Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-117-RC1, 2018


Atmospheric Chemistry and Physics
Discussions
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ACPD

Interactive comment

# *Interactive comment on* "Impact of physical parameterizations and initial conditions on simulated atmospheric transport and $CO_2$ mole fractions in the US Midwest" *by* Liza I. Díaz-Isaac et al.

**Anonymous Referee #2**

Received and published: 14 May 2018

This paper presents the evaluation of multiple WRF model configurations over the US Upper Midwest. The model configurations are constructed by selecting different PBL, cumulus and microphysics schemes. These configurations are also used to simulate atmospheric CO2 mole fractions by using the CO2 fluxes from the Carbon Tracker global inversion system. It is important to use well constrained meteorological drivers in CO2 inversion studies. As the previous studies have shown, uncertainties in the meteorological drivers can lead to large discrepancies in simulations of atmospheric CO2 mole fractions.



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Discussion paper

This study is trying to identify how much different physics parameterizations contribute to error in CO2 transport within the WRF-CO2 model. I have some reservations on the setup and conduct of the modeling exercises and evaluations in the paper:

The WRF-Chem CO2 model needs more explanation. How different is this model from the regular WRF-Chem model, which can simulate passive tracers including CO2? How vertical mixing of CO2 is parameterized in this model configuration? Does this version of the model include convective tracer transport?

The spatial resolution of the inner domain (10km) isn't very high. Given the importance of the representation of heterogeneity in simulation of both anthropogenic and biospheric CO2 fluxes, it'd greatly help to conduct higher resolution simulations (2-4 km).

The vertical resolution of the domain is quite high (40 levels <2km) near surface. However, there are only 19 levels above 2km. How the vertical levels aloft are distributed? The vertical grid spacing will impact how the model captures capping inversion layer, clouds and so on.

14 radiosounding sites are used to evaluate the meteorological simulations. The accurate simulation of vertical mixing is important for CO2 simulations. Unfortunately, the regular radiousoundings in the US don't capture (00 and 12Z only) the deep boundary layers during the afternoon hours in the Midwest due to timing. I recommend using additional data (e.g. ceilometers) to evaluate the daytime evolution of the boundary layers in Midwest.

The choice of the meteorological data for the model verifications is limited to the radiosounding data, which are quite limited in time and space. I suggest adding surface wind, temperature and other measurements to the model evaluations.

It's recommended to use the GF cumulus paramaterization instead of the G3 scheme in WRF. I suggest testing the model with the GF scheme.

There is one key uncertainty associated with using the CO2 fluxes from CT in WRF-CO2 modeling here. The spatial resolution of the EDGAR and CASA CO2 emissions are much coarser than the inner WRF grid spacing here. Consequently, the WRF-CO2 model can't capture the regional CO2 variability even with "perfect" meteorology. This needs to be discussed in this paper. At least, high resolution anthropogenic CO2 emissions (e.g. VULCAN) could be used in such model setup.

Minor comments: Abstract: "...is this variability is..."?

For the WRF model, please cite the recent WRF/WRF-Chem description paper: Powers et al., Weather Research and Forecasting Model: Overview, System Efforts, and Future Directions, AMS. https://doi.org/10.1175/BAMS-D-15-00308.1

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