**Scott Chambers, PhD**
Atmospheric Physicist, ANSTO
Institute for Environmental Research

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Dear Reviewer #2,

Please find below our detailed responses to your comments on "Characterising terrestrial influences on Antarctic air masses using radon-222 measurements at King George Island", by Chambers et al.

Thank you for your time and constructive feedback on this manuscript.

Kind regards,

Scott Chambers

Specific comments:

***The station is an international known meteorological station, however there is [not] any specific meteorological data presented. The information of temporal variations of monthly and daily temperature, wind speed, wind direction, solar radiation, humidity, rain (snow) can be useful. The author can have a look on other publications that this information is available and useful, such in Yu xia et al. 2010 Atmos. Meas. Tech. 3, 723- 731, Grossi et al.2012 rad meas. 47, 149-162 and others. Could these meteorological values be presented and analyzed together with the radon concentrations? Therefore, at least, in section 3.2 the sector analysis could be interested to be presented with meteorological parameters.***

The authors agree that a comparison of radon with meteorological parameters at this site would be of interest. Basic climatological statistics have now been presented in an additional figure of Section 2.1 to accompany the later discussions and assist interpretation by the reader. In order to keep the manuscript to a manageable length, however, we would prefer to leave a more detailed analysis to a dedicated follow-up study, and limit the scope of the current study to: characterising the new detector, characterising the seasonal radon variability at the site compared to existing Antarctic observations, characterising the dominant fetch regions for future planned anthropogenic pollution studies, and demonstrating the versatility of radon in the Antarctic region both as a tracer of (i) synoptic-scale transport in the boundary layer, and (ii) large-scale atmospheric circulation.

***Free snow-ice coverage could be an important radon local source, since the other mentioned continents (South America and specially Australia) are quite far away. Therefore, to have a more robust conclusion regarding the influence of local source, an estimation of the local radon exhalation map according to the snow cover in the region could be interesting to see. For instance, the readers do not know if there is a volcanic area relatively close to the station that can significantly influence the radon concentrations. This local radon map estimation, together with the meteorological analysis, could lead to see some direction that enhanced the radon concentration. Could the authors introduce some information regarding the possible radon map in the region? Is there any possible significant local radon source?***

A complete radon emissions map of the Shetland Island chain would indeed be a useful supplement to the emissions measurements of Evangelista and Pereira (2002). Unfortunately, such a map is not available and is also beyond the scope of the present study. However, in addition to confirming the mean emission flux estimate of Evangelista and Pereira – as mentioned in Section 3.2 – we can use this year of observations to place an upper bound on likely mean radon fluxes for various air mass trajectories over the island chain.

Firstly, we would like to point out that the 50-60 mBq $m^{-3}$ enhancement (above an assumed marine baseline of 30 mBq $m^{-3}$) referred to in Section 3.2 was **mistakenly** derived from only an incomplete summer-autumn subset of the whole 1-year dataset. Considered seasonally, the median enhancement of radon from the island chain is: 52 (summer), 32 (autumn), 18 (winter) and 6 (spring) mBq $m^{-3}$. Based on the wind speed and mixing depth estimates in Section 3.2, this confirms the Evangelista and Pereira (2002) flux estimate of 0.077 atoms $cm^{-2}$ $s^{-1}$ for the most snow-free period of the year, but indicates that mean fluxes could drop to around 0.01 atoms $cm^{-2}$ $s^{-1}$ when snow/ice cover is maximised.

Regarding possible point sources of radon during the most ice-free period, the 97$^{th}$ percentile (~2σ) value of observed radon concentration enhancement from the island chain fetch (limited to SW of the station to avoid influence from South America) in summer was 101 mBq $m^{-3}$. This equates to a maximum mean flux for an air mass trajectory across the island chain of around 0.15 atoms $cm^{-2}$ $s^{-1}$. If the majority of the 100 km land fetch SW of the station is assumed to have the mean radon flux of 0.077 atoms $cm^{-2}$ $s^{-1}$, a spot radon flux of 1.5 atoms $cm^{-2}$ $s^{-1}$ (over a 5 km fetch segment) or 7 atoms $cm^{-2}$ $s^{-1}$ (over a 1 km fetch segment) could yield this estimated mean flux. Given the 200 m range in mixing depths at this site (~400-600m), if these peak observations corresponded to shallower mixing conditions, the quoted fluxes would – understandably – be less.

***I would like to point out that if thoron can sometimes be significant at Antarctic stations, this can probably lead that a very radon close source has a significant effect on the radon. Can the authors comment this idea?***

While other researchers have indicated that thoron concentrations can indeed be significant in Antarctic stations, we installed a 400 L thoron delay chamber on the inlet line of our detector (operating at ~50 L $min^{-1}$) to ensure that less than 1% of ambient thoron would have contributed to our observations.

***Regarding the comparison with Mawson station. At both stations there are high summer concentration and low winter but not similar. Could be partially explained by local effects due to different variable local radon exhalation map? (for instance different snow cover map)***

Median radon concentrations at KSG and Mawson in January (mid-summer) are quite similar (approximately 140 and 130 mBq $m^{-3}$, respectively, see Figure 7b). We suspect that both stations are influenced by enhanced local radon sources at this time of year when snow/ice cover is minimised. In July-August, however, Mawson median radon concentrations are about 20 mBq $m^{-3}$ lower than at KSG. This is likely due to the relative proximity (~900 km) of KSG to a terrestrial radon source (South America) compared to Mawson, which is >4000 km from the nearest significant terrestrial radon source.

***In order to identify local or South America / Australia source it would be interesting to see the measured data for anthropogenic gases. Would be possible to introduce this information in the text?***

At this point in time we have plans to publish detailed investigations of radon in conjunction with (i) site meteorology, (ii) anthropogenic trace gases, and (iii) anthropogenic aerosols. Given the pronounced interannual variability of observations at KSG (which lies on the border between Antarctic and sub-Antarctic regimes), we would prefer to do so when more data is available.