Six years of greenhouse gas fluxes at Saclay, France, estimated with the Radon Tracer Method

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Review 1

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This paper used the Radon Tracer Method (RTM) to estimate greenhouse gas (CO2, CH4, N2O) and CO fluxes at Saclay, France during the period of January 2017 – December 2022. The authors examined the sensitivity of the method to the use of different Radon exhalation maps. Radon exhalation maps from the 19ENV01 traceRadon project, STILT back trajectories from the ICOS Carbon Portal, estimates of radon activities and greenhouse gas data were then used to estimate surface emissions. They found that the estimated CO2, CH4, CO and N2O surface emissions were in good agreement with the literature and that CH4, N2O and CO fluxes were also in fair agreement with inventories. The observation-based RTM method provides an independent approach (alternative to inverse modeling) to verify greenhouse gas fluxes, as demonstrated in this study. This reviewer's major concern is that the presentation of this paper needs improvement and in some places the texts are hard to understand (see examples below). Publication on ACP is recommended after serious editing and addressing the comments below.

We thank the reviewer for his/her helpful comments about the form of the manuscript. Our answers are shown below each point and in italic.

Abstract, Line 12: "CH4, N2O and CO are also in fair agreement with the inventories, though with higher values" – do you actually mean "CH4, N2O and CO fluxes"? "To our knowledge, this is the first study using the latest radon exhalation maps and standardized radon measurements to estimate CO2, CH4, CO and N2O surface emissions" - Is this for any site or for Saclay only? "These fluxes are in good agreement with the literature" – Could you cite the values from the literature for each species?

To our knowledge, it is for any site. The latest maps have been used in Curcoll et al.,2024 but not in combination with the standardized radon measurements. We will add it and the literature values in the abstract.

Page 3, Line 8: Kikaj et al. (2024) – when was this submitted? Not available to the reviewer.

This paper was still in discussion at the time of the submission, it is now published : https://doi.org/10.5194/amt-18-151-2025

Page 3, Line 10: "the radon flux was considered homogeneous over time and space" – is this said for Paris or Europe? Probably this was an assumption made in the study of Yver et al. (2009)? "as it is now known that the radon fluxes varies on space and time" – it is long known (way before 2009) that the radon fluxes vary on space and time.

It is indeed known before Yver et al., 2009 that the radon fluxes varies over time and space but before about that date we did not have access to spatialized maps, only individual measurements at different times and places. We will reformulate to clarify.

Page 4, Line 4: "the nocturnal PBL was above 100m…." – I think you meant the nocturnal PBL height was above the 100 m sampling height of SAC tower.

This will be reformulated for clarity.

Figure 1 caption: what is the CCGCRV code?

The CCGCRV code is a digital filtering curve fitting program developed by Kirk Thoning (Carbon Cycle Group, Earth System Research Laboratory (CCG/ESRL), NOAA, USA) in the late 1980s. It is first used in Thoning et al., 1989 and is available on https://gml.noaa.gov/ccgg/mbl/crvfit/crvfit.html

We will clarify the text to add this explanation.

Page 5, Line 11: Under which conditions will this (<<) be valid?

For short-term variations of C_{Rn} (t), eight hours in our study, we can assume that $\lambda_{Rn} C_{Rn} << \Delta C_{Rn} / \Delta t$, especially as in our study, we also apply a threshold on the radon increase to select events with a significant increase.

In Levin et al., 2021, the whole effect of the decay, estimated to be less than 10% is even neglected. Here, we apply the correction as defined in Schmidt et al.,2001.

Page 10, Lines 9-11: It's well known that radon emissions under freezing temperatures in winter are much reduced. Is the higher soil humidity, which prevents the radon from exhaling, due to low temperature in winter?

It is both due to a reduced evaporation and an increased amount of precipitation and condensation. It will be added in the text.

Figure 3: "the fixed flux from the literature" --- which literature?

We are referring here to the literature average established in Yver et al., 2009. We will clarify in the caption.

Figure 5 caption: it's not clear whether "fluxes" are for Rn or CH4. Please clarify to avoid confusion.

There is indeed some confusion in this caption. It will be clarified in the revised version.

"CH_4 flux in February (top) and August (bottom) 2019 for the sensitivity tests. On the left, the results from using a fixed radon flux from the literature (Yver et al., 2009) is displayed. In the middle, the methane fluxes come from the radon fluxes derived only from the station pixel of the different exhalation maps. On the right, the methane fluxes are derived from the radon fluxes calculated using the combination of the exhalation maps and the nighttime footprint. The colored dots represent the fluxes for the different runs. For each panel, only the runs leading to different results are shown for clarity."

Figure 6: "CH4 2 Flux"?

The typo will be corrected.

Figure 8 caption: "On the left panels, …shown, in the middle panel, we show…" - Editing is needed.

We will rephrase for clarity.

Figure 9: what is "por"?

"por" stands for porosity. We will add it in the caption.

Page 20, Line 6: "for the others, it was either the radon increase that was too low or the number of available hours" – Please clarify.

We use different criteria to select the event, in particular, we check that there is an actual radon increase and we apply a threshold of 1 Bq m−3 and at least data spanning two hours (to have 4 datapoints minimum for the regression) as described in section 3.1.

We will reformulate for clarity.

Page 21, Line 6: "an underestimation for the higher ones" – Not clear. RTM overestimates?

Compared to one another, for the higher values, the inventory is lower than the RTM so underestimates the fluxes or depending on the point of view, the RTM overestimates them. We will reformulate for clarity.

Page 21, Line 15: "though soil chambers" – do you mean "through soil chambers"?

We meant "using accumulation chambers", we will clarify the text.

Page 21, Line 22: "CO RTM and TNOf fluxes do not show a clear seasonal cycle or a trend over the period" – could you make a seasonality plot?Page 24, Line 1: "No trend is observed" – this is also mentioned elsewhere. Did you try to do regression analysis?

About these two points, we will apply the CCGCRV program to estimate trend and seasonality for all the species. We also plan to add the year 2023 and maybe 2024 if the radon flux map for that year gets available in the timeframe of our revision to improve the meaning of such trend estimation.

Page 26, Line 3: do you mean "CH4, N2O and CO fluxes are in fair agreement with the inventories"?

Yes, and we will reformulate accordingly.

Code and data availability: the ICOS Carbon Portal address is not provided. Both the FLEXPART trajectories and the RTM code are not provided (shared on demand only) but should be archived in a public depository (e.g., https://zenodo.org/).

We will add the address (https://meta.icos-cp.eu) and and make the code publicly available in a repository.

Minor comments:

Page 3, Line 5: GHG and 222Rn "concentrations"?

Page 4, Line 27: "respectively, " – add "," before respectively (also check elsewhere in the text).

Section 2.2: Please add references for the Radon Tracer Method at the beginning of this section since this method has previously been used.

Page 8, Line 30: Please add "N" for latitude and "W" for longitude.

Page 9, Line 19: obtained BY

Page 10, Line 7: are showN.

Page 10, Line 15: remove the redundant "Bq".

Figure 18, Line 32: FEWER events

Figure 4 caption: using either….or both the maps and the footprints.

Page 24, Line 2-3: "we are looking here at nocturnal fluxes without photosynthesis only respiration" – how about "…without photosynthesis (i.e., with respiration only)"?

Page 24, Line 5, Line 14: "in average" should be "on average"; change "like" to "as".

All the changes suggested above will be implemented.

Citation:

Curcoll, R., Morguí, J.-A., Àgueda, A., Cañas, L., Borràs, S., Vargas, A., and Grossi, C.: Estimation of seasonal methane fluxes over a Mediterranean rice paddy area using the Radon Tracer Method (RTM), EGUsphere [preprint], https://doi.org/10.5194/egusphere-2024-1370, 2024.

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