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Geoscientific Model Development Discussions

Interactive comment on "A global coupled Eulerian-Lagrangian model and 1 × 1 km CO_2 surface flux dataset for high-resolution atmospheric CO_2 transport simulations" *by* A. Ganshin et al.

Anonymous Referee #2

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This paper describes the coupling of the global Eulerian transport model NIES-TM at medium resolution (2.5 degrees horizontal) with the LPDM Flexpart that describes the transport at fine scale for the final two days of transport and exchange of CO2. CO2 fluxes are derived from a set of offline flux fields that are scaled up to a resolution of maximum 1x1 km and daily values.

The manuscript is well written and describes the work performed in a mostly complete (important exceptions will be noted later) and clear way. The increased resolution obtained by the smart combination of a global Eulerian and a higher resolution LPDM is

the way forward in better and computationally more efficient modelling of the exchange of CO2 and other (greenhouse) gases in order to improve our understanding of the net exchanges and underlying processes controlling the fluxes. However, the setup introduced in this paper is unbalanced and needs rethinking with regards to the linking between scales in time and space. The results section is too short and inomplete. Therefore I would recommend some extra modelling work and a major revision of the paper, in order for the authors to be able to demonstrate the real added value of the high resolution.

One of the major shortcomings of the papers is that the Flexpart model is driven here by rather coarse resolution meteorological fields at a spatial resolution of 2.5 degree, i.e. about 500 km. The Flexpart particle transport will therefore lack the detail to properly describe the transport and local scale phenomena (clocal PBL height, onvection, roughness, orography induced flows, sea breezes etc.) in the area close to the receptors where the high resolution of the fluxes matters most.

Another issue is the generated flux field that has a low temporal resolution and is derived from much coarser undelying data that is being interpolated without introducing realistic variations due to the correct spatial and temporal factors that cause variability at the 1 km and hourly scale. For example in section 3.2 the fossil fuels emissions are only varied for seasonal changes using monthly profiles, where hourly and weekday variations should be considered as well. The ODIAC emission database is based on country total emissions redistributed at 1x1 km using nightlight and known point source locations, but this inherently introduces large spatial allocation errors, for example in regions where electricity is produced by more sustainable energy sources or nucleair energy.

For as far as I can gather from the paper in section 3.3, the monthly NEE fluxes from an optimized CASA model (VISIT) were scaled down to 1x1km from 0.5x0.5 degree using a 1x1 km map of 15 dominant vegetation types, details are severely lacking on how this scaling down has been performed. Usually the CASA model generates zero annual mean net NEE fluxes, while in reality ecosystems show large diurnal variation in the net flux, it is not clear whether the flux data genereated here takes this into account.

The choice for the measurement sites for comparison between observations and modelled values is not well argumented. In p2060 l.5 the only argument is that the sites are representative of both polluted and background environments. As the simulations are performed globally the model performance could and should have been tested at many more sites, as there is now a growing amount of high quality continuous observation data available. There are sites where the "synthetic" test of section 4.1 could be really verified.

The presentation of the results in section 4 is very short and lacks results for comparisons as also noted by reviewer #1. Main shortcoming is that the results do not show significant increases in model skill for the high resolution emission data compared to more aggregated emission data, and in some cases even a degradation of the result is seen for higher resolutions. A more detailed analysis is lacking to sort out whether this is due to shortcomings in the transport model(s) and resulting errors, or in the too coarse temporal resolution of the emission, errors in the downascaling or in other unexplained factors, or in any combination of these factors.

General comments

p2051 l.21-29: Lagrangian models usually depend on e.g. windfields produced by Eulerian models and therefore inherit to some extent some of their disadvantages. Backward trajectory simulations suffer from accumulation of errors and uncertainties (e.g. due to the stochastic representations) and therefore simulations that go back much less than the mentioned period of four months and even periods exceeding a week to several days soon become meaningless.

p2052 l 20: The authors mention that a feature of this study compared to previous studies is that both models are coupled at temporal boundaries compared to spatial coundaries. However this type of coupling has also been employed by others (e.g.

Vermeulen et al, 1999).

References

Vermeulen A.T., Eisma R., Hensen A. and Slanina J. (1999). Transport model calculations of NW-Europe methane emissions. Env Sci & Policy, 2, 315-324

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