We thank the reviewer for the positive and constructive comments on our manuscript.

The feedback from the reviewer has improved the quality of the manuscript. The reviewer's specific comments (shown in italics) are addressed below.

*Problem 1.*

*The Prather SOM and the Lin and Rood methods have been compared directly for the CO2 test case in a recent paper (Prather et al. 2008) that the authors missed. This addresses some of the problems here and should probably be analyzed to see if it is useful.*

Answer 1.

We agree with the referee that in various tests Prather et al., (2008) demonstrated that the respective advection errors in the CTM are greatly reduced with a doubling of resolution. Direct comparison of the Prather Second-Order Moments (SOM) and the Lin and Rood methods confirms the high efficiency of the SOM numerical scheme for tracer transport simulation in the troposphere and lower part of the stratosphere.

We added references on (Prather et al., 2008).

*Problem 2.*

*The pressure-error problem has indeed been known and is "fixed" in both Prather et al 1987 and Heimann and Keeling 1989. Cameron-Smith did a more elegant and better fix to this long-standing problem in Rotman et al 2004. For a range of GCM and analyzed wind fields this is no longer a problem.*

Answer 2.

We added references on (Rotman et al., 2004). In the present model, horizontal mass fluxes are computed following commonly employed method developed by Heimann and Keeling (1989) and discussed by Bregman et al. (2003). The referee suggested "a more elegant" method to fix this long-standing problem (Rotman et al., 2004). Indeed, the proposed pressure-fixer algorithm is promising because by construction this method does not alter the vertical mass fluxes. And thus, does not lead to increased value of vertical movement and enhanced mass transport from the bottom of the atmosphere to the top. However, advantages and disadvantages of this method are still poorly understood. Side by side comparison of flux-correction and pressure-fixer approaches would be necessary to understand relative merits of approaches under discussion here.

*Problem 3.*

*The reduced latitude-longitude grid here was pioneered by Kurihara 1967 and Prather 1987, but more recent developments should be noted (even if not implemented here): the cubed sphere (Putman and Lin, 2007); the replacement of the CFL with a Lifshitz criteria (Prather et al 2008).*

Answer 3.

We agree with the referee that overview of effective methods for simulation of the tracers transport on the sphere would be incomplete without mentioning of more recent model developments using the icosahedral (Niwa, 2010) and cubic grids (Putman and Lin, 2007). The main objectives of these approaches are to avoid the numerical difficulties of the spherical poles.

We added references on (Niwa, 2010) and (Putman and Lin, 2007), and also to (Lin and Rood, 1996) in introduction.

*Problem 4.*

*The authors talk about the much greater numerical diffusion of the van Leer method for surface CO2 (Figure 12). This does not really make sense: at 0.625 deg resolution, both the VL and Pr methods should readily preserve the emissions structures. Perhaps they had better check the code for the lower boundary-layer wind fields and advection? For example, a CTM running Pr(SOM) at 1 deg resolution (not that different from the 0.625 example here) produces highly resolved fold structures in the upper troposphere (Tang et al 2010) that do not look as washed out as Figure 12.*

Answer 4.

The referee is right to point out this problem. We believe that the paragraph from line 24 (p. 1756) should be restated as follows:

The flux-form version tends to merge plumes from multiple sources, as seen in the area of Shanghai (Fig. 12a), because the dispersion associated with time step truncation due to CFL criteria has caused a noticeable distortion in the numerical solution (Ritchie, H.: Application of the Semi-Lagrangian Method to Global Spectral Forecast Models, Numerical Methods in Atmospheric and Oceanic Modelling, NRC Research Press, 445-467, 1997.). Moreover in case of high-resolution simulation, the side effects of the horizontal flux correction method may have a significant importance. The erroneous mass flux corrections may smooth out sharp fluctuations and distort the direction of movement of tracers and as result lead to additional smearing of the concentration. This effect is similar to action of numerical diffusion. The semi-Lagrangian numerical scheme with less dispersion due to less restricted time step (2-3 time bigger than in flux-form version) shows better performance in terms of resolving the sources clearly, as it resolves the plumes from Tokyo, Beijing, Seoul, Shanghai, Hong Kong, Taipei, and other cities (Fig. 12b). For such short-time tracer transport near emission sources, mass-conservation problem of semi-Lagrangian scheme is less important.

*Problem 5.*

*The relative timings for the different methods (Table 1) are perhaps misleading since they are not necessarily based on optimal programming. For example, the new Pr method (see appendix of Prather et al 2008, Tang et al., 2010) is optimized to run 1 deg or finer without a global CFL criterion. The authors may wish to note that the NIES-08/VL & Pr timings, especially for the 0.625 deg case, are not realistic for modern code.*

Answer 4.

This comment is quite reasonable. Table 1 lists the results of the solution of the solid-body rotation test and the performances of the model versions at three different resolutions. Evaluations of the memory and CPU performed on a vector supercomputer NEC SX-8R take into account the cost of reading and processing the meteorological data, as in the case of real global-transport simulations. We used a standard code of Prather scheme (Prather, 1986), because numerical model optimization in order to achieve high performance on vector computer systems requires additional time-consuming efforts. Apparently the original SOM is less optimised to work with high efficiency on NEC vector machines. Nevertheless relatively high computing time and memory demand of this scheme was also mentioned by Petersen et al. (1998).

Actually the reference to (Heimann, M. and Keeling, 1989) is present on p. 1760, lines 31-33

Added references are follows:

Niwa Y.: Numerical study on atmospheric transport and surface source/sink of carbon dioxide. Ph.D. dissertation, The University of Tokyo, 178p., 2010

Prather, M.J., Zhu, X., Strahan, S.E., Steenrod, S.D., Rodriguez J.M.: Quantifying errors in trace species transport modeling, Proc. Nat. Acad. Sci., 105(50), 19617-19621, 2008.

Putman, W.M., and Lin S.-J.: Finite-volume transport on various cubed-sphere grids. J. Comput. Phys., 227, 5578, 2007.

Rotman D.A., Atherton, C.S., Bergmann, D.J., Cameron-Smith, P.J., Chuang, C.C., Connell, P.S., Dignon, J.E., Franz, A., Grant, K.E., Kinnison, D.E., Molenkamp, C.R., Proctor, D.D., and Tannahill, J.,R.: IMPACT, the LLNL 3-D global atmospheric chemical transport model for the combined troposphere and stratosphere: Model description and analysis of ozone and other trace gases, J. Geophys. Res., 109, D04303, 2004.