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Atmospheric Measurement Techniques Discussions

Interactive comment on "Technical note: Dimensioning IRGA gas sampling system: laboratory and field experiments" *by* M. Aubinet et al.

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General comments

This is a good paper, generally well written, of a good length, and with an appropriate level of detail in most cases. A notable exception is the lack of details on the rain cups tested.

A more serious issue is that the authors have used a nonconventional definition of cutoff frequency, based on 50% amplitude response instead of 0.707. I would strongly encourage the authors to revise their results to conform to the usual convention.

Detailed Comments

Abstract

The abstract very good, although I think the importance of pressure drop in the rain cup is overstated, and may detract from the other, more important points.

Introduction

The introduction is also very good – it is a good length and a nice level of detail.

Theory

The first paragraph seems a bit unnecessary. Models for pressure drop in tubing are well known, and showing that the measured pressure drop can be modelled adds little new, and tends to dilute the main message, which is the pressure drop in the filters.

The second paragraph provides either too much or too little detail. Equation 4 is used to generate the theoretical curve in Figure 4, along with "line path averaging (Moore, 1986) and sampling" (page 10742 line 20). The equation I assume the authors used is contained in Moore, 1986, but it is buried in the text, and out of context. If the authors feel this theoretical comparison is important, I'd suggest explicitly providing the equation used and/or providing a reference that applies more directly to a closed-path analyzer. Also, I can find no information in this paper for the effect of "and sampling". It would be interesting to a more thorough treatment of all of the individual components of the theoretical prediction. Alternately, perhaps this section could be omitted in order to focus on the main topic of the paper (frequency response degradation due to filters and rain cups).

Materials and Methods

3.1.1 Gas sampling and pressure drop measurements

For the pressure drop measurements, were the fan and/or zero air flow active? If so, was the pressure drop measurement affected by the direction and velocity of the air

flowing past the intake tube?

3.1.2 GSS frequency response

It can be difficult to make a good frequency response measurement. The results presented here are very impressive, and I would be interested in a bit more detail on the experimental setup. In particular, was there a pressure difference in the IRGA as the system switched between ambient and zero air? Was there a temperature difference as the system switched between the ambient air and zero air?

Pg 10740 line 9: It is not clear to me that testing flow rate vs. chopper frequency implies the concentration vs frequency was necessarily constant. Is it possible there was some mixing of the ambient and zero air before it reached the inlet, at the higher chopping frequencies?

What was the bandwidth setting of the IRGA? The experiment obviously is subject to aliasing. This doesn't invalidate the results, but it does introduce a complication. A brief comment on this might be appropriate.

Pg. 10740 line 12. Cutoff frequency is normally defined as the half-power point (not the half-amplitude point). It is the frequency where the power spectrum falls to 0.5, and thus the amplitude spectrum falls to the square root of 0.5 (0.707). Using the half-amplitude point largely invalidates the results given here, and I strongly encourage the authors to recalculate the results or at least make clear that the results are not the cutoff frequency as it is normally defined.

3.2.1 Site and set up description

This is a good description of the field experiment, although it would be extremely helpful to add some details for the rain cups. The performance of the various rain cup designs is central to this paper. As a minimum, the internal volume of each design should be provided. Photographs or drawings would be most helpful.

3.2.2 Data treatment

Are the spectra amplitude spectra or power spectra? The transfer function is normally defined as the ratio of amplitude spectra.

Equation (5): Did the authors consider using the usual function for a first-order system? This is given as equation 2 in Moore (1986), for example. This is the physically correct model for a mixing volume (large rain cup).

I suspect the authors would find reasonable agreement between their measurements and this model by simply setting tau = V/Q, where V is the volume of the rain cup and Q is volumetric flow. Showing whether this comparison is (or is not) valid might provide a valuable insight into rain cup performance.

4.1.1 Pressure drop

I don't understand the comment that the measurements agree with theory with 5% accuracy. In figure 3 the "no filter" measurement at 10 LPM seems to be approximately twice the theoretical curve.

4.1.2 Cut-off frequency

The results given in Figure 4, and the discussion given here, are misleading. The theoretical line agrees with what I would expect at the nominal 15 LPM flow, assuming the effect of the tube attenuation is small. However, the measured values, as I understand it, are based on the 50% point on the (amplitude) transfer functions. In order to compare measurements to theoretical curve (and to be reported as the cutoff frequency) the measured values must be based on the 0.707 amplitude point.

In spite of this, the last paragraph, "However. . ." is still valid - the fact that the filters did not affect frequency response is the main point of this paper.

4.2. Field results

The results given for the field campaign are also misleading. The cutoff frequency should be based on the 0.707 point, not the 50% point.

5.1 Filter impact

Pg 10744 line 22: "...destruction of the thermocouples...": Although I have no field experience with this IRGA, the destruction of the thermocouple because of a large pore size filter does not seem intuitively probable. It might be appropriate to either expand on this idea or to omit this comment.

Pg 10744 line 25..27: the anecdotal comments on experience with various pore sizes seems very helpful. I very much appreciate seeing this kind of information.

The last paragraph of this section, "Practical considerations..." also provides valuable insight. However, the comment that metal filters are more prone to night cooling is not intuitively obvious to me. Presumably the blockage is from condensation caused by radiative cooling at night? This is of course a concern, and heating is a good way to prevent this, but I see no reason why metal filters would be more prone to this than plastic. Perhaps the authors could provide more explanation here.

5.2 Rain cup impact

Of the three bullet points, the first one seems to summarize the main work presented in this paper. The second point does relate to pressure drop in the rain caps, which is also mentioned. Perhaps I have overlooked the importance of this issue, and some additional discussion could be added? This might become more obvious by including details of the rain cup designs. The third point is not discussed in the paper, and seems speculative and unnecessary.

The cut off frequency (6 Hz) given in the last paragraph is not valid, because it is based on 50% amplitude.

The last paragraph also introduces several concepts that have not been discussed in this paper: cospectral cutoff frequencies, spatial separation, and defensible flux estimates. Perhaps this paragraph could be edited to apply more directly to the topics covered in this paper.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 10735, 2015.