfall patterns in the future. Or rather, to bring attention to what we see as an important scientific consideration and ecological issue. We have reworded the preceding sentence slightly and omitted the sentence in question in the revised manuscript attached as a supplement to this comment.

4. P. 17633, l. 1-10: confusing start. Why define separate Rsoil and Fsoil terms? What is your definition of Rsoil, exactly, if different from Fsoil?

- P. 17633 lines 9 – 13:

" RSOIL can be estimated in the field by measuring soil CO2 efflux (FSOIL) the direct rate of CO2 crossing the soil surface over a period of time (Raich and Schlesinger, 1992). FSOIL can vary spatially and temporally within and across systems as a result of the varied and complex interactions of controlling mechanisms (Drewitt et al., 2002; Trumbore, 2006; Vargas et al., 2010)."



We are considering RSOIL to be soil respiration, i.e. the integrative term of annual CO2 leaving the soil surface wheras FSOIL we are defining as a measurement of soil CO2 efflux. We have attempted to clarify this in the revised manuscript supplement.

5. Introduction generally – long and wanders a bit. I suggest you focus more tightly and concisely on relevant issues

- Parts of the introduction have been eliminated in order to try to parse down length and focus the narrative.

6. P. 17637, l. 19 and throughout: I'm quite uncomfortable referring to these as "treatments" – this is, as far as I can tell, a purely observational study

- The term "class" will be used in lieu of "treatments" as you are correct, no direct manipulations were made and these are observed areas being compared against each other based on a set criteria.

7. P. 17639, l. 8: "cm-3"

- Corrected.

8. P. 17641, l. 1-10: when were these measurements performed?

- Samples were taken during the summer of 2012. Noted in revised supplement.

9. P. 17641, l. 16-: what's your justification for breaking the data this way, at 11 âŮęC? It seems like this was done by judgment, as opposed to reproducibly. There are established statistical procedures for determining optimum change-points

- We have expanded upon this in the revised manuscript, but wanted to expand on that choice here as the analysis in our manuscript hinges on this choice. Our primary reason was to focus on soil CO2 fluxes during periods when fluxes were not temperature limited as we feel the more pressing and interesting ecological question is what controls fluxes across our watershed during periods when temperature may be less of a limiting factor? We have integrated a few methods that have now been added to the revised manuscript supplement attached that we would like to expand on more here.

1) METHOD ONE – Mean Soil Temperature

By fitting a fourth-order polynomial curve to data (soil temperature against Julian day) we see that the period of the year where the mean measured soil temperature at 12 cm is above 11°C degree corresponds to May 6 – October 13 (Figure 1). This period of ~160 days allows for inclusion of the growing season along with a slight buffer on either end that would include early/late season dynamics of relevance. Abbreviated code and out below (full code on GitHub–link in comment below)

POLYNOMIAL MODEL DETAILS AND OUTPUT FROM R:

lm(formula = CVI$TEMP ~ poly(CVI$JD, 4, raw = TRUE))

Residuals: Min 1Q Median 3Q Max -5.0432 -0.8732 0.1255 0.9784 4.9854

Coefficients: Estimate Std. Error t value Pr(>|t|) (Intercept) 3.792e+00 5.785e-01 6.554 9.38e-11 *** poly(CVI$JD, 4, raw = TRUE)1 -1.671e-01 2.052e-02 -8.144 1.26e-15 *** poly(CVI$JD, 4, raw = TRUE)2 3.226e-03 2.194e-04 14.701 < 2e-16 *** poly(CVI$JD, 4, raw = TRUE)3 -1.352e-05 8.961e-07 -15.092 < 2e-16 *** poly(CVI$JD, 4, raw = TRUE)4 1.611e-08 1.242e-09 12.970 < 2e-16 *** — Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.523 on 904 degrees of freedom Multiple R-squared: 0.8675, Adjusted R-squared: 0.867 F-statistic: 1480 on 4 and 904 DF, p-value: < 2.2e-16

2) METHOD 2 - Piecewise Regression

Using the segmented package in R, we conducted a piecewise regression meant to identify breakpoints in data based on change in slope. The natural log of our soil CO2 efflux values, indicated as ln(FLUX) in the included model information, we regressed against soil temperature (°C). The piecewise regression returns an estimated temperature breakpoint of 11.58 ± 0.4781 SE with an R2 of 0.6294 (Figure 2–which admittedly



looks a bit wonky here). This fits well with our 11°C threshold. Model output and abbreviated code are below (full code on GitHub–link in comment below):

***Regression Model with Segmented Relationship(s)***

Call: segmented.lm(obj = cvi.lin.mod, seg.Z = ~TEMP, psi = 10)

Estimated Break-Point(s): Est. St.Err 11.5800 0.4781

t value for the gap-variable(s) V: 0

Meaningful coefficients of the linear terms: Estimate Std. Error t value Pr(>|t|) (Intercept) -2.01052 0.10774 -18.662 <2e-16 *** TEMP 0.26883 0.01322 20.337 <2e-16 *** U1.TEMP -0.17296 0.01756 -9.853 NA — Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5889 on 903 degrees of freedom Multiple R-Squared: 0.6306, Adjusted R-squared: 0.6294

Convergence attained in 2 iterations with relative change -2.659061e-05

10. Statistics generally – why this mix of SAS and R? Would be better to stick with one (ideally R) if possible

- Some of the analyses were completed in SAS previously. A GitHub repository has now been added that includes all of the R code, links to data, and the SAS code with output:

https://github.com/atkinsjeff/atkins_et_al_2014_vegetation_heterogeneity.git

11. P. 17641, l. 17: what test is being performed here, exactly? Just because there's a difference at 11 C doesn't mean this is the correct breakpoint; see comment #9 above

- See response to #9.

12. P. 17648, l. 19: "shrub effect" – you're inferring causality without any basis to do so

- (see comment #6 above)

- This is an excellent point as we cannot definitively infer causality given the nature of our study. Lines 19-24 on P. 17648 have been reworded to highlight our observations of the dynamics beneath shrubs. We have also eliminated the use of the term "effect" in the manuscript.

13. P. 17649, l. 17-: very long paragraph. Break apart for readability

-Note to break on line 28 "The areal extent . . . " has been inserted.

14. P. 17652, l. 24: I applaud posting the data! Ideally, post the code that produces the statistical results presented, too

- GitHub repository: (https://github.com/atkinsjeff/atkins_et_al_2014_vegetation_heterogenei

15. Figure 2: is the line in panel (a) linear, or nonlinear? Note also that overplotting is a significant problem in these panels, and it's hard to see what's going on

- These plots have been cleaned up and color added in code on GitHub and will be included in the final revision.

16. Figures generally: take advantage of color, rather than only grayscale

-If necessary. An easy fix.

We would like to again thank Dr. Bond-Lamberty for his review. We feel these changes have strengthened our manuscript.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/11/C8260/2015/bgd-11-C8260-2015-supplement.pdf

Interactive comment on Biogeosciences Discuss., 11, 17631, 2014.



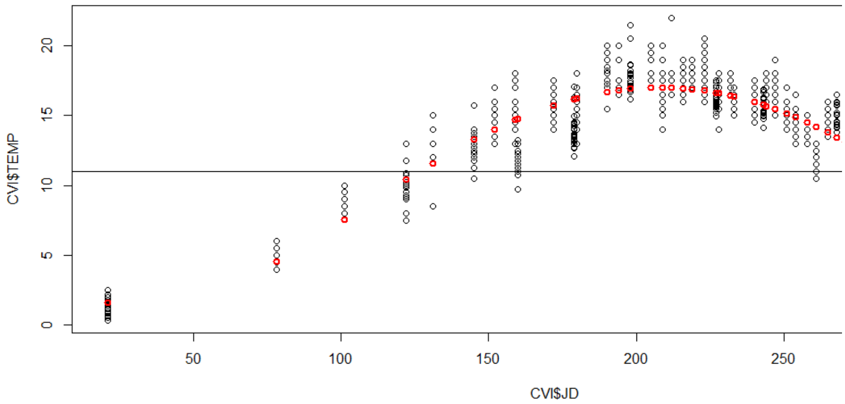


Figure 1. Soil temperature at 12 cm (°C) against Julian Day. The black circles indicat measurements of soil temperature, while the red circles indicate fitted values from polynomial.

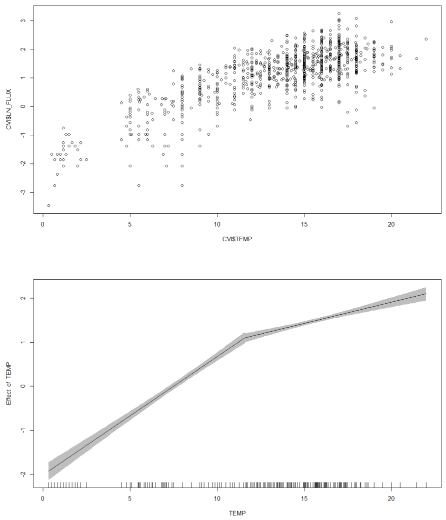


Figure 2. At top, values of the natural log of soil $CO_2$ efflux against soil temperature (°C). At bottom, model output from the segmented package in R where the piecewise regression model has been plotted against soil temperature. The dark line indicates the model and the shaded area indicates the standard error.

**Fig. 2.**



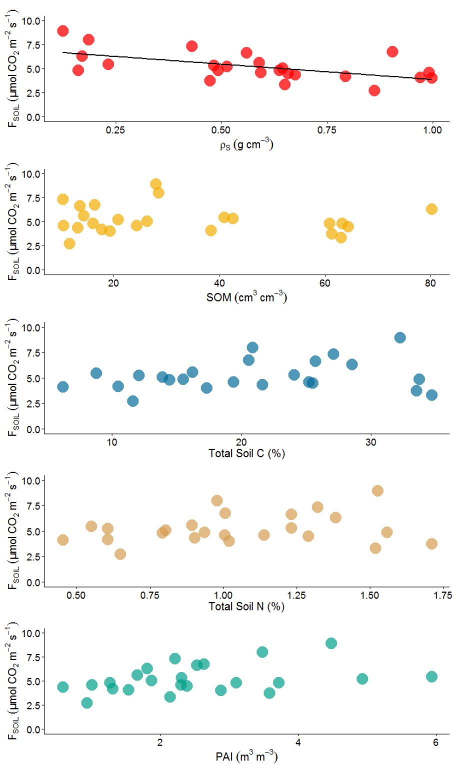


**Fig. 3.** Soil bulk density, Soil Organic Matter, Total Soil C, Total Soil N, and Plant Area Index against mean soil CO2 efflux (for all measurements across all three years where soil temp, was above 11 deg, C)