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Biogeosciences Discussions

Interactive comment on "Can we use hourly CO_2 concentration data in inversions? Comparing high resolution WRF-VPRM simulations with coastal tower measurements of CO_2" *by* R. Ahmadov et al.

R. Ahmadov et al.

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We are grateful to the reviewer for her valuable comments and suggested corrections. Below we give our answers to the comments.

Specific comments:

Title: We agree that the title might be a bit misleading and therefore the first sentence has been removed.

Introduction: We disagree with the reviewer's suggestion that the paper should not involve any discussion about CO2 inversions. The estimation of CO2 sources and sinks is a major target in the CO2 modeling community. There are a number of uncertainties

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in transport models used in inverse modeling which can be analyzed and solved only by performing forward runs. Especially the different kind of rectification effects caused by vertical mixing, sea-land breeze and mountain circulations can be analyzed only using forward model runs. The paper demonstrates the advantages of using high-resolution transport models to resolve the atmospheric CO2 distribution and addresses the shortcomings of the coarse resolution global models used in the inversions. The gain in using high-resolution models in inversions is twofold: better representation of 1) atmospheric transport; 2) variability of fluxes in the vicinity of continental measurement sites, (Gerbig et al., 2009). Summarizing these, we would like to stress that only such forward simulations and their validations against measurements can tell us about the precautions that to be taken into account in inversions. Consequently the paper is not just about the forward CO2 modeling and also a work to be beneficial for future inversion studies. We have substantially shortened the Introduction according to your suggestions, e.g. the part about complex terrain has been completely removed. We have cut some other sections completely or only the relevant references were left. We have added a note that this work is an extension of Ahmadov et al., 2007.

Configuration of the models: We have added a sentence describing the interaction between 10 and 2 km grids. Our discussion is focused on the 2 km grid, since in our 2-way nested run this grid passed all the variables including CO2 to the 10 km grid. Therefore a comparison between two domain simulations will not be meaningful. Since our paper is based mainly on the WRF-VPRM model runs, we have given a more comprehensive description of this model in Table 1. The global models are briefly described in the text.

Results and discussion: A brief description of the weather evolution during the simulation period (Fig. 2) has been added to the text. We have not shown time series of CO2 fluxes at the tower site from the model, since it does not explain the CO2 variability at the site, which is influenced by different air masses from the ocean and land. In addition we would like to draw the reviewer's attention to the studies where the measurement

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and modeling of CO2 fluxes during the campaign are presented (Ahmadov et al., 2007) and (Sarrat et al., 2007). These papers show comparisons between WRF-VPRM and different measurement sites on different days, which clearly demonstrate the capability of WRF-VPRM to capture the spatiotemporal variability of the biospheric CO2 fluxes. (Sarrat et al., 2007) contains the spatial distribution of the CO2 fluxes generated by the WRF-VPRM model. We have not included a discussion about the comparison between measurements and modeling of the CO2 fluxes, since it is out of scope of the paper. We think the comparison of the TM3 and LMDZ models' CO2 flux maps against the WRF-VPRM one would be redundant, since they are on very different scales and obviously the 2 km resolution model using the MODIS data will have much more spatial variability of CO2 fluxes than the models with the much coarser resolution (Ahmadov et al., 2007).

P. 4752, line 5: We have added arrows. There is some variability in the WRF-VPRM model within one hour, however the model does not explicitly resolve eddies due to its limited resolution and it is sufficient to take instantaneous values of CO2 every hour. Conversely, the high-frequency observation of CO2 detects the atmospheric eddies with different sizes and therefore there is a variability of CO2 concentration within one hour, which should be averaged over before comparing to the model. We have included these variations as mean(stdobs) in Table 2., since we have used hourly averaged concentration data from the observations.

P. 4758, lines 3-5: Above we answer to the comments related to the biospheric fluxes from the models.

P. 4759-4760: We have modified the paragraph describing the 20 May CO2 recirculation case to make it clearer, split the paragraph and also shortened a bit.

P.4760, line 6: As described in the paper, the wind comparison from the nearby station explains the complex circulation of CO2 near the tower and the stagnation event was not fully captured by the model and this is already an evidence that even if the modeled

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fluxes were completely correct, we would see the CO2 concentration bias due to the stronger nighttime transport in the model. On the other hand, we cannot exclude a similar bias in nocturnal respiration fluxes. Unfortunately, we cannot compare the CO2 fluxes at the tower site, since there was no flux measurement made at the station or in the vicinity.

Conclusions: We have added information about the performance time of WRF model runs, however please note that this is highly variable from one computing system to another. We agree with the reviewer that, the advantage of the WRF model relative to the global ones might be not as large in other seasons as in summer cases. However it should be noted that this strongly depends on various factors - vegetation and climate zones. Moreover it is well known that the complex terrain sites are very difficult to represent by the coarse resolution models regardless the season, therefore for such stations the high-resolution models are irreplaceable.

Technical corrections: We have improved the clarity of the text and the language. We have taken into account all the technical corrections suggested by the reviewer. We have deleted the paragraph on page 4756, line 13-22. We have also modified the tables, the figures and their captions as per the suggestions. Here are only answers to the questions of the reviewer that are not given in the revised version of the paper: P. 4753, line 19-20: The WRF-VPRM model has been used to do some TRANSCOM runs for a large European domain, July, 2003. However since it has not been yet published we have dropped that sentence. Figure 5a: According to the suggestion we have added the CO2 "tagged tracer", but only the respired CO2 on the figure. This tagged tracer together with the total CO2 concentration from WRF-VPRM clearly shows the recirculation event.

References: Ahmadov, R., Gerbig, C., Kretschmer, R. et al.: Mesoscale covariance of transport and CO2 fluxes: Evidence from observations and simulations using the WRF-VPRM coupled atmosphere-biosphere model. Journal of Geophysical Research-Atmospheres, 112(D22), D22107, doi:10.1029/2007JD008552, 2007.

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Interactive comment on Biogeosciences Discuss., 5, 4745, 2008.