Atmos. Chem. Phys. Discuss., 12, C5698–C5700, 2012
www.atmos-chem-phys-discuss.net/12/C5698/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Variation of CO_2 mole fraction in the lower free troposphere, in the boundary layer and at the surface" *by* L. Haszpra et al.

AE Andrews (Referee)

arlyn.andrews@noaa.gov

Received and published: 13 August 2012

This is a thoughtful paper that describes an important and unique dataset. The authors have considered how the data may be used to evaluate models and/or to assimilate CO2 data in order to estimate fluxes. They have distilled the data into a useful form to inform these applications and have pointed out some of the limitations of the dataset and of their analysis. A few comments and suggestions follow:

1. Units. The units micromole per mol are used throughout, instead of the more common and compact parts per million (ppm). If allowed by this journal, consider stating that units are reported as a dry air mole fraction, and then using "ppm".

2. Pg 11541 line 2. Authors should contact Dr. Colm Sweeney from NOAA ESRL regarding the preferred citation for the North American aircraft network.

3. Pg 11544 first paragraph. I agree with review by Christoph Gerbig that decanting standard gases from large cylinders into small flight tanks can cause concentration changes in both tanks of order a few tenths of a ppm. This can be detected by calibrating both fill tanks and flight tanks against an independent set of standards. Line 9. It seems that the word "completed" should be replaced by "complimented". Also, consider using "baseline" in place of "zero"and "analyzer-drift" in place of "scale-drift".

4. Pg 11544 2nd paragraph. Flights were performed in late morning-early afternoon. I expect that the PBL might still be developing through early afternoon and that the best time to fly would be mid to late afternoon. Perhaps add a few sentences about how this time was selected? Perhaps discuss magnitude of bias e.g., if profiles were obtained earlier than the time that the PBL reached its maximum height on a particular day.

5. Pg 11545. It would be useful to state the mean PBL height so that the bias could be interpreted as a percentage. Even better would be to compute the percentage bias for each profile and then report the mean of that in addition to the mean absolute bias.

6. Pg 11546-47. When interpreting flask vs in situ differences, it would be helpful to consider the standard deviations corresponding to the 2-min averages. In that case, instead of a histogram, it would be useful to present the differences as a scatter-plot with error bars corresponding to the std dev of the in situ data. Line 22: 0.34 ppm bias: which is higher flasks or in situ? Information about the standard deviation of in-situ measurements during calibrations versus atmospheric samples could inform about what portion of the variability is geophysical vs instrument-related. Consider replacing "The most likely cause could be . . ." with "A possible cause is non-linearity. . ."

7. Pg 11549. For those flights where on-board data are used to estimate PBL height, what is the difference in mean PBL CO2 concentration when the observed PBL is used compared to ECMWF PBL height?

8. Section 3.1. It seems that the CO2 gradient observed across all heights on the tower might provide information about which days the 115m level represents a reasonable estimate of the PBL mean values.

9. Pg 11551/Figure 5. Consider adding data from a high altitude site like Jungfraujoch to compare with the >2500m curve in Figure 5.

10. Pg 11552-53: The analysis of fair-weather bias using the 115m tower data (Figure 7) is interesting and robust, but I don't understand the basis for assuming that fair-weather bias at higher altitudes is insignificant. Consider a case where cloudy/foggy conditions prevent flying. Such conditions may be associated with particular synoptic conditions (such as Northerly flow bringing cold air). Given the large-scale latitude gradients that exist in the free-troposphere, it seems rather likely that there could be a fair-weather bias aloft. The likelihood and magnitude of fair weather bias at high altitudes could be studied using continuous output from a model with reasonable fluxes and realistic weather (e.g. CarbonTracker or similar).

11. These papers are highly relevant, and form some of the basis for the Virtual Tall Tower concept that was also mentioned by reviewer Christoph Gerbig:

Yi, C. X., K. J. Davis, B. W. Berger, and P. S. Bakwin. "Long-Term Observations of the Dynamics of the Continental Planetary Boundary Layer." Journal of the Atmospheric Sciences 58, no. 10 (2001): 1288-99.

Yi, C., K. J. Davis, P. S. Bakwin, A. S. Denning, N. Zhang, A. Desai, J. C. Lin, and C. Gerbig. "Observed Covariance between Ecosystem Carbon Exchange and Atmospheric Boundary Layer Dynamics at a Site in Northern Wisconsin." Journal of Geophysical Research|Journal of Geophysical Research 109, no. D8 (2004): 9 pp.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 11539, 2012.