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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "New experimental diagnostics in combustion of forest fuels: Microscale appreciation for a Macroscale approach" *by* Dominique Cancellieri et al.

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1. Major comments

(1) The shape of the fuel sample, as well as its "biological structure", will significantly influence its thermal degradation. Two samples with different number of twigs will burn differently. What was the exact procedure of selecting samples for field experiments, what was the number of twigs and leaves? This also will effect TGA results. As the sample was 5 mg, did it contain only crushed leaves, or twigs as well? If yes, what was the proportion? All of this must have significant effect on the thermal degradation of samples. Full description of the sample preparation procedure should be added to

Section 2.

Reply: We do agree with the reviewer, this part of the manuscript need more details on the sampling process. Some authors have demonstrated that only small particles (< 6mm) are considered in governing the dynamic of fire spread (Burrows, 2001; Morvan and Dupuy, 2004). According to this observation we have decided to sample the foliage and aerial parts of each species. So the proportion of leaves and twigs vary for each specie with a close ratio, around 50% of leaves, for heather and rockrose due to their similar structure. Conversely, the pine is mainly composed by needles for around 75% compared to twigs. To highlight the different structure of specie a picture of each specie (fig. 1) has been inserted in the revised paper.

After the selection of samples, they were brought to the laboratory, washed with deionized water and oven-dried for 12 hours at 333K.

After these preparation stages, we can separate the sampling in 2 cases: - For field experiments, the aim was to keep conditions encountered during of wildand fire, so we have used an intact branch of dried plant. For each specie, only one branch is directly placed on the prototype tube.

- For TGA experiments, dried samples were grounded and sieved to pass through a 100μm mesh, then kept to the desiccator. The sieved powdery sample was stored in airtight plastic containers for future use.

All these informations have been added in the manuscript

(2) Also, after reading the paper it is not clear to me if only one field experiment or several were conducted as all the results are presented as a single measurement. There are no confidence levels and comparison of repetitions.

Reply: For each type of experiment (field and TGA), the tests have been repeated 3 times. For TGA, records exhibit an excellent reproducibility higher than 99.7%. For field experiment, the confidence level is lower than 16%. According to the reviewer

comments, a figure (fig. 7) presenting 3 field experiments and their average has been added into the revised manuscript.

(3) The authors should add more analysis and discussion to the results. Why wasn't the difference of MLR between the experiment and the simulation for pine significant compared to other species? Why MLR of pine two times slower than those of Rockrose and Heather? What is the difference between the obtained kinetic parameters and those found in the literature with regard to multi-scale approach?

Reply: 2 main parameters could be attributed to the different of MLR. First of all, as mentioned by the reviewer, the chemical composition of the species influence the thermal degradation. Secondly, this work highlight the important role of the structure of plant. Indeed, the pine exhibit a very different thermal behavior since it is mainly composed by needles. In order to focus on the influence of these parameters on the thermal behavior of plants, we have added a radar chart (fig. 11) correlating the mass-loss rate to chemical and structural parameters.

(4) The authors should highlight throughout the paper that the obtained results are applicable for surface fires. More intense fires will give different heating and mass loss rates and can result in a mismatch between experimental and simulation results. It would also be worthwhile escribing limitations of their approach.

Reply: In the field conditions experimented in this work, we think that the gap between TGA and field experiments is enough important. This work demonstrates that despite the various change of sample: mass (5 mg vs. 20g), structural form (pulverized vs. intact branch) and in experimental conditions especially the heating rates (30 K/min vs. 10 K/s) the kinetic model obtained at micro-scale can predict in a main way the thermal degradation of wildland fuel. This approach is only focused on thermal degradation of solid fuel, we don't take into account gaseous emission or heat transfer. Moreover, in order to obtain reproducible experimental conditions, we have used a fuel bed composed by Excelsior, further tests should be performed using shrubs as fuel bed.

3. Minor comments

(1) The abstract needs to be rewritten. Specific results and conclusions should be added.

Reply: The abstract has been rewritten.

(2) Section 2.1. A picture of samples needs to be added

Reply: As mentioned previously, a picture highlighting the different structure of samples has been added (figure 1).

(3) It's better to move Fig.1 to the beginning of section 2.3.1

Reply: As recommended, the figure 1 has been moved.

(4) Page 4, lines 21-23. It is not clear where the thermocouples were located, at the end of the tube or mid-height of the fuel brunch?

Reply: There are 2 tubes very close. One allow to place the plant, the other accommodate a thermocouple. Each tube allow an adjustment of elements in height. Thus, it is ensured that the thermocouple is positioned at mid-height of the branch. This part of the text has been rewritten.

(5) There is no reference to Fig. 3 in the text.

Reply: The figure is now cited in the text.

(6) Page 6, line 16. Temperature units need to be changed to K.

Reply: This mistake has been corrected.

(7) Figure 4. Axis ticks are needed on temperature axis. It is also hard to see them on other axes.

Reply: Axis ticks have been added and the thickness of axis has been increased for a better visualization of the graphics.

(8) Figure 5, Table 1-3. It would be worthwhile adding confidence levels.

Reply: As suggest by the reviewer, confidence levels have added in the table 1.

(9) I would recommend merging Fig. 5 and 6.

Reply: We have tried to merge these 2 figures but the rendering is not clear, we think that it is better to let the 2 figures separate for more visibility. If the reviewer wishes we can merge the 2 elements of each figure namely the temperature and the mass-loss but for a single specie and we can propose 3 small graphs as we did for the figure 5. However this disposition does not facilitate the comparisons between species.

(10) Table 3. A column with relative or absolute errors needs to be added.

Reply: The relative errors calculated from experimental results have be added in the table.

The new figures and the revised text have been joined to the answers to the reviewer n°1

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