



HAL
open science

Wildfires physics and modelling

Dominique Morvan

► **To cite this version:**

Dominique Morvan. Wildfires physics and modelling. Workshop on Mathematics and Wildfires, Department of Mathematics, University of Coimbra, Nov 2018, Coimbra, Portugal. hal-02117972

HAL Id: hal-02117972

<https://hal-amu.archives-ouvertes.fr/hal-02117972>

Submitted on 2 May 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Wildfires physics and modelling

Dominique Morvan

Department of Mechanics
Aix-Marseille Université
60 rue Joliot Curie 13453 Marseille cedex 13, France
e-mail: dominique.morvan@univ-amu.fr

ABSTRACT

The behavior of wildfires is governed by various physical mechanisms, at different scales in space (and time), ranging between less than $1mm$ (the flame) to larger than $100km$ (the plume). Many of these physical mechanisms, such as the decomposition of the vegetation into combustible gas and solid, the chemical reaction inside the flame and its interaction with the atmosphere, are nonlinear, which constitutes an additional difficulty for their predictions using numerical models. For all these reasons, the numerical simulation of wildfires is a high challenging multiscale problem. Despite these difficulties, the resolution of some problems in fire safety engineering such as the propagation of a fire front through a wildland urban interface (WUI), needs to describe a fire at a relative local scale (few hundred meters), with a relatively high level of details. It is in this context, that a new class of fire models, referred in the literature as "fully physical models", has been proposed at the end of 90's [1, 2, 3, 4]. Before developing such kind of models, it is capital to identify all scales (in space and time) associated to the physical mechanisms contributing to the ignition and the propagation of a fire through a vegetation stratum.

To avoid the complete description of the vegetation, impossible task if we consider the fractal nature of the interface between all the elements (leaves twigs ...) constituting a plant, it is represented as an equivalent porous media, characterized by a set of local physical properties such as the density, the volume fraction, the composition. Then the problem is formulated from the balance equations (mass, momentum, energy ...) of the coupled system formed by the vegetation and the surrounding atmosphere. This approach is often referred in the literature as a multiphase formulation.

The objective of this lecture, will be to identify all the physical phenomenon and the associated scales, contributing to the dynamics of a forest fire, followed by a short presentation of what is a fully physical wildfires model and a presentation of some results obtained with this kind of approach.

REFERENCES

- [1] A.M. Grishin, F. Albini (editors), *Mathematical Modelling of Forest Fires and New Methods of Fighting them*, Tomsk State University, Tomsk (1996)
- [2] D. Morvan, J.L. Dupuy, B. Porterie, M. Larini, Multiphase formulation applied to the modeling of fire spread through a forest fuel bed, *Symposium (International) on Combustion*, 28, pp. 2803–2809 (2000)
- [3] R.R. Linn, A transport model for prediction of wildfire behaviour, PhD thesis University of New Mexico, LANL (1997)
- [4] A. Sullivan, Wildland surface fire spread modelling 1990-2007: 1 physical and quasi-physical models, *International Journal of Wildland Fire*, 18, pp. 349–368 (2009)

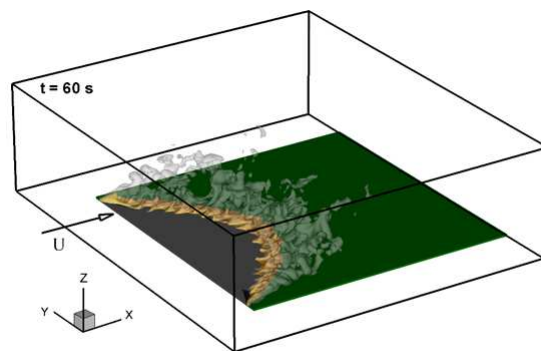


Figure 1: Example of numerical simulation of a surface fire propagating in a grassland (from Frangieh et al Fire Safety Journal 2018, in press)