

Review of “FLEXPART version 11: Improved accuracy, efficiency, and flexibility” by Bakels et al.

The paper is a good summary of the improvements and updates made to FLEXPART at version 11, notably use of the native eta vertical coordinates with ECMWF meteorological data, accounting for the non-sphericity of particles, improvements to the wet deposition scheme, incorporation of a linear chemistry scheme, and the use of OpenMP parallelisation. The accuracy and performance of the model is also assessed using idealised tests, historic tracer experiments and more recent real-life events. The FLEXPART community should be commended on documenting and publication of the details of their model, including keeping this current and up-to-date. I find the paper well written and thorough and have only some minor comments and suggestions detailed below. I have also included a list of typographical errors I spotted. I recommend that the manuscript is accepted for publication after these queries and requests have been addressed.

1. Lines 46-48: The list of Lagrangian particle models seems to lack some of the key Lagrangian atmospheric dispersion models: MLDP0, NAME, SPRAY etc.
2. Line 48 “FLEXPART combines a unique set of capabilities no other model can offer...” and line 83 “offers many features not available in other models”: the authors may want to rephrase these sentences, as it could be read as though the authors are implying FLEXPART is superior to other Lagrangian dispersion models. There is much commonality amongst Lagrangian particle dispersion models and many of the capabilities listed are present in other models. In addition, some of the functionality added to FLEXPART at version 11 has been present in other models for some time. Whilst it may well be true that FLEXPART is the only model to have all of the combination of functionalities listed, other Lagrangian models have some different functionality that FLEXPART may not (such as a Eulerian sub-grid model and radioactive decay into daughter products). The Lagrangian atmospheric dispersion modelling community benefits from different models and from the interactions within the community.
3. Line 92 refers to a Gitlab repository. Has this text been updated following comments by the editor on the suitability of Gitlab?
4. Line 101: The horizontal spatial resolution of the ERA5 meteorological data is quite coarse compared with the resolution of the ERA5 model (~30 km). Why is this? This seems particularly relevant given the use of the native vertical coordinate system to improve particle transport accuracy in this paper. If higher resolution meteorological data is available, this will also serve to improve particle transport accuracy.
5. Does the use of different vertical coordinate systems within and above the boundary layer (when using the eta option with ECMWF meteorological data) lead to any issues at the boundary layer top?
6. Figure 1 caption “absolute latitudes of 40 and 80”. I was uncertain what this meant here, although it was explained in the text. Could you say perhaps ‘between 40 and 80 degrees north and between 40 and 80 degrees south’ in the caption to be clearer?
7. Line 199: For readers not familiar with FLEXPART, could the options CTL and IFINE be defined?

8. Why is equation 5 not recovered, by setting k_N and k_S to be one in Equation 6? Should the two not be consistent in the limit of non-spherical \rightarrow spherical?
9. CAPTEX results: I agree that there are no substantial differences (other than the NMSE and FOEX improvements), but the language is a bit inconsistent with that used to describe the ETEX results (“slightly better”). To be consistent and objective here, “slightly worse” would be more appropriate.
10. Table A1: “used for parameterisation”. Which parameterisation?
11. Line 763: “with the value of IFINE determining the factor by which the time step is reduced”. Is this ‘further reduced’? In other words, is IFINE applied on top of CTL in the vertical?
12. Line 772-773: What about horizontal diffusivities in the stratosphere and vertical diffusivities in the troposphere? Are these assumed to be zero?
13. Line 912; “not listed there”. It’s not clear to me where ‘there’ is.
14. Is the data from the simulations being made available? Please check the journal requirements.

Typos:

1. Line 110: “employs a hybrid pressure-base vertical coordinates” could be “employs hybrid pressure-based vertical coordinates” or “employs a hybrid pressure-based vertical coordinate system”.
2. Line 148. I don’t think you want a ‘respectively’ here, as simulations for both heights were conducted with both vertical coordinate systems.
3. Line 194: Space required between ‘by’ and ‘Cassiani’.
4. Figure 3 caption “are also reported near the top” should be “are also reported near the bottom”?
5. Line 297: “lead” should be “led”
6. Line 328: Can you have “stronger” precipitation, or should it be “heavier”?
7. Line 405: Should “were” be “was”?
8. Line 408: “8 and 20 meters” – above ground level, I presume but I’d prefer this to be clearly stated.
9. Line 412: “FA5” should be “FMS”. SCC is also slightly worse for the eta coordinate, albeit comparable for the z coordinate.
10. Line 475: “starting” should be “start”.
11. The legend and caption in Figure 8 do not agree on which are the solid, dashed and dotted lines.
12. Line 570: “That reduces” should be “This reduces”.
13. Line 588: Remove “even”.
14. Line 736: Remove ‘to’ - “making use of to the convection scheme” should be “making use of the convection scheme”.
15. Line 737: Remove brackets around ‘redist’ – it is part of the sentence.
16. Line 762: “modtion” should be “motion”
17. Line 793: “of of” should be just “of”.
18. Line 858: “now corresponds to a of 0.0062” should be “now corresponds to 0.0062”. Is the mention of ‘6.2’ on this line “the value of $r_{icl,Grythe}$ as reported in Grythe et al.”? It wasn’t clear to me.
19. Line 863: The use of a capital lambda for the scavenging coefficient, as opposed to a small lambda earlier could be confusing to the reader. Indeed, capital lambda is not defined.

20. Line 877” “compared previous versions” should be “compared to previous versions”.
21. Lines 889-890: “parameters pconst, pdconst, and pnconst, respectively” would imply C, D and N (in that order), which is not the order they appear listed on line 889.
22. Line 945: Requires an insertion of ‘iodine’ after ‘gaseous elemental’ or removal of the brackets around I₂.
23. There is some inconsistency in the formatting of units, with spaces missing between units in places (e.g., ms⁻¹ on line 949).
24. Tables A3 and A4 captions refer to the species file number, which I cannot find in the tables.