ISING MODEL AND FIRE FOREST: Fire susceptibility

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Abstract: The critical behavior of fire susceptibility is examined using a network model applied to forest fire spread. This model is characterized by long-range interactions due to flame radiation and a weighting process induced by the combustibles ignition energy and the flame residence time. The susceptibility is investigated using the analogy with magnetic systems. Its critical exponents in the case of universal critical behavior (R=1) are deduced.

Introduction

The term fire susceptibility was extensively used in fire risk analysis. Wildland fire susceptibility was defined as integrating the probability of an acre burning igniting and the expected final fire size based on the rate of spread [1]. Following Carrega, fire susceptibility includes characters that will control the spread of fire (for given weather conditions) [2]. It depends on the flammability of biomass and terrain slope. In other words, the fire susceptibility can be considered as the quantity which connects the perturbation causing ignition (as the wind speed or the lack of moisture content) to the result of this ignition measured by the rate of spread (or the burned area).

In a recent paper by Khelloufi et al. [3], the effect of wind speed on the rate of spread of fire has been examined using a forest fire model [4]. The critical exponents of the rate of spread were studied analogously with those of Ising model in magnetic systems. The rate of spread and wind speed behave similarly to the magnetization and magnetic field. At phase transition of spread/non-spread, the critical behavior of the rate of spread depended on the weighting process of the fuel ignition (ratio of ignition and combustion times) and long-range radiation heat transfer. Therefore, unlike magnetic systems, the critical behavior of the rate of spread of fire is not universal if combustion time of a flame is not sufficient to ignite fuels in its influence zone. The Weighting process and long-range interaction were found to destroy the universality of fire spread critical behavior.

In this paper, the same analogy is used to study the critical behavior of fire susceptibility.

References

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