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7th November 2014

Dr Yves Balkanski
Editor, ACP

Dear Dr Balkanski,

Please find below our response to the first anonymous review of our paper: "On the use of radon for quantifying the effects of atmospheric stability on urban emissions".

We would like to thank the reviewer for their constructive feedback and suggested additional reference material. All comments are addressed individually below.

Kind regards,

Scott Chambers

Responses to specific comments

1. Fig. 2-3 show a key analyses for point (2) listed above **[**"to design a simple method to separate local and remotely advected components to the observed radon abundance"**]. *In discussing Fig. 2, the authors say that back trajectories using the HYSPLIT model are used (but not shown) indicating that the increase in daily minimum (afternoon) radon concentrations from day 253 to day 255 is the result of an increasing land fetch over eastern Australia. On day 257, the abrupt reduction in radon concentration corresponds to a synoptic change in air mass fetch from terrestrial (south westerly) to oceanic (south easterly). I would suggest to be more explicit on this important aspect, by showing examples of back-trajectories for days 255 and 257.***

This is indeed an important point, perhaps best not overlooked in the manuscript for the sake of brevity. For convenience, we reproduce Figure 2 of the manuscript below, and then show the corresponding trajectories.

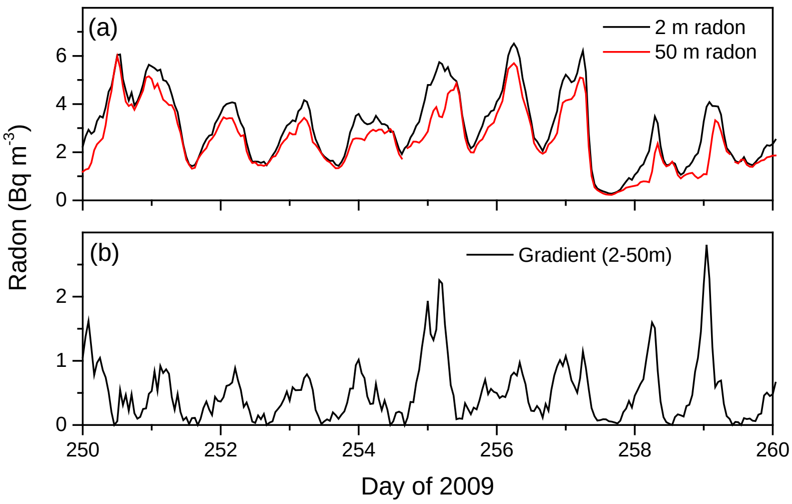
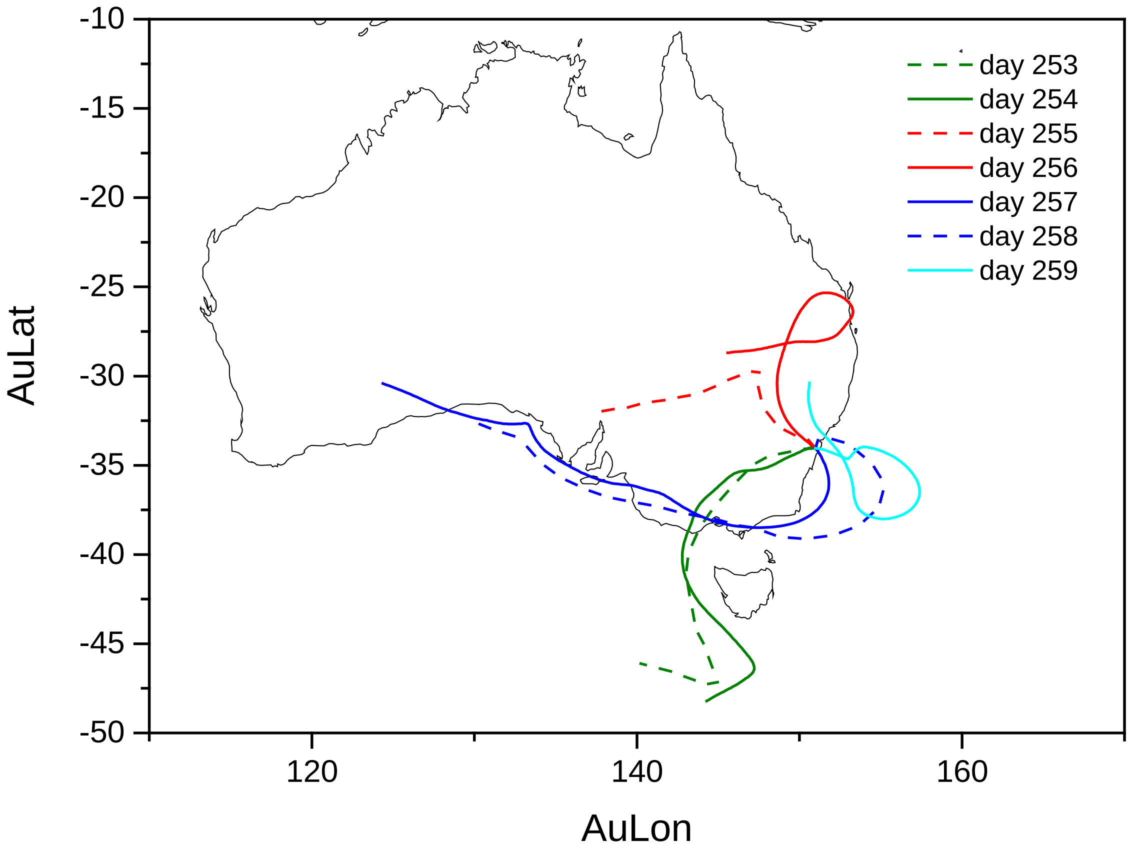


Figure 2 of original manuscript

To generate the following plot we used the PC version of HYSPLIT v4 to calculate 4-day back-trajectories every hour from the start of day 253 to the end of day 259, with a termination height of 200m (within the atmospheric boundary layer (ABL), but sufficiently far from the surface to avoid roughness effects). We then took 5 of the hourly trajectories each day (in the afternoons, between 1300-1700h, when the ABL was well developed), and used them to generate one average trajectory each day; representative of the fetch for that afternoon's air masses.

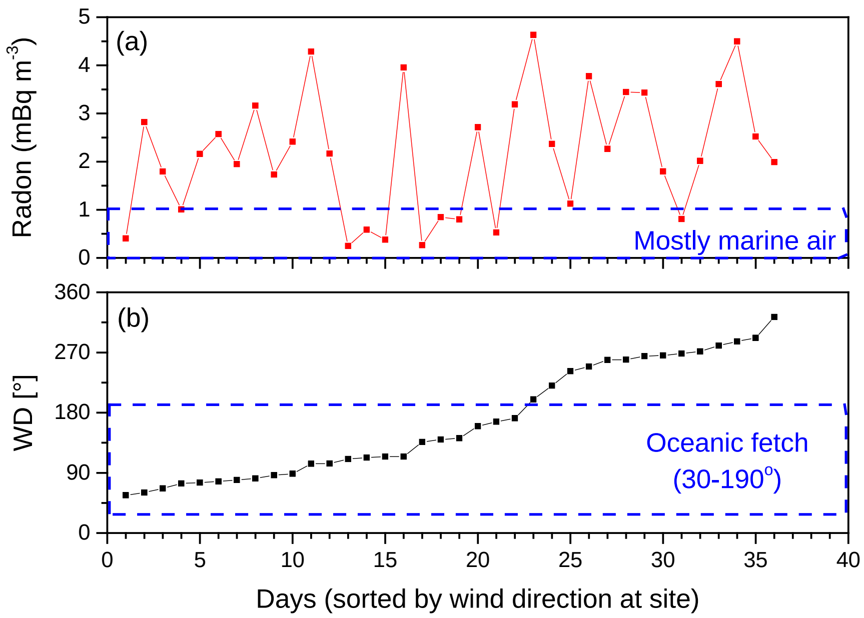


The trajectories in the above plot have been colour-coded for terrestrial fetch duration: shorter land-fetch events (crossing only SE Australia) **in green**; longer land-fetch (over inland Australia) **in red**; and predominantly oceanic fetch **in blue**. For the green events (e.g. day 253 in Figure 2), when daytime minimum radon concentrations are around 1.7 Bq/m^3, there was a moderate amount of land fetch. By comparison, when daytime minimum radon concentrations increase to 2 - 2.2 Bq/m^3 (e.g. days 255-256), air masses had a longer land fetch over inland Australia, as indicated by the red trajectories. Finally, on day 257 when afternoon minimum radon concentrations reduce to 0.2-0.3 Bq/m^3, the blue trajectories indicate an abrupt shift to predominantly oceanic fetch of the air masses for the 2 days prior to arrival at the measurement site.

We will include a version of the above figure, with a short explanation, in the revised manuscript.

2. In addition, for Fig. 3, I would provide a quantitative correlation of the minimum radon concentration during afternoon hours (for all days reported in Fig. 3a) with the wind direction. This could be done by adding an extra-panel in Fig. 3.

At many sites, including much of eastern Australia, wind direction alone is not a good indicator of recent air mass fetch. It is quite common, as shown in the light-blue trajectory for day 259 in the above plot, for an air mass to spend considerable time over land, then move out to sea, and finally approach the measurement site again from the east (a direction which we would usually associated with oceanic fetch). For this reason, it is best to use wind direction in conjunction with back trajectory analysis. To demonstrate the potential pitfalls of using only local wind direction to infer recent air mass fetch, we took all of the days represented in Figure 3 of the original manuscript (36 days in total), and calculated (a) afternoon mean radon concentration (1300-1700h), and (b) afternoon mean wind direction. We then sorted these two series in order of ascending wind direction (see below).



For near-coastal sites in Sydney, wind directions from 30° - 190° should be representative of primarily oceanic fetch; for which afternoon radon concentrations should be well less than 1 Bq/m^3. (For reference purposes, at "baseline" atmospheric stations a commonly adopted threshold for significant terrestrial influence on an air mass is a radon concentration of 0.1 Bq/m^3). As shown in the figure above, many air masses approaching the measurement site from the "oceanic sector" exhibit a strong continental signature (afternoon radon concentrations ≥ 2 Bq/m^3). In fact, only 4 of the 22 days where afternoon winds are in the "oceanic sector" do air masses exhibit nearly-oceanic characteristics (afternoon radon concentrations <0.5 Bq/m^3). We should note here that since the measurement site (Richmond) is 50 km from the coast, even air masses that have had purely oceanic fetch for the past 10 days will accumulate a limited amount of radon (0.2 – 0.8 Bq/m^3) in transit across this coastal strip, depending on their velocity and the depth of the ABL at Richmond.

For the reasons noted above we have chosen not to include a correlation of afternoon wind direction and radon concentration in the revised manuscript.

2. The discussion on the stability effects on boundary layer pollutants (Fig. 8) is bit too short and compact, in my opinion. Links of boundary layer observations of ozone, radon, wind and temperature have been discussed in other papers in the literature and they may probably be cited in the discussion (see for example: Di Carlo et al., J. Geophys. Res., 112, doi:10.1029/2006JD007900, 2007; Pitari et al., Environ. Earth Sci., 71, doi:10.1007/s12665-013-2635-1, 2014).

The authors agree that the interpretation of pollutant concentrations in the current version of the manuscript is very limited. As mentioned in the manuscript's Introduction, however, a thorough interpretation of results is beyond the initial scope of this study. Our intention was primarily to develop and test a method by which radon could be used to classify observations of urban emissions by nocturnal stability category. Given that the manuscript is already quite long, we would *prefer* to include the additional reference material suggested above by the reviewer in the revised version of the text, but leave a detailed analysis of the pollutant behaviour and characteristics to a dedicated follow-up study. On this matter we would ask the advice of the editor.

3. As above for the references to the box model approach.

The authors note, and agree with, the significance of the additional reference material suggested for the section of the paper using a box model approach to estimate equivalent mixing depth. These additional references will be included in the revised manuscript, but, for the sake of brevity (as noted above), we would *prefer* not to significantly lengthen the section of the manuscript regarding the box model analysis. Again, on this matter we would ask the advice of the editor.