

## ***Interactive comment on “Can seasonal and interannual variation in landscape CO<sub>2</sub> fluxes be detected by atmospheric observations of CO<sub>2</sub> concentrations made at a tall tower?” by T. L. Smallman et al.***

**Anonymous Referee #1**

Received and published: 11 October 2013

General Comments:

The study evaluates the performance of a coupled atmospheric-biospheric model – WRF-SPA – with CO<sub>2</sub> observations made from a tall tower in Scotland. Based on the model performance, the study is further extended to assess the representativeness of tall tower measurements in detecting seasonal and inter-annual variation of regional ecosystem CO<sub>2</sub> uptake. The model evaluation part in this paper is largely as a follow-up of Smallman et al., 2013. The paper holds scientifically relevant topic which is necessary for Carbon community; hence lies within the scope of BG. The paper is or-

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ganized well; however some parts are not concise enough. I have a serious concern on the analysis described in sections 4.2 and 5.2 (See “Specific Comments”). This strongly needs to be revised or clarified to support the conclusions. In the present form, it is not adequate to reach the conclusion. Additionally, I suggest authors to consider avoiding line-by-line repetition of sentences here and there from their previous published paper, Smallman et al., 2013. For example, see the whole section 2.1, which is exactly identical to the section 2 of Smallman et al., 2013 - authors can consider revising it or reducing the text by giving reference. Besides on these, I ask authors to kindly work on language fluency for enhancing the clarity of their statements, especially the introduction part. I recommend the paper to be published after minor revision, considering the above and following comments.

Specific Comments:

p. 14312: “The representativeness of TTA ...total land surface net CO<sub>2</sub> uptake (Fig. 5)” -> Please indicate what you meant by land surface CO<sub>2</sub> uptake- Is it tracer concentration or flux? If it is flux, I may follow the basis of your analysis to some extent. But in the referred figure (Fig. 5), the plotted variables are all seem to be concentrations. Please specify the unit here (Y-axis). How can you assess representativeness of the measurements at “national scale” by just comparing concentration fractions (e.g. crop uptake) for two levels (surface and tower level)? If surface CO<sub>2</sub> concentration (e.g. crop uptake) is less than upper level CO<sub>2</sub>, you may vaguely say that there may be some influence from far-field fluxes (but not necessarily at national scale). However, a serious caution should be made for the (local) transport patterns both horizontally and vertically which affect the concentrations in different levels. You can check this with your simulated meteorological fields. Now there comes another issue: the uncertainty in simulated tracer transport (e.g. issues with vertical mixing). So you have to take into account that. Thus, in short, by comparing two levels of concentrations, one cannot say about the ecosystem representativeness at national scale. Another possibility is to do some tests by changing local biosphere (perhaps topography also) + meteorolog-

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ical drivers (e.g. local wind direction) and analyze the impact. Based on results (e.g. dominance of boundary effect), one can say about the representativeness at national scale.

p.14313: "Seasonal variation in net CO<sub>2</sub> uptake .. regional scale net CO<sub>2</sub> uptake" -> This analysis does not seem to be interesting. These are simulated results (not observations!) and are based on parameterization. The regression will give you the results based on how you parameterize the fluxes.

Other Comments:

p. 14303: ". . resulting in significant seasonal and interannual.." -> Add also "spatial"

p. 14303: "..made at the regional scale (e.g. at a tall tower).." -> It is misleading – Did you mean the representativeness of measurements? Please remove it or make it clear otherwise.

P.14307: "..frictional velocity, atmospheric CO<sub>2</sub> mixing ratios .." -> a bit lost here. As far as I understood, the coupled model WRF-SPA simulates atmospheric CO<sub>2</sub>, using met. drivers provided by WRF and associated fluxes calculated by SPA. Then again why do you need atmos. CO<sub>2</sub> concentrations to be passed to SPA? Please clarify.

p. 14308: "Atmospheric CO<sub>2</sub> fields (2002–2007) are from Carbon Tracker Europe"-> Please indicate that it is initial fields of atm. CO<sub>2</sub>

p. 14310: "Statistical comparison of hourly observations with the WRF-SPA simulated ... The annual bias for total atmospheric CO<sub>2</sub> .." -> How did you do the statistical comparison? What is the period of data you used for this? What makes it different from your annual bias calculation?

p. 14310: "..suggests minimal or slightly negative.." -> please remove "minimal". Though it is not clear how you did your statistics (see above comments), another possible reason for this negative impact is the variability. CO<sub>2</sub> "variability" is well captured in the Total CO<sub>2</sub> for active biosphere months when compared to the less variable "forcing-

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only" CO<sub>2</sub>. However, positive fluxes (ecosystem release) are underestimated for winter months.

p. 14310: "an overestimation of night time atmospheric CO<sub>2</sub> concentrations simulated" -> it could also be very well related to the misrepresentation of nocturnal boundary layer. Which model level do you use for your comparison? Also comment on the bug report of YSU scheme as indicated in the "interactive comment" by ED Dellwik.

p. 14310: "reduced in total CO<sub>2</sub> by up to 59% between March–June and October–December of each year" -> I don't see any significant bias "reduction" for October–December in terms of "forcing-only" and total CO<sub>2</sub> residuals by including biospheric fluxes. Please clarify.

p. 14312: "..while cropland is overrepresented on average by 33%.." -> What do you mean by "over-represented" – well represented?

p.14312: "The seasonal profile for forest, managed grassland ..surface" -> not clear

p. 14313-14314:" ..that Scotland's terrestrial ecosystem is likely on average to be a net carbon sink .." ->This is not clear from Fig.3 as you plotted only TTA observations. If you rely on SPA for this estimate, please indicate it explicitly and give numbers.

p. 14314: "WRF-SPA's estimate for Scotland's forest sequestration is overestimated. Forest activity is largely under-represented in observations made at TTA (Fig. 5)" -> I can't see this information from Fig.5. Please explain it clearly.

p. 14315: "The parameterised harvest processes are broadly realistic" -> Do you have a reference for this?

p. 14318: "Cropland is over-represented in tall tower Angus observations for much of the annual cycle" -> over-represented? Please clarify.

Fig 6: I see a shift in maxima for cropland tracer for the year 2007 when compared to flux. Do have an explanation for this?

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Technical corrections:

Fig. 5: Include unit. Wrong legends for lower panel plot.

References:

Smallman, T. L., Moncrieff, J. B., and Williams, M.: WRFv3.2-SPAv2: development and validation of a coupled ecosystem-atmosphere model, scaling from surface fluxes of CO<sub>2</sub> and energy to atmospheric profiles, *Geosci. Model Dev.*, 6, 1079–1093, doi:10.5194/gmd-6-1079-2013, 2013

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Interactive comment on *Biogeosciences Discuss.*, 10, 14301, 2013.