Response to reviewer #3 comments on 'Microphysics of radiation fog and estimation of fog deposition velocity for atmospheric dispersion applications' By Abida et al., 2023

The authors would like to thank the editor and the reviewers for their comments which helped to improve the manuscript. Kindly find below our response point-by-point in blue.

General

In this paper the authors investigate a series of fog events near the nuclear power station Barakah, situated close to the Arabian Sea in an arid environment. The investigation is performed using quite a number of different meteorological instruments on-site and numerical simulations, employing and testing various parameterizations for the planetary boundary layer physics. The final goal is to show whether and how much fog would change the contamination of soil nearby if there would be a nuclear accident with release of radioactive matter. Indeed it is found that fog changes the deposition pattern of the radioactive material. It is said that the results depend on the type of the ground and that therefore the present results are peculiar for the considered site. It is recommended that fog deposition is considered as an additional scavenging mechanism in dispersion models.

The paper is well written and the reader has the nice feeling of a fluent read. My impression is that there are no technical flaws or unjustified statements. Most statements are put into context by mentioning results from similar studies. To my view, this paper can be published after some minor corrections which I think would improve an already quite good manuscript.

We thank the reviewer for taking the time to read our manuscript and provide invaluable feedback.

These are my minor comments:

1. Line 47 ff: Please rewrite "Masson et al. (2015) showed that cloud water was relevant to detect 134Cs (.....) on a longer time scale than both in aerosol and in rainwater." I don't understand this sentence. Additionally, check whether it is 134Cs or rather 137Cs.

   REPLY: Thank you for your feedback. We agree that the sentence was not clear and have rewritten it for clarity (Lines: 51-53). Also, we confirm that we intended to reference ^{134}Cs, which is known to have a longer detection time scale in cloud water. The revised sentence is as follows: 'Subject to the capabilities of trace level measurement, Masson et al. (2015)

found that the detection of ^{134}Cs (a radionuclide released during accident with a half-life of 2.06 year) was possible over a longer time scale in cloud water, compared to its detection in aerosols and rainwater.

2. Line 55: "the number of studies on fog in arid and semi-arid regions has caught recent attention". Please rewrite, as it says that the number of something has caught attention which is surely not meant.

   REPLY: Thank you for pointing out the ambiguity in the original phrasing. We have revised the referred text to clarify that the recent attention has been focused on the topic of fog in arid and semi-arid regions, rather than the number of studies themselves. The revised sentence now reads, 'While there has been growing interest in the study of fog in arid and semi-arid regions (Eckardt and Schemenauer, 1998; Feigenwinter et al., 2020; Katata et al., 2010; Spirig et al., 2021), research regarding fog deposition of radionuclides in such environments is notably lacking.' (Lines: 59 - 62)

3. Line 137: I am not happy with the expression "to measure fog microphysics". Perhaps better "to observe and quantify microphysical processes".

   REPLY: Corrected (Lines: 147-148)

4. Line 146: Has MVD already been spelled out?

   REPLY: Thank you for pointing out the usage of the acronym 'MVD'. We realize that it had not been spelled out before line 146. In the revised manuscript, we have introduced the term 'Median Volume Diameter (MVD)' at its first occurrence to ensure clarity for the readers (Line: 159).

5. Line 147: "2 counts cm-3": Unclear. Either it must be 2 counts per ccm and unit time, or you must add over which time the counting had been integrated.

   REPLY: Thank you for your comment. We understand the confusion regarding the unit of measure. We have clarified this in the revised manuscript to indicate that the '2 counts cm-3' is an instantaneous count per second. The revised sentence now reads as follows: '...we only considered values where the number concentration was greater than 2 counts cm-3 sec-1.'. (Lines: 160).

6. Line 156/7: Incomplete sentence "For a full description of the operational method and measurement uncertainties (..)."

REPLY: We appreciate your observation regarding the incomplete sentence. We have now revised the sentence in the revised version of the manuscript (Lines: 169-170)

7. Line 172: Please find a better expression than "construction structures".

   REPLY: Corrected (Line: 183-184)

8. Line 214: Correct "Forty_-five".

   REPLY: Corrected (Line: 253)

9. Line 223: Please rewrite "the cloud water-rain and the cloud ice-snow are treated for temperatures above and below 0°C."

   REPLY: Thank you for your feedback. In line with your suggestion, we have revised the sentence in line 223 to more clearly distinguish the treatment of liquid and frozen water hydrometeors at different temperatures (Lines: 262-265).

10. Line 399: Not sure whether METAR was defined somewhere.

    REPLY: Thank you for pointing out the usage of the acronym 'METAR'. We realize that it had not been spelled out before line 399. In the revised manuscript, We have introduced the term 'Meteorological Aerodrome Report (METAR)' at its first occurrence to ensure clarity for the readers (Lines: 529-530).

11. Line 403/4: "it is observed that similar to the horizontal visibility, the LWC and number concentration also increase abruptly". This should be rewritten since it indicates that visibility would increase which it doesn't.

    REPLY: Thank you for pointing out the potential for misunderstanding in our original phrasing. We now revised line sentence to clarify that as visibility decreases, the LWC and number concentration increase (Lines: 533-535).

12. Figure 2 should be replaced. The presentation of the data is misleading. The problem is that the data from independent days are shown in the form of a contour plot (or something similar) which results in smooth transitions between these days. Instead, we have 12 independent time series and I strongly suggest replacing the plot with one showing simply the 12 timeseries as 12 single curves.

REPLY: We thank the reviewer for pointing out this. We understand your concern about the potential for misrepresentation when using the contour plot to represent the independent time series data. As you suggested we now revised the Figure 2 to clearly depict the 12 independent time series as individual curves.

13. Line 416 and several other instances: You write "bin size" but you mean "size bin" which are two different things. Additionally, I do not remember whether you defined before what "size" is. Is it the droplet diameter or radius? Please check.

REPLY: Thank you for pointing out the need for clarity in our terminology. We have taken your suggestion and will use 'size bin' when referring to categories of droplet diameters. For clarity, we've added a definition early in the manuscript specifying that 'size' refers to the droplet diameter in our study (Line: 155-156). We appreciate your attention to these details.

14. Line 429: Delete "While" and start the sentence "The second mode...".

REPLY: Corrected (Line: 561)

15. Lines 432/3: Please check the numbers 4.5 vs 5.5 micron. As I understood, there is only one small mode that should be characterised by only one value.

REPLY: Thank you for drawing out attention to this discrepancy. It was a typographical error. The correct value should be 4.5 micron, not 5.5. Corrected in the revised version of the manuscript (Line: 563-566).

16. Line 437: I suggest replacing "discrepancies" with "differences". Discrepancies implies to me that there is something inconsistent, but that seems not implied here.

REPLY: Corrected (Line: 570)

17. Line 474: It seems that onset/termination times and durations are inconsistent here and in table 3.

REPLY: Thank you for bringing this inconsistency to our attention. The fog case on 16th Feb included two distinct fog events, which should have been represented separately in Table 3. We now have updated Table 3 in the revised manuscript. Same is corrected in the text (Lines: 605-608).

18. Line 477: "droplet sizes between 20 and 30". Add units.

REPLY: Units added (Line: 610)

19. Figure 3: x-axis label should be radius or diameter, but not bin.

REPLY: Corrected (Figure 3).

20. Line 528: Check "number concentration were observed Figs. 2a-c". I suggest also that you would better write "number concentrations were measured".

REPLY: Thank you for your suggestion. We agree that using 'measured' is more appropriate and precise in this context. We now corrected this in the revised version of the manuscript (Line: 687).

21. Line 534 and Figure A2: Use "backscatter profiles" instead of "backscattered profiles" (The profiles themselves are not backscattered).

REPLY: Thank you for your suggestion regarding the use of terminology. We agree that 'backscatter profiles' is a more accurate description. We now corrected in the text (Line: 707-708) and Figure A2 caption accordingly to replace 'backscattered profiles' with 'backscatter profiles'. We appreciate your attention to detail.

22. Lines 579/80: Please rewrite "Settling velocities calculated every 5 min and values with visibility greater than 1 km are discarded (Fig. 7b)." I don't understand what you mean.

REPLY: Thank you for your comment. We understand the confusion caused by our original sentence. We have revised it for clarity (Lines:753-754) and it now reads: 'We calculated settling velocities every 5 minutes, discarding the values associated with visibility greater than 1 km (Fig. 7b).' We hope this addresses your concern.

23. Line 588: What is an "increasing relationship"?

REPLY: Apologies for any confusion caused by our use of the term 'increasing relationship.' We intended to refer to a direct relationship, where an increase in Liquid Water Content (LWC) would correspond with an increase in the gravitational settling rate. We have revised the sentence to read: 'This calculation confirms that a direct relationship between LWC in the fog and the gravitational settling rate is not necessarily warranted.' (Line: 761-765). We appreciate your feedback for improving the clarity of our manuscript.

24. Line 681: Here you should repeat or mention the PBL schemes that you use, for the convenience of the reader. A few words on each PBL schemes particular properties and abilities would be helpful as well.

REPLY: We thank you for your insightful remark. Indeed, a reminder of the PBL schemes used is necessary here, and accordingly the text is revised as follows:'Fog simulation is sensitive to the choice of the PBL parameterization scheme. Therefore, we performed five 48-hour WRF simulations, using three local PBL schemes, MYJ, MYNN2.5 and MYNN3.0, and two non-local PBL schemes, YSU and ACM2.' (Line: 891-894, section 5). The properties and abilities of each scheme are now added to the Table 2. Also some discussion about their characteristics can be found in lines 281-289'.

25. Line 697: Replace "ribbon" with "band".

REPLY: We appreciate your suggestion to replace 'ribbon' with 'band'. We agree that 'band' is a more appropriate term in this context. We have made this correction in the revised manuscript (Line: 923-924, section-5).

26. Line 707: Please use a simple dot or an "x" instead of a star for multiplication. In the figures it is a "x" which is ok.

REPLY: Corrected.

27. Line 734: write "long" instead of "longer".

REPLY: Corrected.

28. Lines 773 ff: Please rewrite "the actual impact of fog on radionuclide deposition can vary widely depending on the specific situation as well as more on the solubility and chemical form of the radionuclide-labeled particles." I don't understand the second half of the sentence beginning from "as well as...".

REPLY: Thank you for your feedback. We realize our sentence was unclear. We have rewritten it to better communicate our point: 'The actual impact of fog on radionuclide deposition can vary widely depending on the specific situation. Moreover, the solubility and chemical form of the radionuclide-labeled particles can significantly influence this impact.'

29. Line 807: What is a "size distribution of the mean number of droplets"?

REPLY: Thank you for your feedback. We understand the original phrase was unclear. To enhance the clarity, we have changed it to 'size distribution of mean number concentration' for each fog event.'.