

Interactive comment on “Sensitivity of simulated CO₂ concentration to regridding of global fossil fuel CO₂ emissions” by X. Zhang et al.

Anonymous Referee #2

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The manuscript “Sensitivity of simulated CO₂ concentration to regridding of global fossil fuel CO₂ emissions” by X. Zhang et al. presents an analysis of the impact of the misplacement of fossil fuel emissions to water gridcells when regridding from a fine-scale grid to a coarse-scale grid on simulated atmospheric CO₂. The authors compare two different regridding methods: a ‘traditional’ method where the emissions on the fine-scale grid are simply aggregated on the coarse grid and a ‘reshuffling’ method where emissions on the fine grid are displaced to the nearest coarse land gridcell in case the fine grid cell lies in a coarse water gridcell. The authors highlight this dynamical inconsistency as a potential problem for atmospheric CO₂ inversions.

The reshuffling of emissions is indeed an interesting approach and worthwhile to follow

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up but there are several problems with the current manuscript. The authors claim that this reshuffling of the emissions ensures dynamical consistent results. However, it is not clear what they mean by 'dynamical consistent'. I assume this refers to the different vertical mixing and boundary layer behaviour over land and water grid cells and that land fossil emissions in a coarse grid water gridcell would be advected differently than in a coarse grid land gridcell. This needs to be discussed in the paper.

On the same topic, it is not clear how the meteorological driving fields from MERRA are treated. If the MERRA data have to be regridded as well to match the PCTM grid, then there is the same problem with the treatment of the meteorological fields if data from a fine grid land cell ends up in a coarse grid sea cell or vice versa. This may not be a problem in this particular case if the MERRA met forcing is already on the PCTM grid but it is certainly a problem for many other atmospheric transport and inversion systems. In fact this may actually be a much more important bias and is not limited to CO₂.

But the major problem with this study is that it is only half way done. Since the authors claim that this is potentially an important problem for atmospheric CO₂ inversion the questions are now: What is the impact on the estimated surface fluxes when using the reshuffling method in atmospheric CO₂ inversions? And how do we know that this results in more accurate flux estimates? It needs to be shown that this different way of regridding really results into different flux fields. But the second question is probably even more important because the reshuffling process may create artificial biases and shifts potential natural sinks/sources from water to land gridcells as the overall carbon budget needs to be balanced. So this reshuffling regridding may just move a bias from a dynamical transport process to balancing bias.

And finally it is not clear how fossil emissions from planes and ships should be treated. These data are available now as well on resolutions higher than typical transport models. How are they accounted for in such a reshuffling process?

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