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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A compact and stable eddy covariance set-up for methane measurements using off-axis integrated cavity output spectroscopy" *by* D. M. D. Hendriks et al.

Anonymous Referee #2

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General comments:

This paper describes a new experimental design for eddy correlation measurements of methane flux. The principal advance is to integrate a newly available methane analyzer employing the integrated cavity output spectroscopy (ICOS) technique with the appropriate (but standard) meteorological instrumentation. The technique appears to work well and the content (if not the form) of the manuscript is fairly straightforward. It contains new and original work, and the subject matter is appropriate for ACP. The new instrument and design should be extremely useful for flux studies that address important questions of biosphere-atmosphere interactions. Several minor points are discussed

below, and there are a great many small edits that could improve the manuscript. In general, the manuscript could be shortened (and have a higher impact) by careful editing of the text and figures.

Specific comments:

Abstract, l. 15-18, Where were CH4 emissions measured? Can just add “in a peat meadow”; the details are explained in the text.

p. 11591, l.7-11 Is the ICOS technique linear? (Is the signal linear with respect to methane concentration, allowing a relatively simple calibration?) And does it really operate autonomously in the field? (Is the “claim” verified by your experiments?) If so, a simple wording change can be made for that part.

p. 11592, l.2-8 Is the power required for the scroll pump included in the 180 W (bottom of previous page), or if not, how much additional power is required? Seems that it is.

l.23 It’s not clear to me why the volume of air in the cell adjusted for the ratio of pressures is important (it’s a pretty easy calculation anyway, since P_{cell} is about 1/5 of $P_{outside}$). In any case, “(which is at a pressure of about 1010 hPa)” is a little clearer, if longer.

p. 11594, l.3 The subscript for x [$(s+1)k+l$] is not easy to understand, though the overall equation makes sense. Same for the explanation of l as “the first sample in a subgroup”.

l.19-23 Just using Equation 4, the answer I get is higher than 0.00781 by sqrt(10). There is also a question of different units on both sides of Eq. 4 – what happens to the root of Hz?

p. 11596, l.15 Why is tao the volume of outside air in the cell divided by pumping speed? I would think it should be the geometric volume of the cell divided by pumping speed. The pump doesn’t “know” what the outside pressure is. (Or does a scroll pump transfer a constant mass per unit time rather than a constant volume, as many pumps

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do?) The next sentence is very confusing, though it's understandable from l.10. Do you mean something like "The tao is an e-folding time"? So the remaining change is 37%? Not clear how that can be corrected for during signal processing, or why it needs to be (unless a flux correction is applied based on the heat flux or some other quantity that can be measured without damping).

p. 11597, l.13 Not clear what is the "angle of attack dependent calibration" or what that means.

p. 11598, l.15-16 How can the data from the previous day be used to fill in missing values? If the data gap is fairly short ($\sim$1 minute or less), I would think this would just cause errors. If it is for an entire $^1/_2$ hour period that might be OK. But why not just leave the data point out, if in fact no/not enough valid data were available?

Section 5 (pp. 11599-11601) For the "alternative measurement types", it might be useful to have a statement near the beginning of the section that the raw (10 Hz) data are simply mathematically manipulated to simulate disjunct EC, 1 Hz EC, and REA. The data treatments are well explained mathematically in each case, though the details of the techniques themselves would not be easy to follow if one didn't already know them. References are provided, which should be adequate. For the comparison with REA, one ordinarily won't have the luxury of being able to choose the best value of b based on concurrent EC data for the flux of interest. What was the calculated value of b based on the momentum or heat (latent or sensible) fluxes, which likely will be available?

Figure 2 is not very informative – the only differences from a standard EC setup are explained in the text. Either tighten up the text or cut the figure.

I am not convinced that Figure 5 is necessary. The authors seem to have done a careful job though.

In figure 6, the methane flux slopes show considerable variation. Please comment on this in the text.

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Figure 8 does not seem to show any CH_4 uptake (described in the text), except for one possible spike on Day 181.

Figure 9 is not easy to follow, and does not seem to add much to the text. Not all pictures are "worth 1000 words."

Same for figure 10.

Technical corrections:

I don't think that these need to be part of the published discussion, but here they are anyway. It would also be much easier if the reviewers could just make suggested edits on a copy of the manuscript, which would then be sent back to the authors. The writing is clear overall, but there are numerous small suggestions and corrections that would improve the manuscript.

Abstract, line 6 "2-20 x 10^3" would be better.

l.8 "determined to be 0.10 s.)

l.10 "3-axis"? (hyphenate)

l.13 remove parentheses on eddy covariance

l.17-18 force the minus sign to stick with the 20.

I agree with the previous reviewer that company names are not appropriate in the abstract. Fine to have them in the main text.

p. 11589, l.8 "is by definition 1 (IPCC, 2007)"

l.11 "has therefore only been sparsely applied"

l.13 advantages compared to what? Need a short phrase after "technique" – can be as simple as ". . . eddy covariance compared to other techniques for measuring. . . "

l.14 "nonetheless" (strange, but it is one word)

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l.16 “1980s”

l.22 add comma after “module”

l.23 either capitalize all three words of Quantum Cascade Laser, or don’t capitalize any of them.

l.25 “than TDL spectrometry”

l.26 “optical module, and..”

l.28 have thus implied

p. 11590, l.6 “tested for precision and . . . data processing capabilities are assessed”

l.8 “measurement techniques”

l.10, “were performed”

l.15 Drop “In 1998”. Maybe rearrange to “A measurement cell . . . narrowband laser system by O’Keefe et al. (1998), creating. . . ”

l.25 “the laser beam”

l.26 “at a slight angle, after which it is reflected. . . ”

p. 11591, l.2 “2-20”

l.4-5 “in the cell for each measurement . . . reflectivity of the mirrors in the cell.”

l.11-12

l.15-16 “The internal voltage. . . ” But really, this whole sentence can be cut, particularly the first part. No need to know the internal voltage.

l.17 “The MRT cannot be allowed to drop below 3. . . ” or something like that.

l.21 Rather than having to write “by the user himself or herself”, can just write “which can be done by the user in a dust-free environment” or just “. . . can be done in a dust-

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free environment."

If much of this paragraph is contained in Bear et al., it could be shortened further.

p. 11592, l.3 "Design of the closed-path. . . " (two changes)

l.5 Instead of "under pressure", how about ". . . a scroll pump that maintains the correct pressure in the measurement cell required for sampling at 10 Hz."

l.16 and 18 "toward" Also, delete "free" on l.17

l.26-27 "through" (one both lines, 3 times in all) and "from the Licor" The capitalization of Licor should be consistent between this line and the top of the next page too.

p. 11593, l.2 "3-axis". I'm not sure if "ultrasonic anemometer" should be capitalized either.

l.2-3 "directed into/toward the prevailing wind [direction]"

l.7-8 "determined from the covariance" But more precisely it is the covariance of that property and the vertical velocity, as shown in Eq. 2.

l.12 "purpose"

p. 11594, l.5 space after "subgroup,"

l.19 "the y-intercept at the minimum"

l.24-25 Is it meant to read something like ". . . 45 C, the cell temperature (Tcell) will stay. . . "?

p. 11595, l.1, "in the measurement cell"?

l.3-4 "the influence . . . was assessed"

l.4 "cell"

l.6 missing subscripts on Tcell and Pcell. Not clear why it is important that they have

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a linear relation either. And in Figure 4, there are several sharp changes in T that are not matched by P anyway.

l.9 “respectively” not needed

l.11 “turned off”

l.20 “gas chromatograph”

l.23 “nonetheless”

p. 11596, l.1 “prevailing winds were from the east (continental), which accounted. . . ” or something like that

l.10 “the 63% point (1-1/e). . . ”

p. 11597, l.5 “1000 times the diameter” or “1000 times the inner diameter”.

l.19 “spectra of w, T, and”

l.27 “well-established”

p. 11598, l.8 “CO_2 from nighttime periods”

l.10 “eddy covariance data and comparison”; also it does not seem that the tower is very “high” at all. Finally, it should read “comparison with flux chamber measurements” or “(inter)comparison of EC (tower) data and flux chamber measurements”. It is somewhat confusing as written.

l.21 “nighttime” and “Uncertainties in the CH_4 emissions”. Also, the uncertainties are probably $>$25% when the flux is close to 0.

l.27 “Photoacoustic”

p. 11599, l.6 “On June 10” and “On October 3” three lines later.

l.10 “while that from eddy covariance was” or “while that from the eddy covariance measurements/technique/method was”

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l.17-18 “can generate reliable results too.”

l.22 “might be necessary for operation in remote places/locations”

p. 11600, l.15 delete “all variables of”

l.17 “drawn into”

l.18 “switching is” and l.22 “samples are taken” (keep verb tense consistent)

p. 11601, l.9-10 “on a half hourly basis” and “On a daily basis”

l.14-15 This doesn’t make sense as written. How about “. . . turbulent perturbations, in which CH_4 is transported by high frequency atmospheric turbulence ($>$1 Hz).” or something like that.

l.16 “polder”?

l.27 “suitable” or “well suited”

p. 11602, l.2 Only one “new” in this sentence; I would suggest deleting the second one.

l.3 “satisfactorily”

l.4 “techniques, the absence”

l.5-6 “relative” or “relatively user friendly [operation, or whatever]”

l.12-13 This does not need repeating (and see previous comment on this sentence).

l.16-17 delete “high”; maybe “nor in the field data” is sufficient. And delete “indeed” too.

l.18 “with a 37% underestimate. . . ” is unclear; this can be cut too.

l.22 “appeared suitable”

l.26 “similarly”

l.27-next page. CH_4 emissions where? And change to past tense.

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p. 11603, l.2 “-20” or “20”? I would not consider a negative flux to be a “minimum” either – that would be the one closest to zero for something that doesn’t change sign. Might be better to get rid of “minimum” and “maximum” altogether; same for Section 4.

l.3 “with QCL”

l.7 “measurements, it was” And the fluxes were in much closer agreement than “same order of magnitude” – it was more like 20-30%.

l.12 “the data were used to simulate three (other) flux techniques. . . ” The actual experiments (which would involve mechanical and data acquisition changes) were not performed.

l.19 “reasons,”

Table 1 “calibration factors”. Also, the first two values for “low CH_4” and “deviation” do not appear to be consistent.

Table 2 A b value of 0.75 is used here, 0.70 in the text (p. 11601).

Figure 4 The y-axis is off by a factor of 10 for pressure (hPa).

Figure 6 “required” or “expected” slope?

Figure 7 “Analysis of the effect of variation. . . below u* values”

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 11587, 2007.