Geosci. Model Dev. Discuss.,
https://doi.org/10.5194/gmd-2019-5-RC2, 2019

Geoscientific Model Development Discussions
Open Access
EGU

Interactive comment on "A Lagrangian convective transport scheme including a simulation of the time air parcels spend in updrafts" *by* Ingo Wohltmann et al.

Anonymous Referee #2

Received and published: 1 April 2019

General comments

1. The manuscript introduces a convection scheme for the off-line Lagrangian parcel-based chemistry-transport model ATLAS. The specialty of the scheme is that it resolves temporarily the process of upward transport in a convective updraft, with the aim of better representing chemical transformations, such as the heterogeneous oxidation of sulphur dioxide.

2. The objective and the potential value of such a scheme are obvious, and the step of introducing a corresponding formulation into the ATLAS model is laud-

Printer-friendly version

Discussion paper

able. However, from the work presented it becomes obvious that validation, and specifically the validation of the core component—the residence times during convective updrafts—is very difficult. Therefore, the claim of the paper of a successful validation appears to be not sufficiently supported.

3. The usefulness of the scheme in the context of the whole model will also depend on how well the chemical environment inside a convective cloud is actually modelled. The manuscript is not giving much attention to this aspect, which probably depends strongly on the model resolution (i.e. number of Lagrangian parcels). In addition, it should be compared to the option of just parameterising key reactions such as the heterogeneous oxidation in convective clouds.

4. Admitting that the validation problem is largely inherent and not easily overcome, I think the paper could be acceptable if it would limit itself to a description of the algorithm implemented together with tests conducted so far, while including a clear characterisation of the limitations and the way how a more robust testing and/or tuning will be done, and making it at least plausible that the scheme will be superior to simpler alternatives. This should include, for example, application to case studies with aircraft measurements available.

Specific comments

1. It would be good to include a brief introduction to the ATLAS model and how it works, so that the paper can be understood well without first reading other papers, as there is no easy or natural method to include complex chemistry into a Lagrangian model.

2. Page 4 L 1 ff: '*In the following, it is assumed that the mass associated with a trajectory is equal to the mass of the other trajectories and remains constant.*

This implies that for global model runs, the trajectories need to be distributed uniformly over pressure. The mass associated with the trajectory is then given by air density at the trajectory location and the volume it occupies.' These sentences are not sufficiently precise, for example, it is not possible to speak about the mass of a trajectory.

3. Figures 1 and 6: The blue colour does print well.

4. Page 5, Eq 4: The equation of state should contain moisture (for example in the form of virtual temperature).

5. Page 5, Eq 5 ff: In Δz_{conv}, one would better use just c as subscript, like for other variables.

6. Page 6 Eq. 7 ff: In the integration boundary z_{start}, one would better write z_0 or z_1. The same holds for variable M. In Eq. 9, the subscript 'detrain' could be replaced by z_2, z_d or similar. Better not to use (long) words as subscripts.

7. Page 10, L 22: It is not clear why an artifically degraded resolution of 2° is used for the meteorological input from ERA-Interim.

8. Figure 4 and others: It would be good to frame figures (with tick marks on the upper and right axis) and to use secondary ticks as appropriate (in Fig 4, for each day). The number of digits given should not vary along one axis (as it does in Fig. 6 and others).

9. Page 14, L 10-11: I am wondering why trajectories were initialised at random positions rather than on an equal-area grid. Also, the '150 km horizontal resolution' seems to be add odds with a random positioning.

10. Page 14, L 28 ff: '*Radon is distributed evenly over these parcels by assuming a well-mixed boundary layer*' Wording is not good. Eq. 13 is not an equation. The

emission rate would better not be denoted by e in a context where thermodynamic variables appear, it might be confused with vapour pressure. It is also interesting to learn at this place that parcels transport volume mixing ratios, whereas in other places it was said that they represent masses.

11. Page 14-15, para. starting with line 33: The argument is not very clear. It would appear that an artificial minimum boundary-layer height of 500 m would systematically overestimate the input of Rn into the free atmosphere over land during winter, where probably the emission is already overestimated because of the snow cover effects.

12. Page 15 L 17: I would not call this agreement 'reasonable'. Especially in Fig. 11 it is not good. One is also wondering why no comparisons with single flights were done – in the 1990ies there are ERA-Interim data.

13. Page 16, Figure 8: It is not clear what 'Points per layer' means.

14. Page 16 ff, Figures 9-12: It would be more instructive to show mixing ratios rather than concentrations.

15. Page 18 L 9 ff: Do not repeat explanation of the colour of curves in the text.

16. Page 18 ff, Section 4.3: The implications of choosing a specific cut-off value for the vertical velocity need to be discussed. Would it help to use cumulative frequency distrbutions rather than probability densities?

17. Page 21, Figure 14: A step function or just symbols should be used, not continuous curves, as the data represent binned values. The same holds in principle also for Figure 13, but because of its small size, it would probably not make a visual difference.

18. Page 22, L 15-16: The Rn simulation is not suitable to demonstrate the proper long-term stability of mass distribution as radon has a short lifetime.

19. Language

    (a) Authors should pay more attention to upper vs. lower case. One would not normally capitalise ‘Chemistry and Transport Model’ or chemical elements (‘Radon’).

    (b) Page 2 L 2: It is surprising to see species in a CTM called ‘tracers’.

20. Code and data accessibility: The source code could not be reviewed as it is not anonymously available. Also, to my understanding, access through personal contacts does not conform with GMD code and data availability guidelines. It would also be nice if authors make available the old measurement data on-line in digital form (in which they must have them already), if it is legally possible, rather than pointing to printed publications.

Interactive comment on Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2019-5, 2019.