GENERAL COMMENTS

The authors present data from 1-year long extensive measurements of soil oxygen, nitrous oxide, carbon dioxide and methane concentrations along soil profiles in a northern hardwood forest landscape. They stratified their measurements according to landscape positions and analyzed their data concerning the influence of major regulating environmental factors such as soil moisture and temperature. As opposed to many earlier studies the authors made a great effort to get gas samples even when the soil profile was water saturated, i.e. they sampled soil water and extracted the dissolved gases for analysis. They also determined gas concentrations throughout the whole winter. This data can make a good contribution to our knowledge about soil trace gas dynamics and its biogeochemical regulation dependent on landscape position.

The introduction is largely well written. The methodology is sound and largely well described. A substantial shortcoming of the study as it is currently presented is a lack of suitable graphical presentation and sound statistical analysis of the promising data set. The authors measured time series of soil gas concentrations at several depths. However, they unfortunately don't present their data in a way that spatial and temporal variability can be seen, but instead lumped their data over depth and/or time and only present boxplots and histograms (Figs. 2, 3 and 5). Besides not making it possible to see the variability in the measured data this caused an inflation of the figure count (9 Figures). This data presentation needs to be improved before publication, and I suggest to show either time-series plots per depth or contour plots of the data. During revision, also sound statistical analysis of the data needs to be conducted. I advise that the authors should conduct mostly time series analyses of the response variables for each soil depth (preferably linear mixed-effects modeling) and correlation analyses concerning the regulating environmental factors (which is currently only conducted for a part of the relationships). By their current analysis the authors lost the temporal and spatial information which is a pity concerning the great effort that was made to obtain complete datasets over time and space. The statistical methods need to be well presented and the results of the statistical analyses included in the results, which will then be depth specific. This will largely improve the results section, which I find currently somewhat descriptive.

The discussion is partly good but needs major revision in other parts, as outlined in my specific comments below. In parts it is not clear which of the statements are own interpretation based on the current study and what is accepted knowledge, because references in the latter case are often missing. Also in some paragraphs of the discussion the argument should be improved, for these please see my specific comments below. What I am missing in the discussion is a consideration of processes other than production and consumption that influence and regulate soil trace gas dynamics, i.e. mainly transport along the profile and gas exchange between the soil air and water phases. Especially on P10869/L15-13 this captured my attention. The authors pointed out that, within a 12-day long dry period in between water-saturated soil conditions, the trace gas concentrations did not show the response expected based on the soil oxygen status. However, most of the overall content of the highly soluble gases CO_2 and N_2O in wet soils is in the water rather than the air phase, which, when the water table drops, will re-equilibrate. Also, diffusion is slow in wet soils and it may take some time for gas concentrations to change after a water-saturated soil dried. I advise that these aspects should be considered in the discussion of the encountered patterns. Finally, the authors need to revise their reference list which contains some typos and, more importantly, is very incomplete with many reference entries that are mentioned in the manuscript missing.

I want to strongly encourage the authors to make the effort and achieve a suitable graphical presentation and a sound statistical analysis of their wealth of temporal and spatial data. As it is, they sell their data below their value and the impact of the publication will

greatly increase by improving the Figures and the statistical analysis. I am confident that, after major revision considering the advice given in the review(s), the manuscript may be suitable for publication in Biogeosciences.

SPECIFIC COMMENTS
- I suggest to delete one 'landscape' from the title, and to either name the measured trace gases or call them 'trace gases' instead of 'atmospheric greenhouse gases'.

Abstract
- P10860/L4: I suggest to call them 'trace gases' rather than 'atmospheric gases', throughout the manuscript. You measured these gases in the soil, there they don't contribute to the greenhouse effect.
- P10860/L6: Not necessary to repeat 'oxygen and greenhouse', already mentioned above, suggest to delete and write only 'soil gas dynamics'
- P10860/L7-10: Suggest to make one shortened sentence out of the two, i.e. 'Bimonthly for one year we analyzed depth profiles…from several different…'

Introduction
- P10861/L8: Suggest to reformulate 'has inhibited' to e.g. 'limits'
- P10861/L13: Please use the abbreviations which you defined throughout the manuscript, here for oxygen.
- Unfortunately, a lot of references are missing in the reference list, e.g. Liptzin et al. 2011, Fierer et al. 2005, Yavitt et al. 1995, Kellman and Kavanaugh 2008, Likens and Davis 1975 and so on…please go through the whole reference list carefully and make sure it is correct and complete. Please also check the reference list for typos (e.g. P10881/L29 correct 'function). Please also clearly identify references of the same author (group) and year both in the text and in the reference list, e.g. for Yu et al. 2006. Please also sort all references for the same statement in the text chronologically, as well as in the reference list sort the references per author chronologically.
- P10862/L11: Suggest to expand 'by climate and topography'

Materials and methods
- P10862/L24: WS3 is already defined, not necessary to repeat.
- P10863/L3: I suggest to delete 'at the HBEF', same in line 5, and I suggest to delete 'W3' in line 10.
- P10863/L6: What is an 'intermediate aspect'?
- P10863/L19: I suggest to insert 'to compare soil gas dynamics'
- P10864/L4: I suggest to insert 'water saturated'
- Sections 2.2 and 2.3 are pretty long. I suggest to resort them, by presenting only the setup of the sampling stations in 2.2 (no mentioning of measurements yet), and describing the measurements and analyses in 2.3. I am giving further suggestions where these sections can be shortened below, and encourage the authors to also try themselves to make these sections more concise. In parts, sentences are also formulated rather complicated, please revise again.
- P10864/L7-8: As I understand it this sentence says the same as the following one, and can therefore be deleted.
- P10864/L17: Isn't the soil pit the gas well…?
- P10864/L18: Please spell out 'outer diameter' and so on, also in L23.

- P10864/L20: We don't need to know the weight of the needle, please delete.
- P10864/L22-23: You mean here installation of the sampling tubes?
- P10864/L24: In order to shorten I suggest to delete the reason why the PVS tubes were used.
- P10864/L27: This doesn't fit here, and I think it can be deleted since you give the temporal sampling schedule on P10865/L26 ff.
- P10865/L1: Down to which maximal depth?
- P10865/L9: I assume you mean 'did not reveal differences'? Please include which statistical test you used and the *P*-value.
- P10865/L16-18: This is very important! How did you conduct these corrections/calculations?
- P10865/L20ff: I understand that this was a big challenge, and I am impressed by the effort you conducted in order to obtain gap-less time series of gas concentrations. However, in order to shorten, I suggest to delete most of the first sentence, i.e. shorten to 'During winter, residual soil moisture…'
- P10866/L22/23: How often and when was the O_2 meter calibrated? Please include.
- P10867/L4: I suggest to delete ECD and FIC here, already said before.
- Section 2.4: The description of the statistical analysis is not clear, e.g. which data were analyzed by the Dunn's method? In general the statistical analysis must be improved before publication. You are dealing with time series data however data were lumped before analysis with ANOVA? This is neither clear nor advisable. The time series data should be analysed with linear mixed-effects models (Gueorguieva & Krystal, 2004; Crawley, 2009), and correlation analyses should be conducted to pin down effects of environmental explanatory variables for the response variables.

Results
- P10867/L19: I suggest to re-introduce the soil type abbreviations here as they are not common.
- P10867/L22: Please include the *P*-value for this statement.
- P10868/L6: I suggest to say in Section 2.4 that you considered effects statistically significant if *P*-value < 0.05, and delete here. The statistical analyses need to be improved as written above, and then the exact *P*-values of the tests need to be given in the results sections. When you updated the statistics and data presentation as advised in the General Comments please present the results here separately per soil depth (or summarize if patterns are similar at all depths).
- P10868/L12: 'GHG' has not been defined, rather stick with trace gases as used before.
- Table 1: What does the * mean for T2 A? Please include a measure of variation of the data, e.g. standard errors.
- Fig. 2: This figure conveys little information because the data is lumped in an uninformative way, i.e. over depth and time. Also Fig. 3 is not very informative because of the same reason. The manuscript contains many figures. I suggest to delete Figs. 2 and 3 and, instead of the lumped values which are currently shown, show gas concentrations both depth specific and over time. Suitable plots are e.g. time series plots for each depth per soil type, or contour plots.
- Section 3.3: This section needs to be improved. Please restructure to not jump back and forth between the different gases, become more specific and, most importantly, conduct statistical analyses. CH_4 did not have an inverse relationship with WFPS as you stated. Please present and analyze your results depth wise rather than lumping everything together. If soil moisture differed so much in the different UICP profiles

and this co-varied with the gas concentrations please provide statistical assessment, e.g. by correlation analyses.

- Fig. 5: I don't find this figure very illustrative. If you follow my suggestion to present the data either as depth-specific time series or as contourplots these will also show the seasonal patterns. You can then replace Figs. 2, 3 and 5 with that one figure which, I think, will make pattern recognition much clearer.
- P10869/L15-17: Based on the boxplots in Fig. 5c I don't find the pattern you describe evident for N_2O. I think this will become much clearer if you follow my advice to present depth-specific time series or contourplots.
- P10869/L17/18: Please test this relationship statistically and provide the regression equation.
- P10869/L21: Please also test statistically for a correlation between temperature and N_2O concentrations.
- P10869/L22/23: Please either provide the scatterplot or add '(data not shown)'.
- P10870/L3: What is the error estimate of the slope…standard deviation, standard error, confidence interval,…? Please define. Please add also the number of samples and the *P*-value of the analysis.
- P10870/L3-5: Please test this statement statistically and provide correlation statistics.
- P10870/L8-15: About O_2 concentrations at which depth are you talking here? These are not shown in Fig. 8, and it is not mentioned.

Discussion
- In general, the discussion is well written in large parts, but it is often not clear what is own interpretation/discussion and what is accepted knowledge from the literature. Please insert references for statements that are accepted knowledge or have been shown in earlier studies! This is especially evident in Section 4.1, e.g. P10872/L2-11, P10872/L28/29.
- Consider in your discussion that soil trace gas concentrations are not only influenced by production and consumption but also by transport and exchange with the water phase.
- P10873/L29: Why this reference here?
- P10875/L5-14: One can deduce the argument you want to transfer here but please make it explicit, i.e. you think that you didn't have large winter gas fluxes because you had no periods of severe soil freezing?
- P10875/L15: In this paragraph a couple of facts are laid out but it is unclear which argument shall be transferred. Please reconsider.
- P10878/L6-8: How do you get to this conclusion based on your study?

TECHNICAL CORRECTIONS
- P10860/L2: Delete the comma after 'greenhouse gases' and after '(CH_4)', otherwise it sounds as if these were the only greenhouse gases.
- P10860/L13: 'changes in O_2'
- P10860/L20: 'exhibited'
- P10861/L1: 'by' forest soils
- P10861/L13: 'redox conditions'? (and in other places as well)
- P10862/L13: 'suspected'
- P10862/L16: Delete the comma after CH_4.
- P10862/L17: 'mechanisms' (plural)

- P10862/L17: Correct 'nitrification and denitrification'
- P10864/L2-3: 'O-', 'A-', 'Bh-' and 'Cd-horizon'; 'Inceptisols' (plural)
- P10864/L11: 'of the predominant soil types'
- P10864/L14: Delete the comma after N_2O; 'For soil gas sampling…we employed'
- P10864/L16: 'to a depth of 60 cm'
- P10864/L17: 'down to the Cd horizon'
- P10864/L23: 'back-filled', 'a…PVC pipe'
- P10865/L1: '20 cm, and ~15 cm thereafter'
- P10865/L26: 'were collected'
- P10866/L21: 'air-tight'
- P10867/L3: 'provided'
- P10869/L15: This is Fig. 5 b, c.
- Fig. 1: 'Contour intervals are'
- Fig. 2: Suggest to put (a) and (b) in the same position as (c) to (e); delete ' after carbon dioxide
- P10871/L23: well-drained
- P10875/L19: 'appeared' (past tense)
- P10875/L20: Delete the comma after 'although'.
- P10876/L5: Please correct the typo in 'atmosphere'
- P10876/L9: Please correct the authors name, it is 'Jungkunst'

References

Crawley MJ (2009) *The R book,* Chichester, John Wiley & Sons Ltd.
Gueorguieva R, Krystal JH (2004) Move over ANOVA, progress in analyzing repeated-measures data and its reflection in papers published in the archives of general psychiatry. *Archives of General Psychiatry,* **61**, 310-317.