Replies to reviewer comments #1

We wish to thank the reviewer for his/her valuable comments on the manuscript and suggestions for changes that largely helped to improve it. Our replies to the individual remarks are printed in blue color:

A very interesting and useful contribution on the consequences of using long sampling lines in single-filter atmospheric radon measurements. A simple method is developed, and verified both in the laboratory and field, for correcting single-filter radon measurements for the effects of losses due to deposition of aerosol-attached radon progeny onto the walls of inlet tubes of varying lengths up to 200m. The results are discussed with reference to a number of possible aerosol deposition mechanisms inside tubing, with the outcome that the technique is both supported theoretically and has its limitations specifically identified and quantified. The prospect that inlet tubing deposition effects can be accurately corrected will reduce an important source of uncertainty in single-filter radon measurements, and expand the list of potential applications for these (relatively compact) detectors to include tall tower sites. This manuscript falls within the scope of AMT and describes topical original research worthy of publication. Furthermore, the manuscript is for the most part clearly written and well structured. I therefore recommend acceptance, after attention has been paid to a few minor issues and technical corrections listed below.

Minor changes / technical corrections

Abstract

P1, L11: Change “tubing (laboratory test) and” to “tubing in the laboratory, and”.

Done

P1, L12: “Progeny loss increased exponentially with length of the tubing”. I think this is over-stating it a bit, as the increase could equally well be described as “linear”. Perhaps just say “Progeny loss increased steeply with length of the tubing”.

OK, true, we changed it.

P1, L13: After “for 8.2 mm ID rolled-up tubing of 200 m length”, I think you should add “at a flow rate of 1 m^3 hour^-1” or similar. I think it is important to specify the flow rate, as the deposition efficiency is strongly dependent on it (see Eq. 3).

Yes, has been changed

P1, L19: Change “above 1” to “between 1-2”.

Done.

1 Introduction

P1, L22: Change “used as tracer” to “used as a tracer”.

Done

P1, L25-26: Change “shortly after the generation of the progeny” to “shortly after generation in the atmosphere”.

Done

P1, L26-27: Rewrite sentence as “In so-called two-filter systems, filtered air that only contains 222Rn (with ambient progeny removed) is flushed through a large delay chamber and the new 222Rn progeny produced in situ inside the tank are then collected on a second internal filter. . .”.

Done, thank you.

P1, L30: “In this style of detector, atmospheric 222Rn activity concentration is then. . .”.

Done

P2, L8: Change “implemented e.g. at tower stations, where” to “implemented at locations (e.g. tower stations) where”.

We changed that.

P2, L22: Change “Zahorowski, 1998). Alternatively, the Heidelberg” to “Zahorowski, 1998), whereas the Heidelberg”.

Done

P2, L23-24: Delete “, and routine maintenance work and data evaluation are less demanding than for the two-filter systems (Whittlestone and Zahorowski, 1998)”. This is not generally true with modern versions of the two-filter detectors, which are very robust and include automated calibration and background checking systems that allow them to operate for months or even years at a time without human intervention.

We removed the second part of the sentence.

P2, L32: Change “Whittelstone” to “Whittlestone”.

Corrected

2 Methods

P3, L7: Change “used as tracer” to “used as a tracer”.

Changed

P3, L19: Change “estimating the atmospheric” to “estimation of the atmospheric”.

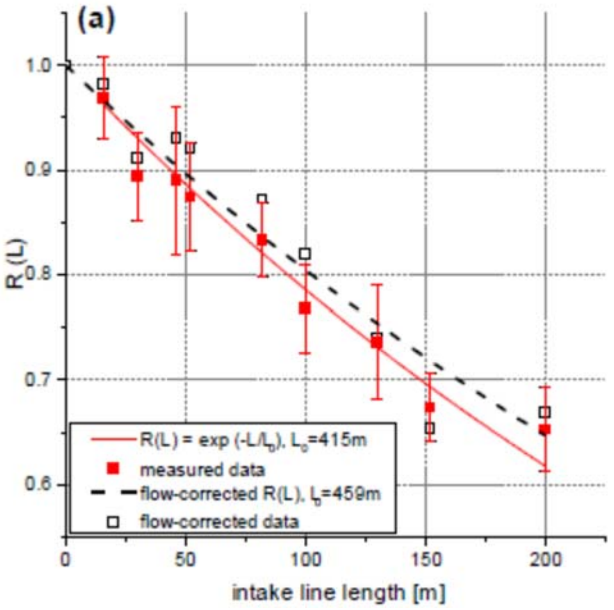
Changed

P3, L31: Change “ratios of two” to “ratios for the two”.

Changed

P4, L3: It would be nice to know if there are any ambient temperature or humidity effects on deposition rates, but I guess this was out of the scope of your study. However, I would have thought that it would be fairly easy to test the effects of different flow rates, especially given the expected strong dependency on Q (see Eq. 3). Did you investigate flow rate sensitivity?

Unfortunately, we did not test experimentally the dependency of flow rate on aerosol loss in the tubing, and you are correct about the rather strong dependency of the loss, based on Equation 3 and 4, (much less though on Eqs. 5a and b). Based on these four equations, we have now estimated the effect of flow rate differences from 1 m3 hour-1 in our laboratory experiments with the different line lengths (and pumps used). The maximum theoretical deviation of loss (6.8%) occurred at a flow rate of 1.4 m^3 hour^{-1} with the 100m line. Note that a flow rate of 1 m^3 hour^{-1} (±10%) was used in all experiments with lines longer than 100m. To take this effect into account for the general loss correction (Eq. 2), we have now added in Figure 2 corrected values that have been adjusted to a nominal flow rate of 1 m^3 hour^{-1} as well as a second fit curve through these corrected values. As all flow rates for line lengths ≤ 100 m were higher than 1 m^3 hour^{-1}, all these adjustment are positive and the characteristic length L_0 of the fit curve is about 10% larger (L_0 = 459 versus 415). When using the adjusted fit curve for R(L) this would lead to a maximum difference in the loss correction of 4.5% with a 200m line. The revised Figure 2a is displayed below.



P4, L20: Change “For these measurements” to “For these latter measurements”.

Changed

P4, L22: Change “They allow to determine possible” to “They allow the determination of possible”.

Changed

P4, L24: How is the flow rate maintained in the 200m tube on the tower? Was it the same as in the laboratory tests? Given the expected strong dependency of deposition efficiency on Q (Eq. 3), it would have been good to know the variability of flow rate achieved through the 200m tube on the tower.

The mean flow rate was here 1.1 m^3 hour^{-1} (±10%), i.e. similar to the laboratory line tests with tubing > 100m. Theoretically we estimate a 2% change of aerosol loss for a 10% change in flow rate.

3 Results

P5, L9-11: Need to rearrange / change the first two sentences after Eq. (1) in order to explain some of the terms better. I suggest something like: “where parameters A and C0 are constants, and R(L) is the “saturation” activity ratio for line length L. The activity ratios for the 200 m line test have been fitted accordingly in Fig. 1b, with the fit curve plotted as a solid red line with R(L)=0.66”.

We changed this part accordingly, thank you.

P5, L12: Change “They yielded” to “This process yielded”.

Changed

P5, L13: “An exponentially decreasing. . .”. Looking at the plot, this could equally well be described by a linear fit. Maybe you should explain your choice of an exponential fitting function (e.g. we would expect $R(L) \rightarrow 0$ as $L \rightarrow \infty$).

We added a respective sentence.

P5, L19: Define L0 (e.g. “where L0 is a constant parameter”).

Added

P5, L20: Change “then principally” to “therefore in principle”.

Changed

P5, L23-25: Please elaborate briefly how you corrected and “normalised”? I guess you added [1-R(L)] to both sides of Eq. (1), which is equivalent to modifying CLTM on the LHS by adding CHD-R[1-R(L)]?

We divided all data by their respective saturation value, this was added to the text.

P5, L28: Change “as shown in Fig. 2b” to “as shown in Fig. 2a”.

Changed, thanks.

P6, L24: At what flow rate? What was the variability of the flow rate?

The flow rate was 1.1 m^3 $hour^{-1}$ (±10%)

4 Discussion

P9, L9: Change “were quite more turbulent and sharper bended” to “were quite a lot more turbulent and more sharply bended”.

Changed

5 Conclusions

P10, L25: Change “pile-up” to “accumulation”

Changed