Answer to reviewer 1

The manuscript describes an instrument sensitive to radon and thoron in concentrations frequently found in near-surface air above continents. Characterisation and calibration of the instrument were thorough, though only for radon and not for thoron (lines 114-115). Hence, the manuscript title requires modification. The instrument can help to make sure that radon concentrations measured at different stations within a monitoring network are real and unaffected by differences between instruments' performance, their individual calibration, or differences in data processing.

- First of all, authors want to thank the reviewer for his/her time. We have now removed the reference to thoron within the title and modified the abstract in relation to it. Although the instrument is capable to measure thoron, is true that it was not calibrated and characterized for this gas measurements.

There is little I can add to the earlier discussion between Scott Chambers and the Authors. The main additional issue I would like to raise is the long-term stability of the instrument's calibration. Is the instrument assumed to maintain its current calibration throughout its lifetime, even when travelling frequently and extensively? Or, is regular re-calibration foreseen? If so, how often? Lines 496 to 499 hint at a calibration unit for "...very short calibration or recalibration [...] under field conditions..." The next sentence states this issue "...will be the object of a future paper." There are two further papers announced, one on a field intercomparison with an ANSTO detector (lines 499 to 501) and another one on the "full calibration procedures" (last line in AC2). Is it really necessary to distribute the outcome of this enterprise among four (!) papers? From my point of view, the mobile calibration unit definitively has to be included in the present manuscript, as should be more details about the air dryer and the thoron delay volume that will go with the instrument once it will be 'on the road' as a travelling standard instrument. Please add these items also to Figures 1 and A2. In addition, please show in the schematic diagram of Fig. 1 the position of the air pump.

- In regard to the long-term stability of the instrument's calibration, a previous ARMON version used at the Spanish station of Gredos and Iruelas (Grossi et al., 2018) and now running at the Barcelona station, was calibrated after several years of being in the field at the INTE radon chamber and after travelling over 800 km by car. In this paper the ARMON v2 calibration factor obtained at the INTE chamber (Barcelona, Spain) was compared with the one obtained at the PTB (Braunschweig, Germany) where the instrument arrived 18 months late after travelling by car for the traceRadon project campaigns from Barcelona to the PTB, then to Saclay, France and back again to the PTB. This point has been now clarified within the manuscript with the following text (section 3.4):

'Results of the calibration at PTB, done 18 months after the calibration at INTE, also confirm that the calibration of the instrument is stable over the time, as it was already appreciated in the older version of the monitor (Grossi et al., 2012, 2018; 2020; Vargas et al., 2015). However, in a mark of calibration procedures of radon measurement network it is suggested to perform periodical stability checks of the efficiency of the diferent radon and radon progeny instruments running at the diferent stations'.

- In regard to the number of papers where the results of the ARMON calibration and characterization, of the calibration procedure of radon and radon progeny monitors (not only the ARMON) running at atmospheric stations and of the intercomparison of different radon and radon progeny monitors will be presented, the scientific community of the traceRadon project already decided to create a Special Issue in the journal of Atmospheric Measurement Techniques where the different outputs from the different authors and over the years will be published under the same umbrella. This division will help the readers to easily follow the different research developments. More Info here: https://amt.copernicus.org/articles/special_issue1257.html
- Finally, in the present manuscript as suggested by the reviewer the drying unit and the pump were added to Figure 1 and A2. The calibration procedure of the ARMON will be different depending if the station needs or not a drying unit for this instrument. Actually, we have observed that there are stations (as for example the ICOS station of Saclay, France) that can deliver dry sample air, so no drying unit is needed, while in others a drying unit may be used. Anyway, the drying unit with a delay unit is now presented in Appendix C.

At the end of AC1 you state that "... air inside the sphere is at atmospheric pressure because it is an open circuit." This presumption cannot be correct. If air pressure inside the sphere would be exactly the same as outside, there would be no air flowing through the sphere. Yet, the sphere is continuously flushed with 2 L/min. Upstream of the sphere a filter, downstream a flow meter (Fig. 1). Both restrict flow in addition to the tubing connecting the sphere with the outside. It may not be necessary to continuously monitor pressure inside the sphere, but I would suggest to determine once the pressure difference between inside and outside the sphere and add the offset to the pressure reading from the atmospheric station. Even if the correction is small, it should be included because not doing so introduces a perhaps small but systematic error.

- Thank the reviewer for this suggestion. We have done the calculation assuming a high pressure difference between inside and outside the ARMON detection volume and the uncertainty is really small. The error induced in the radon concentration due to errors of pressure or temperature has been now added in section 3.3:

‘As for the STP correction, the values of T and P uncertainties have been taken from the sensor uncertainties. A higher uncertainty could be due to the distnace between the the sensors positon and the detection volume of the instrument. However, calculus show that these uncertantiies will be negligible. Let the Reader consider that an increase of the temperature uncertainty of 2 degrees will suppose an increase in the uncertainty of $1.4 \cdot 10^{-3}$ Bq m^{-3}, and an increase of 5 hPa in the uncertainty of Pressure will only increase total uncertainty by $4 \cdot 10^{-3}$ Bq m^{-3}‘.

3.) Perhaps tell the reader already in line 139 that the detection volume is 20 L.

- The correction has been applied as suggested.

4.) Line 445: The humidity was < 150 ppm, so why Eq. 2 and not Eq. 13?

- We have now compared both calibrations (INTE and PTB) using the exponential fit (Eq. 13).