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17th June 2014

Dear Reviewer #1,

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. We will address the purely grammatical corrections directly in the revised manuscript.

Kind regards,

Scott Chambers

1. Question of radon uncertainty:

When dealing with such low radon concentrations (< 100 mBq/m^3) and making inter comparisons (e.g. between KSG and Dumont d'Urville; p. 11557) the question arises how reliable a few tens of mBq/m^3 are between data sets?

The error in measurement of raw counts by the KSG radon detector increases with decreasing radon concentration. The detector's "lower limit of detection" (LLD) is actually the equivalent radon concentration when the counting error reaches 30%. The LLD of the KSG detector is 25 mBq m^{-3}; at this concentration a 30% counting error equates to an error in concentration of ~7 mBq m^{-3}. However, at 40 mBq m^{-3}, and 100 mBq m^{-3}, the counting error is **17%**, and **9%**, respectively. Aside from the counting error, there is also variability associated with the detector's monthly calibrations to consider. So far, the standard deviation of monthly calibrations about the mean of 0.37 was 0.008 (ie. about 2.2%). Lastly, the calibration source is accurate to ±4%. Therefore, at a radon concentration of 100 mBq m^{-3} we expect a combined error of ~15% (15 mBq m^{-3}) on an hourly measurement (increasing to ~36% at 25 mBq m^{-3}). This will of course be greatly improved for longer averaging periods (the relative error drops off as ~N$^{-1/2}$ for N data points).

While we are not in a position to comment on the accuracy of the measurements by Polian et al., (1986) over Dumont d'Urville, from the point of view of measurements made by the KSG radon detector, differences in mean or median values of a few tens of mBq m^{-3} are therefore likely to be meaningful.

On p. 11552 (line 25) the radon concentrations between KSG (76.5 mBq/m^3) and Mawson Station (63.7 mBq/m^3) are compared. However, the standard deviation for KSG is 100 mBq/m^3 compared to the 33.4 mBq/m^3 for Mawson Station. Is this comparison still meaningful?

The standard deviation of the KSG observations is considerably more than that of the Mawson measurements due to the proximity of South America to KSG (not related to measurement

uncertainty). However, since the high variability in radon at both stations is primarily contributed on synoptic timescales, and the averaging length used (1 year) is considerably longer than these timescales, the quoted mean values should be fairly representative of the time periods in question. On the other hand, since there is considerable interannual variability in mean radon concentration at both sites, we agree that it would be prudent not to overemphasise the significance of the observed 13 mBq m^{-3} difference in annual mean values. Further to this point, the somewhat subjective way in which the described background adjustment was made to the Mawson radon record should be kept in mind; for example, we arbitrarily chose the 3rd percentile value (roughly -2σ) as the reference point when making the background adjustment; if, say, the 5th percentile value had been used instead, this would have increased the Mawson annual mean by ~7 mBq m^{-3} (more than half of the observed difference).

On p. 11557, some radon values even have a figure behind the decimal point, e.g. line 2 (34.7 mBq/m^3), while others, e.g. line 5 (74 mBq/m^3) does not. There should be consistency here.

Whenever a figure behind the decimal point was omitted, its value was zero (e.g 74.0 mBq m^{-3}). But thank you for pointing out the inconsistency; we have rounded all results in the revised manuscript to the nearest whole mBq m^{-3}.

It is suggested that under section 2.2 (Radon measurements) the issue of radon uncertainty is defined more succinctly.

Based on the information provided above, the question of radon uncertainty for the KSG detector has been addressed more succinctly in Section 2.2 of the revised manuscript.

2. Atmospheric lifetimes:

P 11545 (line 26) to P 11546 (line 2): Since radon's oceanic…….distant terrestrial pollution: The half-life of radon (3.82 days) is << than the atmospheric residence time of many trace gases such as CO, CH4 and CO2. Perhaps the authors can be more specific in what is meant by: ***"….and its (radon) atmospheric lifetime is comparable to that of many anthropogenic emissions…"***

As it stands the statement in question is indeed misleading; the point we had intended to make was that the half-life of radon is comparable to the lifetimes of short-lived atmospheric pollutants (e.g. NO_x, SO_2). This has been clarified in the revised manuscript.

3. Population centres and radon

P 11550 (line 21 to 24): "In terms of potential anthropogenic pollutant sources…" This sentence can easily be misunderstood that highly populated regions could also be a source for elevated radon levels. The sentence in lines 23 and 24 might be changed to: "Based on the findings…….considerable inter-annual variability in trace gas emissions (e.g. CO and CO2) is likely for this fetch region.

Thank you for drawing our attention to this ambiguity, we have addressed it in the revised manuscript.

Points (a) – (f) that were raised pertaining to grammatical corrections will all be changed, as suggested, in the revised manuscript.