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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modelling CO_2 weather – why horizontal resolution matters" *by* Anna Agustí-Panareda et al.

Anonymous Referee #2

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This study demonstrates the advantage of using a high-resolution model by taking into account of the effect of atmospheric transport, flux variations, and topography. An ensemble of ground-based continuous measurements all over the globe that includes CO2 surface network and TCCON (column) are used to derive model errors. The model errors that are arisen only due to fine-scale horizontal variability are deduced by using single modeling system (CAMS) at various horizontal grid sizes, but maintaining the vertical resolution and using the same set of flux inventories. The local flux influence and its dependence on resolution are investigated by switching off the CO2 surface fluxes. Noteworthy is that the study also shows the importance of representing local gradients of CO2 fluxes in urban regions and during night-times for reducing the atmospheric CO2 representativeness error. The dependence of forecast skill on hori-

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Discussion paper

zontal resolution and extent of the forecasting period is discussed. The topic is of very high interest to the ACP community, particularly relevant for atmospheric inverse modelers who aim to retrieve CO2 sources and sinks at regional scales. The manuscript is well written; the analyses are conducted carefully and the results are presented in a logical order with appropriate support and interpretation. I recommend this paper for publication in ACP, after addressing the comments below.

Comments:

Impact of horizontal resolution on representation errors (P11-12, Fig. 11): I see data gaps in Fig. 11. In my understanding, the representation errors are calculated using the standard deviations of modeled concentrations at a fine scale (9km interpolated to 0.1 degree) within the global grid boxes of 1 degree $\times$ 1 degree. In that case, I can't understand why such data gaps exist? Had any filtering been adopted? Please clarify. Also, it would be very helpful if the manuscript includes the monthly averaged modeled simulations at 9 and 80 km resolutions (spatial plot) for surface and column concentrations. I would suggest authors include those plots, allowing the reader to do the visual comparison in terms of statistical (as done in Fig.11) and model-predicted (9 km vs. 80 km) sub-grid variability.

Table 3 and Fig. 5: Why there exists difference (in magnitude) between the standard deviation of inter-station RMSE (sigma-RMSE) given in Table 3 ((in brackets and in bold, last column) and those given in Fig. 5 (a) & (b)? I assume that the authors used "All stations" in January and July for these calculations.

Fig. 7 (b): XCO2 daily min vs. daily mean/max in July. It's rather surprising to see the high RMSE values for daily min. What caused RMSE (daily min) to be almost doubled compared to RMSE (daily mean) and RMSE (daily max, nighttime?), given that RMSE (hourly) doesn't show this high value?

Minor comments:

Fig. 1: In Fig. Caption, please indicate the model's resolution used.

Fig. 5, 6 & 7: In Fig. Caption, the standard deviation of R is not mentioned though it is given in the plot. You may please rewrite as: "The standard deviation of the plotted variable from each station is shown. . ."

Table 2: Since there is no change in flux datasets used for different experiments, please remove the last column and indicate details of CO2 fluxes in the figure caption.

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