We would like to thank the two reviewers of this paper. All of their suggestions and comments have been considered for the improvement of the revised manuscript. Below, answers (in blue) to their specific comments are provided. Where relevant, here we also show the changes applied to the revised manuscript to comply with the recommendations.

Reviewer 1

Specific comments

1. I feel that a solid aspect of this paper is that the ARMON monitor performs extremely well and has excellent potential for deployment in radon networks. The other instruments have all been components of previous inter-comparison studies. Therefore, I suggest that the manuscript should be ARMON centric rather than being an inter-comparison study. I think that there is huge value in the work presented herein and the ARMON should be showcased. Perhaps change the title of the manuscript to reflect this?

We agree with the reviewer that the introduction of a new direct radon monitor, such as the ARMON, in the inter-comparison of radon/radon progeny monitors for atmospheric activity concentration measurements is the most solid aspect of this work. We also agree that this monitor seems to have a great potential to be used within radon networks. The measurement technique of the ARMON is not new because it was already applied in previous instruments such as one built at the Brazilian National Institute for Space Research (INPE) (Pereira and da Silva, 1989; Tositti et al., 2002). In addition, the ARMON monitors have been already used in the past years for different studies in the atmospheric research field (Grossi et al., 2012; Vargas et al., 2015; Hernandez-Ceballo et al., 2015; Grossi et al., 2016; Grossi et al., 2018).

However we would like to point out, from a general point of view, that this is the first time that four direct/indirect radon monitors, based on different measurement methods, have been compared in parallel at two measurement heights. This gives the opportunity of comparing their responses under the same atmospheric and meteorological conditions. It is also the first time that the performance of the ARMON has been compared with another direct radon monitor such as the ANSTO detector, which has been quite well characterized.

As correctly stated by the reviewer, the ARMON has a higher detection limit than the ANSTO detector, and a larger uncertainty. At the same time the ANSTO detector seems to slightly smooth the time series when fast changes in the atmospheric radon concentration are occurring. In order to correctly evaluate all these previous observations, the authors think it is necessary (and they are already planning), a long term inter-comparison campaign to specifically compare the performance of the ARMON and ANSTO detectors in detail, as explained in the Conclusions of this paper.

Therefore, in the present manuscript we would prefer to present the results of these comparisons between different monitors without focusing on any one instrument in particular.

However, the revised manuscript will showcase the introduction of another portable direct radon monitor, the ARMON, its potential, and the importance of completely evaluating its qualities and faults as a direct radon monitor for atmospheric stations as reported in the following new paragraphs:

Lines 391-397 of the revised manuscript: 'Figure 2 and 3 show a larger hourly variability of the HRM and ARMON signals compared with the ANSTO ones. This difference in variability is likely attributable a combination of a larger counting uncertainty of the HRM and ARMON detectors, and that only an approximated response time correction could be applied to the output of the ANSTO detectors (Griffiths et al. 2016) for the setup of this intercomparison. Further investigations should be carried out to clarify these differences and to exactly quantify the detector uncertainties for low ^{222}Rn concentrations typical of outdoor environmental monitoring at or above 100 m a.g.l.'

Lines 534-536 of the revised manuscript: 'Finally, the direct new portable ARMON seems to have a great potential for being used within atmospheric radon networks. In order to deeply evaluate the qualities and faults of this new instrument a long term inter-comparison study should be carried out using a direct ANSTO instrument.'

2. In the abstract, the author mentions that this paper evaluates "correction factors between monitors". I think that the author needs to highlight that the slopes from the scatter plots are the correction factors.

This is correct and we will explicitly mention this in the revised manuscript as suggested by the reviewer:

Lines 33-34 of the revised manuscript: '…..linear regression fits between the monitors exhibited slopes, representing the correction factors,…'

3. I would like to see a section which compares the outcomes of this study with those from previous instrument comparisons (e.g. Schmithüsen et. al., 2017) to put the findings into context. How well do they agree? How site-specific are these corrections and what can be done to overcome this? What needs to be considered in future inter-comparison studies?

We agree that a section where the findings of this study are compared with those found in previous studies could be of interest. We decided here to compare the slopes/offsets of the regression lines calculated in this study between ANSTO and LSCE monitors against the HRM because they were also calculated in Schmithüsen et. al., 2017 for other ANSTO monitors and at different heights. The following section has been added to the revised manuscript:

Lines 412-432 of the revised manuscript:

3.2 Comparison with past studies

The results obtained in the present study of the slopes (b) and offsets (a) of the regression lines calculated between ANSTO or LSCE monitors against the HRM are here compared with the ones presented by Schmithüsen et. al., 2017. Table 3 shows a summary of this comparison. All slopes (correction factors) are defined as (routine station monitor) / HRM because this last was used as reference instrument by Schmithüsen et. al., 2017.

Site/Input Height	Schmithüsen et al., 2017			Present study		
ANSTO/HRM	**Activity Range (Bq m^{-3})**	**b**	**a**	**Activity Range (Bq m^{-3})**	**b**	**a**
Cabauw: 200/180 m	0-8	1.11±0.04	0.11±0.06			
Saclay: 100 m				0-11	1.03±0.01	0.15±0.06
Lutjewad: 60 m	0-6	1.11 ± 0.02	0.11 ± 0.02			
Heidelberg: 35 m	0-15	1.22 ± 0.01	0.42 ± 0.04			
Cabauw: 20 m	0-12	1.30 ± 0.01	0.21 ± 0.03			
Orme des Mérisiers: 2 m				0-22	1.17±0.01	0.63±0.03
LSCE/HRM	**Activity Range (Bq m^{-3})**	**b**	**a**	**Activity Range (Bq m^{-3})**	**b**	**a**
Orme des Mérisiers: 2 m	0-9	0.68±0.03	-0.18±0.09	0-15	0.76±0.01	-0.29±0.03

Data in Table 3 need to be analyzed taking into account that a unique traceability chain is not yet available for atmospheric radon measurements and the different monitors routinely running at the different stations could have different calibration chains (e.g. radon source, primary standard, etc.). Generally speaking, for both studies it can be observed that the correction factor between the atmospheric ^{214}Po activity concentration measured by HRM and the atmospheric ^{222}Rn activity concentration measured by ANSTO at each station approaches unity with the increase of the height of the sampling input. By contrast, the offsets of the regression fits decrease with the increase of the input height.

The only case where the compared instruments were exactly the same and at the same height is for Orme des Mérisiers station. Here the slope between the atmospheric ^{214}Po activity concentration measured by LSCE and HRM is equal to 0.76±0.01. This number is slightly larger but within uncertainties well comparable to the number reported by Schmithüsen et al. (2017) of 0.68±0.03 (see Table 3).

4. I think it would help to rearrange the methods section to clearly state that "direct" and "non-direct" methods are being compared. As highlighted above I feel that this is the really strong part of the manuscript as this brings in a second "direct" measurement.

We have rearranged the methods section as suggested by the reviewer.

5. Section 2.1.2. Can you add a little bit of information to describe how the measured progeny from the HRM one-filter monitor is related to 222Rn activity concentration? This is discussed in Schmithüsen et al (2017) but it would be good to see it repeated here.

We have added the following paragraph in the revised manuscript:

During the measurement campaign carried out at Saclay, where air samples were collected via a 100m Decabon tubing (see below), the line loss correction of Levin et al. (2017) was applied to all data of the HRM. No loss of aerosol was assumed in the short tubing used at Orme de Mérisiers station. Here we report for both sites ^{214}Po activity concentrations. However, for the 100 m intake height at Saclay we would not expect any disequilibrium, meaning that, based on the results from Schmithüsen et al. (2017), the reported ^{214}Po activity concentrations directly correspond to ^{222}Rn activity concentrations. By contrast, for the low 2 m intake at ODM we expect a ^{214}Po/^{222}Rn disequilibrium of about 0.85 to 0.9.

6. Section 2.1.3. It is stated that the ARMON is portable. Can you elaborate and possibly give the dimensions?

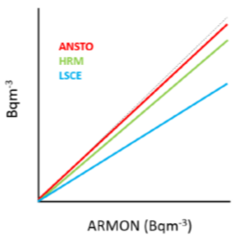
We have added this information in the text and within the table 1.

Lines 208-209 of the revised manuscript: The detection volume of the ARMON is safety isolated because it is located within an external wood cube of 0.18 m^3.

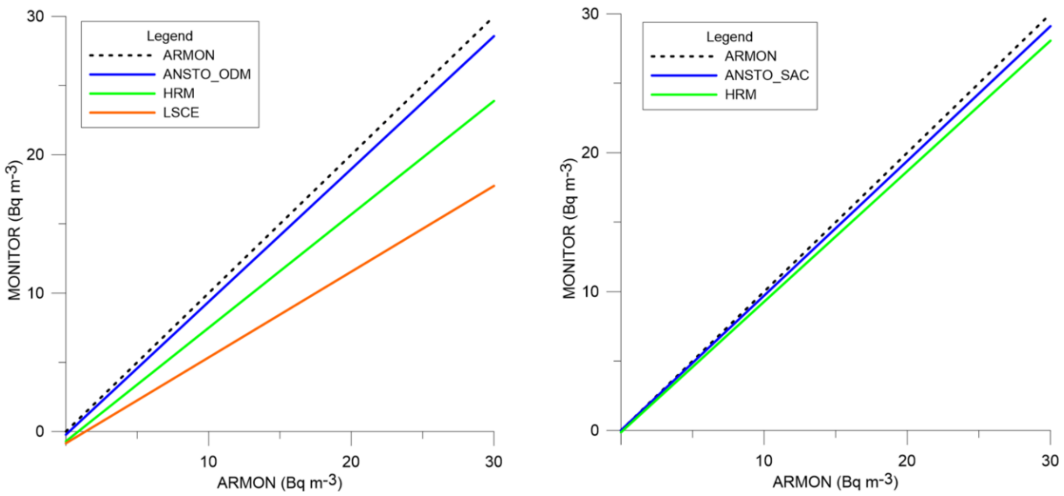
Monitor	Method	α Spectrum	Flow Rate (L min^{-1})	Detection Limit (Bq m^{-3})	Typical uncertainty (k=2)	Remote Control	Need of dry air sample	Need of corrections depending on the height of the inlet	Portability Level and monitor size	References
ANSTO	Dual-flow-loop two-filter	No	~83	0.03	8-12%	Yes	No	No	Low ; 1.92 m^3	Whittlestone and Zahorowski (1998) ; Brunke et al. (2002)

ARMON	Electrostatic deposition	Yes	1-2	~0.2	20%	Yes	Yes	No	Medium; 0.18 m^3	Grossi et al. (2012)
HRM	One-filter	Yes	20	~0.05	15-20%	Yes	No	Yes	High; 0.08 m^3	Levin et al. (2002)
LSCE	One-filter	Yes	160	~0.01	20%	Yes	No	Yes	High; 0.03 m^3	Polian, 1986; Biraud, 2000

7. I suggest an additional figure with a synthesis of the slopes between the different monitors that are summarized in Table 2. This could be in the form of ANSTO vs. all of the other monitors for each site. However, keep table 2 as it contains all of the detail, it's just not easy to picture and visualize. I have added a figure to demonstrate what I mean.



We have added Figure S7 in supplementary material to summarize the results of Table 2 for SAC and ODM stations using the ARMON as a reference.



Technical comments Figures:

Sometimes hard to distinguish between the blue traces (ANSTO) and the black traces (ARMON) on the figures. However, this may be due to my eyes?

We have tried a number of different colors to improve the readability of these graphs. Finally, we decided to use red for the ARMON data. All figures within the revised version of the manuscript have been changed in agreement with this.

Line 42: replace “because of the” with “from the”.

Lines 200 – 201: “method C”. It’s unclear what this means.

Line 251 and 252: I don’t understand this sentence.

Line 251 - 257: Switched tense after the first sentence.

Line 255: Replace “Fine” with “fine”

Line 261: Replace “in order to” with “To”

Line 353 – 358: This long sentence is hard to follow. Please revise.

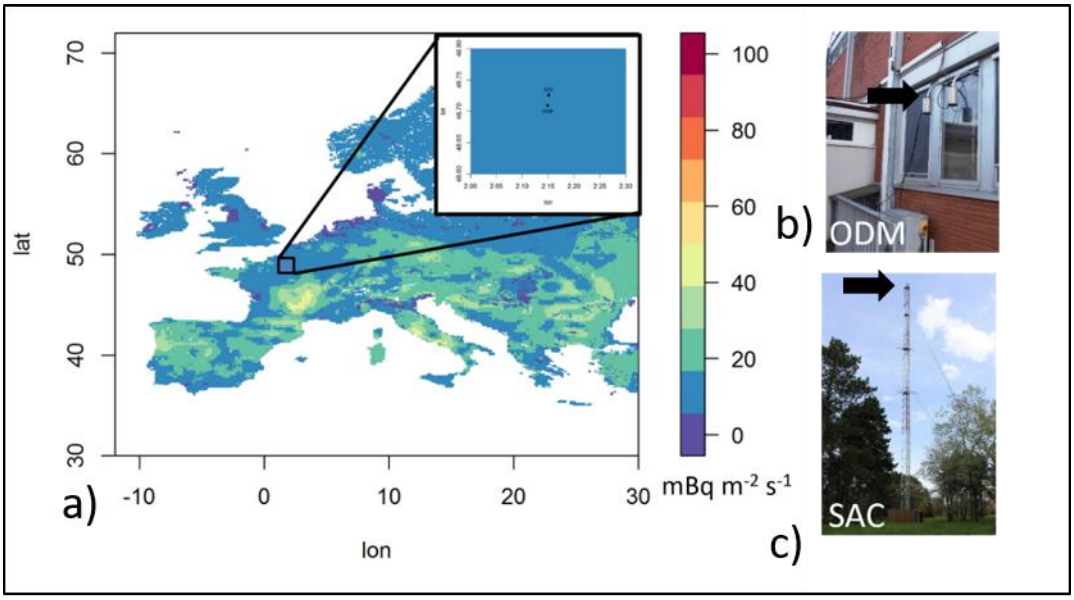
Line 383: Remove “compared” Use “ ” or “alpha” Use “progeny” or “daughters”.

The previous changes suggested by the reviewer have been applied in the revised manuscript.

Reviewer 2

Fig. 1: maybe add small arrows pointing to the inlets, particularly in case (c)

As suggested by the reviewer we added black arrows to figure 1 of the revised manuscript to indicate inlet positions.



Section 2.3: the first sentence (lines 251-252) is not clear to me... I would also suggest specifying the height at which the meteorological measurements are taken, as well as the atmospheric aerosol concentration

The paragraph has been modified in the revised manuscript:

Lines 286-293: Meteorological data used within this study were available from continuous measurements carried out at the SAC and ODM stations at 100 m and at 10 m a.g.l. respectively. The measurements were carried out with a Vaisala Weather Transmitter WXT520 ·(Campbell Scientific) for: (1) wind speed and direction (accuracies of ± 3 % and ± 3 ºC, respectively); (2) Humidity and temperature (accuracies of ± 3 % and ± 0.3 ºC, respectively). In addition, the atmospheric aerosol concentration was measured at ODM site using a fine dust measurement device Fidas® 200 S (Palas) at 10 m a.g.l.. The measurement range is between 0 and $20 \cdot 10^3$ particles cm^{-3}. All the accuracies refer to the manufacturer's specifications.'

Figure 2: possibly display also (maybe as supplemental material) the plot of the difference time series

The hourly time series of the differences and the ratios of ^{222}Rn and ^{218}Po measured by ANSTO, HRM and LSCE monitors again the ^{222}Rn measured by the ARMON have been presented in Figures S1 and S2 of the supplemental material.

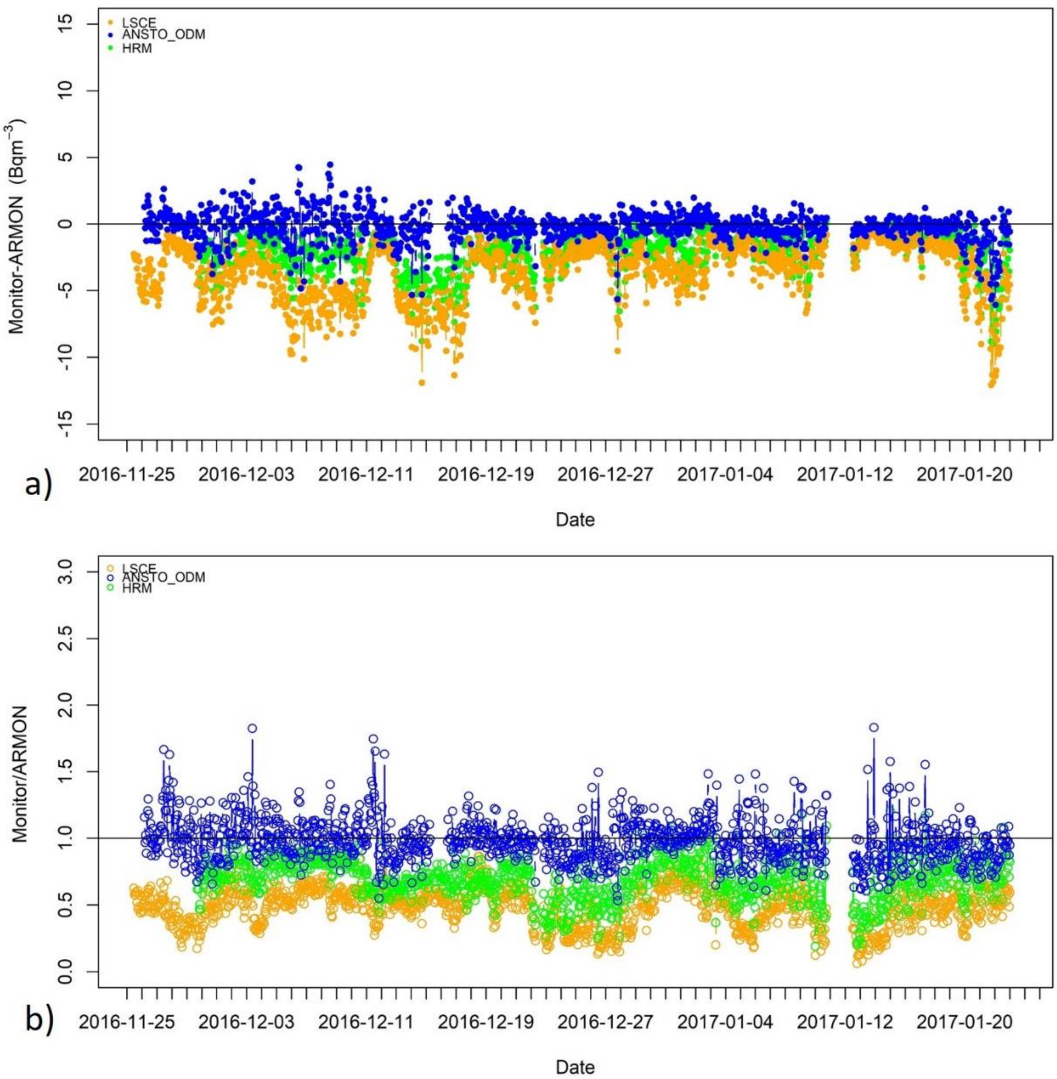


Figure S1. Hourly time series of the differences (a) and the ratios (b) between the atmospheric ^{222}Rn or ^{218}Po activity concentration measured by each monitor (HRM (green circles), LSCE (orange circles) and ANSTO_ODM (blue circles)) and the ^{222}Rn measured by the ARMON at Orme de Merisiers (ODM) station during Phase I (between 25 November 2016 and 23 January 2017).

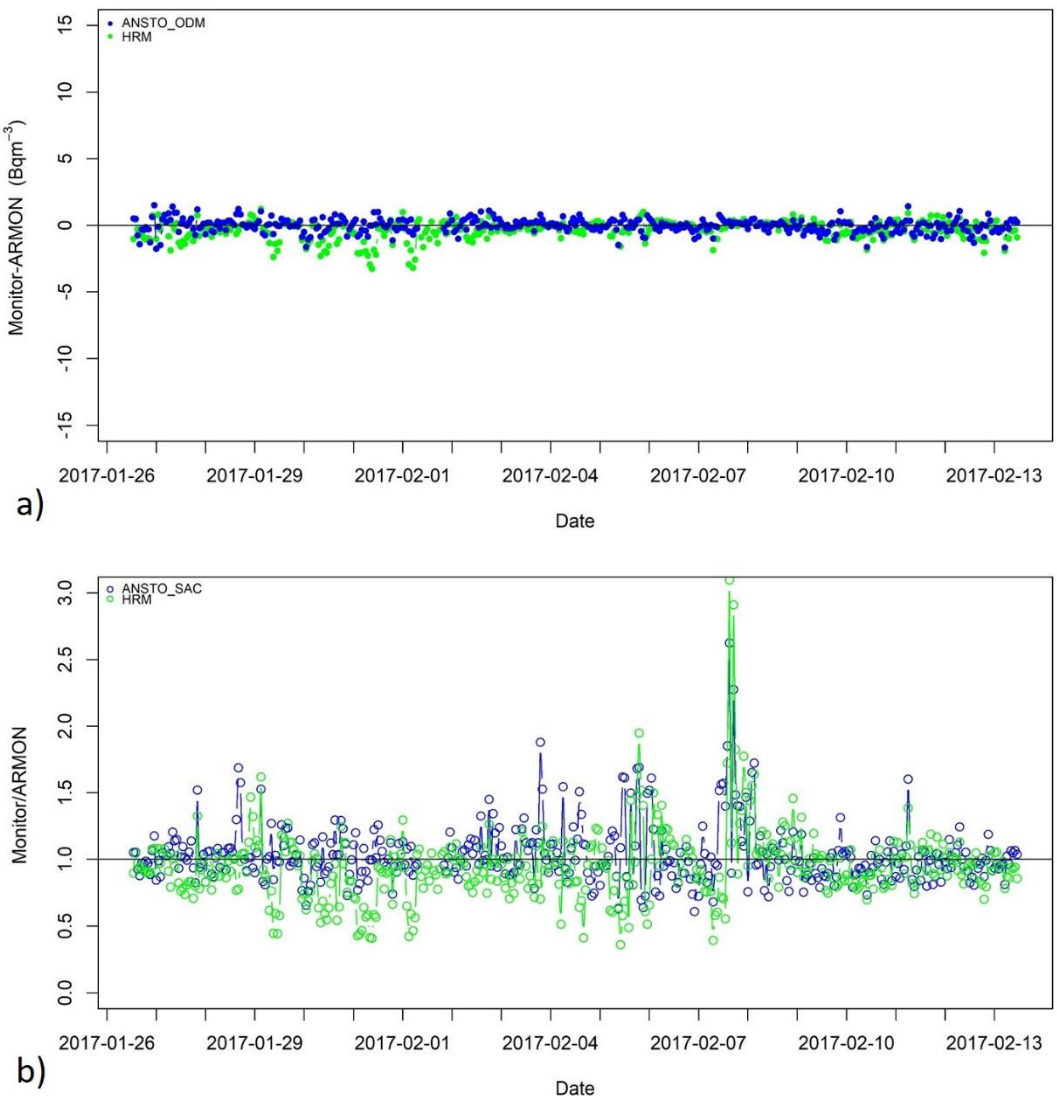


Figure S2. Hourly time series of the differences (a) and the ratios (b) between the atmospheric ^{222}Rn or ^{218}Po activity concentration measured by each monitor (HRM (green circles) and ANSTO_SAC (blue circles)) and the ^{222}Rn measured by the ARMON at Saclay (SAC) station between 25 January 2017 and 13 February 2017.

Section 3.3: in my opinion it is not clear that data does not show any evident pattern... for example, at least by eye, seems to me that LSCE and HRM values relative to ARMON as well as relative to ANSTO_ODM show a decreasing trend with temperature...

The reviewer was right. A small influence has been observed at ODM as suggested by the reviewer. The following paragraph has been added within the revised version of the manuscript and a Figure S8 has been presented within the supplemental material.

Lines 448-465: 'Data does not show any evident patterns at 100 m a.g.l. (SAC station), which could indicate that there is any impact on ^{222}Rn or ^{222}Rn progeny measurements due to change of ambient temperature and relative humidity, at least not until saturated conditions are achieved. By contrast, a small decrease, of about 10^{-2} ºC^{-1}, is observed in the ratio between the ^{214}Po activity concentration (measured by HRM and LSCE monitors) and the ^{222}Rn activity concentration (measured by

ANSTO_ODM and ARMON monitors) with the increase of the ambient temperature (Figure S8 of the support material) at 2 m a.g.l. (ODM station). This temperature dependency may be attributable to the effect of atmospheric activity concentrations, increasing during nightime, on the disequilibrium between radon and its progeny. However, this influence on measured $^{214}Po/^{222}Rn$ ratios seems quitesmall compared with other observed effects (e.g.: loss of progeny within the sample tube (Levin et al., (2017)), atmospheric aerosol concentration (see below)).'

Page 16, line 421: maybe aerosol loading (instead of aerosol burden)

Change has been applied in the revised manuscript.

- given the relevance of the ARMON direct monitor in this inter-comparison study, its uncertainty should be clearly indicated. It is reported as 20% in Table 1, but in Figure 2 the measurements from the ARMON detector show large spikes which seem to be large than 2 Bq/m3...

The total uncertainty of the atmospheric radon concentration measured by the ARMON has been estimated to be of about 20% (k=2). This total uncertainty takes into account the uncertainty of the ARMON calibration factor F_{Cal}, the uncertainty related with humidity correction factor and the uncertainty on the net counts per minutes of detected ^{218}Po. This last one, as reported in Grossi et al., 2012 and Vargas et al., 2015, is depending from the ^{218}Po total counts and the 32% of total counts of ^{212}Po decaying in ^{212}Bi.

The ARMON has been calibrated within the INTE's radon chamber for a concentration interval ranging between 10^2 Bq m^{-3} to 10^3 Bq m^{-3} and an absolute humidity interval between $2\cdot10^2$-$2\cdot10^3$ ppm. The calibration factor F_{Cal} has an estimated uncertainty of about 10% (k=2). The ARMON calibration, as well as the calibration of the other monitors participating in the inter-comparison campaign, was linearly extrapolated for lower atmospheric radon concentration values because of the lack, so far, of a really low radon source and a robust traceability chain for low atmospheric radon concentration measurements.

The differences observed in Figure 2 and 3 of the manuscript could be due to a larger ARMON uncertainty for low atmospheric radon concentration measurements or to a smoothing effect of the ANSTO detector, due to its big volume, when fast changes occur in the atmospheric radon concentration. This should be better investigated in the near future thanks to long-term comparison campaigns and detailed analysis of the total monitors response uncertainties for low activity concentrations.

We have added within the revised version of our paper the following paragraphs:

Lines 203-209: 'The total uncertainty of the atmospheric radon activity concentration measured by the ARMON is of about 20% (k=2) where it is including the calibration factor F_{cal}, the background due to the presence of ^{212}Po from ^{220}Rn and the humidity correction factor (Grossi et al., 2012; Vargas et al., 2015).'

Lines 395-401: 'Figure 2 and 3 show a larger hourly variability of the HRM and ARMON signals compared with the ANSTO ones. This difference in variability is likely due to a larger uncertainty of the HRM and ARMON detectors and that only an approximated form of the Griffiths et al. (2016) response time correction was able to be applied to the ANSTO detectors in this study due to lack of information gathered during their setup. Further investigations should be carried out to clarify these differences and to exactly quantify the detectors uncertainties for the low ^{222}Rn concentrations typical for outdoor environmental monitoring at or above 100 m a.g.l.’

Lines 538-540: ‘Finally, the new portable ARMON seems to have a great potential for being used within atmospheric radon networks. In order to deeply evaluate the qualities and faults of this new instrument a long term inter-comparison study should be carried out using a direct ANSTO instrument.’