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Biogeosciences Discussions

Interactive comment on "Regional scale modelling of meteorology and CO_2 for the Cabauw tall tower, The Netherlands" *by* L. F. Tolk et al.

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Dear referee,

We would like to thank you for giving useful suggestions and advices with regard to the content of our manuscript. We have taken all of them into account and provided clarifying answers as well as a number of changes in the text and figures. The corrections included in the revised paper are listed below.

On behalf of all authors, Lieselotte Tolk

- General comment 1 (concerning the range of plausible values for the parameters): To visualize the variability in the CO2 fluxes induced by the uncertainty in the parameters, we added the range of simulated CO2 fluxes to the flux time series in figure 5,

similar to the range of CO2 mixing ratios in figure 6. A description of this variability, in comparison with the observations and literature values (Jacobs et al., 2007) is added to section 4.1. The limited number of observations within the simulation domain may not be representative for the full area, and just using these to estimate the parameter variability may lead to an underestimation of the uncertainty. This is the reason we used the optimized parameters based on a large number of Fluxnet observations (Groenendijk et al., 2009). To avoid a too large variety of environmental conditions, we only selected the temperate zone within Europe. Its range agrees well with observations and literature values for the situation in our domain. In the study of Jacobs et al. (2007) the variability of model parameters is determined for several Dutch grassland sites. The standard deviation of their respiration parameters are almost the same as in our study. Their photosynthesis model, and therefore those parameters are different, but the range is also comparable to the range used in this study. They showed that the standard deviation of their GPP parameters was between 20 and 60%, and conclude that within small regions with relatively uniform climatic conditions the variability is similar to that observed at European scale. This confirms that used range for the parameter values is a good estimate. It is also in line with the observed CO2 fluxes. The observed respiration at Cabauw, Horstermeer and Lonzee is in the lower part of the range, while the observations at Lutjewad are often near the top of the range. Also assimilation at Lutjewad is near the maximum, while Lonzee and Cabauw are near the minimum and Horstermeer is in the middle. The best estimate based on the atmospheric CO2 mixing ratio (40 umol m-2 s-1) is lower than that of the prior parameter (70 umol m-2 s-1), but within the range .

- General comment 2 (concerning the variability of energy flux parameters):

The parameters controlling the surface energy flux in this study were selected to encompass both the observed energy fluxes and the atmospheric observations which, as described in the paper, are not in agreement. We acknowledge that the true range of parameters might be even larger than used currently, and our uncertainty estimates may be conservative. This is added to section 3.2 and 5 and we emphasize in the text that the uncertainty estimate due to changes in the energy fluxes estimated in this study is a minimum value to take into account in future inversion studies. Additionally, we performed a new simulation in which the minimal stomatal resistance of 40 s/m suggested by Jackson et al. (2003) for grass is applied (Table 1 in this reply). With these settings the simulated range covers the observed surface fluxes. Their estimated values thus agree well with the eddy covariance observations, but do not match well with the observed atmospheric temperature. A possible explanation is that the parameter optimization of Jackson et al. (2003) for a single site is applicable to the small spatial scale that is represented well by the eddy-covariance data, while the atmospheric derived parameter values represent average values for the full footprint of the tall tower. The discrepancies of the parameters in table 5 and the parameters estimated by Jackson at al. (2003) might thus be explained by the scale of the observations. This is added to section 5, the reference to this paper is also added to section 3.2.

Reply to specific comments:

- The simulations were performed using constant values for the parameters in 5PM. This technical point is added to section 2.3.

- We change the title of the paper to 'Modelling regional scale surface fluxes, meteorology and CO2 mixing ratios for the Cabauw tower in the Netherlands'.

- We added to the text that the studies of Lin and Gerbig (2005) and Gerbig et al. (2008) are performed at a coarser scale and that our study is performed at a higher resolution. In section 2.1 we added a description of the topography of the domain. Additionally, in the introduction we emphasized more the importance of high resolution simulations to reduce transport errors due to topography.

- p5898 – 3: corrected

- p5901 – 20: This sentence is rephrased with: 'The fact that the surface flux observa-

tions and the atmospheric observations both suggest different optimal β's indicated an uncertainty in what the correct β should be in the simulations for the full domain.'

- p5902 – 3-12: We rephrased this part, by adding the limited horizontal resolution of 4 km as a possible cause of error in PBL modelling, and removed the remark that PBL schemes need improvement. The test with the vertical layers was included because it is obvious that a too low vertical resolution should cause problems in resolving the top of the boundary layer; but the experiment we performed earlier showed that higher resolution gives no improvement.

- p5904 – 21: The sentence is rephrased with: "... when the air had passed land areas.".

- p5907 – 29: The sharp drop in the background signal at Cabauw in the morning of doy 163 is covered by signals from within the domain. It was caused by the daily cycle of the CO2 concentration at the border of the domain, with low concentrations during the day. This concentration was advected from the border of the domain and reached Cabauw in the morning. It coincided with a reduced assimilation signal, which was advected away from Cabauw, and with the normal morning increase in the respiration and fossil fuel signal that accumulated in the same air during the night. At doy 164 the reduced background signal remained longer, because of changing wind directions. This led to a reduction in the simulated afternoon CO2 concentration (372 ppm instead of e.g. 381 ppm at doy 160 and 162). However, the timing and magnitude of the change in wind direction was not simulated perfectly (see figure 2). The lower simulated than observed CO2 mixing ratio at the afternoon of doy 164 was due to this transport error. Even though the background signal is covered by the signal from within the domain, it is also important to have a good estimate of the background concentrations, because errors associated with it are advected over the domain and lead directly to errors in the simulated CO2 mixing ratio.

Interactive comment on Biogeosciences Discuss., 6, 5891, 2009.

Sim. time	SM	rsmin	veg. frac.	B-ratio sim	H sim	LE sim	Tobs - Tsim
0.25	0.23	40	70	0.09	44	481	2.3

Table 1, results of a simulation with a reduced stomatal resistance, addition to table 5 in the manuscript.