

## ***Interactive comment on “Global distribution of CO<sub>2</sub> in the Upper-Troposphere and Stratosphere” by M. Diallo et al.***

**Anonymous Referee #3**

Received and published: 21 June 2016

### **General:**

The paper presents the global Lagrangian reconstruction of CO<sub>2</sub> in the upper troposphere and stratosphere for the time period 2000-2010. This reconstruction is validated with in situ observations. It is astonishing that such a simple method can reconstruct CO<sub>2</sub> with such a quality. Nevertheless there are still some differences and a possible origin of these differences is not well discussed (representation of convection, mixing, etc.)

The monthly zonal means are used for the description of the seasonality of transport both in the troposphere and in the stratosphere as well for the interpretation of the BD circulation. The results show a very impressive, detailed and quantitative picture how the seasonal cycle of CO<sub>2</sub> (“breathing of the Earth”) propagates upwards into the stratosphere. This important contribution is supported by well-performed figures. The

C1

formation of the inverse vertical gradients of CO<sub>2</sub> over the course of the year is a very interesting feature which can be used to validate other transport models.

However, the quality of the presentation, especially of the text can (and has to) be improved. I think that the very experienced co-authors could help to do this job. The paper may be acceptable after a major revision improving this point

### **Major points:**

1. My only major point is the quality of the text (outline, titles of the sections and subsections). I am not a native speaker but my feeling is that not only the structure of the paper but also the quality of many sentences can be significantly improved.

### **Minor points:**

1. Abstract L 1  
please remove “relevant”. You can only hope that this will be a relevant data set
2. Abstract L 8  
I would replace “guided” by “driven”
3. Abstract L 11  
...with mid-latitude vertical profiles measured in situ from aircraft and balloons exhibit a remarkable agreement...(you should not give a complete description of the used data in the abstract)
4. Abstract L 17  
...out of the tropics to the mid and high latitude stratosphere (but mainly into the northern lowermost stratosphere around 15 km - is it not something that follows from your Fig. 6)
5. Abstract L 21  
...and is nearly constant above 35 km (is it what you would like to say ?)

C2

6. P.4 L3  
These studies.... - please rewrite this sentence
7. P.4 L12  
...to help to validate the stratospheric representation in global CTMs...
8. P.4 L14  
...to the very localized in situ observations which have high spatial resolution, a large spatial...
9. P.4 L18  
Chadin et al showed.... (please rewrite this sentence)
10. P.5 L5  
...are also weak... (what do you mean ?)
11. P.5 L21/22  
"model's lack of realistic stratospheric influence" - not clear, please explain
12. P.6 L10  
The small scale variability...and the scarcity of suitable observations ... (I would recommend to reformulate this sentence)
13. P.7 L14  
Trajectory starting....(you are using backward trajectories, so maybe you would like to write: "Trajectories reaching the boundary layer during the backward integration..."
14. Section: Data  
You should shortly describe here the aim of both upcoming subsections
15. Section 4 and 4.1  
I think, you should use a different title like "Reconstruction of CO2" and describe C3

it accordingly. "Initialization" is a very misleading term. So you use backward trajectories plus Carbon Tracker/WDCGG data in the boundary layer to reconstruct CO2 everywhere in the UT/S region. Please reformulate the text between L10 and L20....

16. P.11 L14  
Maybe you should change  $b_0$  (which is too close to  $b$ ) to something different.
17. P.12 eq (2) and (3)  
Maybe you should avoid to introduce  $Corr$ , i.e. use only one formula in two lines
18. P.11 eg. (1)  
You also did not clearly explain that you need your eq. (1)-(3) only for CO2 reconstruction cases which are older than 10 years and you do not have any information from the backward trajectories. Maybe you should reformulate some sentences...
19. P.12 4.2.1  
Once again: for me it not a "flight track initialization" but much more a "Lagrangian reconstruction of CO2 along the flight track" - maybe you should reformulate it
20. P.12-13  
You repeat here many arguments and formulations from Lugs Ed al., 2005. I do not think this is necessary. I strongly recommend to remove this part and cite the original papers. Instead of this, you should better explain your eq (7), i.e. how displacement in the geometric space is related to a displacement in  $\theta$ -space.
21. P.14, 4.2.2  
Once again, please use the term "Reconstruction" in the title of this section and change accordingly the following text...

22. P.14 5.1  
Here, I miss any reference to Fig 2.
23. P.14 L 24  
Your abbreviations of the dates are not clear and maybe you should the notation like 26th February 2000, etc.
24. P.15 L 6  
aging vortex core
25. P.15 L 7  
"corrective step in this instance" - I do not understand what you mean
26. P.16 L 6  
"accurate" - please remove it
27. P.16 L 8  
...from the global reconstruction calculated by...
28. In Fig 4a and 4b you denote the regions as tropospheric and stratospheric boundaries. However, in the model there is only one lower boundary prescribed by the Carbon Tracker values. You should exactly say what you mean with your boundaries. For me, 4a validate your model in the middle troposphere around 7-9 km and 4b in the region between 16-17 km. Please clarify this point.
29. P.17 L 3  
with respect to
30. P.17 L 4-7  
please give a more detailed explanation of the discrepancies. "as it will be confirmed shortly" could be replaced by "We discuss this point in the next section".

## C5

31. P.17 L 12  
...derived from our Lagrangian reconstruction
32. P.17 L 19  
grows
33. P.17 L 21  
in the southern hemisphere
34. P.18 L 4  
propagates
35. P.18 L 5  
is removed from the atmosphere due to...
36. P.18 L 6  
into the lower stratosphere driven by the lower branch...
37. P.18 L 9  
west side (can you give more detail how the Asian monsoon anticyclone contributes to this transport)
38. P.18 L 13  
which is maximum...
39. P.19 L 1-2  
localized gradient, etc. - please give a more detailed explanation