

## ***Interactive comment on “Comparison of one- and two-filter detectors for atmospheric $^{222}\text{Rn}$ measurements” by Y. Xia et al.***

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We thank both Referees for their constructive and helpful comments on our manuscript. Apart from minor corrections or clarifications asked for in a revised manuscript, there are three larger issues, which we are going to discuss. Both Referees ask for (a) more information on the one-filter detector, and both have some concern about our results being (b) site-specific or (c) instrument-specific.

Regarding (c), the concern is that other one-filter detectors can separately measure  $^{218}\text{Po}$ , which is in closer equilibrium with  $^{222}\text{Rn}$  than is  $^{214}\text{Po}$ . The only example of such an instrument that we are aware of is the ‘Radgrabber’, which has been developed by the Environmental Measurements Laboratory of the U.S. Department of Energy for real-time atmospheric measurements on aircraft platforms. The instrument

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uses electrostatic fields to collect charged  $^{218}\text{Po}$  directly from the atmosphere on a solid state detector (Lee and Larsen, 1997). Hence, it is in principle a one-filter detector that derives  $^{222}\text{Rn}$  concentrations directly and exclusively from atmospheric  $^{218}\text{Po}$  concentrations. Therefore, differences in estimates of atmospheric  $^{222}\text{Rn}$  concentrations to those determined by a two-filter instrument would be smaller than in our comparison, where the one-filter detector counted  $^{218}\text{Po}$  and  $^{214}\text{Po}$  together. The Radgrabber is an exception among the diverse range of one-filter detectors. None of the one-filter detectors mentioned as operating at GAW stations in the WMO/GAW report No. 155 (2004) derives estimates of atmospheric  $^{222}\text{Rn}$  solely from the detection of  $^{218}\text{Po}$ . All include counts of  $^{214}\text{Pb}$ . Hence, conclusions derived from our comparison are not limited to a very specific or unusual instrument. The one-filter detector on Schauinsland represents a common and widely applied principle to estimate atmospheric  $^{222}\text{Rn}$  concentrations based on the collection and alpha-counting of both short-lived  $^{222}\text{Rn}$  progeny ( $^{218}\text{Po}$  and  $^{214}\text{Po}$ ) from atmospheric air. Also the two-filter detector we used, is not the only instrument measuring atmospheric  $^{222}\text{Rn}$  instead of atmospheric  $^{222}\text{Rn}$  progeny. Other instruments include those based on the design by Iida et al. (1996) and widely used in East Asia (e.g. Moriizumi et al., 2008), and the two filter detector developed by the Environmental Measurements Laboratory (EML) as described in Collé et al. (1996). Hence, the instruments in our study represent the two measurement principles of the majority of detectors currently in use.

(b) We agree that the absolute values of our results are somewhat site-specific. The degree to which deposition of  $^{222}\text{Rn}$  progeny is affected by forest canopies in the various wind sectors would be different at other stations, which may be closer or further away from a forest edge, or where forest canopies are not similar to those on Schauinsland. The effect of precipitation is probably less site-specific. However, more generally, our results show that changing meteorological conditions affect the relative difference between one- and two-filter detectors. Consequently, there is not one single disequilibrium factor for a specific site that could be used to directly transform short-lived progeny to  $^{222}\text{Rn}$  activity concentration. Site-specific disequilibrium factors cover

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a range of values depending on meteorological conditions. This more general outcome of our study applies to probably most other stations.

(a) Both referees suggested a more detailed description of the one-filter detector. Unfortunately there is not a more recent reference for one-filter detector used in our study than the already cited article by Stockburger & Sittkus (1966). We redraw a sketch of the detector from Stockburger & Sittkus (1966) to clarify its construction (Fig. 1). Air passes through an aerosol filter (mixed cellulose ester, pore size  $1.2 \mu\text{m}$ ), where progenies of  $^{222}\text{Rn}$  and  $^{220}\text{Rn}$  are quantitatively deposited. The effective filter area is  $300 \text{ cm}^2$ . At a distance of 14 mm above the filter is a stack of three independent, methane-filled, proportional counters having the same length and width as the active filter area. The lower counter measures  $\alpha$ -activity from progeny of  $^{222}\text{Rn}$  and  $^{220}\text{Rn}$ . The counter in the middle detects only the high energy  $\alpha$ -activity of  $^{212}\text{Po}$  ( $^{220}\text{Rn}$  progeny). By difference, the  $^{222}\text{Rn}$  progeny activity can be derived from the activity measured in the lower counter. The counter on top is shielded from below with a sheet of  $10 \text{ mg cm}^{-2}$  and counts  $\beta$  particles only.

## References

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Caption:

Fig. 1: construction of one-filter detector: the upper counter is a  $\beta$  counter which measures the  $\beta$  activity from the  $^{222}\text{Rn}$  and  $^{220}\text{Rn}$  progenies; the lower and middle counter are  $\alpha$ -counters which measure  $\alpha$  activity from progeny of  $^{222}\text{Rn}$  and  $^{220}\text{Rn}$ , and  $\alpha$  activity with higher energy from  $^{212}\text{Po}$  ( $^{220}\text{Rn}$  progeny), respectively. (redrawn from Stockburger & Sitttkus, 1966)

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 675, 2010.

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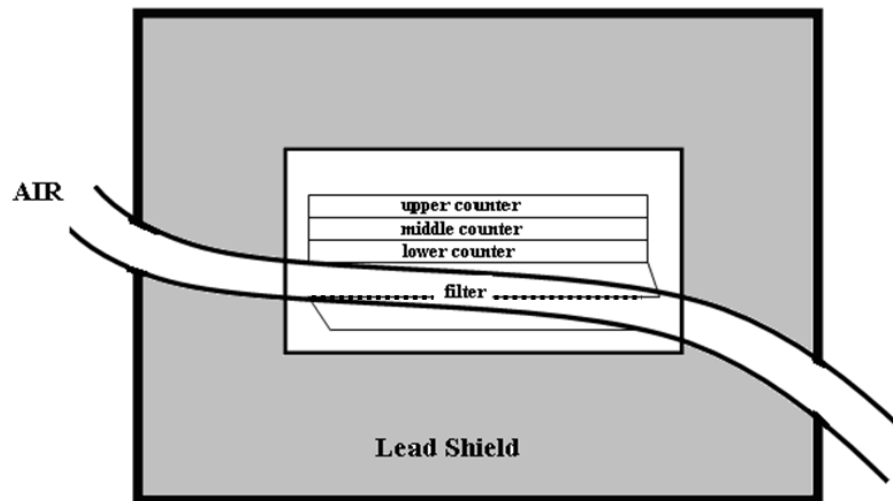
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**Fig. 1.** construction of one-filter detector

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