We are grateful for useful comments on our paper. Several changes in the manuscript were made, which we list up further along with answers to reviewer's comments.

Problem 1

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.

Answer 1

Reviewer is correct to mention the deficiency of our setup. Our version of FLEPART model is driven by meteorological fields at a spatial resolution of 1.25x1.25 degree (about 125 km). As we argue in the paper this resolution is close to the observed horizontal scale of variability in atmospheric winds and temperatures often expressed as correlation radius. We completely agree that it is important to use as higher as possible resolution of analyzed data and emissions and we are working on that. Presently our model couldn't resolve locale scale phenomena like sea breezes, which can be handled locally if we use wind fields generated with regional model like WRF. But it works well in case of stronger winds or in case if motion is close to geostrophic that is observed. Despite the crude wind resolution problems, the model still shows some improvements which can be explained by the mentioned properties of the large scale circulation.

To move forward we need to use some model that provides us with high resolution fields. And we plan to implement this technique in the future. Also we provided some explanation about using high resolution emissions and medium resolution meteorology within the text of manuscript.

On the other hand we should stress that the main innovative part in the model is focusing on how to represent and handle efficiently kilometer scale fluxes at global scale, which we hope readers can learn from.

Problem 2

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.

Answer 2

We do agree emission datasets prepared at hourly time scale, for instance, would be suitable for high-resolution simulations like presented in this paper. Emission dataset at hourly time scale are only available for certain regions and cities (e.g. Vulcan (Gurney et al. 2009)). But, as far as the authors concern, there is no available global CO2 emission dataset prepared at hourly time scale. We therefore used the best available emissions databases that are currently available only with monthly spatial resolution for fossil fuel and oceanic fluxes, and 1day variation for biosphere.

Problem 3

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.

Answer 3

The use of nightlight data for a proxy for spatial distributions of fossil fuel CO2 emissions assumes a high correlation between CO2 emissions and lights from human activities (e.g. Oda and Maksyutov, 2011). Oda and Maksyutov (2011) only utilized the high correlation to estimate spatial distributions of CO2 emissions and did not use nightlight data to estimate CO2 emissions by translating lights into the amount of electricity used. Therefore, the spatial allocation error the review pointed out would not happen in the procedure shown by Oda and Maksyutov (2011). When compared to bottom-up high-resolution fossil fuel CO2 emission dataset such as Vulcan (Gurney et al. 2009), large spatial allocation error could be found especially over regions where the correlation is weak. The ODIAC inventory however shows very good agreement with Vulcan than other existing top-down type fossil fuel CO2 emission inventory.

Problem 4

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 generated here takes this into account.

Answer 4

VISIT is different from CASA. It has prognostic phenology as opposite to CASA which is driven by NDVI observations from space. VISIT model provides biospheric fluxes with 1 day temporal resolution, and it is not neutral on annual scale.

Problem 5

The choice for the measurement sites for comparison between observations and modeled 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.

Answer 5

We choose sites that are representative for a range of conditions demanding application of the higher resolution model: suburban (MRI), relatively clean continental site (Fyodorovskoe) and polluted area (London). To perform more simulations for all continuous stations globally we need much more CPU time. But we think that presented sites are representative for their classes. There is also a feeling that background monitoring sites can be analyzed with medium resolution models like Koyama et al (2011) or Rigby et al (2011)

Problem 6

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.

Answer 6

Our aim is to demonstrate the possibility of simulations with high resolution emissions inventories. On the possible reason for increasing misfit for higher resolution:

The simulated concentration variation is higher at high resolution, which results in larger misfit in cases where the timing and amplitude of the high concentration events simulated with a model do not match observations, main reasons supposedly being the misrepresentation of the wind fields and fluxes at high resolution (added to conclusions).

Problem 7

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.

Answer 7

That is why we use short trajectories

Problem 8

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).

Answer 8

Our work doesn't pretend that we are the first who uses temporal coupling. We want to demonstrate that our work is the first which uses 1km emissions and coupled model for global scale. And we don't use spatial coupling, nesting etc like other authors for regional scales. For this purposes we use temporal coupling in global domain. We added references to Vermeulen.

We changed text to:

"We did not adopt apply the spatial coupling at the domain boundary employed by similar regional models described above; instead, we implemented a coupling at temporal boundaries in global domain."

References:

Gurney, K. R., Mendoza, D. L., Zhou, Y., Fischer, M. L., Miller, C. C., Geethakumar, S., and de la Rue du Can, S.: High resolution fossil fuel combustion CO2 emission fluxes for the United States, Environ. Sci. Technol., 5535–5541, doi:10.1021/es900806c, 2009.

Koyama, Y., Maksyutov, S., Mukai, H., Thoning, K., and Tans, P.: Simulation of atmospheric carbon dioxide variability with a global coupled Eulerian-Lagrangian transport model, Geosci. Model Dev., 4, 317–324, 2011.

Oda, T. and Maksyutov, S.: A very high-resolution (1km×1 km) global fossil fuel CO2 emission inventory derived using a point source database and satellite observations of nighttime lights, Atmos. Chem. Phys., 11, 543–556, doi:10.5194/acp-11-543-2011, 2011.

Rigby, M., Manning, A. J., and Prinn, R. G.: Inversion of long-lived trace gas emissions using combined Eulerian and Lagrangian chemical transport models, Atmos. Chem. Phys. Discuss., 11, 14689-14717, doi:10.5194/acpd-11-14689-2011, 2011.

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