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Geoscientific Model Development Discussions

Interactive comment on "Mass-conserving coupling of total column CO_2 (XCO_2) from global to mesoscale models: Case study with CMS-Flux inversion system and WRF-Chem (v3.6.1)" *by* Martha P. Butler et al.

Anonymous Referee #2

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General remarks

The authors compare total column CO_2 over Norther America computed from WRF-Chem with results from the CMS-Flux inversion system which is based on GEOS-Chem. For this purpose they developed a scheme for nesting WRF-Chem into GEOS-Chem in a way that the mass of CO_2 introduced into WRF-Chem from GEOS-Chem is conserved. Although only minor differences between the results of the two models were found for the total vertical column of CO_2, more pronounced differences were found between the vertical CO_2 distributions computed by the two models.

This investigation could generally be useful for the community who do inversions of satellite derived CO_2 concentrations. However, the paper suffers in major parts from imprecise language and unclear descriptions of important aspects. In particular, the description of the methods does not allow finding out whether the very little added value of the higher spatial resolution could eventually be attributed to the way how surface CO_2 fluxes are implemented in WRF-Chem. I cannot recommend the publication of this paper unless the paper is improved in these aspects.

Detailed comments

Throughout the paper the language of the paper is imprecise which makes major parts of the paper hard to read. Already the abstract is a good example: What is meant by 'fluxes' in the first sentence? Fluxes from the surface? Fluxes from which sources? What is meant by 'transport'? Long rage transport? What is 'our' North American domain?

A few further examples (by far not complete) are: Page 1, last line: 'do not agree well': With what? Page 2, lines 21 and 23: The expression 'curtains' is somewhat odd. Page 6, first line: What does 'dried of water vapor' mean here (odd wording anyway)?

The meteorological driver of GEOS-Chem is GEOS-5 while meteorological boundary conditions for WRF-Chem are from ERA interim. In how far can differences between these meteorological drivers contribute to the differences in upper air wind fields and CO_2 concentrations from WRF-Chem and GEOS-Chem. This should be analyzed in more detail.

The authors describe in much detail how they achieve mass conservation when deriving CO_2 surface fluxes for the WRF-Chem simulation from the fluxes applied to GEOS-Chem. Does this result in surface fluxes smoothed to the GEOS-Chem grid, which are used as input for WRF-Chem? What CO_2 emission patterns (anthropogenic, biogenic) are still resolved in the WRF-Chem simulation? It is not clear whether the emissions for the WRF-Chem simulations are really better spatially resolved than for

the GEOS-Chem simulations. Eventually show emisssion input for WRF-Chem and for GEOS-Chem in the supplementary material.

Page 6, line 2: 'We do not scale the diurnal cycle overlay.'? How large is the difference between the diurnal cycles of the emissions applied to GEOS-Chem and WRF-Chem? Section 2.4.2: Why is the averaging performed over such a big area?

Page 9, lines 3-6: These sentences are hard to understand. This should be explained in more detail. Please mention also the magnitude of the differences between the individual GOSAT XCO_2 soundings which are located within a single GEOS-Chem cell?

Page 12, line 14: Why is convective transport of CO_2 not included? WRF-Chem can handle convective vertical transport of atmospheric trace compounds.

The conclusions must be extended. Currently they contain mostly a description of data availability and a short summary.

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