Response to comments from Reviewer #1

On behalf of all coauthors, I would like to thank the reviewer for their time and effort in reviewing our manuscript. It was encouraging and rewarding to see the support of our suggested reimagining of this well-established technique for independent top-down estimation of local to regional GHG emissions. Indeed, we are hopeful that the suggestion of stability typing (at sites where appropriate) and 8-point checklist of somewhat flexible criteria important to the technique will assist with clearer interpretation of future results – but the reviewer is also quite right in mentioning the potential for using this information to reanalyse prior datasets.

We agree with the reviewers' suggestions regarding technical issues and have addressed these with tracked changes in a revised version of the manuscript that will be posted at the end of the review process.

Regarding one point:

***line 427**: Not sure whether the acronym 'PTI' has been introduced in the text before?*

The acronym PTI (Persistent Temperature Inversion) was first introduced at line 216.

The reviewer also inquired about the implications of considerations discussed here for other implementations of the RTM. As noted in the *Introduction*, four implementations of the RTM have appeared in the literature, each targeting different spatial scales and temporal resolutions of emission estimates: (i) a regional-to-continental scale approach; (ii) a regional scale plume/event-based approach; (iii) the local-to-regional scale nocturnal accumulation approach discussed in this manuscript; and, (iv) a local scale profile method.

To recap, the main recommendations of this manuscript were to consider stability class typing in conjunction with the nocturnal accumulation implementation of the RTM, and to think of the technique's eight main considerations on a case-by-case basis (in view of site characteristics and measurement setup):

(i) nocturnal window definition,
(ii) radon and target gas accumulation thresholds,
(iii) radon-to-target gas regression linearity thresholds,
(iv) measurement height,
(v) defining the contributing fetch,
(vi) spatial and temporal radon flux variability,
(vii) RTM temporal resolution, and
(viii) application specific selection of a suitable radon monitor.

The local scale profile method is most comparable to the method described in this manuscript, since it is also based on accumulation measurements within the nocturnal boundary layer. In principle, stability classification would also be beneficial for this approach, and measurement heights (point iv above), would be set low, but all of the other seven considerations would apply. However, since the contributing fetch region is typically much smaller for this approach, the degree of sensitivity of result to each of the seven remaining points would likely be dependent on the small-scale fetch heterogeneity. For example, if looking at small-scale fetch in a broadly homogeneous region, results would presumably be less sensitive to points (i), (v) and (vi) above. While measurements are close to the surface (where radon concentrations are larger), since radon *gradients* need to be accurately characterised, low measurement uncertainty would also be important for this implementation.

Regarding the two regional-scale implementations of the RTM, they both target observations in a well-mixed, fully developed, boundary layer. In this respect, stability classification would not benefit these approaches. To the contrary, in fact, since both techniques are seeking to characterise emissions from larger (typically more remote) regions, it would usually be a requirement to minimise very local influences (for which a wind speed threshold, based on measurement height, is usually applied, and measurements below some agreed critical wind speed are excluded). For these approaches the accumulation threshold requirement is replaced by a minimum concentration above the regional expected “baseline” (clean air) value. It is still important to characterise the contributing fetch region (though at higher wind speeds, in a developed boundary layer, trajectory or plume dispersion model fetch estimates are likely to be more representative of “truth” than under stable nocturnal conditions). Similar challenges regarding the representation of spatial and temporal variability of the radon flux will remain. Air mass travel times are generally longer, so it becomes more critical to account for radon decay in transit, and the measurement uncertainty for radon detection is usually less critical given the large differences typical between radon concentrations of “baseline” and continental air masses.

Scott Chambers (on behalf of all co-authors)
17-July-2026