Dear reviewer,

We would like to thank you greatly for the review and feedback on our manuscript. Below, you can find our responses to your specific comments:

- In line 56, the authors state that DERMA is designed for long-range dispersion modeling and performs better on these scales. However, in line 30, they mention that puff models generally work well when the puffs are young, while additional assumptions and complications arise as the puff evolves. This appears contradictory. The statement on line 30 suggests that puff models are better suited for short-range applications (young puffs), whereas DERMA is tailored for long-range scenarios (more evolved puffs). Could the authors clarify whether DERMA operates fundamentally differently from other puff models in this regard? It would be helpful to explain the specific advantages DERMA offers over other puff models, and to provide justification for implementing a new turbulent diffusion scheme rather than adapting one of the existing models that may already perform better on short spatial scales (e.g., PPM).

Thank you for the question, we can see why these statements may appear contradictory. The description starting in line 30 aims at describing the limitations in the puff concept itself (puffs growing too big for the physical assumptions to hold). However, the next parts of the text discusses different possible approaches to overcome this limitation; either by introducing puff splitting or stochastic movement. To describe how we overcome this in the DERMA model, we write (line 47-49): "..., *the puffs in DERMA are likely to stretch over different flow regimes. However, a vertical stochastic transport scheme inside the PBL is used as an alternative to puff splitting; by randomly moving puff centroids inside the PBL to new vertical positions, each puff is exposed to the vertical wind shear over time.*"

Yes, DERMA does operate fundamentally differently from other puff models in some respects (that we know of), by combining the assumption of uniform distribution in the vertical dimension with the stochastic transport scheme. This formulation is very efficient and works well for longer scales. Thus, the justification for developing a new turbulence scheme is that we want to keep the existing long-distance formulation of DERMA, and we therefore needed to design the new short-scale formulation such that it was compatible with the existing framework.

Further, as described for the PPM model (line 40-44): " ... *in order to keep puffs smaller than the meandering scales, PPM uses more puffs and more frequent puff splitting than in regular puff models and should be considered a compromise between the two model types, with respect to both accuracy and efficiency.*" Hence, the PPM model has a different aim than DERMA, and its formulation is therefore not suitable for our purposes. Although the concepts of the two models are similiar on shorter scales, we want DERMA to remain a computationally efficient alternative to more expensive (and possibly more accurate) models.

We have made some updates to the introduction and hope that it is more clear now.

- Consider indexing the puffs and particles as j_{part} and j_{puff} for clarity and consistency in code and notation.

Thanks for the suggestion. Instead, however, we have tried to clarify the meaning of the notation used in the revised manuscript.

- While not essential, a simple cartoon or schematic illustrating the additions to the model would be a helpful visual aid. For example, a diagram showing puff sizes, centroids, and particle behavior under different conditions (e.g., vertical wind shear, puff vs. eddy size) would enhance understanding.

Thank you for this comment. We have now included a schematic drawing illustrating the behavior of the DERMA model.

- Line 130-132 and 141: It would be useful to clarify how the 'good results' for parameters such as β_{min} and α were determined. Were these values chosen based on statistical analysis of the experiments?

We have updated these descriptions the revised manuscript.

- Line 139 and 145: Does the transition between Gaussian and uniform distributions occur within a single timestep, or is there a gradual change? If the former, could such abrupt transitions introduce temporal inconsistencies when tracking puffs?

The transition happens during one time step. However, we argue that the transition is still somewhat gradual, since the puff is only transformed after the standard deviaiton is equal to *pblh*/2, i.e. the concentration field is already vertically diluted and "close to" a uniform distribution.

Indeed, there is a small risk of some temporal inconsistensies, but this is not only true for the transition between the two states. Inconsistencies may also occur when (1) a puff is moved vertically with the stohastic transport scheme, or (2) a puff either escapes or re-enters the boundary layer. It is clear that if we look at the evolution of a single puff, the behavior is not physical, but when considering the combined concentration field, we have not observed any inconsistencies in the behavior for the cases considered.

Finally, it should be mentioned that using puff splitting may in principal cause similar inconsistencies, so this is probably more a feature of puff models as such than something specific for the DERMA model.

In the revised manuscript, we added some discussion about this.

- Line 180: Please provide a brief justification for the choice of constant values used here.

We have done so in the revised manuscript.

- Figure 1: It would improve interpretability to include an example of a concentration field at a specific timestep overlaid on one of the geographic maps. Alternatively, a comparison showing differences in concentration fields between the old and new models for a case with more dramatic changes (e.g., Oeresund experiment) would be instructive.

Thank you for the comment. We have now included a figure showing concentration fields from both models for a selected release scenario.

- Figure 4: To improve readability, consider adding contours or using a higher transparency gradient to help visualise the spread of points in the scatter plots.

Good point, we have updated the figures.

- Line 334: The term "fraction" should likely be replaced by "percentage."

Yes, of course you are right. Thanks for noticing this.

- Section 3: Do the authors have an explanation for the low percentages of the factor predictions? Especially for the ETEX experiment, where the measurement stations are quite far away and are therefore not so sensitive to small absolute changes. That less than half of the model values lie within 1/5th and 5 times the measured values stands out since other statistics appear reasonable. It would be helpful to double-check these numbers and, if accurate, offer a brief discussion or hypothesis to explain them.

We have included a short discussion on this. But, basically, we have looked at other models' performances for the same experiment and can see that fa_2 and fa_5 values of this magnitude are to be expected (and similarly for the other statistical parameters).

- Several references appear to be missing DOIs.

Thank you for noting this. We have now updated the list of references.