

## ***Interactive comment on “Modelling soil organic carbon stocks in global change scenarios: a CarboSOIL application” by M. Muñoz-Rojas et al.***

**Anonymous Referee #2**

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The BG Discussions paper by Muñoz-Rojas et al. aims at modeling the impact of climate change on soil organic carbon stocks in a Mediterranean context (Andalusia, south Spain), using the empirical model CarboSOIL. The model was run for 3 scenarios of climate change, simulated by 4 different global climate models. The results show a general decrease in SOC stocks in soils up to 50 cm depth under climate change, and an increase of SOC stocks in the 50-to-75-cm soil layer.

The topic of this study fits the scope of Biogeosciences. This work contributes to quantification of global change impact on SOC stocks in areas where SOC content and soil degradation are critical environmental issues. But this manuscript still needs work to be suitable for publication in Biogeosciences. I have a several general comments and specific comments which could help to improve the manuscript.

C3766

### **GENERAL COMMENTS**

The main shortcoming is that the description of the model and of the underlying hypotheses is not done properly in the materials and methods section.

– It may be useful at least to clearly mention at the beginning of the section “model description” that the model used is an empirical one, based on regression and correlations techniques.

– I feel that the hypothesis is that the spatial variability in SOC stocks currently observed in Andalucía is partly related to the spatial variability of climate (temperature and precipitation) in this region. It is thus possible to infer a model of SOC dependence to climate variables (and other additional variables) from a spatial dataset, and this model can be used to predict the response SOC stocks to climate evolution. The validity of this hypothesis and the relevance of the datasets need to be discussed in the last section of the paper: is the range of climate variability observed across the region consistent with the range of variation predicted in climate change scenarios? Are their spatial covariations of soil, climate, land use in the input dataset which could be limiting for modeling the impact of climate change?

–The validity domain of the model and its genericity have to be specified.

Additionally I wonder about the contrasting predictions of SOC stocks evolution in the 50-to-75-cm soil layer as compared to the rest of the soil profile and I feel this issue should be better discussed regarding model construction and the data used for its calibration.

### **SPECIFIC COMMENTS**

Abstract: Please clarify the status of the Valencia data set in the paper and specify that CarboSOIL is an empirical model.

p. 11001 l.8: What do you mean by “specific for certain agricultural management”. RothC has been used and evaluated in a range of contexts.

C3767

p. 11002 l. 11-28: What does the CarboSOIL model stand for exactly? Does it refer to the set of regression models? This is not clear to me whether the equations and parameters of the submodels are specific to each context. What is the genericity of the model?

p.11002 l.14-15: What about the consistency of the prediction of SOC stocks in the different soil layers of a soil profile? Is there any procedure used in the modeling approach to ensure it? between the different soil layers? between CarboSOILTOTAL and the sum of the predictions of the other models? Is CarboSOILTOTAL useful?

p. 11002 l.20-27: I do not understand if calibration and validation are part of this work. If not, the different statistical techniques tested during model development should not be mentioned here; only the final model used should be appropriately described. Similarly, Valencia dataset should not be mentioned in the materials and methods section nor on the location map (Figure 1). If yes, the model chosen should be described in the Results section rather than in the Material and Methods section.

p. 11003 l. 27-28: Please give more information about the spatializing process: how did you manage input data with different spatial resolutions? What is the resolution of the output SOC stock map?

p. 11005 l. 9: What does “type of fluvial network” refer to? Please explain.

p. 11008 l.1: I suggest changing the title of section 2.7 for “CarboSOIL model evaluation” since no validation methods nor sensitivity analysis strictly speaking, are developed in this work.

p. 11010 l.8-13: The percentage change must also be weighed against the initial stock: Arenosols, Solonchaks and Planosols must also have low levels of initial C. Similarly, the initial content must be taken into account when you compare relative SOC stocks evolution in the different soil layers and in the different land use classes.

p. 11011 and 11012: In this section, you list the models used to simulate climate

C3768

change implications on SOC stocks. A stronger analysis of the advantages and drawbacks of empirical models compared to process-based models should be provided here. In particular, their ability to predict changes in SOC stocks in deep soil layers, whereas processes are different from those involved in the surface layers (priming effect) and SOC transfers are not simulated, should be discussed.

p. 11013 l. 17-20: According to Table 2, the parameter related to precipitation is null for all models except CarboSOILTOTAL. Change in precipitation should not have any impact on SOC stocks in the 0-to-25-cm soil layer in Figure 3. Decrease in SOC stocks in the surface layer and increase in SOC stock in the deep layer cannot be explained by the decrease in annual precipitation. Please elaborate.

p. 11013 l. 20-24: Are the input variables “type of fluvial network” and “active soil erosion processes” modified in the climate change scenarios?

p. 11014 l. 19-20: Erosion processes and growth in depth of the vegetation roots are not modeled with CarboSOIL. Overall the components of climate change, which could explain the contrasting evolution of SOC in surface and deep soil layers, are not clearly analyzed in the discussion. Please clarify.

Figure 1: The scale is missing.

Figure 2: This figure is useless; it should be removed.

Figure 4: Is it possible to standardize the scale on the Y axis, to help the reader analyze changes in SOC stocks.

Figure 5: Please change <8 for <-8

Table 5: This table is redundant with Figure 6.

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C3769