Review of
"Tropospheric carbon monoxide over the Pacific during HIPPO: two-way coupled simulation of GEOS-Chem and its multiple nested models" by Y. Y. Yan et al. [MS No.: acp-2014-485]

General:
This work investigates the impact of two-way coupling of regional chemical transport models (CTMs) with finer horizontal resolutions to a global CTM with coarser resolution. The focus is on the feedback of CO and how it changes the results of the global model, which are then compared with data from several field campaigns (HIPPO) over the Pacific. The authors show that the two-way coupling of all simulated chemicals causes a global increase in CO concentrations that are closer to observations than the results of the global model alone. They ascribe this to better representation of resolution-dependent processes, as natural emissions, in the higher resolved nested models.
Investigating the resolution dependency of atmospheric chemistry is an important research topic. Global chemistry climate simulations are restricted to coarse horizontal resolutions because of computational costs and the presented newly developed two-way coupler has the potential to improve such simulations with relatively low additional CPU time needed. The results are presented in a well structured and concise way. Tables and figures are well chosen to support the understanding of the text. Applied methods are generally feasible to analyze the different simulations and compare them with the HIPPO data.
I have only one major and some minor comments:

Major comment:
1) Section 4.3: There is a strong north-south gradient in the CO mixing ratios (Fig. 6). I recommend to analyze mean profiles (as in Fig. 8) separated for different latitudinal bands, e.g., 60-90N, 30-60N, …. From Fig. 6 it seems to me that the simulated underestimation of CO over the North Pacific is partially compensated by slight overestimation over the South Pacific (at least for the coupled model), which would lead to better congruence of the simulated and measured profiles in Fig. 8 for the wrong reasons. Profiles for different latitudes would bring regional differences to light and could help understanding which processes are not well captured by the model.

Minor comments:
1) P18962 L8ff: This is too technical for the abstract in my opinion. I recommend anything like: "We develop a two-way coupler, PKUCPL, allowing for exchange and interaction of chemical constituents between the global model (at 2.5 long.×2 lat.) and three nested models (at 0.667 long.×0.5 lat.) covering Asia, North America and Europe, respectively."
2) P18963 L2, L3, L6: Write "global model <u>alone</u>". See also comment No 5).
3) P18965 L14: Give little more information on the setup. How are the 47 layers distributed over the atmosphere? What are the time steps of the global and the regional models?
4) P18966 L7: Please note how/why these regions of the nested domains were chosen. To cover the regions with highest CO emissions?!
5) P18966 L16ff: Please mention one time – maybe in this paragraph – that "global model" refers to the standalone global model results and "two-way coupled model" refers to the results of the global model with feedback from the regional models. Or always call it "global model alone" and "two-way coupled global model" to make it clearer which results you describe.
6) P18967 L21: What interpolation method is used for horizontal regridding? Conservative? Which order? Please note in the text.
7) P18967 L25: I would prefer "wall-clock time" instead of "computational time" in this context. Computational time I read as total CPU time, which, of course, is much higher when running the coupled system.

8) P18970 L22f: I understand that not all test simulations can be done for a whole year or even longer. But please discuss how well January 2009 represents the annual budget and mention that there remain uncertainties because of analyzing only one month. How robust are the results? What can you say about statistical significance of the numbers in the following paragraph/Table 3?

9) P18971 L4: What is meant by "global all-source emissions"? Only the online emissions can be affected by the two-way coupling.

10) P18971 L15ff: Please discuss briefly, what the link is between the small-scale spatial variability and the photochemical efficiency of NOx, …?

11) P18971 L25ff: I agree that 1.5% represent the "non-emission small scale variability" and this should appear in Table 3-B2 instead of "other factors". Then the remaining 4.6% need to be "emission small scale variability". Is that what is meant by "small-scale horizontal distributions" in Table 3-B1? In my opinion, "concentrations" needs to be canceled on P18971 L29. Please make this more clear.

12) P18973 L8: On this website they say "there were 787 profiles flown". Why do you use only 620?

13) P18973 L10f: Please describe in more detail how the model data are interpolated/regridded to "ensure spatiotemporal consistency with the HIPPO data". The comparison of 2.5°x2° model data with the flight tracks is not straight forward. What is done to put the data on the same vertical grid? In Fig. 5 you show profiles at 0.1 km intervals which is much finer than the vertical resolution of the model, I guess. Please clarify.

14) P18974 L2ff: I would expect the numbers of the mean bias (0-9km, North/South Pacific) also for the coupled simulation here. Then these numbers do not need to be repeated at the end of section 4.3.

15) P18974 L25: Which "stratospheric influences" are this? What could be the reasons why the models reproduce only an about 10 ppb change at 9 km height compared to the measured 20 ppb?

16) Section 4.3, Fig. 8: Please discuss the seasonal differences. What could be the reasons why the simulated profiles seem to fit better with the measured ones during NH-winter in (a) and (b) while it looks worse in (c) – (e)?

17) P18975 L23ff: How were the numbers for emission increases determined?

18) P18977 L2ff: cf. comment No 9) 4.6% are due to "small-scale spatial variability in NOx ..." emissions. Is that right?

19) P18977 L20ff: Could you draw a general conclusion on the emission increase? Would you recommend to increase the CO emissions by an averaged value of 25? % for future simulations with the global model?

20) P18978 L5: What is meant by "multi-layer" in this context?

21) Table 4, footnote 3: "delta air pressure" is not clear to me. Is it the thickness of layer i in hPa?

Technical corrections:

1) P18976 L17: ...those simulated by the global model...

2) Fig. 4: Please include the abbreviations (GM) and (NM) behind "Global/Nested Model" in the center box.

3) Fig. 5: To make it more clearly, please include the zero line in panels b)-d) for the differences.

4) Fig. 6: In the present form each panel looks like one single time series. To distinguish between different campaigns, I recommend to put little spaces or vertical lines between the single campaigns.