

Interactive comment on “A high-altitude balloon platform for determining exchange of carbon dioxide over agricultural landscapes” by Angie Bouche et al.

Anonymous Referee #2

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This paper describes a system for relatively easily made CO₂ profile measurements consisting of a balloon and an instrument to measure CO₂, and a budgeting approach to derive regional-scale biosphere-atmosphere exchange fluxes. The approach is not new, but the simplicity of the measurement system might open possibilities for involving citizen science groups to contribute measurements. The paper is well-written, and fits well within the scope of AMT. However, a few issues listed below should be addressed before the paper can be recommended for publication.

General comments: The introduction should be modified to include more relevant literature, I give three examples below. 1) The use of satellite borne remotely sensed of atmospheric mole fraction column for inverse modelling of fluxes is only a recent

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development. The introduction should therefore also refer to the standard approach of inverse estimation of surface-atmosphere exchange fluxes using the combination of transport models and atmospheric mole fractions from measurements made at an atmospheric network of observing sites, see for example Enting et al. (1995), or Gurney et al. (2002). Enting, I. G., Trudinger, C. M. & Francey, R. J. A synthesis inversion of the concentration and $\delta^{13}\text{C}$ of atmospheric CO₂. *Tellus B* 47, 35-52 (1995). Gurney, K. R., Law, R. M., Denning, A. S., Rayner, P. J., Baker, D., Bousquet, P., Bruhwiler, L., Chen, Y. H., Ciais, P. and Fan, S.: Towards robust regional estimates of CO₂ sources and sinks using atmospheric transport models, *Nature*, 415(6872), 626–630, 2002.

2) Furthermore the introduction needs to refer to other budget studies based on profile measurements, a list is shown below. Wofsy, S. C., Harriss, R. C., and Kaplan, W. A.: Carbon dioxide in the atmosphere over the Amazon basin, *Journal of Geophysical ...*, 1988. Denmead, O. T., Raupach, M. R., Dunin, F. X., Cleugh, H. A., Leuning, R.: Boundary layer budgets for regional estimates of scalar fluxes, *Global Change Biology*, 2, 255-264, 1996. Laubach, J. and Fritsch, H.: Convective boundary layer budgets derived from aircraft data, *Agricultural and Forest Meteorology*, 2002. Chou, W. W.: Net fluxes of CO₂ in Amazonia derived from aircraft observations, *J. Geophys. Res.*, 107(D22), 4614, doi:10.1029/2001JD001295, 2002.)

3) In terms of the measurement technique, a reference to the recent AirCore approach would be appropriate: Karion, A., Sweeney, C., Tans, P. and Newberger, T.: AirCore: An Innovative Atmospheric Sampling System, *J. Atmos. Oceanic Technol.*, 27(11), 1839–1853, doi:10.1175/2010JTECHA1448.1, 2010.

The materials and methods section should include a more complete description of the measurements and the approach. How was the LI-640 instrument calibrated? Was the air dried before measurement of the mole fraction? If not, what is the expected impact of changing amounts of water vapour in the atmosphere between the two flights (see e.g. the Webb correction (Webb et al., 1980) in case of eddy covariance flux measurements)? Reference: Webb, E. K. and Pearman, G. I.: Correction of flux measurements

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for density effects due to heat and water vapour transfer, Q.J.R. Meteorol. Soc., 1980.

An assessment of the uncertainty of the approach should be given. This includes the uncertainty of the CO₂ profile measurements, such that error bars can be shown both in the CO₂ profiles and in the NEE contribution profiles (Fig. 4). It also includes a discussion of the uncertainties introduced by the assumptions made in the budgeting approach (neglecting advection).

Specific comments Figure 1: The units on the x-axis of the right panel seem wrong. The shown contributions to NEE from the different height intervals should have units of flux per height interval, or something like micro-moles/m²/s/km, such that when vertically integrated the units are those of NEE.

Line 204: The link to ameriflux does not work

Line 224-225: this could also (and more likely) be the residual layer, i.e. the previous days mixed layer, combined with a change in advection. I guess that is what is mentioned in the next sentence (lines 225-227)

Line 281: it should be assessed if at least the wind direction or changes in wind direction between the first and second flight of 23 July 2015 are pointing to a contamination. This should also be done for other flights to exclude potentially contaminated profiles, since otherwise only the data that look strange are checked for this.

Line 319: In terms of future applications, the authors might want to include the use of these profile data in regional scale inverse modelling, which would allow for taking advective contributions into account.

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