In the following, quotes by Anonymous Referee # (RC1) and #2 (RC2) will be shown in *italic* followed by our replies. Quotations from the manuscript are given in “quotation marks” with the changes in **bold**.

RC1: 1. *Plausibility validation and limitations:*

While the paper states that direct comparisons to in-situ data are not feasible due to scale and data availability, it would be good to supplement the plausibility tests with some quantitative reasoning or reference to typical values, if possible.

Providing some context to the plausibility tests would indeed improve the manuscript. We enhanced section 6.4.4. with a few sentences on the heavy precipitation amount:

“For winter in Hamburg, a precipitation amount of over 40 mm after one hour is an extreme case, as synoptic conditions are more favourable for extreme precipitation events in summer than in winter (Weder et al., 2017). As parts of the model extension are also intended to be applied for studies on the impact of heavy precipitation, this extreme case was chosen for the plausibility tests.”

“Weder, C., Müller, G., and Brümmer, B.: Precipitation extremes on time scales from minute to month measured at the Hamburg Weather Mast 1997 - 2014 and their relation to synoptic weather types, Meteorologische Zeitschrift, 26, 507-524, 770, https://doi.org/10.1127/metz/2017/0812, 2017.”

RC1: *Also, it would be helpful to have a discussion of the limitations and assumptions of the hit rate-based method.*

To improve the discussion of the limitations of the method, we revised the respective paragraph in section 6.3:

“We use this dependency to our advantage. The comparison of results of different model versions (e.g. with/ without parallelisation, code extensions used with values of zero for the variables) **should lead to very similar results**. **In contrast**, extensions of a model with new or changed process descriptions **and nonzero values for variables** should provide different model results and **thus small hit rates**.**”**

RC1:*2. Hit rate method:*

- *The 95% threshold is adopted from VDI (2017) and WMO. While this reference is appropriate, it would be good to more explicitly explain why this threshold is suitable in the context of this study, particularly for variables related to precipitation.*

Commonly used confidence levels are 99 %, 95 % and 66 %. A confidence level of 99% is a very strict threshold suitable for very controlled experiments. The confidence level of 66 % would allow for quite a lot of uncertainties when comparing different types of data like for example simulation results with measurement data. For our study, this confidence level would not be strict enough. 95 %, as suggested by VDI, is quite strict while allowing for some uncertainties. For increasing the strictness, we chose smaller threshold values instead of a higher confidence level. Therefore, using 95% fits our purposes well.

The revision of the paragraph above should also make this clearer.

RC1:

- *In cases where hit rates are expected to be low, e.g., some cases are lower than 40%, the paper should provide more context. For example, what constitutes an acceptable range for deviations due to added processes? Any sensitivity analysis or benchmark expectations could clarify whether such a result indicates model improvement or other reasons.*

In this paper we performed plausibility tests and no sensitivity analyses. Sensitivity studies can be found in a previous study (Ferner et al. 2023, https://doi.org/10.1127/metz/2022/1149).

RC1:*3. Model generalization.*

The model domain and test building represent a highly simplified urban environment. A general discussion of how the model might perform in larger, denser, or more heterogeneous urban areas would be useful for understanding the broader applicability of these extensions. E.g., would the added processes scale well to city domains, or would numerical stability or computational cost become limiting factors?

For model development and testing a simplified domain was chosen, where features of a more realistic urban setting like stretched grids, obstacle corners and terrain slopes are still included. Sensitivity studies for a more heterogeneous and realistic urban neighbourhood were carried out in the already mentioned previous study (Ferner et al. 2023). There, the grid was designed following the recommendations of the VDI.

However, when applying the extended model to larger domains, computational cost indeed becomes an issue. To reduce the number of grid cells, an irregular grid was used.

Numerical stability is not an issue.

RC2: *But the numerous equations are not easy to follow, requiring the readers to read earlier reference papers. Some papers are very old and might not be easy to find. I would suggest improving the equations, such as explaining all symbols used in the equations. In the appendix (List of symbols), please give units for dimensional variables. Some equations might be excluded in the MS.*

The equations are taken from earlier publications. Some of them are old and/or in German. We wanted to have all equations relevant for the model extension of MITRAS to be found in the same publication, therefore we did not remove any more equations.

We added units to the list of symbols (e.g. "h orography height **[m]**"). We also moved the thermal conductivities to their correct places in alphabetical order and corrected the notation of the concentration of active ice nuclei.

RC2:

1. *5, 8, 12, 13. Please double-check these equations (after they have been recalculated to SI units). I did check Eq. 5, and found the dimensions are consistent. I would suggest that the units in the equations should be removed.*

Units in cloud microphysical equations have historically been quite peculiar as they are derived from empirical data. We improved the readability of the equations by using another notation, which reduces the occurrence of peculiar exponents. Removing the units altogether was not an option for us. Unfortunately, we could not avoid that the ventilation factor (Eq. 12) still includes units with an exponent. For depositional growth and melting and freezing we still reference Doms et al. 2011.

For example, Eq. 5 (terminal velocity of rain) is changed to:

“v_TR=68.81 (10^-3 rho0**/kgm^-3** q_1^2r**/kgkg^-1**)^0.1905”

RC2:

2. *Section 6.2. Please give the boundary conditions for the domain boundaries.*

We updated section 6.1 (model set-up) with the boundary conditions.

“At the lateral boundaries and at the upper boundary a gradient of zero is assumed except for boundary normal winds, where boundary values are either calculated (lateral) or large-scale values are prescribed (top). At the bottom boundary for wind fixed values are prescribed. For temperature and specific humidity, the surface energy budget is calculated (Sect. 4) and for cloud, rain, and snow water content, the flux at the boundary equals the flux in the model (Sect. 3.2).”

RC2:

3. *Section 6.1. It would be good to check mesh sensitivity or give comments to justify.*

Mesh sensitivity is not the focus of the current paper. Here, we checked the reliability of the added processes by plausibility (see also our response to RC1’s comment on model generalization).

RC2:

4. *Table 3 and Fig. 11. The difference in v-wind component {\Delta v} near the ground is very large. Why don’t you set up a case with a flat ground surface?*

A case without consideration of orography is included in Ferner et al. 2023.

CEC1*: “After checking your manuscript, it has come to our attention that it does not comply with our ‘Code and Data Policy’.”*

For reasons beyond our control and outlined in detail to the editorial team, we are unable to make the model code publicly available. However, we have archived the code of the model versions used in this manuscript in restricted repositories and updated the code and data availability section.

“The code of the MITRAS versions used in this manuscript can be found on Zenodo (version 3.0: https://doi.org/10.5281/zenodo.15705546, University of Hamburg, Meteorological Institute, MEMI (2025a); version 3.1: https://doi.org/10.5281/zenodo.15705664, University of Hamburg, Meteorological Institute, MEMI (2025b); version 3.3: https://doi.org/10.5281/zenodo.15705608, University of Hamburg, Meteorological Institute, MEMI (2025c)).”

“University of Hamburg, Meteorological Institute, MEMI: MITRAS version 3.0, Zenodo [Code], https://doi.org/10.5281/zenodo.15705546, 2025a.

University of Hamburg, Meteorological Institute, MEMI: MITRAS version 3.1, Zenodo [Code], https://doi.org/10.5281/zenodo.15705664, 2025b.

University of Hamburg, Meteorological Institute, MEMI: MITRAS version 3.3, Zenodo [Code], https://doi.org/10.5281/zenodo.15705608,765, 2025c."

Further changes:

We also added the time to Figs 11 and 12 ("**at 8:32:00 LST**") and changed the word "**vapourisation**" to the British spelling in Section 2.2 and in the List of Symbols.