

Interactive comment on “Improving the inter-hemispheric gradient of total column atmospheric CO₂ and CH₄ in simulations with the ECMWF semi-Lagrangian atmospheric global model” by A. Agusti-Panareda et al.

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The authors would like to thank the reviewers for the comments which have been addressed below and have contributed to improve the clarity of the manuscript.

General comments

- *CO₂ and CH₄ are long-lived greenhouse gases, thus I suggest considering a*

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longer period (probably the whole simulation period: 1st of March 2013 to 30 April 2014) for analysis (Fig. 1-6, 10-11) excepting comparison with Polarstern observations.

The mass conservation error is very small at the beginning of the simulation and it grows with time as it accumulates (see Fig. 1 for the accumulation throughout the whole period from 1st of March 2013 to 30 April 2014). For this reason, we have chosen to start the simulation one year before the Polarstern campaign in order to assess the accumulated errors after one year of simulation. If we include the whole simulation period in the evaluation of the mass fixer impact, then we would be looking at the mean impact which has the same pattern as the accumulated impact but a much smaller amplitude (see Fig. 2 for whole period compared Figs 5 and 6 in the manuscripts covering the Polarstern period). Thus, using the mean impact, instead of accumulated impact, would make the detection of significant differences between observations and simulations more difficult. This will be clarified in the revised manuscript (section 3) by emphasizing the importance of evaluating the accumulated impact of the mass fixer during the last month of the simulations, as opposed to the mean impact throughout the whole period.

- *The main aim of the paper is improving the inter-hemispheric gradient of total column atmospheric CO₂ and CH₄, however it is useful to study vertical cross sections and/or profiles of mass conservation error.*

In the proportional mass fixer experiments, the mass fixer correction is applied uniformly throughout the column, whereas in the tailored Bermejo and Conde mass fixer, most of the correction is performed at the lower levels where the atmospheric mass and the tracer mass are largest (Fig. 3). This is mentioned in section 2.2 of the manuscript. Further work should be done to compare the

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impact of the mass fixer on the vertical gradients of CO₂ and CH₄ using observations, e.g. from aircrafts, but this is out of the scope of this study.

Technical comments

- *Page 3, line 9: performace -> performance* Done.
- *Figures 3-6: no labels for TCCON FTS sites; TCCO2, TCCH4 should be replaced with XCO2 and XCH4 respectively.* Done. We have not been able to include the TCCON labels on the map because they would obstruct the small plot. We have included a reference to the TCCON table listing all the sites and their lat/lon coordinates in the Figure captions instead.
- *Figures 7-10: CO2 and CH4 should be replaced with XCO2 and XCH4 respectively.* Done.

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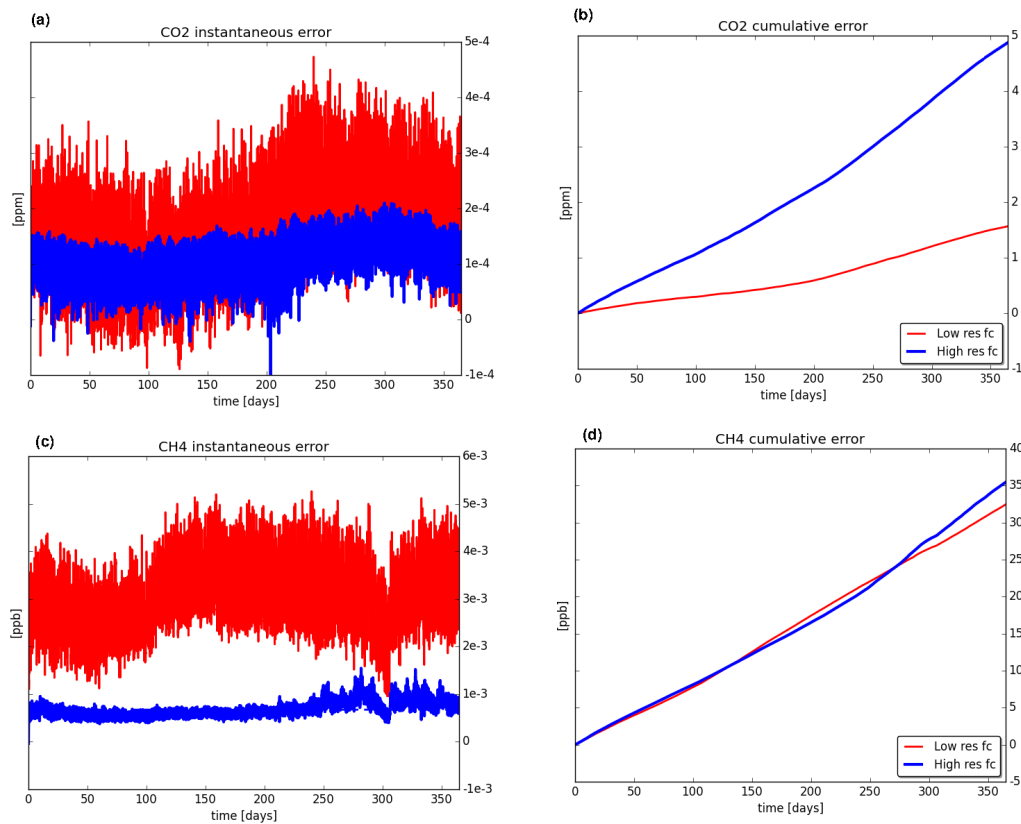


Fig. 1. Time series of instantaneous and accumulated global mean mass conservation error for CO₂ and CH₄ from 1 March 2013 to 30 April 2014. Low/high resolution experiments are depicted by red/blue lines.

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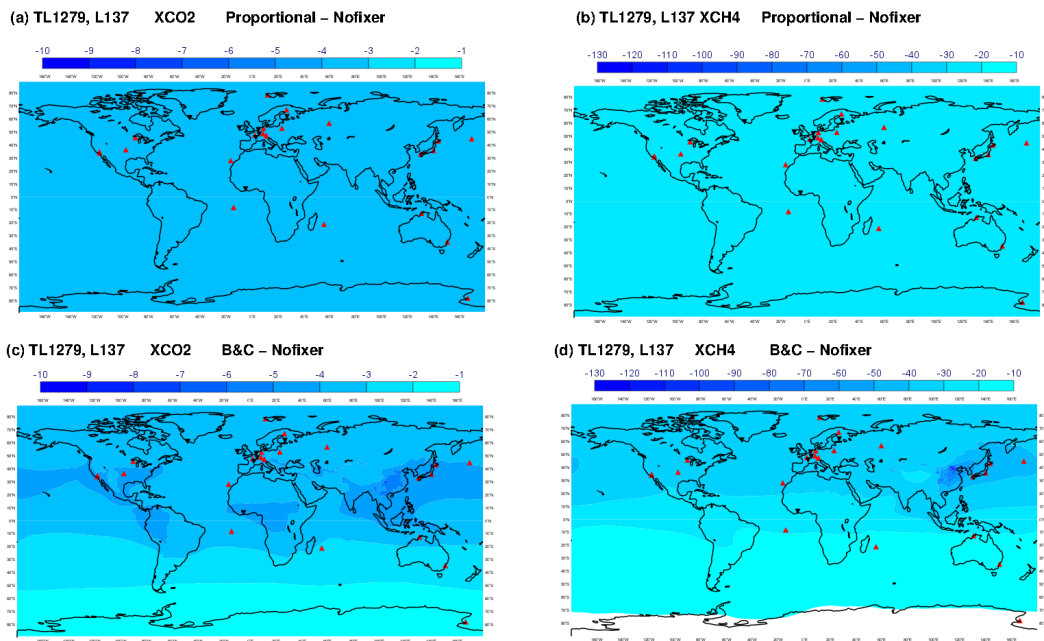


Fig. 2. Difference in mean XCO₂ [ppm] and XCH₄ [ppb] from 1 March 2013 to 30 April 2014 between simulations using the proportional and no fixer (a,b) and B&C and no fixer (c,d) at high resolution.

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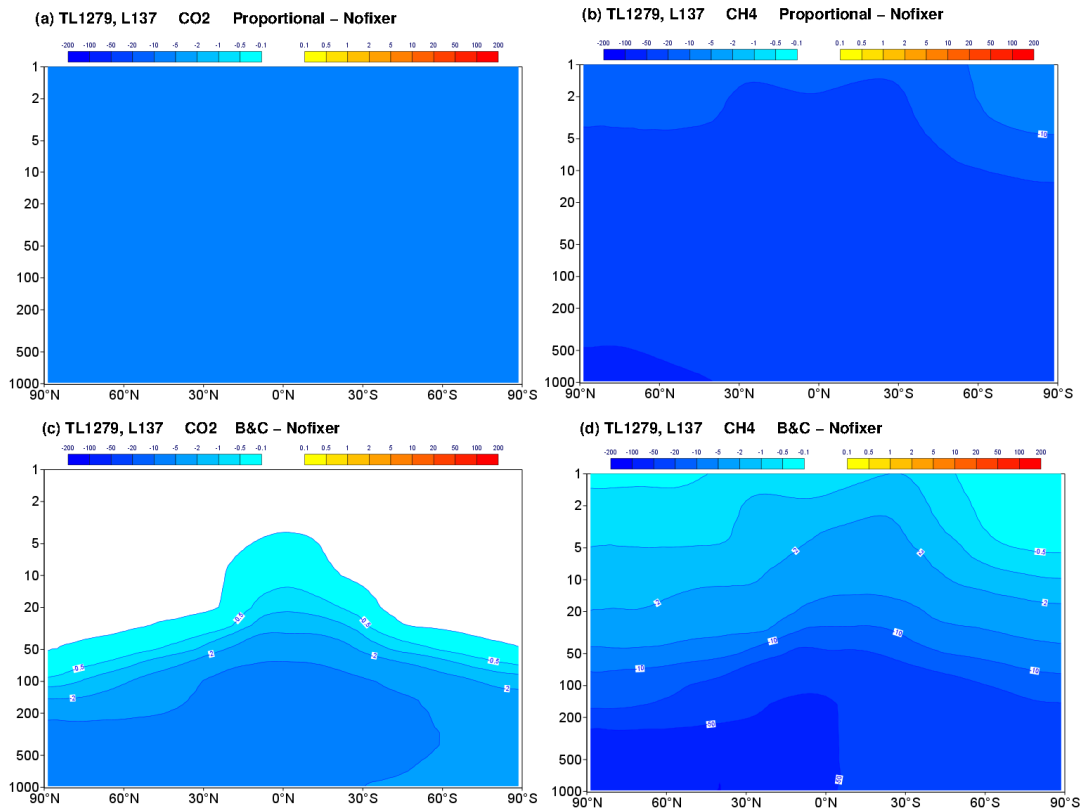


Fig. 3. Vertical section of zonal mean differences in CO₂ and CH₄ from 7 March 2014 to 10 April 2014 between simulations with proportional and no fixer (a,b); and B&C and no fixer (c,d) at high resolution.

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