

## ***Interactive comment on “Coupled carbon-water exchange of the Amazon rain forest, I. Model description, parameterization and sensitivity analysis” by E. Simon et al.***

**Anonymous Referee #1**

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### General comments

In this paper, the authors describe, parameterize and test the parameters sensitivity of a one-dimensional multilayer model (CANVEG) used to calculate water-carbon exchange between the vegetation and the atmosphere in the Amazon rain forest. The paper addresses relevant scientific questions within the scope of BG, 1/ is the different sub-models and their parameterization able to reproduce observed biochemical and physical processes? 2/ what is the variability of calculated sensible, latent and CO<sub>2</sub> fluxes due to parameters uncertainty? By presenting adequate results to support most of the interpretations and conclusions the authors succeeded in answering these questions. The paper does not present novel concepts, tools or data, but the authors used very extensive datasets to test and validate the different sub-models and to constrain

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the parameterization. The originality of the paper is that no such work has been done with such a model for the Amazon rain forest. The methodology for modeling and parameterization is mostly valid and present no major flaws. The datasets, the model and methodologies are well detailed and documented. The paper is well written and the overall presentation is well structured and mostly clear.

#### Specific comments

1) My major scientific criticism of the analysis is how the sensitivity analysis has been performed. Typically, model sensitivity analysis is done by changing model parameters (by  $\pm x$ ) and evaluating the effect of those changes on the output of the model ( $\pm y$ ). The sensitivity is defined by  $dy/dx$ . The model parameters are changed around their calibrated value by a fixed percentage (for example  $\pm 10$  percent), which allow to compare the sensitivity of the model to different parameters for the same relative change. Elasticity is a normalized sensitivity defined by  $xy/dydx$  and would allow the authors to compare the sensitivity of different outputs. In this paper the authors tested the sensitivity of the parameters around their "uncertainties", which in percentage are different for every parameter. This does not allow the parameter sensitivities to be compared with each others. In addition, these "uncertainties" are statistically poorly defined as the range of possible values guessed by the authors based on fitness between predictions and observations. In my opinion these uncertainties should better be constrained using the range of value published in the literature, or by Monte-Carlo analysis (but this analysis probably requires unreasonable computational resources with a model like CANVEG).

2) Amongst the various parameters cited in paragraphs 3.1 to 3.6 and appendix 5 to 8, only 8 are involved in sensitivity analyses in paragraph 3.7. Why this choice? Why the authors didn't test the model sensitivity for other parameters ( $Ds_0$ ,  $J_{max}/V_{cmax}$  ratio,  $H_{aero}$ ,  $R_d$ ,...)?

3) page 350, line 27: what is the rationale for changing the optimal temperature of

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Jmax? Do the authors have any data to support this? They could actually modify a lot of different leaf gas exchange parameters and come with the same improved fit. The authors need to better argue for the modification they propose.

4) page 352, line 9-14: what is the rationale for changing  $aA$  for the wet season, and other parameters ( $\alpha$  and  $\theta$ ) for the dry season? Why not only  $aA$ ? What is the rationale for changing  $\theta$ ? Do the authors have any data showing variable  $\theta$  for the dry and wet season? What about  $Ds0$ : I would rather expect a change in the sensitivity of stomatal conductance to VPD when soil moisture decrease. Do the authors see such trend in the data? The authors need to better argue for the modification they propose.

5) The authors present the different dataset (Table 2) used to constrain the parameters of the model. The paragraph 2.3 intends to give an overview of the equations and parameters that have been calibrated or tested, but the following paragraphs 3.1 to 3.6 give the impression that more parameters and equations have been calibrated and/or tested. This is confusing and a synthesis table is needed with the parameters that have been calibrated or tested, with their "recommended" value, their calibrated value (and ideally their range found in the literature), and the dataset(s) used for calibration.

6) It is not clear if the evaluation of the photosynthesis and stomatal conductance models (paragraph 3.6) was done using calculated vertical gradient of QPAR or using chamber measurement of QPAR? In addition, the evaluation of the photosynthesis model was not done independently of Eq.(2) describing the vertical profile of  $V_{cmax}$  as a function of the vertical distribution of leaf area. Why the authors didn't use measured  $V_{cmax}$ ?

7) One of the weaknesses of the model is its treatment of the respiration fluxes. Soil respiration contributes for a great proportion of total ecosystem respiration. However its calculation is oversimplified and the data used to calibrate the Arrhenius function are rather limited, extending only for 2 months during the dry to wet season (no data during

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April-May, wet-to-dry transition). Was decomposition of coarse woody debris included in soil respiration measurements, and thus included in the soil respiration model? This carbon pool can be important in Amazon rain forest. In addition, the calculation of leaf respiration is oversimplified ( $R_d$  is a fixed proportion of  $V_{cmax}$ ) and stem respiration is not taken into account. No sensitivity analyses were made for  $H_{soil}$  and  $R_d$ . I agree that the inadequacy of leaf respiration calculation ( $R_d$  is a fixed proportion of  $V_{cmax}$ ) may explain the low sensitivity of NEE fluxes to changes in  $V_{cmax0hc}$  (page 353, line 10), which is not realistic. This is probably linked to the balance between the parameterization of  $R_d$  and  $J_{max}$  in association to the fact that photosynthesis is probably mostly light limited in the lower part of the canopy.

#### Technical questions and corrections

- 1) page 336, line 16: "...to study some feedbacks..."
- 2) page 338, lines 10, 15, 18, 19: confusion arises by giving different names for the same site (Rondonia = Jaru, and Manaus = Cuieiras).
- 3) page 339, line 7: please refer directly to the list of symbols in page 363. Make sure that ALL the symbols are defined in the list of symbols; which is not the case presently.
- 4) page 339, line 15-16: "The relationship to derive QPAR...,": from what?
- 5) page 340, line 19: how many layers?
- 6) page 340, line 24: the appendixes should probably be numbered from 1 to 4?
- 7) page 341, line 10 (and Table 3):  $C_{ref}$  is needed too.
- 8) page 342. line 24: see also important work from Ulo Niinemets.
- 9) page 344, line 4: which ecological database? How do you estimate  $V_{cmax0hc}$  from nitrogen availability?
- 10) page 343, equation 3: which parameters are fitted?

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11) page 343, equation 4, 5, 6: is there any parameters in these equations that are actually calibrated? or these equations are just tested? Please clarify 1/ which equations are tested, 2/ which parameters are tested or calibrated, 3/ which dataset is used for each equation, process or parameter. A synthesis table is needed.

12) page 343, equation 6:  $Q_v0$  instead of  $Q_v$ ?

13) page 343, line 6: clarify how did you derived bulk soil surface conductance?

14) page 345, line 3: why you didn't use measurements made at the site?

15) page 345, line 6: why you didn't use measurements of  $h_c$  made at the site? Why and how is it estimated?

16) page 345, line 12: how did you estimate WB, WT, and zB? How did you "optimize"  $a_{i1}$  and  $a_{i2}$ ?

17) page 345, line 26: how did you derive these parameters? Is there no graph showing observations vs predictions?

18) page 346, line 4: could you give  $y = f(x)$  and the number of observations?

19) page 346, line 16: how did you calculate the relative error?

20) page 374, line 4: refer to table 5 for recommended value.

21) page 348, line 3: what is the  $r^2$  of this log-fit?

22) page 349, line 22: why do you give a range for Q10? by the way, this range is pretty large.

23) page 350, line 11: cite references for recommended values?

24) page 350, line 22 and Figure 12: this figure is a little bit confusing. From the figure it is not clear if  $\alpha$  is lower than the recommended value. Why not showing An measured vs  $Q_{abs}$ , with 2 lines showing the predictions with and without optimization of the parameters (for standard conditions)?

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25) page 350, line 27: what is the rationale for changing the optimal temperature of  $J_{max}$ ? Do you have any data to support this? You could actually modify a lot of different leaf gas exchange parameters and come with the same results (improved fit). You need to better argue for the modification you propose.

26) page 351, line 1: the offset of which relationship?

27) page 351, line 23: why the model parameters have not been optimized?

28) page 352, line 9-14: what is the rationale for changing  $a_A$  for the wet season, and other parameters ( $\alpha$  and  $\theta$ ) for the dry season? Why not only  $a_A$ ? What is the rationale for changing  $\theta$ ? Do you have any data showing variable  $\theta$  for the dry and wet season? What about  $D_{s0}$ : I would rather expect a change in the sensitivity of stomatal conductance to VPD when soil moisture decrease. Do you see this trend in the data? You need to better argue for the modification you propose.

29) page 353, line 2: what is net assimilation here? NEE or GPP?

30) page 356, line 6, eq. 7: what is  $m$ ?

#### Tables and figures

Some figures (for example Figures 4, 5b, 8, 9, 10, 13) are really too small to be easily readable.

$C_i$ ,  $R_s$ ,  $R_{soil}$ ,  $SH_{,i}$  (...) in Fig. 1 are not explained in the legend and not defined in the list of symbols.  $QLW_0$ ,  $QPAR_0$ ,  $g_{soilH}$  in Table 2 are not defined in the list of symbols. Make sure that ALL the symbols are defined in the list of symbols.

Table 1 and 2: be consistent with site names.

Table 2 and following: refer to the list of symbols.

Table 3: what about  $C_{ref}$ ?

Table 6: give LAI values for dense-open.  $a_A$  is not a correlation coefficient.

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Table 7: what are the sources for the parameter values if not marked or bracketed. Bracket values for HvJ and Sj are not explained in Sect 2.2.

Fig. 1: some symbols are defined, neither in the legend nor in the list of symbols.

Fig 6: what is m?

Fig 8b: what is the r2?

Fig 10: change Okt for Oct.

Fig 13a: this figure is confusing. Please clarify which lines are for L95 and B87.

Fig 13b and c: gives  $y=f(x)$  and r2 for the different parameterization.

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Interactive comment on Biogeosciences Discussions, 2, 333, 2005.

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