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PhyFire, an online wildfire simulation tool

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Abstract

In this work we present the wildfire spread tool PhyFire, developed by the research group on Numerical Simulation and Scientific Computation at the University of Salamanca. The PhyFire model is a simplified two-dimensional physical wildfire spread model based on the energy and mass conservation equations, that uses radiation and convection as dominant heat transfer mechanisms, and takes into account some three-dimensional effects. PhyFire is a single-phase model: only the solid phase is considered, the gaseous phase is parameterized through flame temperature and flame height in a non-local radiation term (Asensio et al., 2020). This term allows modelling the radiation from the flame above the fuel layer, enabling it to cope with the effect of wind and slope over the flame tilt. The convective term is critical, as wind is one of the most influential factors in a fire spread. The influence of fuel moisture content and heat absorption by pyrolysis are introduced in the model by means of a multivalued operator representing the enthalpy. The model also allows to simulate random phenomena such as fire-spotting (Asensio et al., 2021). In order to provide a response in a reasonable period of time, the solutions provided by the PhyFire model are approximated by using efficient numerical methods and parallel computation techniques. PhyFire is adapted to data assimilation which allow correcting the uncertainty of a forest fire during the simulation (Ferragut et al., 2015). The PhyFire model is integrated into a GIS environment (Prieto-Herráez et al., 2017) that automates the acquisition and processing of geographic information. In this way, a single environment is available in which the necessary data can be obtained to launch the model, carry out the simulations and show the results, allowing the connection of the mathematical model with the real world. This tool is accessible on a website

(http://sinumcc.usal.es), and can be used to carry out a simulation by providing the simulation area, fire ignition location and meteorological data. The developed tool returns the state of landscape (burning, burned and unburned area) for several time steps. In order to adapt the simulation to real situations, fire suppression tactics can be incorporated by modifying the fuel load and type via GIS.

Keywords: fire behaviour research, wildland fire spread modelling, wildland fire spread simulator

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