

Interactive comment on “Soil respiration compartments on an aging managed heathland: can model selection procedures contribute to our understanding of ecosystem processes?” by G. R. Kopittke et al.

Anonymous Referee #3

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General Comments

The authors present a procedure (including model selection method and model outputs integration) to estimate the age impact on annual soil respiration in heathland. Some soil CO₂ efflux, NEE and ecosystem respiration measurements have been performed rigorously on trenched and untrenched plots. The corrections due to the trench effect have been correctly taken into account. The experimental part of the study is well described. In the modelling part, the models tested were simple equations with variables corresponding to available data. Consequently, (i) they don't include any re-

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relationships more “processes based” and representing the processes involved in the CO₂ production (e.g. temperature dependence with energy of activation,...); (ii) the variables involved could be slightly different from potential drivers of Rs, Rh or Ra (for example in this study soil water content is measured in the mineral layer when the main water storage zone influencing respiration located in organic layer; pg 16272 L 9-11). When models are chosen before the design and set up of the experimental device, the variables represented in the selected models can be measured or determined with a higher accuracy. All this makes the simplest model to be the more representative of the data and it is unable to reproduce some situations depending of variable non taken into account in the selection procedure (high soil CO₂ efflux on 21 March 2012 with, apparently, dependence to active microbial biomass). In addition some Rs parameterisations chosen give apparently Rs dependence in opposition with some well known behaviour (see specific comments Pg 16526, L 2-Table 3). The way to select the “best” model is questionable, some criterion being more adapted that the RMSE, like the Nash criterion (Nash and Sutcliffe, 1970), to estimate the goodness of a model outputs comparing to a data set. In this selection procedure, it seems that two models are identical (Selsted-T and GLMM-T, pg 16289) but give very different RMSE results for the calibration (Fig. 8) This decreases the credibility of the model selection procedure. The main important conclusion of the study is the age effect on the annual carbon exchanges in heathland. For the total and autotrophic respiration fluxes (Rs and Ra), this effect is established from data and figure (Fig. 11) without any representation of the uncertainties. Without proof of a significant difference between the Rs or Ra values presented, it is very imprudent to conclude to age impact. The main uncertainty due to the one on the model parameters determination (R_0 and k in $R=R_0 \exp[k \cdot T_{soil}]$) should be at least proposed. The same remarks could be made for the percentage given for the ratio Ra/Rs. Specific Comments P 16242, L 6-9: Carbone in live roots is a pool of soil C (could be large in forest). The fact is that Rh and Ra can have very different dependence to biotic and/or abiotic factors and each of them has to be estimated separately for long term P 16242, L 17: “Once field data has been

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collected, the interpretation of the RS, RA and RH data has generally been undertaken through a comparative analysis and discussion of the original observations". Could you clarify? P 16243, L 10-11: "measures of fit for the calibration data" Do you mean parameter representing goodness of the regression? P 16246, L 24-25: Why Untrenched Validation plots are located only in Old vegetation and not spread over the three age communities? Can this impact the validation? P 16249, L 3: "A loess smoother curve". Could you clarify? P 16251, L 23- P 16252, L 3: Indicate here that this CO₂ fluxes event is linked to a special meteorological episode (freeze followed by thaw). Could this kind of extreme events be more frequent in the future in your heathland location? If yes, it becomes important to be able to reproduce it in the model (see general comments). There is agreement on the fact that impact of extreme events will become as important as long term drift (see Carbo-Extrem program founded by the FP5 of the European Community). Your choice is clearly to study only the influence of "uniform" climatic change. This should be taken into account with better emphasis in your discussion and conclusion (and especially they have to be more cautious). P 16252, L 10: How do you "identify" an effect before t tests? P 16252, L 26: Is not clear for which plots and communities measured or modeled values of soil moisture are used in the model calibration and validation. If measured data exist is preferable to use them in the calibration-validation process otherwise your introduce additional uncertainty due to your hydrological model (determination of the parameters,...). Model values should only be used when measurements are missing. Pg 16526, L 2-Table 3 : There is a problem with some functions like $R_s = R_0 + kT + a(M - 1)^2$ with R_s decreasing when M (=SWC/SWC at field capacity) rises toward one, so when SWC increased. It's in opposition with what is usually observed during drought (R_s decrease with SWC) Pg 16256, L 6: PFD can be used as substitute for P (Photosynthesis) but not for T_{soil} which is not often correlated to PFD Pg 16258, L 9-10: Are total respiration in Middle and Old communities significantly different from zero in spring? (and in autumn or winter)? Pg 16260, L 17: What means significant for a model parameter? Could you clarify? Section 3.4-3.5-3.6: Make a table giving the RMSE (for calibration and validation) and

including only the models and variables set for which the parameters are significant. Then, reduce drastically the sections 3.4, 3.5 and 3.6. Don't need to speak about the no significant parameter cases. Pg 16264, L 20-25: An estimation of the uncertainty on the percentage and annual values presented should be given (see General Comments). Pg 16264, L 20-25: What is the annual carbon loss estimates for the Middle age community? Pg 16265, L 11-13: Which the parameter set (Young, Middle or Old community) has been used to obtain 350 gC m⁻² yr⁻¹? What's represent the 322 gC m⁻² yr⁻¹? Pg 16266, L 20-29: Could be suppressed Pg 16267, L 9-10: Have you some LAI data to support this argument? Pg 16267, L 20: "the ratio of moss biomasses and the ratio of photosynthetic rates". This data should be presented in the Results section Pg 16267, L 20 - Pg 16267, L7: The authors pretend that this CO₂ emission peak as no impact on annual value (reason why this data was deleted from the calibration data set), but which peak duration have been chosen to draw this conclusion? How long are the periods between the 21 March 2012 (peak date) and the date of the preceding and following measurements? If peak is as long as these periods added (worst case, unrealistic but what is the real period?), is it impacting the annual C loss? Pg 16271, L 20-25: Repetition could be suppressed. Pg 16272, L 9-11: Could you use your water bucket model to estimate the soil moisture content in the organic layer? Pg 16276, L 19-20: How do you pass from soil respiration annual estimates to total C exchange for the ecosystem? Reference Nash, J.E., Sutcliffe, J.V., 1970. River flow forecasting through conceptual models part I: A discussion of principles. Journal of Hydrology 10, 282–290.

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