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Geoscientific Model Development Discussions

Interactive comment on "Three-dimensional methane distribution simulated with FLEXPART 8-CTM-1.1 constrained with observation data" *by* Christine D. Groot Zwaaftink et al.

Anonymous Referee #1

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This paper is nicely written and addresses sharply the question whether local nudging of CH_4 mixing ratios at the surface towards stationary observations does improve the overall 3-dimensional performance.

It is an attractive method to directly include several local surface observations instead of averaged two dimensional fields. The authors provided a coherent evaluation with surface stations and aircraft profiles. However, I also would be interested in the comparison with spatially inclusive and comprehensive data sets as satellite data, which would further evaluate the whole column.

In the following I list a couple of questions concerning the manuscript.

- On page 2 line 44 you state that inverse modeling approaches need GHG concentrations as input. That is likely the case, however, I wonder if you mean the inverse modeling of CH_4. In this case, nudging towards observations as in your case would influence the a priori. Maybe you could be a little more specific in what kind of situation the 3D concentrations are needed. Moreover, what do you think about the use of these 3D data sets for radiation simulations?
- Introduction: To my knowledge there are a couple of models which perform nudging of GHGs. Could you list some and describe the difference or similarity to your method?
- Page 3 line 108-110: Where does those fields come from? Simulations of Chemistry-Climate Models? I understand that some reference work is not published, but the loss of methane is an important part in the simulations and needs to be replicable.
- Page 3 line 118-121: This is a very long sentence. However, the information it holds is very crucial (simulation period). Please reformulate. Furthermore, why is the scaling factor applied?
- Could you also invest a sentence in this paragraph on the introduction of your reference and sensitivity simulations? It gets lost in the results. I like the table 1 as an overview, however, it is difficult to understand without a short explanation (what is important?).
- page 8 line 307: Have you considered the methane lifetime? Compared the one of FLEXPART and TM5? What about OH and temperature?
- page 9 line 333: Are the simulated profiles sampled to the campaign profiles? Or is a certain spot chosen?

- General: If the performance of this nudging method decreases at higher altitude, I am curious to what extent does this improve the 3 dimensional field of the whole atmosphere/troposphere. Since the 3D fields are part of the motivation, could you comment on that?

Technical corrections:

- page 6 line 207: What about NW1 and NW2? I would assume that it should be (NV1-3 and NW1-3).
- Table 1: Could you highlight (additional horizontal line) the simulations with variable spatial width? What do the variable temporal width (NW1-3) mean? How are they constructed?
- Fig 11, legend: Should it be TM5 RA instead of RM5 RA?

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