Experimental investigation on the burning of shrubs

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Abstract
This study aims to improve the knowledge on the combustion of Maquis shrubland for providing scientific bases for landscape management. The combustion dynamics of natural and isolated shrub was investigated. A typical shrub of Mediterranean vegetation, rockrose (cistus monspeliensis), was considered. This work was conducted in two steps. A structural characterization of shrubs of rockrose was firstly performed. The masses of the different class of particles composing the shrub, classified by range of thickness, were determined. Attention was paid to the composition of the crown and particularly to the thin particles (leaves, 0-2 mm diameter, more than 2 mm of diameter), which participate the most in the combustion process. The average mass distribution of these classes of particles along the height as well as their mass proportion in the crown were obtained. Then, the combustion dynamics of shrubs of rockrose was studied experimentally. Fire experiments were carried out with a Large Scale Heat Release apparatus which allows the measurement of the Heat Release Rate based on oxygen consumption principle. Two sets of two radiant panels were used to preheat and perform the ignition of the vegetation. The combustion study was based on the flammability criteria previously defined in the literature. The four criteria composing the flammability (ignitability, sustainability, combustibility and consumability) and their associated measurable parameters were investigated distinctively. New measurable parameters were proposed to study the combustibility and consumability. The study highlighted the influence of the moisture content and the ignition position on the parameters associated to the four criteria. Finally, the flammability was investigated as the combination of these criteria. A principal component statistical analysis was performed that revealed the relationships between the studied parameters. This analysis highlighted the presence of four flammability regimes depending on the position of ignition, time to ignition and the proportion of the thin particles within the crown.

Keywords: Wildland fire, calorimetry, flammability, vegetation characterization

1. Introduction
Different landscape managements are set-up to reduce the intensity and the impact of wildland fires. The treatment of these vegetation areas is based on the reduction of the amount of fuel at the ground level. However, the related practices are mainly performed from empirical knowledge and a quantitative approach relying on physical quantities is required by managers. Some experimental (Morvan and Dupuy 2004; Cruz et al. 2011) and numerical works have been devoted to the understanding of the combustion of shrubland but there remains a lack in measurement of physical quantities like the heat release rate to clearly understand their burning. More particularly the study of the combustion of isolated shrubs was poorly investigated (Tachajapong et al. 2014; Li et al. 2017). The influence of the Moisture content (MC) on the combustion dynamics was observed for Natural Douglas fir (Babrauskas 2006; Mell et al. 2009). A decrease of the effective heat of combustion was observed with an increase of MC. The effects of the ignition method, MC and bulk density on the rate of spread were studied for reconstructed chamise (Tachajapong et al. 2014; Li et al. 2017). An increase