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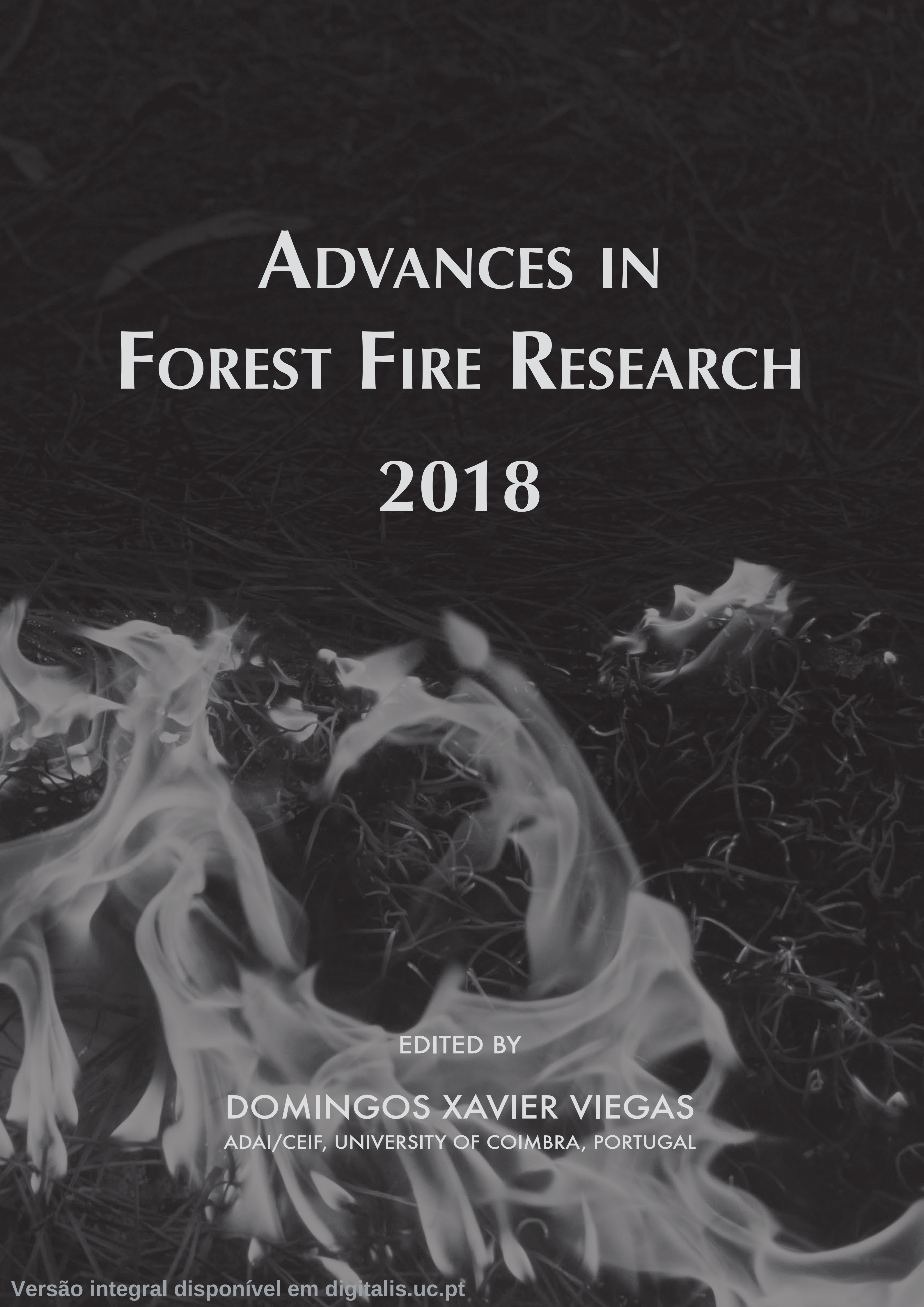

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Concurrent multi-scale physical parametrization of fire-spotting: A study on the role of macro- and meso-scale characteristics of the system

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Abstract

The strong impact of wildfires in terms of lives and homes lost and of damage to ecosystems, calls for an urgent improvement in the risk management. The aim of the present research is the improvement of these software codes by proposing a complete physical characterization of fire-spotting within an approach that is ready to be implemented as a post-processing routine of standard outputs. The main feature of the proposed method is that the effects of random fluctuations are included in a way that preserves the existing structure of the operational and industrial codes and can be implemented directly. The operational code WRF-SFIRE have been used to test the proposed post-processing routine. Results show the suitability of the approach for simulating random effects due to turbulent convection and fire-spotting, which are cases not resolved by standard operational codes. Results of simulations including response analysis with test cases are shown and discussed.

Keywords: Fire-spotting, Simulation, Multi-scale characteristics

1. Introduction

Propagation of a wildfire is a multiscale phenomenon involving processes from the scale of the combustion chemistry to the fire-atmosphere coupling including effects due to the flame geometry (Sullivan, 2017a, 2017b). One of the key aspects of fire propagation is the so-called fire-spotting (Fernandez-Pello, 2017). It occurs when burning embers tear off from the main fuel source and cause new independent ignitions. It accelerates significantly the fire spread causing dangerous consequences and increasing the damage. Moreover, the fire-spotting is a challenging issue in wildfire science due to its unpredictable nature.

Here we study the role for the emergence of fire-spotting phenomena and the ignition of secondary fires of both a macro-scale factor as the atmospheric stability, and of a meso-scale factor as the flame length.

Because of the interactions among scales, we follow a concurrent multiscale modelling that means estimating parameters related to aspects occurring in a very large range of scales and implementing them into the model for the macroscopic fire perimeter, see Figure 1.