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Wildfire propagation modelling

Gianni Pagnini (1,2), Vera Egorova (1), Andrea Trucchia (1,3), Andrea Mentrelli (4), and Inderpreet Kaur (5)

(1) BCAM - Basque Center for Applied Mathematics, Bilbao, Spain (gpagnini@bcamath.org), (2) Ikerbasque–Basque Foundation for Science, Bilbao, Spain, (3) University of the Basque Country UPV/EHU, Leioa, Spain, (4) University of Bologna, Bologna, Italy, (5) Max-Planck-Institut für Chemie, Mainz, Germany

Wildfires are a concrete problem with a strong impact on human life, property and the environment, because they cause disruption and are an important source of pollutants. Climate change and the legacy of poor management are responsible for wildfires increasing in occurrence and in extension of the burned area. Wildfires are a challenging task for research, mainly because of their multi-scale and multi-disciplinary nature. Wildfire propagation is studied in the literature by two alternative approaches: the reaction-diffusion equation and the front tracking level-set method. The solution of the reaction-diffusion equation is a smooth function with an infinite domain, while the level-set method generates a sharp function that is not zero inside a compact domain. However, these two approaches can indeed be considered complementary and reconciled. With this purpose we derive a method based on the idea to split the motion of the front into a drifting part and a fluctuating part. This splitting allows specific numerical and physical choices that can improve the models. In particular, the drifting part can be provided by chosen existing method (e.g. one based on the level-set method) and this permits the choice for the best drifting part. The fluctuating part is the result of a comprehensive statistical description of the physics of the system and includes the random effects, e.g., turbulent hot-air transport and fire-spotting. As a consequence, the fluctuating part can have a non-zero mean (for example, due to ember jump lengths), which means that the drifting part does not correspond to the average motion. This last fact distinguishes between the present splitting and the well-known Reynolds decomposition adopted in turbulence studies. Actually, the effective front emerges to be the weighted superposition of drifting fronts according to the probability density function of the fire-line displacement by random effects. The resulting effective process emerges to be governed by an evolution equation of the reaction-diffusion type. In this reconciled approach, the rate of spread of the fire keeps the same key and characterising role that is typical in the level-set approach. Moreover, the model emerges to be suitable for simulating effects due to turbulent convection, such as fire flank and backing fire, the faster fire spread being because of the actions by hot-air pre-heating and by ember landing, and also due to the fire overcoming a fire-break zone, which is a case not resolved by models based on the level-set method. A physical parametrization of fire-spotting is also proposed and numerical simulations are shown.

References

Kaur I., Pagnini G., Fire-spotting modelling and parametrisation for wild-land fires, in Proceedings of the 8th International Congress on Environmental Modelling and Software (iEMSs2016), Toulouse, France, July 10–14, 2016. pp. 384-391.

Kaur I., Mentrelli A., Bosseur F., Filippi J.-B., Pagnini G., Turbulence and fire-spotting effects into wild-land fire simulators. Commun. Nonlinear Sci. Numer. Simul. 39, 300-320 (2016)

Pagnini G., Mentrelli A., Modelling wildland fire propagation by tracking random fronts. Nat. Hazards Earth Syst. Sci. 14, 2249-2263 (2014)