Referee 2

General comments

The manuscript aims to understand how environmental and management factors affect SOC in mountain grasslands. And fitted a set of models with explicative purposes using data that comprise a wide range of environmental and management conditions to find the most important driver of grassland SOC. The authors are to be commended on the framing of an interesting study, the collection of a reasonable set of ancillary environment and management data and soil data in what appears to be good quality piece of research. The workload of this article is very huge.

However, too many sections and repetitive statements in this article. Be better structured and more concise to attract readers.

Please, see our answers to referee 1 about the modifications in the text structure.

Deep discussion and comparison of your work is needed in an international context. In discussion section, some discussion on the mechanism of environmental and management factors should be added.

We would really appreciate it if you could specify more about which mechanisms need more discussion. Referee 1 found that discussion section was “overall, well supported by relevant references and the limits are underlined”. We recon you have a point concerning biochemical or management species effects on SOC: the mechanisms are not widely explained but, as we explain in the text, that is a difficult task since there are few publications addressing these issues. We revised the published works from this manuscript was sent to Biogeosciences until now and, under our view, no remarkable novelties have appeared in these topics. We would appreciate it if suggestions about ideas or publications we could omit were made in order to improve the manuscript.

I suggest you add a conclusion section, a concise and clear conclusion will make your article more eye-catching and let readers understand the conclusion of this article more quickly and easily.

We separated the conclusions from the discussion section, and we changed that paragraph to make it as much clear and concise as possible, focusing on the main contributions of our manuscript to scientific knowledge.

As the manuscript contains some uncertainties in description of the methods, results, and English writing, I suggest a moderate revision necessary before it can be acceptable for publication in this journal.

We corrected the uncertainties in the text. The specific comments of both reviewers were really helpful and we really appreciate them.

Specific comments

Line 75 “Soil organic carbon plays key roles in the terrestrial ecosystems.” It sounds strange.

We rephrased this sentence as follows:

“Soil organic carbon (SOC) is crucial in the functioning of terrestrial ecosystems.” (L 77)

Line 179 At least one to two replicates of each patch type were sampled. What are the types of the patch?

To clarify this point, we rephrase this sentence as follows:

“Grassland patches were then listed by type and arranged within each list randomly to determine sampling priority. At least one to two replicates of each patch type defined by the stratification variables were sampled.” (L 191 - 193)

Line 155 Not clear sampling design description. Showing a figure with sampling design would be helpful. Add a schematic of experimental design to make it clearer.

We added figure S2, which illustrates sampling design.

Line 192 The abbreviation for soil organic carbon had appeared in line 75, here only need to write SOC.

Change done. (L 206)

Line 193 There are 30 variables written in table S1, but here you have written 29 independent environmental variables. Are the two management variables belong to environmental variables? Please check these numbers.

Change done. (L 207)

Line 194 These variables were grouped into Regional, landscape, livestock management,

soil nutrient stocks, and herbage variables? If so, replace “:” with “,”.

Change done. (L 208)

Line 201 MTS?

M-T. Sebastià. We changed this to make it clear. (L 2015)

Line 220 Here used livestock stocking rates which measured as livestock units ha-1 to determine grazing intensity. But the feed intake of different types of livestock is different. For example, the intake of cattle is higher than that of sheep. So, can’t simply use the livestock units/ha-1 as livestock stocking rates, you need use standard livestock unit.

We used a standard transformation index where 8 small ruminants correspond to 1 big ruminant. This is standard and provided by the Catalan Government for the region.

Line 314 Geophysical model based on geophysical predictors and grazing management? There haven't grazing management in Figure S4.

Now figure S4 has grazing management.

Line 371 Authors need to better describe statistics of SOC.

We add some information about the statistics of SOC. However, we do not know what more to add apart of basic descriptive statistics we already show. We will really appreciate it if you could specify what statistics you miss in this part of the text. (L 407 - 410)

Line 375 Generally, a part of the sample is used for modeling, and the other part is used for validation. Please describe clearly in here and in Line 279.

Concerning the line 375 (now 412) (BRT model) we did not validate the whole model with a fraction of the dataset, because our BTR model was fitted by cross validation (CV; it is used to select the number of trees with the best performance). Note that according to Elith et al. (2008), results of this cross validation procedure are often very similar to those obtained with independent datasets. Additionally, note that each tree was actually fitted with 66% of the data (out of the bag fraction parameter), so our procedure properly dealt with stochasticity too. All these are standard methods explained by Elith et al. (2008), so we prefer just to refer to this publication instead of extending our methods section, and to focusing on other parts of the statistical procedure that need to be clearer as possible. However, if you think that some of the standard aspects of the BRT procedure deserves to be explained in our manuscript, we will follow your advice.

We detailed the herbage-bromatological analysis (L 279 (Now 291) and so on). 130 samples where used for the validation of NIRS equations.

Line 379 Silt in here, loam in fig.2. Use consistent terminology of silt, loam, etc? Use one, Please!

Change done. Silt is now the only name used.

Line 382 Why TSIS was the most relevant selected climate predictor? In figure 6s, Soil C/N has a higher relative importance.

TSIS was the most relevant of the climate predictors (without considering other variable types). To clarify this point, we rephrased this sentence as follows:

"TSIS was the most relevant of the considered climate drivers." (L 419)

Line 383 Please confirm this sentence and the quoted figure. I didn't find TSIS in figure S5 and S6. In table s1, TSIS described as MST-MAT. In figure s8, MMT also described as MST-MAT Use consistent terminology of MMT, TSIS, etc? Use one, Please!

Change done. MMT is a previous nomenclature. TSIS is the proper one.

Line 381 Aboveground biomass and silt had a high relative contribution in the final BRT model obtained, why not selected them in the linear models?

This was also true for soil K and silt. This point was discussed in the "Considerations about the modelling procedure" subsection inside the discussion section. "However, BTR model provided some valuable information, as identified some SOC drivers eliminated in the GML procedure, like aboveground biomass or soil silt and K (Fig. 2 and S8), probably masked by the effects of other variables in our linear models (Yang et al., 2009). These factors presumably were paths through which other variables drove SOC (de Vries et al., 2012), and they should be considered as potential SOC drivers in further studies." (L 463)

Basically, as multiple predictor variables can not only be correlated but also have true cause-effect relationships between them (i.e. precipitation and aboveground biomass), what means that in a linear model, some drivers could be discarded not because they have no effects on the response variable, but because their effects were already included in other variable. In other words, some variables, like aboveground biomass, soil K or silt were not included in the linear models probably because they were correlated with other drivers which were included in the models. The advantage of including BTR analysis is that we could detect some of these variables. There is more about BTR models in some answers to referee 1.

Line 1121 Please add the fitting equation in figure 3 and 4. It is hard to distinguish which trend line belongs to which grazing species or grazing intensity. You can distinguish by color, or add the legend.

We changed all the plots to the main document to color plots, so lines and dots are more distinguishable than before. We also added the sentence "The estimates on Table 2-3 were those used to elaborate these plots." so the equation values can be easily found.

Line 25 in SUPPLEMENT Figure S1: points indicate sampling location, sampling location means the sample patches? Please add the legend of the points in this figure.

As we explained in the methods section, each sampling patch contains a sampling location, located in the middle of the grassland patch. Sampling location were added in the legend of this figure. As you suggested in some lines above, we added the figure S2 to clarify the sampling design, and the legend of the points in Fig. S1.

Line 39 in SUPPLEMENT There is no reference of Figure S3 in the text.

We added the reference in the "general linear models" subsection, in the material and methods section:

"We designed and executed a modelling procedure based on general linear models (Legendre and Legendre, 1998) and a hierarchy of controls over function (Diaz et al., 2007; de Vries et al., 2012). We log-

transformed SOC using natural logarithm to prevent a breach of the normality assumption by the residuals of the models (Fig. S4).” (L 343; Fig. S3 is now S4)