Responses to Reviewer 2

Comments to the authors

We really appreciate your patient review and helpful comments. We replied each comment below and modified the manuscript accordingly.

Please delete the following texts in the section 2.2, as I do not think it is really relevant to the scientific issues discussed, but rather to the technical details of the model setup.

“The model was installed on Puhti supercomputer at CSC (IT Center for Science, Finland), and 90 CPU (Central Processing Unit) cores were utilized for each parallel simulation run. One simulation year cost about 10 hours in real life.”

Response: Thanks for point out this. We removed this sentence in the modified manuscript.

Here The authors conduct two years run of TM5-MP： one year is used for spin up and the other is used for analysis. I am not sure if it is too short for one year simulation to calculate the mean state of variables.

Response: Since this question was raised by both reviewers, we replied in the same way as shown below:

We have conducted a 12-year simulation for the year 2009, in which the input data of 2009 were applied repeatedly for every simulation year. We found that for short-lived trace gases like monoterpenes and hydroxyl radical (OH), half a year was enough for the spin-up. For long-lived trace gases like methane (CH4), which are either prescribed or strongly constrained in the model, 7 to 8 months were enough for the spin-up (Fig. R1). We note that one-year spin-up for TM5-MP was also applied in previous studies (e.g., Williams et al., 2017; Myriokefalitakis et al., 2020). Therefore, we can assume that the results are already stable in the second year. And we added a sentence to clarify it and added Fig. R1 as Fig. S1.

"Each simulation ran for two years, with the first year serving as the spin-up and the results from the second year were analyzed."
->
"Each simulation ran for two years, with the first year serving as the spin-up and the results from the second year were analyzed. The one-year spin-up in TM5-MP simulations was also applied in previous studies (e.g., Williams et al., 2017; Myriokefalitakis et al., 2020), and was validated here in a 12-year simulation test case (see Fig. S1)."

Meanwhile the figure order in the supplement were also changed as:
Fig. S1: Time series of 12-year simulation for testing spin-up.
Fig. S2: Annual mean BVOC emissions during PI.
Fig. S3: Comparison of various aerosol quantities between mh and pi_zero.
Fig. S4: Comparison of various aerosol quantities between mh_gsrd and pi_zero.

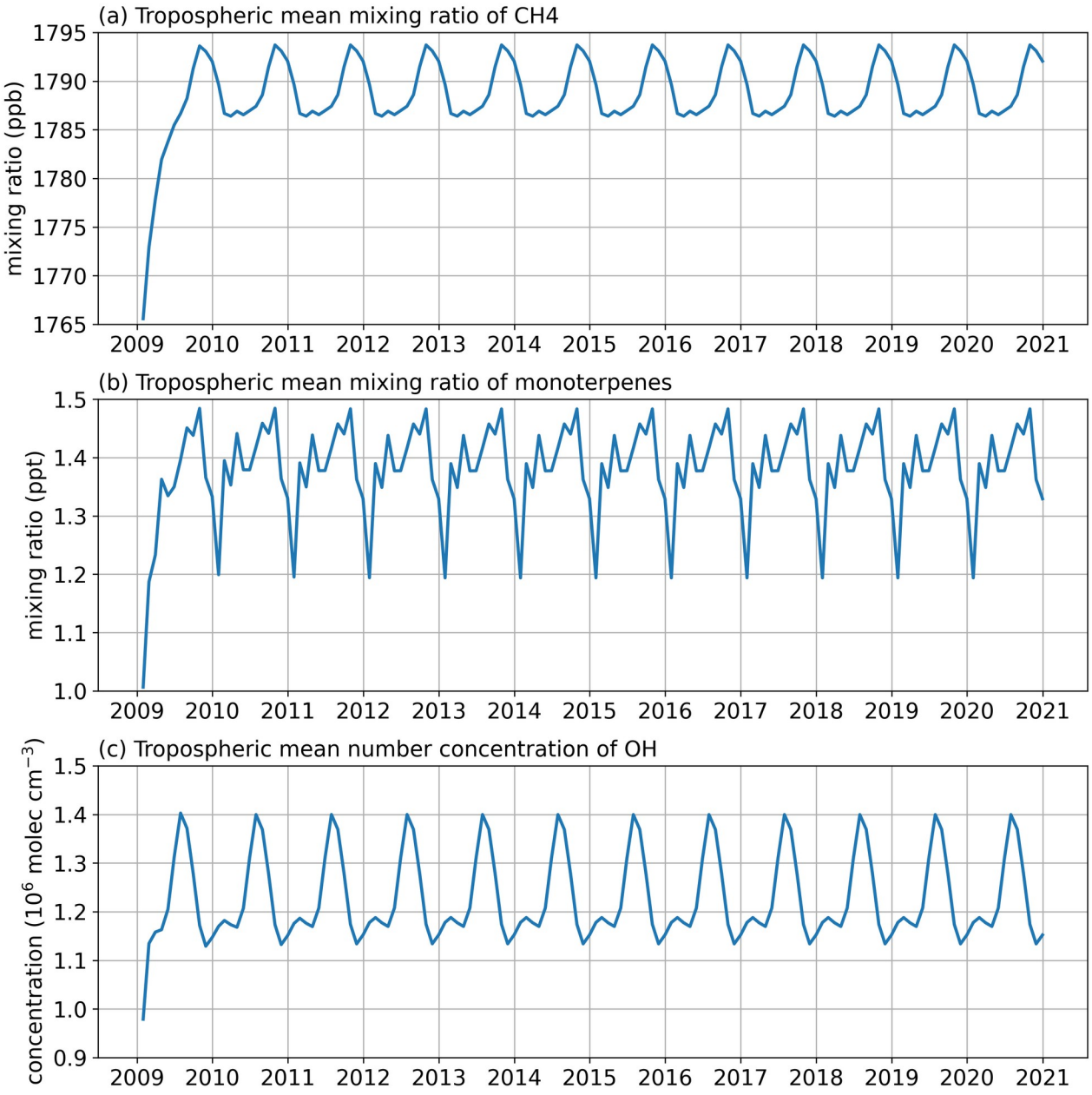

Figure R1: Time series of (a) tropospheric mean mixing ratio of methane (CH4), (b) tropospheric mean mixing ratio of monoterpenes and (c) tropospheric mean number concentration of hydroxyl radical (OH) in a 12-year simulation. The input data of 2009 were applied repeatedly for each year, but the tick labels show increasing year numbers to represent the continuous simulation years. Here the tropospheric mean values are calculated over the first 21 model layers, in which the global mean air pressure of the top layer (layer 21) is around 200 hPa.

References:

Myriokefalitakis, S., Daskalakis, N., Gkouvousis, A., Hilboll, A., Van Noije, T., Williams, J. E., Le Sager, P., Huijnen, V., Houweling, S., Bergman, T., Rasmus Nüß, J., Vrekoussis, M., Kanakidou, M., and Krol, M. C.: Description and evaluation of a detailed gas-phase chemistry scheme in the TM5-MP global chemistry transport model (r112). Geoscientific Model Development, 13(11), 5507–5548. https://doi.org/10.5194/gmd-13-5507-2020, 2020.

Williams, J. E., Folkert Boersma, K., Le Sager, P., and Verstraeten, W. W.: The high-resolution version of TM5-MP for optimized satellite retrievals: Description and validation. Geoscientific Model Development, 10(2), 721–750, 2017.