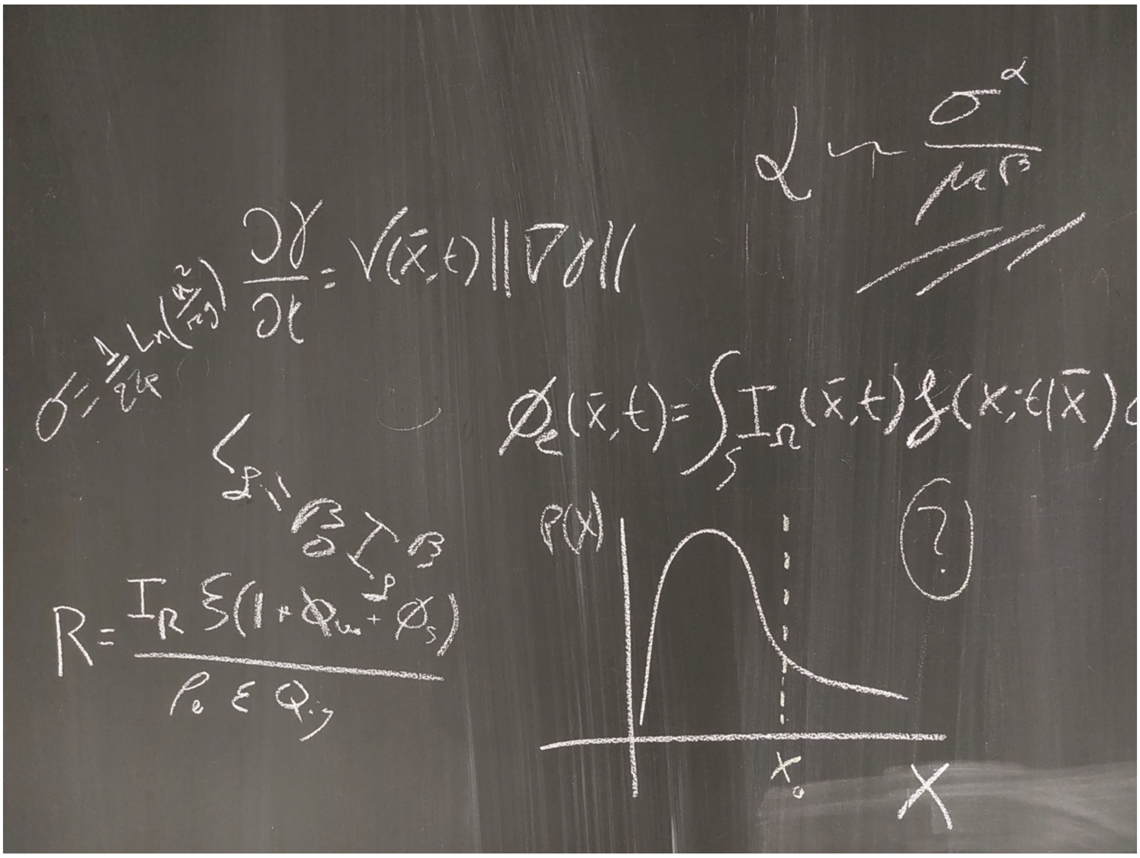
BCAM Workshop on Wildfires:
Mathematical, Physical and Statistical investigations
1-2 December 2022



basque center for applied mathematics

EUSKO JAURLARITZA
GOBIERNO VASCO

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

EXCELENCIA SEVERO OCHOA

BCAM Workshop on Wildfires:
Mathematical, Physical and Statistical investigations
1-2 December 2022

Wildfires are an emergency! And there is no need to stress the high threat that they are at social, ecological and economical level. Actually, our communities cope, year after year, with record-breaking events all over the world and, unfortunately, the Iberic peninsula is among those areas that are more affected by fatalities. Therefore, it is evident the necessity for aiming a definitively enhancement in wildfire understanding and management, from prevention, prediction and protection to political policies.

Wildfires are scientifically concurrent multi-scale phenomena and this multi-scale nature exists also at the management level. The management of fires goes from fire-fighters and volunteers to civil protection agencies passing through operational and supporting services. Thus, highly multidisciplinary expertise is involved.

For what concern the more fundamental mathematical and physical point-of-view, the full set of equations describing wildfire behaviour is known and it is quite long. Actually, from the concurrent multi-scale framework, the system is described by the set of equations concerning the combustion process and the heat release, as well as by the set of equations concerning the heat transfer mechanisms and the interaction with the atmosphere. However, in analogy with the weather system, even if the set of equations for studying wildfire propagation is known it is impossible to solve them. Moreover, the problem is complicated also by the fact that, in general, reduced-scale experiments are unlikely to contribute to an understanding of wildfires mainly because so many processes occur contemporarily during a wildfire event (e.g. buoyancy, convection, radiation, chemical reactions, and wind flow), and spanning over so many ranges of temporal and spatial scales that they cannot scale simultaneously to allow for the derivation of simplified analogues.

This workshop aims to gather researchers involved in studies on theoretical aspects of wildfires science for an advancement in its understanding through mathematical, physical and statistical tools.

As a matter of fact, there is a cultural lesson to be learned on wildfires. It is crucial, in fact, to remind that although wildfires are often perceived as destructive disturbances, but when evolutionary and socioecological factors are integrated, fires in most ecosystems can be understood as natural processes that provide a variety of benefits to humankind. Wildfires generate open habitats that enable the evolution of a diversity of shade-intolerant plants and animals that have long benefited humans. Actually, fire is a force of nature, too, with an important role in evolution and ecology. Fire may be an essential element of the ecosystem, or an unnatural element to be avoided. As an ecological process, fire not only is part of a complex network of interactions that shape ecosystem functioning but also is shaped by management actions and people's perceptions that affect an ecosystem's (in)ability to regulate fire, which in turn shapes the positive or negative impacts of fire on human well-being and how society views fire. Moreover, (wild)fire can be understood as a potential provider of multiple ecosystem services, even if the difficulty in understanding the role of wildfires in providing ecosystem services still persists.

In any case, there is no ”blame game” to be played because fire is part of the Earth system, and human dimensions of fire regimes are embedded in complex ecological, economic, political, technological and social relationships. In fact, fire is part of the history of humankind since ever by pulling in the humankind evolution wildfires together with anthropogenic fires and by changing from opportunistic to intentional use of fire: as documented about Homo erectus, who appeared in Africa about 1.9 million years ago, and was the first to control and use fire. Moreover, by remembering that any myth is the way how people interpreted their lives, finding worth and purposes in their existence, and created civilisation and a cultural identity, since this historical origin, fire passed also through the myth of Prometheus for playing a fundamental role in our society.

Thus, within this cultural context, advancements in understanding wildfires and improvements in their management are key tools for mimicking the ancestral role of wildfires in an increasingly populated world and then only an improved fire-management can help to learn this lesson about fire.

List of Speakers

Paolo Fiorucci (CIMA Research Foundation, IT)
"Integrating key physical aspects in empirical models to support fire risk management"

María Isabel Asensio Sevilla (University of Salamanca, ES)
"The simplified physical fire spread model PhyFire: Model, numerical methods and pathways forward"

Yamina Baara (Université des Sciences et Technologie d'Oran, DZ)
"Modeling forest fires: Statistical physics applied to fire safety"

María José Ginzo Villamayor (University of Santiago de Compostela, ES)
"The intervention of algorithms in forest fires"

Gianni Pagnini (BCAM, ES)
"Probability density function of a random area and its application to wildfires"

Marcos López De Castro (BCAM, ES, contract ending on November 2022)
"*A comparison study of probabilistic fire-spotting models on a CA-based wildfire simulator*"

Vera Egorova (University of Cantabria, ES)
"Integrated Climate-Biome Classification of the fire-spotting generated fires"

Khadij Khellonf (Université des Sciences et de la Technologie d'Oran, DZ)
"Forest fire spread with non-universal critical behavior"

Alberto Tinaburri (Vigili del Fuoco, Corpo Nazionale, IT)
"Regional forest fires database: a tool to support forest fire management and emergency response"

Dominique Morvan (University of Aix-Marseille, F)
"How science can contribute in the understanding of wildfire behaviour"

Theodore M. Giannaros (National Observatory of Athens,
Institute for Environmental Research and Sustainable Development, EL)
"Coupled fire-atmosphere modelling"

Fabio Alaimo Ponziani (Vigili del Fuoco, Corpo Nazionale, IT)
"Water based shields deployment on terrain during wildfire spread: A modelling approach using distributed information through autonomous agents"

Andrea Trucchia (CIMA Research Foundation, IT)
"Wildfire simulation with cellular automata"

Maryam Mirzakhani Seminar Room

	Thursday 1 December	**Friday 2 December**
9:30 10:30	Paolo Fiorucci	Dominique Morvan (zoom)
10:30 11:00	*Coffee Break*	*Coffee Break*
11:00 11:45	María Isabel Asensio Sevilla (zoom)	Theodore M. Giannaros (zoom)
11:45 12:30	Yamina Baara	Fabio Alaimo Ponziani
12:30 13:15	María José Ginzo Villamayor	Andrea Trucchia
13:15 15:00	*Lunch*	*Lunch*
15:00 15:30	Gianni Pagnini	***Closing Round Table*** (15:00 – 16:00)
15:30 16:00	Marcos Lopez	
16:00 16:30	Vera Egorova	
16:30 17:00	*Coffee Break*	
17:00 17:45	Khadij Khelloufi	
17:45 18:30	Alberto Tinaburri	
20:00	*Dinner*	

Integrating key physical aspects in empirical models to support fire risk management

Paolo Fiorucci
CIMA Research Foundation, Italy
paolo.fiorucci@cimafoundation.org

Abstract

The integrated use of modern tools, consisting of mathematical and physical models, Earth Observation data, and Artificial Intelligence procedures, is becoming a game changer in the support to prevention and preparedness for wildfires. Such tools should be an all round ally in all the phases of wildfire management. A support of models and multi-source data is useful before the fire event, from the long term planning (e.g., through hazard mapping), to the early warning systems improvement. During the wildfire events, a decision support system backed up to the support of fire fighting activities. After the fire, Earth Observation data, drones, and models are used for the estimation of burned area and fire severity, to assess the losses and to ultimately support restoration activities. Recent wildfires will be shown as examples of the use of such a modeling chain, connecting forecasters and wildfire scientists to end users, stakeholders and decision makers.

The simplified physical fire spread model PhyFire: Model, numerical methods and pathways forward.

María Isabel Asensio Sevilla
University of Salamanca, ES
mas@usal.es

Abstract

Understanding and predicting the behaviour of a system as complex as a wildfire is an undeniably useful tool for reducing their negative effects. Mathematical modelling and numerical simulation play a fundamental role, and it can ultimately assist in decision-making in preventing and fighting wildfires. The rapid increase in computing power and the advancements in technology allow more complex models to be a real option, so research is focusing on physical-based models. The PhyFire model is framed within the physical-based models. It is a single-phase simplified 2D physical model based on the fundamental physics of combustion and fire spread. It considers convection and radiation as the main heat transfer mechanisms, taking into account the heat lost by natural convection, the effect of the flame tilt caused by wind or slope, the influence of fuel moisture content and fuel type, and some random effects. The resulting Partial Differential Equations (PDEs) are solved using efficient numerical and computational tools to obtain a software with efficiency levels comparable to empirical models, including its own finite element toolbox and parallel computation techniques. The PhyFire model can be coupled with other models: a high definition wind field model (HDWind) and a pollutant dispersion model (PhyNX). The interaction of wind-fire and the evolution of smoke clouds generated by fires are the next pathways forward.

Modeling forest fires: Statistical physics applied to fire safety

Yamina Baara
Université des Sciences et Technologie d'Oran, DZ
baara.yamina@gmail.com

Abstract

Forest fires destroy each year millions of hectares of wildland throughout the world, with disastrous economical, ecological and environmental consequences. This phenomenon repeatedly affects countries that have the most developed technological means (United States, Canada, Australia, southern Europe, etc.). This year Algeria was hit hard, and the authorities had to become aware of the dangerousness of forest fires. The failure to control fires is caused by the complexity of physico-chimical involved in the spread of fire, the porosity distribution of the vegetation and its roughness as well as the topography of the terrain. fire scientists use deterministic methods to deal with fire safety issues despite all of the random aspects. In particular, according to the American standard ASTM 1354, the critical flow estimate for the ignition of materials is the average flow between the minimum for which it ignites and the maximum for which it does not ignite. Our approach for determining the critical flow of inflammation is based on phase transitions. In this part of statistical physics, any physical quantity A follows a universal behavior as a function of the control parameter X near the threshold X_c of the transition:

$$A \propto (X - X_c)^{\pm t} \tag{1}$$

The phase transition concept is used for estimating the critical flow $q"_c$ by a calorimeter cone for the ignition of 3 forest fuels and varying the incident flow. In addition, we found that there is no critical water content for ignition, contrary to the results of the literature. Regarding fire spread, the dynamics of fire front cannot be investigated by the rate of spread because of the dispersion of fire pattern. The fractal analysis may be better used to study the temporal evolution of the fire front width and its pattern's effective dimension. It has been shown to exhibit an anomalous relaxation process before the extinction of the initial fire-line that is well described by a Kohlrausch–Williams–Watts-like relaxation function. The decrease of the fire pattern's dimension corresponds to a transition from a structured fire front induced by the collective effects of burning fuels to a dispersed one caused by their individual effects. This anomalous relaxation indicates the existence of a sub-diffusion process of the spreading fire regardless of the impact length and fuel occupation density.

In collaboration with K Khelloufi and N.Zekri (nouredine.zekri@univ-usto.dz)

The intervention of algorithms in forest fires

María José Ginzo Villamayor
University of Santiago de Compostela, ES
mariajose.ginzo@usc.es

Abstract

In this seminar, ITMATI's experience in different projects related to forest fires since 2013 will be presented. The general objective of these projects is the development of an expert system for the monitoring and management of the resources involved in extinguishing a forest fire and to assist in decision-making by those responsible. To this end, mathematical, statistical and computational algorithms have been developed and will be presented during the seminar, including an algorithm for automatically monitoring the routes taken by aircrafts during their fire extinguishing work, and an algorithm that provides an optimal planning for the aircrafts that will work in extinguishing the fire.

The results of these algorithms contribute to the development of technologies to optimise firefighting efforts and they will make it possible to reduce the area affected, to increase the safety of the brigades, improve coordination in firefighting operations, and to provide optimal planning of the aircraft that will work on extinguishing large forest fires. It will also be possible to reduce the investment, operation and maintenance costs of operations, increasing the coverage and efficiency of the service.

Probability density function of a random area and its application to wildfires

Gianni Pagnini
BCAM, ES
gpagnini@bcamath.org

Abstract

We show that the probability density function (PDF) of a burned area enclosed by a random fire-perimeter is driven by the PDF of the bounding-box sides. In particular, the random value of the area emerges to be proportional to the random position of the bounding-box sides times an averaged coefficient dependent on the geometry of the burned area. Therefore, the two PDFs are functionally equal. This means that the PDF of the burned area is driven and functionally equal to the PDF of the position of the head of the fire. The displacement of the head of the fire is given by the rate of spread (ROS), thus the PDF of the burned area results to be driven and equal to the PDF of the ROS. This result holds in general whenever the fire exhibits an advancement along a main direction. The main theoretical result has been tested by different families of stochastic processes. This study can be understood as a start for the development of a theory of stochastic dynamics of wildfire propagation with the aim, for example, to provide physically-grounded initial perturbations of wildfire perimeters for ensemble forecasting.

A comparison study of probabilistic fire-spotting models on a CA-based wildfire simulator

Marcos López De Castro
BCAM, ES
malopez@bcamath.org

Abstract

Wildfire propagation is a non-linear and multiscale phenomenon in which there are involved multiple physical and chemical processes. One critical mechanism in the spread of wildfires is the so-called fire-spotting: a random phenomenon which occurs when embers are transported over large distances by wind, causing the start of new spotting ignitions which jeopardize firefighting actions. Due to its nature, fire-spotting is usually modeled as a probabilistic process. Three principal processes are involved during the fire-spotting: firebrands' generation, transport and landing, and spot ignition. In this workshop, we will present the physical parametrization of fire-spotting *RandomFront*, developed by the Statistical Physics research group in BCAM. *RandomFront* has been implemented in the operational wildfire spread simulator PROPAGATOR, based on a cellular automata approach. For validation purposes, the laboratory-scale framework is not a suitable setting because of scaling laws. Therefore, we have reproduced the evolution of a real wildfire occurred in Italy, in which the fire-spotting effects played a critical role in it spread, to test how *RandomFront* is able to reproduce wildfires at its natural scale. In addition, we have implemented established fire-spotting empirical parametrizations for cellular automata-based wildfire models to compare the performance between them. The results show that *RandomFront* parametrization, on the one hand reproduces the main spotting effects given by the available literature parametrizations, while, on the other hand, generates a variety of fire-spotting situations as well as long range fluctuations of the burning probability. The physical parametrization allows for complex patterns of fire spreading in this operational simulator context.

Integrated Climate-Biome Classification of the fire-spotting generated fires

Vera Egorova
University of Cantabria, ES
vera.egorova@unican.es

Abstract

In present study we are aimed to provide a simple yet complete addition to operational fire spread models for representing the random behavior of fire-spotting in various climate classes through simple inputs related to the wildfires. Previous results from different test cases highlight the sensitivity of the proposed simple physical parametrization in simulating different scenarios of the generation of secondary fires by fire-spotting under different climatic conditions. Since climate change may cause extreme conditions that contribute to the high fire intensity and larger wildfires, the proposed here parametrization allows us to model the fire-spotting process in various climatic zones and to adjust the existing operational model to the climatic changes. Fire-spotting involves aspects among scales: from the combustion chemistry in microscale, to fire-atmosphere interaction in macroscale. At the meso-scale level, fire-spotting is affected by the mean wind and fireline intensity, which is found to be in a strong interaction with the surrounding factors, such as fuel and local orography. At the macroscopic level, the atmospheric stability conditions impact the fire-spotting pattern. Both, meso- and macro-scale factors are taken into consideration in the proposed probabilistic model devised to provide a physical meaning to the spread of fire by virtue of firebrands, which allows the integration of the diversity of all these parameters into a few differentiable regions. For this purpose, the classification is based on the Köppen-Geiger climate classification, as it is done in the study of complex natural systems in a broad range of topics in hydrology, agriculture, biology, and many others. Previous studies show as well that fire-spotting is a vegetation-dependent phenomena, since not all types of vegetation can generate sufficient combustion energy or produce the firebrands. In order to represent the vegetation component of the fire-spotting generation, the biome world map is incorporated, resulting in the integrated climate-biome classification for the fire-spotting generated fires.

Forest fire spread with non-universal critical behavior

Khadij Khelloufi
Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Ageria
ph_khadij@hotmail.fr

Abstract

Recently, forest fires have taken the attention of scientific researchers due to their increase and their enormous material, human and even economic damage. This phenomenon threatens billions of forest and natural terrestrial resources. It severely destroys the forests and the natural resources of safeguard (no future generation) as well as the soils by the disappearance of the humus and the essential organic matter. Understanding this mechanism and predicting fire spread is mainly established by modeling; An extension of the original Small World Network model [Nature 393 (1998)] introduced by N.Zekri (Phys.Rev 2005) adapted to forest fires, has been used as a paradigm to the Ising Model in this paper, this variant is basically a percolation model with Two types of long-rang connections beyond nearest neighbors. A probabilistic interactions induced by firebrand emission (not considered in this work) and a deterministic one due to flame radiation. a weighting process induced by the combustibles' ignition energy and the flame residence time [01]. Unlike magnetic systems, this model exhibits a non universal phase transition. The critical exponents of the rate of spread depend both on the local interaction and on weighting. Near the transition, the exponent x of rate of spread is found to be equivalent to that of correlation time. The weighting process exhibits a new phase transition related to the heating process. This transition is analogous to the gelation transition in spin glasses. Furthermore, the critical exponents of the fire susceptibility caused by the wind effect exhibit a crossover from a standard isotropic percolation (IP) to a directed one (DP) [02-13].

REFERENCES:

[01] Zekri N, Khelloufi K, Zekri L, Porterie B, Kaiss A and Clerc JP (2012) *Role of weighting in the dynamics of front propagation*. *Physics Letters A376* P2522. http://dx.doi.org/10.1016/j.physleta.2012.06.013

[02] J.Marro and R. Dickman, "*Nonequilibrium Phase Transitions in Lattice Models*", Cambridge University Press*, Cambridge* (1999). https://doi.org/10.1017/CBO9780511524288

[03] P. Grassberger, "Directed percolation: results and open problems", WUB (1996) 96-2

[04] H. Hinrichsen, *Adv. Phys. 49* (2000) p. 815. https://doi.org/10.1080/00018730050198152

[05] G.Odor. "*Universality in Nonequilibrium Lattice Systems theoritical foundation*", *World Scientific* (2008)

[06] M. Henkel, H. Hinrichsen, S. Lübeck, "*Theoretical and Mathematical Physics: Nonequilibrium phase transition volume 1(absorbing phase transition)*", *Springer* (2008) https://doi.org/10.1140/epjb/e2008-00022-4

Regional forest fires database: a tool to support forest fire management and emergency response

Alberto Tinaburri
Ministero dell'Interno, Corpo Nazionale dei Vigili del Fuoco, Roma, Italia
alberto.tinaburri@vigilfuoco.it.

Abstract

Unlike in the North American countries, in Italy there is a prescribed date for the start of the forest fire season, usually fixed on the 15th of June of each year, and for the closure date, the 15th or 30 th of September. Starting from 2000, national and regional forest fire fighting resources are shared including personnel, vehicles, helicopters and airplanes. The national resources are mainly represented by airplanes (air-tanker CL-415) and helicopters (S64-F), distributed in a number of sites throughout Italy and deployed by the Unified Air Operation Center (COAU), an interagency control room. Each Region has the duty to develop its forest fire response plan and establish a Permanent Unified Operating Center (SOUP), coordinating the intervention of the regional aerial resources (helicopters AB 412) supported by the local ground forces (park rangers, civil protection volunteers, fire stations). In order to increase the response capacity during the forest fire season, each Region can establish an agreement with the Regional Firefighter's Department to deploy an additional contingent of firefighters and vehicles, distributed in a number of sites throughout its territory. If multiple forest fires occur simultaneously or cross multiple regional jurisdictions, SOUP can also request the support of its confining regions or from COAU. Given this regulatory framework, involving several authorities on national, regional and local basis, it is difficult to get a comprehensive view covering both aerial and ground forces deployed on forest fires, integrated by a systematic reconstruction of the burned areas. This study is focused on the forest fire statistics and the burned area mapping in the region Lazio, Italy. The statistics are based on a three-year period (2019-2021). Specific data on ground and aerial firefighting forces and the mapping of the burned area for each individual forest fire event exceeding 5 acres have been reconstructed, merging data derived from national, regional and local sources. Currently the database comprises nearly 2 thousand forest fire records, geospatially referenced.The database allows to assess the use of aerial forces (regional helicopters and national air-tankers) or the proportion of the ground forces to aerial forces deployed in forest fire fighting, and provides a sound basis for further analysis, being a single event reconstruction, or monitoring the seasonal trend and the firefighting response efficiency achieved. The statistics support that most of forest fires nowadays is due to human activity and the damage caused is favoured by the climate change in the Mediterranean region.

How science can contribute in the understanding of wildfire behaviour

Dominique Morvan
Aix-Marseille Université (France)
dominique.morvan@univ-amu.fr

Abstract

After a short introduction of the consequences of wildfires upon ecosystems and human activities, the presentation is focused on physical phenomena and parameters governing wildfires behaviour. At local scale, on a flat terrain fire behaviour is mainly affected by the competition between two forces: the inertia of the wind along the horizontal direction and the buoyancy along the vertical direction, resulting from the difference of temperature between the thermal plume and the ambient air. The ratio between these two forces impacts the aerology at the vicinity of the fire front and also heat transfers (by convection and radiation) between the flame and the vegetation located ahead of the fire front. Two regimes of fire spread have been identified: plume dominated and wind driven, each one characterizes by its own specific properties. The second part of the presentation focus on detailed physicial wildfires models, based on the resolution of balance equations (mass, momentum, energy ...) of the coupled system formed by the vegetation layer and the surrounding atmosphere. Some numerical results obtained in 2D and 3D are presented, in order to illustrate the capabilities of this approach.

Coupled fire-atmosphere modelling

Theodore M. Giannaros
Institute for Environmental Research and Sustainable, Greece
thgian@noa.gr

Abstract

Coupled fire-atmosphere models are models that interactively couple the atmosphere with fire behavior, allowing for resolving two-way interactions between the fire and the atmosphere (what is most often know as that "the fire creates its own weather"). These models have been increasingly used over the past decade to advance our understanding of rapidly changing fire behavior and complex fire-atmosphere interactions. Despite their increasing use and promising results, we have not yet exploited their full potential. This presentation provides an overview of the current capabilities of coupled fire-atmosphere models, including their limitations, and discusses future prospects towards the next generation of couple fire-atmosphere models.

Water based shields deployment on terrain during wildfire spread: A modelling approach using distributed information through autonomous agents

Fabio Alaimo Ponziani
Ministero dell'Interno, Corpo Nazionale dei Vigili del Fuoco, Roma, Italia
fabioalaimo.ponziani@vigilfuoco.it

Abstract

Wildfire spread is of concern whenever the physical dimension of the involved area makes a scale jump due to several conditions, such as the interplay of nature and shape of the combustible terrain involved, the atmospheric conditions and the turbulence generated, the road paths that can be followed by rescuers in tackling the fire and by people fleeing away. In order to help manage such a critical situation, to assist action planning in rescue operations and territorial recognition, a modelling approach based on autonomous agents can be an added value if the essentials elements of the problem can be captured and then solutions can be presented. This study deals with modelling some actions of active protection during wildfire spread using distributed information through autonomous agents by means of the NetLogo platform. This is a tool where the elements of the problem at hand are translated into different entities – the agents – that may interact in different ways, thus modelling physical or logical or cognitive behaviours to make some examples. There are three types of NetLogo agents: patches, turtles and links; they live on the virtual world where some of the attributes of the agents can be planned in advance and the actions expressing the interactions among them may then emerge by the context, by reaction or adaptation. A terrain is modelled considering some typical attributes expressing the nature of the combustible material present and its humidity, the free spaces between combustible areas, the variation in altitude, slopes and solar exposition. The atmospheric conditions are modelled considering wind speed and direction. The fire spread is modelled by an advancement of a representative flame front depending on terrain and wind. The active protection is modelled by deploying water-based shields through different patterns to see their impact and ability to tackle the fire advancement. The issues addressed in this work may be summarised as a first part dealing with an introduction to Complex Systems and the settings of some NetLogo models for virtual landscape and agents interactions, and a second part dealing with the behaviours and trends coming from the NetLogo models. Since our research is still ongoing with the NetLogo platform, further models and improvements are on the way. For instance, models for flame front merging and ember/burning debris jump at a distance, improvements in the use of probabilistic data and geographic mapping.

Wildfire simulation with cellular automata

Andrea Trucchia
CIMA RESEARCH Foundation, Italy
atrucchia@bcamath.org

Abstract

The development of exhaustive wildfire management strategies is a priority, especially in fire prone areas such as the Mediterranean basin. The lack of prevention and preparedness capacities and the problem of rapidly sharing useful information to cope with the direct impacts on exposed people and infrastructure are important issues among first responders and Civil Protection Authorities (CPAs). Extreme weather conditions are well known triggers of the main wildfire emergencies in southern EU countries, where the fire propagation can be extremely fast, making the authorities struggle in coping with wildfire events. For these reasons, the adoption of fast operational tools in emergency response, based on reliable wildfire spread maps (which in turn are used to generate risk maps), is an urgent requirement for first responders and CPAs. Wildfire models can be useful in predicting the wildfire spread in space and time, helping the definition of firefighting strategies. PROPAGATOR is a cellular automata model which simulates wildfire spread through empirical laws that result in probabilistic outputs. The model requires as inputs the wind field, fine fuel moisture content, the digital elevation model and the fuel cover. The underlying grid is made up of 20 meters-square cells. The model has been an object of continuous improvement, now being able to simulate a selection of firefighting activities and the fire spotting phenomenon via different formulations. A new module allows us to compute and store the fireline intensity of the simulated front. This improvement allows the user to quantify the severity of the fire evolution, for fast impact assessments. Recent experiments with finer grids are a promising outcome that may show the scale-invariance of the probabilistic rulesets used by the computational core of the simulator.