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Biogeosciences Discussions

Interactive comment on "CO_2 budgeting at the regional scale using a Lagrangian experimental strategy and meso-scale modeling" *by* C. Sarrat et al.

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Dear P. Isaac,

We would like to thank you for your constructive remarks and suggestions about our paper. We tried as much as possible to take into account your suggestions in order to improve the paper. In fact, as you will see, most of the comments are introduced in the revised text or in the figure legend. Note that 2 additional figures have been added as a response to your comments and to the other referee question. These figures deal with the surface energy fluxes and with aircraft and balloon trajectories.

We will now answer to each of the remarks you made:

Point 1: We added in the text some more information on the way to prescribe the parameters in the Isba-A-gs surface scheme, including the LAI (in section 2). Additional information has been given on the preliminary calibration of the 2 most important parameters for CO_2 component of the surface scheme (the ecosystem respiration and the mesophyl conductance).

Point 2: Yes, we agree that the latent and sensible heat fluxes are very important for a good meso-scale simulation. We have now included a new figure, which gives the comparisons between the simulated and the observed latent and sensible heat fluxes at 4 different sites. You will see that the agreement is rather good, although the model tends to overestimate the flux comparing with the eddy covariance observations. The overestimation appears more marked for latent heat flux than for the sensible heat flux. The conclusion includes now some discussion regarding the number of flux stations, which would be necessary to improve the estimation of the regional CO_2 budget.

Point 3: Concerning the entrainment, the paragraph has been clarified. In fact, the integration of the CO_2 vertical profile above the Atmospheric Boundary Layer (ABL) doesn8217;t require the estimation of the entrainment flux, as the turbulent fluxes are null in the free troposphere! Nevertheless, we have established an estimation of the entrainment flux for the Piper-Aztec measurements specially to answer your question:
If we establish a link between the entrainment of CO_2 and the entrainment of sensible heat and if we assume that the exchange coefficient K is similar for CO_2 and temperature, then:
the entrainment flux for Θ is : $\overline{w'\Theta'}_{entr} = -K\frac{\partial\Theta}{\partial z}$ and for CO_2 is : $\overline{w'CO'_2}_{ent} = -K\frac{\partial CO_2}{\partial z}$
Moreover, many previous studies (Tennekes et al, 1973, for instance) proposed a value of $\overline{w'\Theta'}_{ent} = 0.2.\overline{w'\Theta'}_{surf}$ and so, ENT_{obs} = $\overline{w'CO'_2}_{ent} = 0.2.\overline{w'\Theta'}_{surf}\frac{1}{\frac{\partial\Theta}{\partial z}}.\frac{\partial CO_2}{\partial z}$

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We can deduce the value of the entrainment flux: ENT_{obs} = - 0.83 $\mu.m^{-2}.s^{-1}$, that is to say approximatively 10 % of the Lagrangian term.
We think that it is difficult to introduce this material in the text.

Point 4: Yes we agree with you, that this study offers the potential to apply the budgeting techniques to the temperature and to the water. Unfortunately, this would require to re-run the model with additional diagnostics. This is not possible within the frame of this paper. However, we have added some information on the quality of latent and sensible heat fluxes.

Point 5: In the discussion and conclusion, some considerations have been added on the respective errors and uncertainties associated to the 3 budgeting methods.

Point 6: Editorial: we tried to re-check our English

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