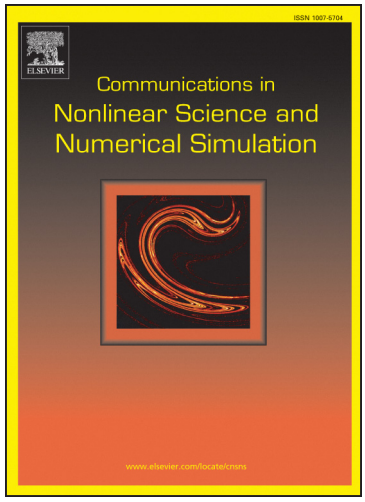

Complexity in Forest Fires: from Simple Experiments to Nonlinear Networked Models

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Complexity in Forest Fires: from Simple Experiments to Nonlinear Networked Models

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Abstract

The evolution of natural phenomena in real environments often involves complex nonlinear interactions. Modeling them implies the characterization of both a map of interactions and a dynamical process, but also of the peculiarity of the space in which the phenomena occur. The model presented in this paper encompasses all these aspects to formalize an innovative methodology to simulate the propagation of forest fires. It is based on a networked multilayer structure, allowing a flexible definition of the spatial properties of the medium and of the dynamical laws regulating fire propagation. The dynamical core of each node in the network is represented by an hyperbolic reaction-diffusion equation in which the intrinsic characteristics of trees ignition are considered. Furthermore, to define the simulation scenarios, an experimental setup in which the propagation of a fire wave in a small-scale medium can been observed has been realized. A number of simulations is then reported to illustrate the wide spectrum of scenarios which can be reproduced by the model.

Keywords: Modeling, Forest fire, Complex systems, Nonlinear systems

1. Introduction

Modeling the dynamical behavior of fire propagation in a forest is a stimulating field of interest. The prediction of fire front direction, speed, and