FLAME STRUCTURE MODELING IN FOREST FIRES

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Abstract

The knowledge of flame structure is a key issue when evaluating forest fire behavior for prevention and suppression management. Flame geometry, thermal and flow characteristics are needed as input variables in many sorts of fire studies; i.e. to compute heat transfer mechanisms, crown fire activity, fuel-breaks efficiency, suppression effectiveness, etc. Also, flame structure has to be very well described to validate the new generation of fire behavior CFD-type prediction models that are being developed. This work in progress presentation wants to summarize the work done in flame modeling applied so far to forest fires and to present the on-going efforts at empirical and physical level that CERTEC is devoting to reach in a near future the goals set in this subject. We are distinguishing here two different approaches depending on whether flame modeling is based on spreading fires or on stationary fires.

Flame modeling of spreading fires has been generally performed through semi-empirically or empirically based approaches, particularly when dealing with flame geometry. This has lead to environment dependent flame models, i.e. models restricted to particular fuel complexes and narrow meteorological conditions. In this sense, an extensive collection of experimental data by which these models have been developed and validated has been gathered. A deep exploratory analysis has been performed to detect gaps in terms of fuel and experimental conditions. Following, the models have been evaluated undertaking the corresponding analysis concerning conceptual validity, sensitivity and predictive validation. The final objective of this study is to integrate pre-existing efforts proposing an empirical flame model system with a global scope, i.e. workable in a wide range of fire situations. Results obtained up to now and future steps are presented.

Regarding stationary fires -i.e. fires that represent for instance static or very slow spreading flame fronts or torching fires in isolated fuel clumps-, they have been studied either using empirical or theoretical approaches. Furthermore, CFD numerical simulations have been already shown its great potential to study this type of fires. Some significant contributions have been already done in terms of flame dimensions and thermal characteristics. Here we briefly present our results already obtained through stationary fires experiments -both at laboratory and field scenarios- and we give some bullet points of the idealization phase of a theoretical model that shall be performed in following stages of this work.