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Atmospheric Chemistry and Physics Discussions

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# *Interactive comment on* "Accounting for the vertical distribution of emissions in atmospheric $CO_2$ simulations" *by* Dominik Brunner et al.

**Anonymous Referee #1**

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General comments. The study aims at understanding the amount of bias in simulating the near-surface CO2 concentrations, related to representation of the elevated anthropogenic CO2 emissions by power plants and industries. Authors report significant differences between the results obtained with common assumption of placing all emissions near surface and with more accurate approach taking into account the stack height and plume rise. The results are useful for sizeable community of CO2 modelers interested in anthropogenic CO2 emissions and their verification with atmospheric measurements, both ground-based and space-based. Authors identify a problem with modeling a plume rise of exhaust by cooling towers, that complicates realistic estimates of CO2 plume injection height. The paper is well written and can be accepted with minor corrections reflecting the comments.



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Detailed comments

1.The comparison contrasts sets of $CO_2$ simulations in lowest 20 m near surface made with emissions emitted either at surface or at more realistic heights. It should be mentioned that the observations are often made at higher elevations than 20 m, using either small towers (40-100 m) or tall towers (200-300 m tall). For modeling such observation sites, the conclusions presented in this study can serve more as a warning, rather than ready to use estimate of emission height-related bias.

2.Lagrangian plume models (eg STILT, FLEXPART) are often used in backward, adjoint mode for inverse modeling, and some are used in studies cited here (Page 3 Line 8). In that setting they have to assume emissions are mixed quickly in surface layer of nonzero thickness. It can be as thick as diurnally varying PBL height (Lin et al., 2003) or assigned a constant value (Ganshin et al., 2012). This is done to minimize sampling errors in estimating adjoint tracer concentration near surface, which is made by counting particles in the surface layer. In case of using relatively thick layer, the assumption may reverse the effect of neglecting $CO_2$ emission height, towards having more errors from surface emissions rather than from elevated stacks.

Technical corrections:

Page 2 Line 11 Add period after $CO_2$ and before “Top-down”.

Page 3 Line 8 Add year to Lauvaux et al.

Page 3 Line 15 It is worth noting earlier references to air quality modeling, such as SMOKE-CMAQ modeling system (eg Houyoux et al, 2002), to emphasize that the problem had long been recognized and addressed. For $CO_2$ modelling audience it is also useful to mention that in air quality modeling effort is made to account for plume rise height of biomass burning emissions (eg Achtemeier et al, 2010).

Page 4 line 6 Written as "COSMO is the first NWP model worldwide" - it appears that similar effort with ASUCA model (Shimokawabe et al., 2010) was done in about same



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time, suggest checking, rephrasing.

Page 7 line 16 Suggest revising “In order to prevent re-heating,” as “In order to avoid re-heating,”

Page 12 Line 10 Need to add year to Bagley et al.

References


Achtemeier, G.L.; Goodrick, S.A.; Liu, Y.; Garcia-Menendez, F.; Hu, Y.; Odman, M.T. Modeling Smoke Plume-Rise and Dispersion from Southern United States Prescribed Burns with Daysmoke, Atmosphere, 2011, 2, 358-388.

Ganshin, A., et al: A global coupled Eulerian-Lagrangian model and 1 × 1 km CO2 surface flux dataset for high-resolution atmospheric CO2 transport simulations, Geosci. Model Dev., 5, 231-243, https://doi.org/10.5194/gmd-5-231-2012, 2012.

Houyoux, M., Vukovich, J., Seppanen, C., Brandmeyer, J.E., 2002. SMOKE User Manual, MCNC Environmental Modeling Center, 486 pp.

Lin, J. C., C. Gerbig, S. C. Wofsy, A. E. Andrews, B. C. Daube, K. J. Davis, and C. A. Grainger (2003), A near-field tool for simulating the upstream influence of atmospheric observations: The Stochastic Time-Inverted Lagrangian Transport (STILT) model, J. Geophys. Res., 108, 4493, doi:10.1029/2002JD003161, D16.

Shimokawabe T. et al., "An 80-Fold Speedup, 15.0 TFlops Full GPU Acceleration of Non-Hydrostatic Weather Model ASUCA Production Code," SC '10: Proceedings of the 2010 ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis, New Orleans, LA, 2010, pp. 1-11. doi: 10.1109/SC.2010.9



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